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ORBE NOVUS

Astronomia e Studi Gerbertiani

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In copertina:
Imago Gerberti dal medagliere capitolino e scritta ORBE NOVVS nell'epitaffio tombale di Silvestro II a S. Giovanni in Laterano (entrambe le foto sono di Daniela Velestino).

Collana diretta da Rosalma Salina Borello e Luca Nicotra

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Introduzione
Costantino Sigismondi

L'edizione del convegno gerbertiano del 2009, in pieno anno internazionale dell'astronomia, si è tenuta nella Basilica di S. Maria degli Angeli e dei Martiri il 12 maggio, e a Seoul presso l'università Sejong l'11 giugno 2009.
La scelta della Basilica è dovuta alla presenza della grande meridiana voluta dal papa Clemente XI Albani nel 1700, che ancora funziona e consente di fare misure di valore astrometrico.
Il titolo di questi atti, ORBE NOVUS, è preso, come i precedenti, dall'epitaffio tombale di Silvestro II in Laterano, e vuole suggerire il legame con il "De Revolutionibus Orbium Coelestium" di Copernico, sebbene il contesto in cui queste parole sono tratte vuole inquadrare Gerberto nel suo ministero petrino come *il nuovo pastore per tutto il mondo:* UT FIERET PASTOR TOTO ORBE NOVVS.
Elizabeth Cavicchi del Massachussets Institute of Technology, ha riflettuto sulle esperienze di ottica geometrica fatte da Gerberto con i tubi, nel contesto contemporaneo dello sviluppo dell'ottica nel mondo arabo con cui Gerberto era stato in contatto.
Solo qualche anno dopo la morte di Gerberto, nel 1009, troviamo negli scritti di Alhazen delle frasi sulla necessità di acquisire una certa abilità sperimentale con gli strumenti che lasciano ben intendere sull'attenzione al dato osservativo dell'astronomia di quel tempo.
Paolo Rossi, direttore del dipartimento di Fisica dell'Università di Pisa, affronta il problema delle traduzioni delle opere di Gerberto e ce ne offre un saggio in occasione della pubblicazione per i tipi di PLUS della corrispondenza di Gerberto tra il 983 ed il 997, ed in questa collana dell'Epistolario di Gerberto, al quale lui stesso ha contribuito con la traduzione dei privilegi papali già pubblicati in Inglese da Harriet Pratt Lattin nel 1961. Sono possibili diverse traduzioni, con mutamenti di senso anche piuttosto robusti, tuttavia lo sforzo di portare in Italiano tutto il corpus gerbertiano ha già superato la boa di metà viaggio dal 2003 ad oggi. Resta da tradurre la Geometria, nella Patrologia Latina 139, il cui primo libro esiste già in Francese.
A Flavio Nuvolone, docente di patristica dell'Università di Friburgo, e profondo conoscitore degli studi gerbertiani, è stata chiesta una panoramica sulle ultime pubblicazioni su Gerberto.
Marco Zuccato, ricercatore all'Università Paris-VII Denis Diderot, ci ha dato un contributo sullo stato dell'arte sulla dibattuta questione di Gerberto e l'Astrolabio.

Gerberto come *cornerstone*, pietra angolare, della storia dell'astronomia Europea è così individuato dal professor Nha Il Seong della Yonsei University di Seoul, presidente della commissione di Storia dell'Astronomia dell'Unione Astronomica Internazionale.

Il suo contributo sui due osservatori pre-galileiani è stato presentato alla giornata dedicata a Galileo e Gerberto presso l'università Seijong di Seoul, l'11 giugno 2009, organizzata dall'Ambasciata Italiana e dall'Istituto ARCSEC Astrophysical Research Center for the Structure and Evolution of the Cosmos. L'altro contributo, scritto con Sarah Lois Nha, completa il panorama dell'astronomia prima del telescopio in estremo oriente con le informazioni più accurate del Nha Il-Seong Museum of Astronomy fondato dallo stesso prof. Nha a Yecheon (Korea) nel 1999.

Nella stessa giornata, oltre alla relazione su Galileo ed il suo *annus mirabilis*, il 1609, per cui è stato indetto nel 2009 l'anno dell'astronomia, ho fatto conoscere Gerberto ai Coreani mettendo in relazione Silvestro II, papa e scienziato allo stesso tempo, con la figura del re Sejong (1397-1450) che ha promosso le scienze anche con invenzioni personali, dando alla Corea l'identità nazionale e l'alfabeto *hangul*.

Altri contributi hanno impreziosito il convegno di S. Maria degli Angeli: il prof. Jorge Nuno Silva dell'Università di Lisbona ha trattato dei giochi matematici al tempo di Gerberto, importanti per capire il contento culturale entro cui Gerberto agiva, e che sfruttava anche nella didattica, oltre che per criptare messaggi come nel caso del Carme Figurato, ampiamente discusso nel volume Doctissima Virgo; la professoressa Laura C. Paladino ha parlato del rapporto tra Gerberto e la scrittura, mentre la dottoressa Daniela Velestino, direttrice della sezione Epigrafia dei Musei Capitolini, ha trattato dell'*imago Gerberti* analizzando le tradizioni iconografiche del papa scienziato presentando anche un'immagine inedita dal medagliere capitolino.

A tutti va la mia profonda gratitudine per il loro impegno culturale preso nei confronti di una figura straordinaria, e pure ancora poco conosciuta e valorizzata, come quella di Gerberto d'Aurillac.

Reflections on the Teaching of Gerbert of Aurillac

Elizabeth Cavicchi

Abstract: For one born to French peasants, Gerbert took advantage of exceptional educational opportunities: monastic training at Aurillac; mathematical studies in Spain; tutoring the Pope and Emperor in Rome. Serving Reims cathedral school for twenty-five years, Gerbert transformed its curriculum and practices; his students disseminated these innovations across Europe. Gerbert's teaching was research: seeking out unsanctioned, classical texts; analyzing mathematical arguments; observing the sky. His students did what they learned: speaking; observing; making music. He invented instructional instruments: diagrams; an abacus; astronomical spheres. He nurtured relationships of trust among teachers and students. Gerbert's creativity is a provocative impetus for us to face pedagogic inadequacies and develop responsive teaching that stands the test of time.

Introduction

Over a millennium ago, Gerbert of Aurillac's teaching so affected himself, his students, and history, that its legacy pervades the practice and pursuit of learning that we continue today. Gerbert's teaching is documented by his letters to his teachers and students; in one colleague's appreciative account of Gerbert's efforts, and through other evidences and historical inferences. Qualities of teaching – and the instructional mechanisms and activities that emerge in the Gerbert stories – can inspire us as teachers and learners in renewing our teaching for the future. This paper describes timeless examples and practices from his teaching in relation to the themes: teaching as research; innovations with instruments and action; and the painstaking art of fostering teaching relationships with students.

Groundings for Gerbert's Teaching

That Gerbert came to be a teacher at all was already an uncommon feat in the stratified society of the medieval French countryside. Being born into a peasant family would ordinarily have precluded any access to formal education. But sometime in the mid-950s the young child Gerbert was given to be trained as a monk at the Benedictine

monastery at Aurillac,[1] where only his "obscure" origin was noted.[2] The monastery was
founded in 894 by Gerald, a local noblemen so renowned for charity and justice that he was elevated as a saint.[3] Its third abbot, Saint Odo, arriving around 925 from Cluny, brought with him that monastery's movement of reform in monastic life and liturgy.[4] In the context of this reform, and under the direction of the noble-born monk Raymond of Lavaur, Gerbert studied the medieval curriculum of the "trivium", consisting of grammar, dialectic (logic) and rhetoric.[5] Gerbert's training under Raymond differed from most monastic instruction at the time, which excluded study of the Latin classics on the grounds of their pagan sources. Raymond taught and admired the writings of the Romans, deeply imparting their heritage to the young Gerbert.[6]

Showing an extraordinary capacity for learning, Gerbert's fluency with the basic curriculum became evident to Aurillac's abbot. The arrival in 967 of Borrell, the imminent Count of Barcelona from Spain, allowed Abbot Geraud to secure for Gerbert a further education beyond the limits of contemporary monastic schools. Like the recipient of an advanced international fellowship today, Gerbert's travel to Catalonia, Spain immersed him in a stimulating and strikingly open environment for learning. In this region of Spain, the "Spanish March" (occupied by Charlemagne), coexisting contact among Christian and Islamic communities gave rise to an unusual "tolerance and unorthodoxy" in intellectual life that was unmatched in Europe at the time.[7] There Gerbert had access to extensive repositories of manuscripts not available elsewhere, including the works, instruments, and learning that Islamic scholars preserved, developed and recorded.[8] Studying at the monastery of Santa Maria de Ripoll,[9] he studied the quadrivium consisting of arithmetic, geometry, music and astronomy, which would later become the standard curriculum that medieval universities provided to students upon completion of the trivium. During his three year stay in Spain, Gerbert mastered "mathematics extensively and successfully"[10] to the

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[1]BAIRD (1994), p. 5.
[2]DARLINGTON (1936), p. 509.
[3]ODO OF CLUNY (1995), p. 329.
[4]FLUSCHE (1994), p. 9-10; NOBLE & HEAD (1995) p. 294; VAN RONK (2003), p. 19.
[5]FLUSCHE (1994), p. 10.
[6]DARLINGTON (1949), p.459.
[7]FLUSCHE (1994), p. 11.
[8]BURNETT (1998), p. 330-331; ZUCCATO (2005), p. 169.
[9]LATTIN (1932), p. 62.
[10]DARLINGTON (1949), p.460; RICHER (1930), II, p.43.

point where his depth and facility in mathematical understanding surpassed anything attained by scholars in the Christian West.

Yet again, Gerbert's achievements as a student brought about new opportunity for travel and unprecedented educational experiences. Hatto and Borrell took Gerbert with them to Rome to assist in their efforts to establish Vic as an archdiocese.[11] After this mission's completion, Gerbert remained in Rome where his learning and intellect impressed the pope, John XIII (whose office Gerbert would later hold as Sylvester II). Emperor Otto I retained Gerbert as the tutor for his teenage son Otto II, thus initiating a long-term relationship of education between Gerbert and three generations of German emperors Ottos I, II, III.[12] The German emperors' patronage would provide the power base for Gerbert's subsequent elevations from his status as a monk of peasant origins to prominent ecclesiastical posts (culminating with his appointment to the papacy by Otto III in 999). In these posts, the former peasant Gerbert wielded power, interacting as an equal with people of higher status, a trait that may be traced to his upbringing in the non-feudal society of Aquitaine, France. However, actions he took as an ecclesiastical administrator were effective only while his patron held force over his adversaries.[13]

As Gerbert commenced teaching in tutoring Otto II, his own learning branched out from the available texts and curricula to matters of practical governance. Perhaps in this context of crafted arguments, he became sufficiently aware of deficiency in his understanding of logic and sought to remediate that lack through further study. The scholar Gerannus, archdeacon of Reims, approached Gerbert to learn mathematics from him, in exchange for teaching Gerbert logic. Taking up this next opportunity, Gerbert relocated to Reims in 972, leaving Rome and his role in Otto I's court.

At Reims, Gerbert held positions of leadership in education and administration for a quarter century. Soon after his arrival at Reims, Gerannus died. Gerbert replaced him as schoolmaster for the next ten years and then served five more years in that role from 984-989. Subsequently he was elected archbishop of Reims, which he held from 991-997.[14] Gerbert's longevity as an educator at Reims, along with his transformative practices, came to influence instruction and learning both there and in Europe. At the same time, his lack of noble status and his teaching of pagan authors figured in the condemnations

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[11] FLUSCHE (1994), p. 13.
[12] BAIRD (1994), p. 8-9; DARLINGTON (1936), p.509-510, 516-518.
[13] VAN RONK (2003), p. 13-26, 33; FLUSCHE (1994), p. 45; 49-50.
[14] LAKE (2008), p. 20.

by which rival ecclesiastical factions sought to depose him from that post.[15]

Teaching as research

Modern teaching is often dismissively portrayed as not producing or advancing knowledge. While this attitude colored one scholar's interpretation that regarded Gerbert's scholarship as centered on "teaching, not research"[16], another scholar espied the thorough integration of research within Gerbert's teaching.[17] In viewing Gerbert in the context of modern theories of teaching, my evidence is that what Gerbert did avoids the artificial dichotomy that has emerged in the current day between teaching and research. Despite his roots in monastic tradition, the accounts of his later teaching depict a surprisingly modern and open attitude toward learning, that one might consider exemplary for a present-day teacher. Throughout Gerbert's learning and teaching, he actively researched many avenues at once: the curricular materials, the students, and his own understanding. Curiosity kept his mind in motion, opening possibilities for learning that broke new ground in the instructional offerings at medieval monasteries. By involving students in an ongoing process of seeking, he engaged students in ways they could pursue later on their own, as their curiosity and skills matured.

The research underlying his teaching is apparent in Gerbert's pursuit of new knowledge through his travel to Spain, and residences in Rome, Reims and beyond. By visiting libraries having extensive manuscript collections, he read and learned from works that were outside the limited holdings of most monastic libraries. Gerbert's seeking out of books in manuscript and of Latin translations became a lifelong passion. His correspondence discloses many efforts to request copies of manuscripts, as he amassed a personal library of his own.[18]

Gerbert did not just acquire books and let knowledge stay frozen in foreign texts. Into his tutoring of the future emperor, Otto II and afterward of young monks at the Reims cathedral, Gerbert integrated what he learned from classical, pagan and Arabic authors. Having worked to understand the works himself, he shared that experience by involving students in reading from these newly accessed materials

[15] VAN RONK (2003), p. 6, 29, 34-38; RICHÉ (1985), P. 54-55.
[16] DARLINGTON (1949), p. 468.
[17] GASC (1986), p. 111, 117.
[18] BAIRD (1994), p. 20-21; RICHÉ (1985), P. 52, 56.

throughout the course of their studies, beginning with their elementary lessons.

Gerbert infused the standard curriculum of the trivium with fresh life. Medieval knowledge in these areas was linked to the commentaries and translations into Latin of Greek works by Aristotle and others made by the sixth century Christian Boethius. However, the use of Boethius' Latin translations as instructional texts had fallen off; Gerbert contributed to their reintroduction in instruction. To these conventional texts, Gerbert added readings from classical Latin poets, such as Virgil, satirists such as Horace, and other authors of antiquity.[19] Gerbert selected passages from these classical texts that exemplify the range of metaphoric and non-literal usages of language, thus engaging his students with the depth and power of literary arts.[20] Through reading primary texts, going over passages line-by-line and word-by-word together, Gerbert and his students were doing research together. They came into contact with expressions of grammar and rhetoric and understandings of life that challenged and stretched their perspectives. In learning some classical passages by heart, the students had the potential to more deeply appreciate the eloquence of words and meanings combined.[21]

Prior to Gerbert, the treatment of the quadrivium in medieval instruction was rudimentary, based on inadequate and derivative texts.[22] Instead, Gerbert drew on the original works in these areas and the understandings of mathematics, music and astronomy that he encountered and studied during his stay in Spain. Drawing upon this knowledge, he composed mathematical texts which became standard, stimulating the writing and teaching of yet other mathematical topics.[23] These works and educational efforts initiated by Gerbert made a beginning for crossing the large gap that had arisen between the limited mathematical capacities of the medieval West, and the understanding of scholars in the Muslim world during that time.[24]

Gerbert grounded his instruction by conducting experiences where he and his students made observations and performed calculations with instruments including the abacus,[25] the organ,[26] the astrolabe and

[19] GASC (1986), p. 114; BAIRD (1994), p. 14-15.
[20] LAKE (2008), p. 157-161.
[21] RICHÉ (1985), P. 56-59.
[22] BAIRD (1994), p. 16.
[23] PEKONEN (2000), p. 69.
[24] HEILBRON & BYNUM (2000), p. 13; ZUCCATO (2005), p. 169.
[25] RICHER (1930), v. 2, pt. 1, para. 54, p. 62-64; IFRAH (1985), p. 476-477; PEKONEN (2000), p. 68-69.
[26] FLUSCHE (1994).

original astronomical sighting devices that he devised.[27] Departing from the repetitious exercises typical in monastic schools, Gerbert's use of these tools in instruction plunged him and his students into activities that were new for them. These activities stimulated inquisitiveness; teacher and students were doing research together. Addressing his student as "diligent researcher"[28], Gerbert's correspondence with student Constantine of Fleury provides a window into their mutual inquiry in the context of constructing an astrolabe or interpreting mathematical relationships. [29] The spirit of intellectual growth that Gerbert admired and encouraged is expressed in the opening of a letter on mathematics:

> O Constantine, sweet solace of my labors, we are entrusting your sagacity, which has always flourished in the freest honesty of studies, with a prepublication of these axioms designed for the utmost exercise of the mind. By using them, the way for grasping these ideas immediately is opened to those persons of less comprehension…[30]

The abacus and Hindu-Arabic numbers that Gerbert adopted from his Arabic-inspired studies in Spain were a counterpoint to the awkwardness of Roman numerals then characterizing mathematics done in Europe. Astonishing Pope John XIII with his mathematical agility, Gerbert went on to pioneer instructional uses of these mathematical tools, integrating them into his computations, writing and teaching. Credited with revitalizing mathematics in the West, Gerbert's oral presentation of the abacus and nine Hindo Arabic numbers (without zero) introduced students to new means of computing and his written text influenced subsequent treatments of geometry. [31]

It took courage for Gerbert to draw on classical, pagan and Moslem works in his teaching, and to expand mathematical studies beyond basic routines. Such writings and analyses had no prior place in the sanctioned medieval curriculum; Gerbert had to *create* the environment in which these new studies could take hold. This commitment put him professionally at risk, under repeated accusations throughout his life and papacy that ascribed his agile analytic facility

[27]LATTIN (1961), p. 5; POULLE (1985).
[28]GERBERT, Letter 7, in LATTIN (1961), p. 44.
[29]GERBERT, Letters 2-7, in LATTIN (1961), p. 35-46; BURNETT (1998), p. 333.
[30]GERBERT, Letter 6, in LATTIN (1961), p. 43.
[31]RICHER (1930), v. 2, pt. 1, para. 54, p. 62-64; IFRAH (1985), p. 476-477; PEKONEN (2000), p. 68-69; FALCOLINI, (2009).

and sky observing to occult dealings, and critics who abhorred his inclusion of non-Christian authors in instruction.[32]

The seeds of curiosity and tolerance sowed in Gerbert's teaching gave rise to a profound legacy through the emergence of science and humanistic inquiry in the West. Inseparable from Gerbert's conduct of teaching as research was the courage to persist and innovate, amid immense opposing powers. The world of learning that now involves us had its start in teaching that respected the depth of classical works while fostering students' experiences in observing the sky and doing mathematics as a researcher.

Innovation with instruments and action

Gerbert's innovations in the medieval classroom went beyond reading aloud from newly adopted texts and expounding these with interpretations and ideas that went outside the usual instructional boundaries. Gerbert put his students into action by *doing* what they were learning about. Students calculated, observed the sky, presented oral speeches and sounded musical instruments. To involve students actively with these matters that did not come up in everyday life, Gerbert expended a great "quantity of sweat" in devising visual aids, instruments and tools.[33]

Gerbert's world was a sphere and he put that sphere into students' hands as a wood ball modeling the earth. Using the ball for more than its shape, Gerbert set it in relation to the constellations of stars surrounding earth. Against that combination of earth and stars, he installed an adjustable "horizon" ring or hoop. When positioned in correspondence with the observer's location on the earth sphere's surface, this ring functioned as a horizon boundary. It divided the stars that an observer on the rotating earth could see, from those that are obscured from view. Gerbert's ring – which could be set so as to designate the sky horizon for any point on earth – is the first use of such a device that is recorded in Latin, a finding made by the scholar Zuccato after examining all relevant prior texts.[34] By the ninth century, an adjustable horizon ring was a standard feature of Islamic celestial spheres, thus Zuccato concludes that Gerbert's use of it derives from exposure to Islamic science during his stay in Spain.[35]

Imaginatively placing himself on the ball's surface as an observer looking up, Gerbert realized that this construction indicated the shapes

[32]DARLINGTON (1949), p. 466; FLUSCHE (1994), p. 21, 23, 47, 77-81.
[33]RICHER (1930), v. 2, pt. 1, para. 50, p. 58-59; DARLINGTON (1949), p. 467.
[34]ZUCCATO (2005), p. 171-172; 178-185.
[35]SAVAGE-SMITH (1985), p. 15; ZUCCATO (2005), p. 186.

of paths that the stars would have in the viewer's sky. He checked these predictions based on the model by personally observing the setting and rising of actual stars to establish their "oblique paths" of rising and setting at all parts of the world.[36] The ball that started as a pedagogic tool enabled the teacher to take the reciprocal perspectives of being on and off the Earth's surface, giving rise to research questions that in turn extended the pedagogic value of this instrument.

Gerbert went on developing means of adapting spherical geometry in forming representations of earth and heavens that were not mere models, but instead functioned as interactive instruments where students had something to hold, look through, and adjust. He equipped one instructional earth sphere with a hollow tube that served as its polar axis and a semi-circle half-hoop, marked with equal (angular) divisions that revolved between the poles over its surface. Manipulating the half-hoop around the sphere "brought to light circles [such as the Arctic circle] which were new to the eyes and securely fixed them deep in the memory" of students.[37]

While Gerbert's initial instructional model was a wood ball, his subsequent designs did away with that solid core, to emphasize the spatial relationships linking an earthbound observer to the celestial surroundings. In Gerbert's most intricate device – which he claimed took a year to make[38]-- six tubes moved as one unit within a spherical cage of wires configured in the shapes of stellar constellations. These tubes simultaneously represented the polar axis and earth's circles of latitude and served as astronomical sighting aids. When the instrument was properly positioned under the night sky, the wire model constellations would superimpose over the real constellations.[39]

In a letter to Constantine of Fleury, after describing how to construct this "hemisphere", Gerbert concluded with advice for observing through its sighting tubes:

> Accordingly, when our polestar can be observed, place the hemisphere … under the open sky in such a way that, [looking] through the tubes …, you may perceive the polestar itself .. having placed the hemisphere .. so that it is immovable, you will be able to determine the North Pole through the upper and lower first tube, the Arctic Circle through the second, the summer through the third, the equinoctial through the fourth, the winter through the fifth, the Antarctic [Circle] through the sixth. As for the south polestar, because it is under the land, no

[36] RICHER (1930), v. 2, pt. 1, para. 51, p. 60-61; DARLINGTON (1949), p. 467.
[37] RICHER (1930), v. 2, pt. 1, para. 53, p. 62-63; DARLINGTON (1949), p. 468-469.
[38] DARLINGTON (1949), p. 471; GERBERT, Letter 156, in LATTIN (1961), p. 183.
[39] ZUCCATO (2005), p. 170-171.

> sky but earth appears to anyone trying to view it through both tubes.[40]

By looking through the tubes, past the model star, to sight the true star – or the earth standing in the way—a student was involving eyes, body and mind. In a retrospective account describing Gerbert's teaching, Gerbert's close associate Richer of Saint Rémy affirmed that an untrained student using this sphere could locate constellations "without the aid of a teacher".[41] The teacher's creativity lay in designing these spherical observing aids and in putting students into direct and provocative action with them. In the process, Gerbert's teaching provided students with intellectual space in which they could work through the relationships that he and others had identified in the materials under study.

In teaching rhetoric, a subject which then had more established instructional precedence than astronomy, Gerbert also devised original instrumental aids and practical activities. Of an intricate diagram of rhetoric, Gerbert wrote that he drafted it by hand "out of love for them [students]". Having both his more skilled, and his less able, students in mind, he regarded this diagram as a tool that opened doors for them all and called it:

> a work truly wonderful for the ignorant, and useful for the studious for comprehending the fleeting and very obscure materials of the rhetoricians and for fixing them in the mind.[42]

Like the astronomical sighting spheres, the diagram of rhetoric transformed abstruse theory into patterns and relationships that students could grasp and even try out in usages of their own.

Giving his students the opportunity to test their learning in the arena of speech, Gerbert's culminating assignment required students to prepare their own arguments and dispute a skilled opponent. Richer commended the outcome of students' trial disputes:

> …they conducted themselves according to this art in such a way that they seemed to act without any art at all, which is the greatest achievement for an orator.[43]

This "practice under fire" had crucial consequences both for Gerbert personally in his later role as Pope Sylvester II, and for those of his students who went on to governance and politics, such as the two

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[40] DARLINGTON (1949), p. 469-470; GERBERT, Letter 2, in LATTIN (1961), p. 36-37.

[41] RICHER (1930), v. 2, pt. 1, para 53, p. 62-63; DARLINGTON (1949), p. 469. Richer is often regarded as a former student of Gerbert, however Lake's interpretation of Richer's likely birthdate puts him too old to be an age peer with Gerbert's typical students; LAKE (2008), p. 163-164.

[42] GERBERT, Letter 105, in LATTIN (1961), p. 139.

[43] RICHER (1930), v. 2, pt. 1, para. 48, p. 56-57; DARLINGTON (1949), p. 465; LAKE (2008), p. 161.

Emperors under his tutelage. To a colleague, the Abbot at Tours, Gerbert disclosed the function of oratory in public life, something he sought to develop through teaching and practice:

> For speaking effectively to persuade and restraining the minds of angry persons from violence by smooth speech are both of the greatest usefulness.[44]

Gerbert sought to further students' understanding through their *interactions* with instruments, where they manipulated something, observed, and interpreted on their own. For him to be able to compose instruments that had this educational function, took a double research effort on his part: both into the subject matter, and into the ways of rendering it accessible to learners. Gerbert innovated in teaching through investigating the whole world, discerning relationships among all its apparent parts *and* creating means by which these relationships were what brought his students into active contact with the world. A letter to his student Constantine explicitly states this pedagogical concern that students engage with underlying relationships. In describing the mathematics he had written for students to exercise their minds in using Hindo-Arabic numbers, Gerbert emphasized his view that it is critical for students to "discuss numbers… [since] the nature of all number revolves only about … relationships."[45]

Engaging with those relationships is core if learners are to put learning into practice beyond the classroom and into their own life. Gerbert's students accomplished this mastery, distinguishing themselves as leaders whose actions impacted both the large events of history and the course of education and administration in the ecclesiastical schools that gave rise to the first universities. Two generations of emperors who ruled from German lands, Otto II and III, and the French Capetian King Robert II, were tutored and trained by Gerbert.

Students at Reims who went on to become bishops and abbots extended Gerbert's teaching in introducing its humanistic outlook at the many schools they directed in and near France. Others put their learning into action through lives of scholarship, mathematics, administration, and oratory. The students at these schools and the progeny of these educational policies contributed to the eleventh century reforms that are epitomized by Pope Gregory VII (the monk Hildebrand) who brought to a broader world the reform work begun by the Cluny monastery and Gerbert's teaching.[46] A tribute that

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[44] GERBERT, Letter 50, in LATTIN (1961), p. 90.
[45] GERBERT, Letter 6, in LATTIN (1961), p. 43.
[46] DARLINGTON (1949), p. 473-476; FLUSCHE (1994), p. 25-26.

Gerbert dedicated to his own teacher, Raymond, redounds to his own teaching, when interpreted across the wide and diverse reaches of his numerous students' work and lives:

> The pupil's victory is the master's glory.[47]

Teaching relationships

Gerbert's letters allow us to look into the depth of connection that teaching, learning and research brought about between him and others. A shared inquiry into the subject matter of math, astronomy or rhetoric underlay this connection in the epistles that come down to us. The student's inquiry inspires the teacher in response.

This reciprocity of teacher and student is eloquently expressed in Gerbert's correspondence with the student Constantine. After studies with Gerbert at Reims, Constantine had returned as a teacher to the Benedictine monastery at Fleury, France which had nurtured his youth. As a new teacher, Constantine sought to carry out the novel pedagogy developed by Gerbert, including student activities with instruments, the quadrivium, and readings from pagan classics.[48] Gerbert responded to Constantine's requests for advice in constructing instructional instruments,[49] interpreting mathematical passages[50] and contending with opposition to this innovative work that eventually arose among the leadership at Fleury.[51] In his response on constructing the abacus, Gerbert denoted himself as teacher and Constantine as "diligent researcher", continuing:

> Only the compulsion of friendship reduces the nearly impossible to the possible. Otherwise, how could we strive to explain the rules of the abacus unless urged by you, O Constantine, sweet solace of my labors?[52]

Their exchange in interconnection – not the one or the other separately - transforms the impossible into the possibilities of learning. The process is not linear and steplike, but responsive and interactive.

Gerbert's teaching relationships did not always reach such fullness as that with Constantine. Another former student, Remi of Trèves (Trier, Germany), also wanting to acquaint his students with the instruments that Gerbert devised for teaching, solicited from Gerbert not a

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[47] GERBERT, Letter 196, in LATTIN (1961), p. 229.

[48] WARREN (1909), p. 285-288.

[49] GERBERT, Letters 2, 7, in LATTIN (1961), p. 35-38; 44-47.

[50] GERBERT, Letters 3-6, in LATTIN (1961), p. 38-44.

[51] GERBERT, Letter 92, in LATTIN (1961), p. 126-127; WARREN (1909), p. 285-288; RICHÉ (1983), P. 67.

[52] GERBERT, Letter 7, in LATTIN (1961), p. 44.

description (like Constantine) but an actual astronomical sighting sphere. Gerbert initially promised to provide a sphere in exchange for a copy of a classical manuscript. Although Remi completed a copy, there was a misunderstanding about the nature of the original. When Remi attempted to resolve the discrepancy and repeated his request for the handmade sphere, Gerbert refused.[53] In the meantime, the death of Gerbert's mentor had embroiled him in chaotic politics. Rebuking the student for having

inconsiderately taken into account [only] .. what you seek

Gerbert urged the student to wait:

> …endure the delays imposed by necessity, awaiting more opportune times in which we can revive the studies, now already ceasing for us.[54]

Having lost his own teacher, the balance between this teacher and a student-seeker broke down under loads coming from outside. Exceeding what he could handle, these forces soon moved Gerbert out of the world he had been creating through teaching, and into perils and burdens of political power and his eventual papacy.

Teaching that stays with us, is teaching given of and through the heart, and is deeply transformative. Gerbert experienced that depth with Raymond and his other teachers at Aurillac, whom he addressed through the "great love we are bound to you", [55] attributing to them "whatever knowledge I possess"[56]. Asking for their guidance and prayers, he reflected on the reserve and perspective that contemplative study with them engendered for him and others. In a life that excursed beyond both their classrooms and his own, Gerbert struggled in renewing what they inspired, which he longingly called:

the certain leisure of studies rather than the uncertain business of wars.[57]

Conclusions

Teaching and learning intertwine inseparably in the transitory moments of experience in a way that is always uncertain. Gerbert shared his sense that all pursuits partake in a lifelong process of learning and teaching, when writing to another teacher:

> Both when I am at leisure and when I am occupied, I teach

[53] DARLINGTON (1949), p. 471-472.
[54] GERBERT, Letter 160, in LATTIN (1961), p. 187.
[55] GERBERT, Letter 51, in LATTIN (1961), p. 90.
[56] GERBERT, Letter 196, in LATTIN (1961), p. 229.
[57] GERBERT, Letter 51, in LATTIN (1961), p. 90.

what I know, and I learn what I do not know.[58]

Teaching and learning occur so dynamically that we seldom detect, record or describe the transformative action happening among ourselves, and thus tend to devalue it. Perhaps the long extent of past time – distancing us in time and culture from medieval lives – assists us in seeing there what we dismiss in pedagogical experiences that are closer to hand. The evidences and heritages of teaching and learning – to which we have access now – allow us to perceive in the medieval accounts a substantive and vibrant core of researches, actions and relationships by which Gerbert and his students interacted with their world and built understandings that took their minds and hands to new places.

We live and learn through the lasting benefit of their courageous efforts. But Gerbert's legacy portends more than an acknowledged debt; it directly challenges us to develop ourselves through creative, committed contemporary teaching and learning. The timeless lessons of his teaching remain relevant – and accessible to undertake through such actions as: infusing our teaching and learning with the curiosity of research; innovating participatory activities with instruments; refusing to artificially separate teaching and research; and developing human relationships that elicit our deep potential for learning.

Acknowledgements

Costantino Sigismondi introduced me to the life and teaching of Gerbert and encouraged my reflections for this volume. My experience of the teaching of Eleanor Duckworth kindled my perception of qualities of research, inventiveness and relationships in the historical records of Gerbert's teaching. Alva Couch sustains and inspires my hopes for teaching and learning.

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Activity inspired by Medieval Observers and Tubes
Elizabeth Cavicchi

Abstract: As a scientific apparatus, a hollow tube can be used to demonstrate and model many properties of the physical world. In medieval times, tubes were an instrument of science and teaching in optics, astronomy and acoustics. By sighting through a tube held both near and away from the eye, eleventh century experimenter Ibn al-Haytham argued that light travels only in straight lines. In tenth century Europe, Gerbert of Aurillac's students set up a tube to view the North Star all night. Viewing the sky by additional tubes showed them about the seasons. They also made sounds with an early tube-based organ. Twelfth century illustrators show a medieval person looking through a tube to tell time at night. These stories invite you to explore with tubes. Play and imagine; experiment and create. What do you notice, see, hear and wonder about?

Introduction

People have always been curious about what and how we see and hear. In medieval times, observers invented many ways of using a hollow tube to help them notice science relationships with light, astronomy, sound and music. A tube can be a guide, a resonator, a sighting aid, or a musical instrument. A tube with nothing inside can assist someone to see or understand something that might otherwise be missed. Early accounts of activities with tubes illustrate how the simplicity of a tube led to a more complete perception and understanding of the physical world.

This article invites you – students and teachers – to try out looking and exploring with tubes. What do you see? What do you hear? Take on the perspective of people who might have looked through and listened to tubes. Stretch your imagination. What else can you do with tubes?

A Tube for Sighting in Medieval Studies of Islamic Scientists

Tubes were not always what someone used to view far-off sky, mountains or buildings. Greeks and Romans of the classical period who were surveying a piece of land or watching the night sky might employ a sighting rod or dioptra. Sticking out at right angles from each end of this rod was a flat extension, with a hole punched through it. To observe with it involved aligning those two holes with whatever someone wanted to see, and then peeping through both holes. The rod might be mounted on a support or pivot having angle markings to use in measuring its position (Figure 1 A top).[1] This sort of viewing through paired holes in "vanes" mounted on a bar or "alidade" was a component of the astrolabe (Figure 1A), and of other instruments used by astronomers even after the telescope's invention early in the seventeenth century.[2]

Tubes become more evident in the manuscript records that come down to us from medieval times. For astronomical observing sometimes a tube replaced the dioptra, for example on some instruments at the renowned mid-thirteenth century Maragheh observatory in Iran as well as among surviving or recorded Chinese instruments dating from the Mongol and Ming dynasties.[3] Mention of optical demonstrations involving tubes occurs much earlier, among the productive era of science produced in the Islamic world during the ninth through eleventh centuries.[4]

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[1] LEWIS (2001), p. 51-108. Aristotle described looking through a tube to see far; he also wrote that someone sitting in the bottom of a deep well can see stars in the daytime, EISLER (1949), p. 313.
[2] EVANS (1998), pp. 141-161.
[3] JOHNSON (1940), p. 38; EISLER (1949), p. 313; NEEDHAM (1974), p. 75; DEANE (1994), p. 132.
[4] KHEIRANDISH (2009).

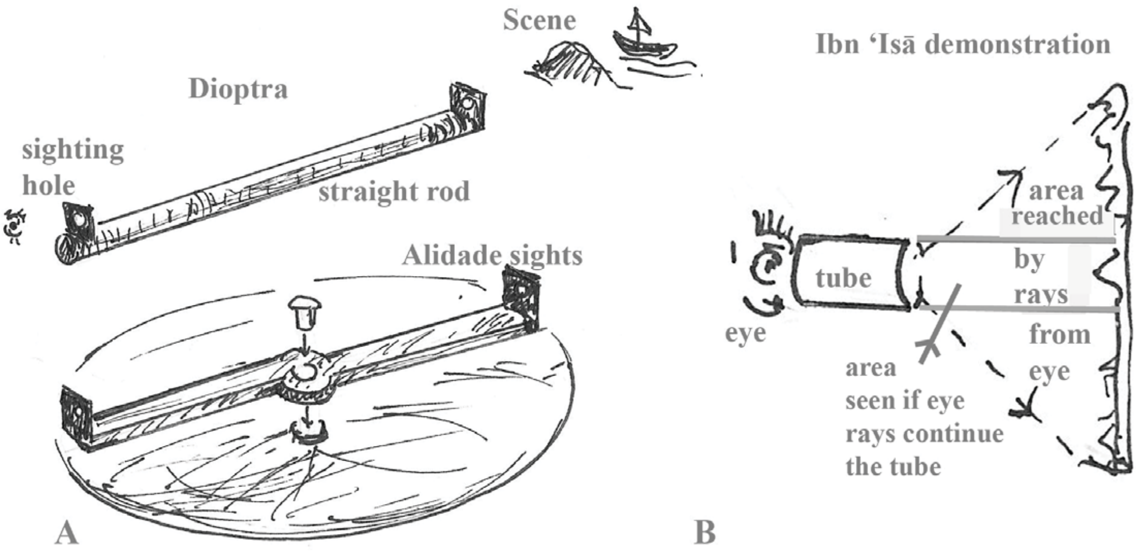

Figure 1 A: Top: a dioptra with two upright sighting holes on a rod; Bottom: the sighting vanes on the alidade of an astrolabe. **B:** Diagram of the area that will be seen if the rays of an eye fan out after passing through a short tube, in Ibn 'Īsā's demonstration.

The ninth century work of Ibn 'Īsā on optics is a pioneering example from science history where part of the writing takes the form of presenting an observation to be tried with an instrument -- the tube. A short copper tube would be placed over one eye. Looking through it at something, he expected the view of that object would be wider than what would correspond to continuing the tube's diameter directly onto the object (Figure 1 B). Ibn 'Īsā came to have this expectation on the basis of the prevailing interpretation that vision occurs by means of rays that the eye sends into the air on paths that widen out like a cone to reach the things we see.[5] While the tube's opaque wall would block these supposed eye's rays, once those rays passed beyond its barrier they would then be free to spread outward. The eye would see whatever the eye's expanding rays fell upon.

[5]For the translated text of Ibn 'Īsā's tube demonstration, see KHEIRANDISH (2009), pp. 79-83; 96-97.

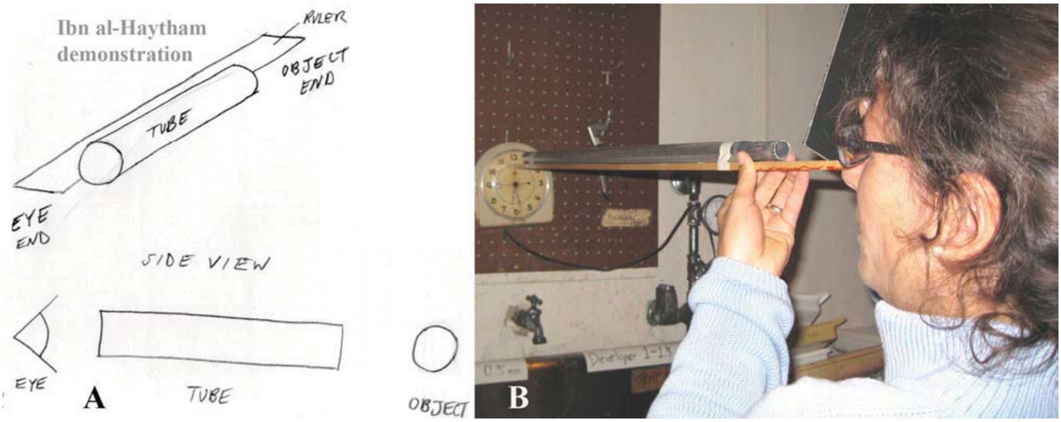

Figure 2 A: Diagram of a tube positioned on a ruler between the eye and object; drawing by Cecily Lopes. **B:** Photo of the tube and ruler as used to view a clock.

A hollow tube figured in the ground-breaking experimental demonstrations that Ibn al-Haytham developed in the eleventh century in support of the opposing premise: that rays travel from an object to the eye. As part of the analysis that he constructed in the course of arguing for this alternative understanding of vision, Ibn al-Haytham showed that vision perceives only by means of straight lines between object and eye. He described the tube carefully: it should be a very straight cylinder whose circular ends were of the size to fit over a person's eye. In one demonstration, he rested the tube on a longer ruler whose far end touched the object (Figure 2 A). First, with the tube's end right at the eye (like Ibn 'Īsā) he looked through; then with the tube put toward the object, he still saw the same portion of the object through the tube (Figure 2 B). In each case, when he put a barrier put over half the tube's far end, it blocked him from seeing half the object. Ibn al-Haytham argued that if light did not take straight lines, it could get to the eye by curving in the open space between eye and tube, and around the barrier.[6]

[6]For the translated text, see IBN AL-HAYTHAM (1989), Bk. 1, Ch. 2, pp. 7-8; KHEIRANDISH (2009), pp. 99-101.

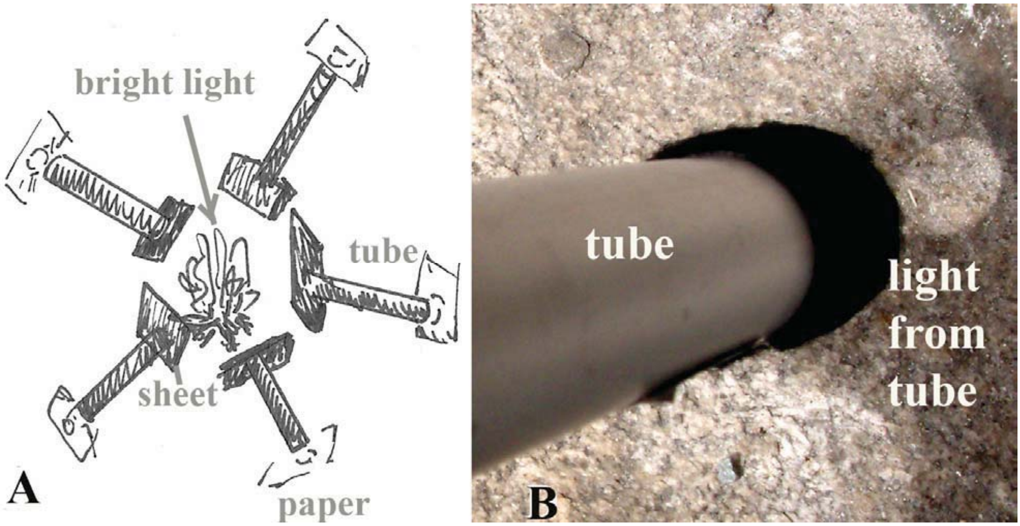

Figure 3 A: Diagram showing a bright light and five different positions of a tube passing through a hole in a sheet; white sheet at its far end shows a bright dot of light. **B:** Photo of a tube and the dot of light produced at the end that is away from the light source.

To show how light comes off something bright like a fire, Ibn al-Haytham used a tube in a different way, without looking through it. He fitted the tube into a hole in a copper sheet. When he held the sheet up to the bright fire, no light got to the other side of the sheet, except what went through the tube (Figure 3). Beyond the far end of the tube, he put a white board, instead of his eye. Whatever light entered the tube might show up on that board, where he looked at it while standing to the side. The white board was a viewing screen that made it safe to observe very bright light without directly affecting the human eye. The firelight that Ibn al-Haytham saw on the board had only gotten there by going through the tube, on a straight line (Figure 3 B). If he tipped the tube and its blocking sheet in different ways, firelight still came through the tube to its far end. If he raised, lowered, or moved the flame, again some of its light passed through the tube. With the help of these observations, he argued that light travels "in every straight line" coming from a bright object.[7] The tube was a tool for identifying the paths that light takes, and at the same time its straight form served as a model for those same paths.

[7]For the translated text, see IBN AL-HAYTHAM (1989), Bk. 1, Ch. 3, pp .18-20. EISLER reports an astronomical use at the Maragheh observatory for sunlight passing through a tube, EISLER (1949), p. 313.

The straight tube aided these observers in their efforts to understand how we see, and how light goes from place to place. Since the tube worked both for looking through and for letting light through, both Ibn ʻĪsā and Ibn al-Haytham used it, even though each came to a different, contrary, understanding of how the eye sees things. Light and looking are interrelated in such a way that looking through a straight tube shows us something, unlike a tube that is bent, curved or some other shape.

A Medieval Teacher and some Tubes

In the late tenth century, between the lives of Ibn ʻĪsā and Ibn al-Haytham, a teacher at the cathedral school in Reims, France had his students use tubes for viewing the night sky and learning about sound. At that time, not much about science, math or music was taught in Europe, where the schools were typically part of monasteries. This teacher, Gerbert, was a son of peasants who lived near one of those schools in Aurillac, France. Somehow he was given the special opportunity to study there, even though in those days peasants had no access to education. He was so interested in learning more that the abbot who directed that school arranged for Gerbert to travel to Spain to study. In Spain, Gerbert learned math and science from books and instruments that originated in the Islamic world, where more innovation was going on in these scholarly areas.[8]

When Gerbert returned to France to teach, he introduced his students to the new knowledge of math, astronomy and music that he learned during his travels. Gerbert's lessons made a fresh beginning for math and science in the part of the medieval Europe where people communicated in Latin. Unlike the book-based trivium that formed the basis of learning in the European monasteries, Gerbert's teaching put students into the experience of actually doing whatever they were learning about instead of just copying out of handwritten books by hand. If the students were learning astronomy, he had them go outside and look at the stars; if it was math, they did calculations; with music, they made sounds and listened. Gerbert provided his students with instruments for active learning, tools that students could use in looking, calculating, and listening. One former student wrote that Gerbert expended a considerable "quantity of sweat" in making these instructional instruments![9]

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[8] LATTIN (1951) is a book about Gerbert written for young readers. Also see DARLINGTON (1949), p.459-60; CAVICCHI this volume.

[9] RICHER (1930), v. 2, pt. 1, p. 58-59; DARLINGTON (1949), p. 467.

Gerbert interpreted the earth and the heavens around the earth as spherical. To help his students think about spherical relationships among the earth and stars, he made a wood globe to stand for the earth and set up wire hoops that could be moved around the globe's outside, to show what stars might be doing as they rise and set from the view of someone on earth. To help his students apply those relationships while they looked at the night sky outside, Gerbert made a sighting instrument. It had six tubes mounted so as to point in different directions. The tubes were held within a spherical support that had constellations patterned on it in wire. To use this instrument, students had to first set the sphere up so when they looked through one particular tube, they viewed the North Star. Now keeping the sphere in that same place, when they looked through each of the other tubes, it pointed them toward the place in the sky of Arctic circle, or the equinox circle, or the circles that show the limits of the summer or winter sky.[10]

Almost a planetarium "in reverse," this tube sighting sphere was an early use of a model for illustrating the invariant properties of the physical world. At that time, understanding the invariants of the night sky was crucial to everyday survival. People needed to know when winter was coming to prepare for its hardships; by following where the stars were every night, they could predict winter's approach. But unaided, the human eye cannot discern the small changes from day to day. Gerbert's instrument gave students aid in perceiving the subtle motions of stars, and how these motions related to the calendar and seasons.

This model was unrelenting in showing that not everything behaves the same way; if the student didn't aim the first tube in the device at the North Star, but instead at some other star, then all the other tubes would be pointing in the wrong directions for identifying those reference circles in the sky. In a letter to one of his students, Gerbert described how to be sure that the tube was aimed at the North Star:

> If you doubt that this is the polestar [North Star], station one tube in such a position that it does not move during the whole night and look toward that star which you believe to be the polestar. If it is the polestar, you will be able to see it the whole of the night; if any other star, it will soon not be visible through the tube because it will have changed its position.[11]

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[10] RICHER (1930), v. 2, pt. 1, para. 50-53, p. 62-63; DARLINGTON (1949), p. 467-470; GERBERT, Letter 2, in LATTIN (1961), p. 36-37; EISLER (1949), p. 321.

[11] DARLINGTON (1949), p. 469-470; GERBERT, Letter 2, in LATTIN (1961), p. 36-37.

We learn some of Gerbert's contributions via his correspondence with his students. A former student, Constantine, who had started as a new teacher, wanted to make for his own students a spherical device with sighting tubes like Gerbert's. In a letter to Constantine, Gerbert advised him to choose tubes of the same length, around one foot long, for the astronomy project, instead of tubes of all different lengths that are "like organ pipes".[12]

Constantine later became so skilled as a teacher, that Gerbert recommended that others go to him to learn music with the organ.[13] At that time, learning music was part of learning math; the lengths of the tubes in the organ have mathematical relationships. Gerbert wrote a mathematical work on the organ in which he discussed the measurements of the different lengths of pipes.[14] These tubes were probably made of brass.[15]

It is surprising – given the key role of the organ in the modern church – that in medieval times, it was not even accepted as a church instrument. In later centuries, organs came to be great instruments of church music, having hundreds, thousands, or even tens of thousands of tubes whose lengths varied from under a foot to thirty-two feet or more. There were instruments having multiple tubes in antiquity; organs sound in David's psalm celebrating musical instruments for offering praise.[16] The organs of classical Greece had several pipes and a keyboard for selecting which pipes would sound. It took work from a person, or another source such as a windmill, to operate an action of air piston and water chamber that sent air into the instrument's sounding pipes.[17] However, in early medieval times, organs were uncommon in Europe; their tubes' haunting sounds made them unwelcome in churches where some feared hearing ghosts or the devil in the breathy tones.

Since the organ was more accepted and developed in the Islamic society in those days, perhaps Gerbert learned to make and use organs during his student years in Spain where he had the opportunity to learn from other cultures. Later in life while he was directing a monastery

[12] DARLINGTON (1949), p. 469-470; GERBERT, Letter 2, in LATTIN (1961), p. 36-37; FLUSCHE (1994), p. 123.
[13] FLUSCHE (1994), p. 126.
[14] FLUSCHE (1994), p. 142-144.
[15] WARMAN (1903), p. 39.
[16] Psalm 150, 4. The instrument is variously rendered as organ, flute or pipe in different English translations of this verse; organ appears in the 1611 King James version.
[17] HERO (1971), sec. 76-66, p. 105-109; WARMAN (1903), p. 43-44; FARMER (1931).

in Bobbio, Italy, Gerbert probably built organs and taught students to work with organs as a way to understand sound and music. Afterward, he returned to the school in Reims, France, but was unable to retrieve the hand-made organs. His own teachers in Aurillac wrote to him repeatedly, asking about these organs that were left in Italy. Wars and politics made it impossible for Gerbert either to transport the organs to France where the monks could learn to play them at school, or to send a French student to Italy for practice with the instrument there.[18]

With tubes in their hands, Gerbert's students could try out something for themselves. They did not just take someone else's words for what they had to know. The students were the ones working out how to position the tubes to see something in the sky. The students were also making sounds with tubes, listening to how one sound related to another. And, through what they learned while doing activities with tubes and other instruments, Gerbert's students became so thoughtful and skilled that, like Constantine, they became the teachers and leaders of people in coming times.

By noticing what was going on with the actual tubes, Gerbert's students were learning science. From the different orientations of same-sized tubes in Gerbert's sphere mounting, the students could tell how the observed parts of the heavens related to each other and to where they stood on earth. They were using a model to help them notice what changes from night to night in the sky. From the different lengths of tubes in the organ, the students could uncover how a sound's pitch relates to a sounding tube's length. By having many tubes in a single instrument, the students were encouraged to compare and contrast the properties of those tubes, whether for astronomy or music. Tubes played many roles in doing and learning science: tubes aided people in seeking out physical invariants of light, stars and sound; tubes enabled one person to reproduce someone else's experiment; tubes were part of the models that people formed to interpret what they observed with tubes.

Drawings from Old Manuscripts of Medieval Observers with Tubes

None of Gerbert's teaching instruments with tubes exists today. However, some of Gerbert's writings on science and math were preserved in books of manuscripts that people copied by hand. Even though he came from a peasant family and was not noble, Gerbert's

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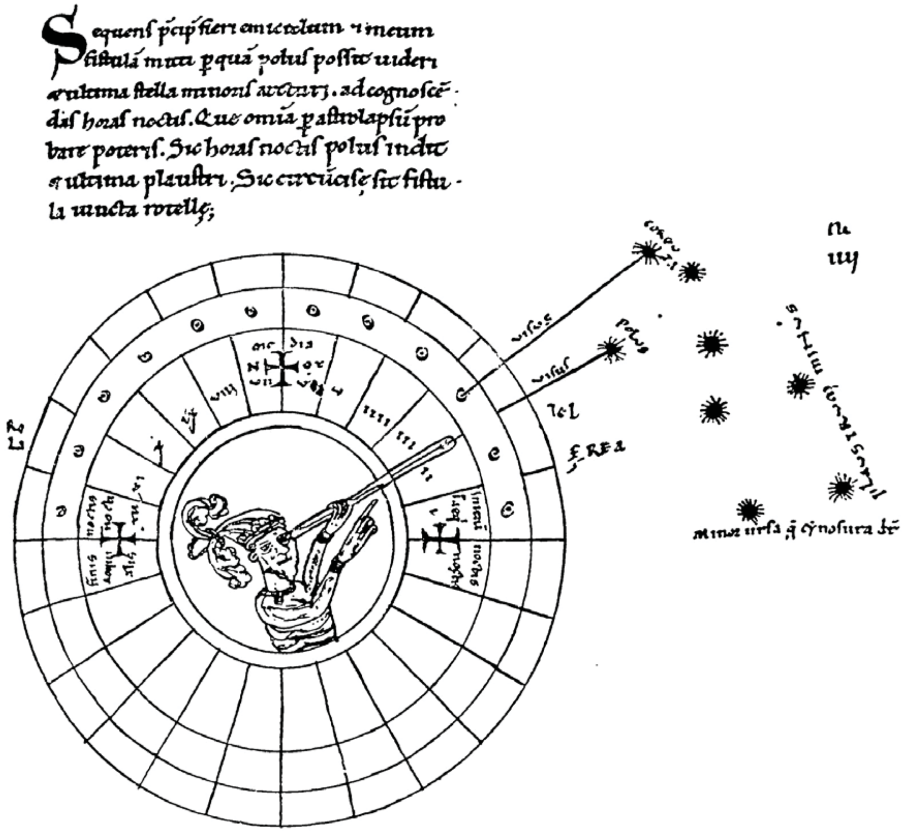
[18] FARMER (1931), p. 155-157; FLUSCHE (1994), p. 125-129.



work gained importance in the eyes of others when he became Pope Sylvester II during the final years of his life.

A medieval person looks through a tube at the sky in a few illustrations to hand-written books of the twelfth century. The two drawings that are reproduced below were made by artists who may have never looked through a tube themselves. Although these artists' drawings may be exaggerated and inaccurate, they help us imagine what it was like for a medieval person to look through a tube at stars.

Figure 4. MS Chartres no 173, originally at Médiathèque L'Apostrophe, Chartres, France, reproduced with permission.

One drawing of a tube (Figure 4) was part of a manuscript that was kept in a library in Chartres, France for nearly 800 years until it was destroyed during World War II bombings in 1944. Before the war, a scholar who was studying that same manuscript took a photograph of its illustration showing a medieval man viewing the North Star through a tube. His photograph reproduced below reminds us of how

Gerbert, his students and their students observed and understood the stars, and of how human works are vulnerable to loss.[19]

Notice how a line goes from the North Star (Polaris) through the tube to the man's eye. The writing above the drawing indicates that he is using tube observations to find the hours of the night.[20] This observation is different from what Gerbert's students did when they used the sphere with the six tubes mounted through it. This drawing puts the man within a circle whose outer rings are divided in twenty-four parts, like the twenty-four hours of a day and its night. The tube is oriented at the North Star, which is located above the horizon about a third of the way up toward the highest part of the sky. The North Star stays there all night, while the other stars travel along circles around it. Looking up all night at the stars, they seem to move like a great clock dial in the sky.

Mechanical geared clocks would not be available until far in the future. Navigators at sea, astronomers and others had to know the time at night. So from antiquity, people have carefully watched the stars' paths from night to night over one year and over many years. Putting these observations together, they worked out patterns in where the stars were at different times, and used these patterns to design and mark instruments. To use one of these instruments, it had to be oriented so someone could see the North Star along its tube or dioptra, then after noticing where the other stars were, find the place on the instrument's dial corresponding to them, and read off the present time of night from its markings. The orientation of the tube or dioptra was a basis for finding the angle to whatever fell within its view.

A tube aimed at the North Star appears in another twelfth century manuscript which still survives among the medieval volumes that were created and preserved by the Benedictine monastery of Mont-Saint-Michel, France (Figure 5). This illustration is found in a book of writings on science and technology that includes a text by Gerbert.[21] The book's beautiful artwork lets us peep into medieval life. We see the old-style of curly hairdos, tight stockings and loose costume along with the comedy of an observer's body pretzeled upside-down with a tube. This illustrator lets us *feel* a medieval observer's plight in trying to watch the bigger world and make sense of it.

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[19]This manuscript contained a work by Gerbert on the astrolabe. MICHEL (1954), p. 176-177; POULLE (1985), p. 607, n. 19.

[20]Partial translation of the text: "According to this method, one makes a half-circle, and within it one fastens a tube by which one might see the pole and the last star of Ursa Minor, to know the hours of the night…" MICHEL (1954), p. 176.

[21]LATTIN (1932), p. 62.

While showing us what the harried observer went through, this illustrator is less precise about how someone might use a tube while watching stars at night. Unlike the drawing in Figure 1 which shows the North Star about where someone in France might see it, in this one the North Star is directly overhead where no one then had seen it. And the circle around the man, which might stand for the instrument's dial, has no markings. Even with these exaggerations, the drawing adds something new for us to puzzle about. There is a sightline parallel to the tube, going to another star.[22] How might the observer have gotten an eye under that sightline's lower end?

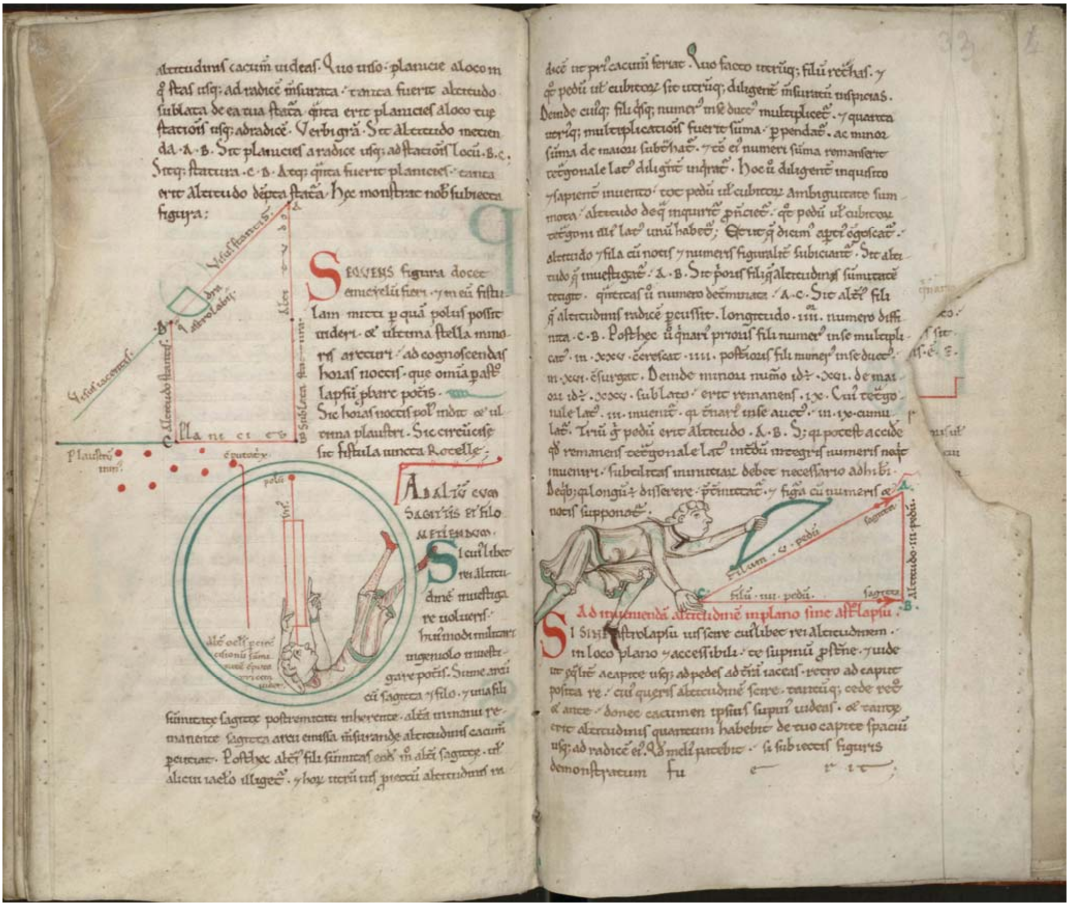

Figure 5. Ms 235 fol.32v, Ville d'Avranches, Avranches, France; reproduced with permission.

[22]POULLE (1985) p. 609-610. Like Ibn 'Īsā, this artist probably believed that the eye sees by sending a beam out to the object.

One of Gerbert's contemporaries reported that while Gerbert was in Magdeburg, Germany to tutor the seventeen-year old Emperor Otto III, he observed the North Star with a tube and used it to tell the time at night.[23] Gerbert was perhaps the first European to make time observations while sighting the star through a tube, rather than by a simple dioptra. We do not know if the tube instrument that Gerbert constructed in Germany was similar to the tubes illustrated in these two drawings by artists of a later time.

Let these stories and drawings open a window for you to the people and science of medieval times. They are beginnings for your imagination and curiosity, not something to copy directly. Invent your own ways of doing something with tubes. Put yourself and a tube in a medieval person's world. Look and listen.

Exploring Tubes!

Like Gerbert's students who did whatever they were learning about, now I invite you to play and explore with tubes. Playing and exploring is a wonderful way to learn. Let whatever you notice or do with tubes become a new curiosity for you. Have fun!

What surprises you? How can you change the tube or how you use it; does something different happen then? What tube activities might you invent to try with your friends or other people?[24] What might you try next?

Collect tubes of different lengths, shapes, widths, and materials. Some tubes you might find include: cardboard mailing tubes; brass or aluminum hobby tubes; soda straws; coffee stirring straws; plastic tubes; plastic pipes; clear plastic tubes. Take a sheet of paper and roll it into a tube. If you make your own tube out of paper, it can be as small or wide or long as you like. You can tape tubes together to make them longer.

Play around with looking through different tubes. What do you see? How might you show your friend something that you saw with a tube? Do others see something different?

Can you sight something that is moving? What happens when you

[23] POULLE (1985) p. 607-610; FLUSCHE (1994), p. 56-57.

[24] The activities of four-year-old children in exploring with clear tubes and water are described in HAWKINS (1969).

watch it through the tube? Imagine looking through a tube for a whole night at a star, like the medieval person; how would you get ready to do that? What do you see at night?

What sounds can you make with tubes? What changes how a tube sounds? Combine tubes, sounds, and other materials. Create music with tubes.

As you explore, look, observe, and make sounds with tubes, what differences and contrasts do you notice between the tubes or what is going on with them? Describe what you see, hear, feel and do. Is there anything related to the tubes that you can measure and compare?

Imagine the students who used tubes in medieval times for looking at the sky, understanding light, and making sound. What might they do, notice and wonder about? What can you find out by trying to do what they did? Continue their story with something you do and observe.

There is always more with tubes that you can explore and try. You might take photos, write notes, or make drawings of what you do and discover; this will become your own story. Every person's story is different, and everyone's story is related!

The photos below (Figures 6-9) might inspire your own explorations with tubes! What will you try, see, hear, create and discover with tubes?

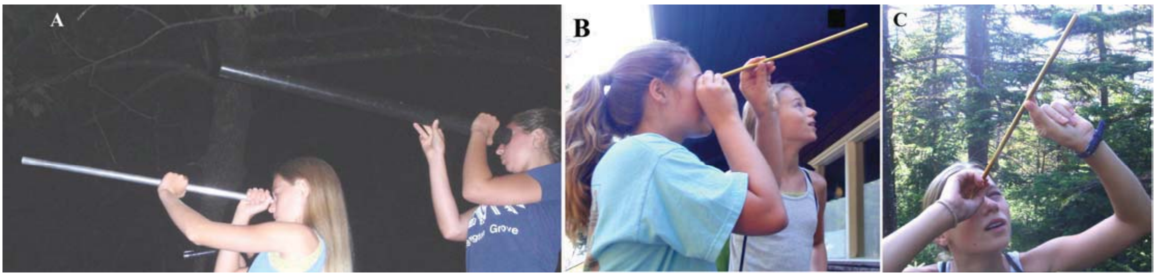

Figure 6: Three sisters looked through tubes. **A:** On a dark summer night, they viewed the moon by tipping the tubes just a little above level. **B:** One morning later, the moon was already high when they first looked at it through a narrow tube. **C:** Later on it was even higher.

Figure 7 A and B: To see the stars overhead, the sisters leaned very far back, and even put their heads on a table, almost like the medieval person in the drawing. **C**: The sisters made sounds with tubes by blowing over the tubes. **D:** They tapped tubes with their hands and listened.

Figure 8 A: The sisters tapped tubes and danced. **B:** They made original music and creative rhythms by clanging and blowing tubes. **C:** One girl dropped a small tube through a long one. **D:** She rolled and clanged tubes on the floor.

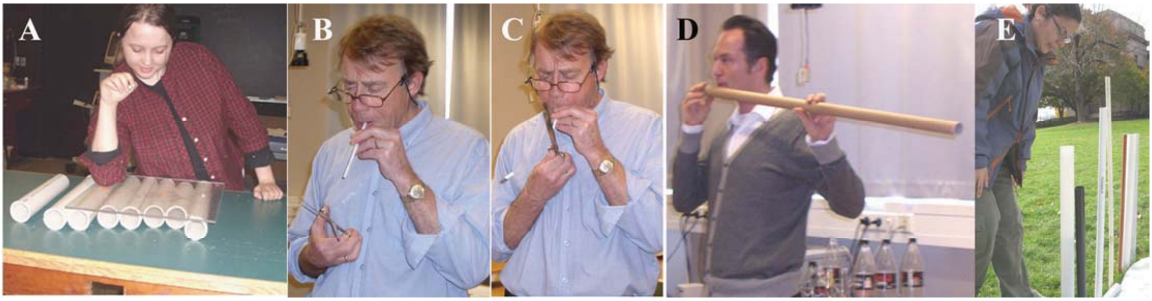

Figure 9 A: A college student lined up several tubes of the same size so they rolled together to carry a weight. **B and C:** A musician made tones by blowing into a soda straw while he cut it with scissors. **D:** A teacher blew into a tube sideways. **E:** A student set tubes upright outdoors to watch their shadows.

Follow these safety issues when you use tubes:
Never let your eye look through a tube at the sun or at a very bright light. Remember that Ibn al-Haytham was careful to let bright light pass through the tube onto a solid object. You might try holding a tube so that bright light goes through it onto the floor, but never put it toward someone's eye.
Never look into a tube without first checking that its inside is clean and empty. To make a tube safer for looking through, tape a clear cover over one end. Never drop something into a tube unless you are sure it is safe for the object to fall out.

Do not experiment with tubes and flame unless you are being guided by a person who has experience with flame.

When we explore tubes, we are being creative while doing something – like looking, making sounds, constructing and arranging tubes, and wondering about what happens. We might see, do, or hear something for our own first time. We are beginning adventures in learning about the world and ourselves, adventures that we share with the students and scientists of medieval times.[25]

Acknowledgements
Costantino Sigismondi introduced me to the story of Gerbert and encouraged my thoughts about a teaching activity related to Gerbert's tubes. Elaheh

[25]For examples of exploration as a way of teaching and learning, see DUCKWORTH (2001); DUCKWORTH (2006);
CAVICCHI (2008); CAVICCHI (2009).

Kheirandish introduced me to the optical writings of medieval Islamic science and invited me to try these experiments with our students. James Bales and others at the Edgerton Center at MIT support a welcoming setting for my historical experimental teaching. John Peter Collett, the Forum for University History, and the School Laboratory at the Department of Physics of the University of Oslo, Norway sponsored my sound exploring workshop with tubes and other materials. The teaching of Eleanor Duckworth inspires my efforts to open up experiences of exploration for learners. Peter Heering, Alythea McKinney, Klaus Staubermann, Ryan Tweney express history, science and materials in their teaching and research. Alva Couch sustains my hopes for exploring. I thank my students in tube explorations: Emanuela Fabbri, Mingwei Gu, Julia Kingsdale, Cecily Lopes, Ana Malagon, Marco Santambrogio and participants in the Sound Workshop at Skolelaboratoriet, University of Oslo. My heartfelt joy with the three sisters: Violet, Elise and Julia Cavicchi! This work honors the memory of my longtime teacher, Philip Morrison.

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From Gerbert's Letters to Sylvester's Privileges: the seasons of a man

Paolo Rossi

Abstract

Translating a 10th century text is a difficult task because of the major loss of information concerning the context: therefore each new translation is also a new interpretation. Panvini's and Rossi's Italian translations of Gerbert's letters are commented and compared.
Sylvester's privileges are considered from the points of view of their literary style (far from that of the letters), of their historical relevance and meaning, and especially with the aim of extracting indications on Gerbert's psychological evolution after his access to Papacy

Riassunto

Tradurre un testo del X secolo è un compito difficile a causa della grave perdita di informazioni relative al contesto: pertanto ogni nuova traduzione è anche una nuova interpretazione. Le traduzioni italiane di Panvini e di Rossi delle lettere di Gerbert sono commentate e confrontate.
I privilegi di Silvestro II sono presi in considerazione dal punto di vista del loro stile letterario (lontano da quello delle lettere), della loro rilevansa e significato storico, e specialmente con l'obiettivo di estrarne indicazioni sull'evoluzione psicologica di Gerbert dopo la sua ascesa al Papato.

About translations

When present day educated readers approach Gerbert's extant texts, and especially his letters, they immediately face a problem when trying a translation into their modern languages. Gerbert's complex personality is indeed reflected into a very complex style of writing. Moreover a thousand years have passed, and most references and information possessed by his contemporaries have been lost. As a consequence the difficulty of interpreting his texts is sometimes enormous, and the problem cannot be solved on purely linguistic grounds. In many cases problems arise just because of our ignorance concerning names, places and circumstances. By the way, some of Gerbert's letters are almost coded messages, probably to the point that even most of his contemporaries would not have been able to interpret them.

However such difficulties can also become a motivation for a specific effort in understanding at least what can still be understood. Such an effort, in my opinion, should lead not only to elaborating interpretative essays, but also to editing translated versions. Such versions might make Gerbert's original thoughts more accessible, albeit through their interpretation, to the less educated readers. Many young students approaching medieval history do not have the time, patience and sometimes even the technical preparation that are needed in order to access the original texts. However if we were to passively accept this fact we would also accept the notion that most of our ancient culture is bound to be available only to a more and more restricted group of experts in the field.

Translations are therefore very welcome, and one must not think that a single translation of any given text be enough. First of all, as we already observed, each translation is also an interpretation. Besides that, we must keep in mind that language is a living and continuously evolving reality, and many of us have experienced the fact that a dated translation (say a Nineteenth Century one) is often something that must be interpreted rather than an interpretation tool.

We therefore welcome the generous effort made by professor Sigismondi in order to make Panvini's Italian translation[1] of Gerbert's letters available to a larger audience. Dr Maria Giulia Panvini Carciotto (Catania, 8/12/1949–16/10/1996) had prepared, some time before her untimely departure, a complete and fully annotated version. Her translation is rigorous, but not without attention to literary values, and it is therefore quite readable, even if the original text is often very cryptic. Notes are sober, as the author herself declares in the Introduction, but they are accurate and usually exhaustive.

Panvini's translation is based on F. Weigle's edition[2] published in 1966 in *Monumenta Germaniae Historica*. In the meantime a new edition has appeared in 1993 in the *Belles Lettres*, due to Riché and Callu[3] who took also care of offering a French translation of Gerbert's *Correpondance*. This was one of the reasons why we decided to get involved in a new Italian translation[4], which will be soon published by Edizioni PLUS (Pisa) in the Series "*Fonti tradotte per la storia dell'alto medioevo*".

One of our main purposes (marking also some difference with Panvini) is a very strict adherence to the original text, even when this may imply a loss of literary grace, in order to minimize the student's

[1] M.G. PANVINI CARCIOTTO (2009)
[2] F. WEIGLE (1966)
[3] P. RICHE et J.P. CALLU (1993)
4 P. ROSSI (2009)

effort of conversion into his native language when comparing with the original text. We also aim at complementing the translation with a very large set of notes and especially with a rich complementary information (a standard feature of the Series) regarding all the historical, linguistic, chronological, geographical and prosopographical aspects (including genealogies and bishops' lists) that may be relevant to the text.

It may be interesting, in order to understand the different spirit and purpose of the two translations, to compare the two versions of Letter 1, addressed in Spring 983 by Gerbert (who was then in Bobbio as its Abbot) to Emperor Otto II. Boldface is used only for identical words and sentences

Panvini's translation

Gerberto, una volta libero, al suo signore Ottone, cesare sempre augusto. Mentre prendo in considerazione i pubblici affari dei feudi, temo di occupare con gli affari privati le orecchie del mio serenissimo signore. Il mio signore parli nel rispondere al suo servo nel modo che gli è solito, in modo che risulti che egli è al suo servizio. Non ci sia l'ambiguità, propria delle lettere, che non evidenziano la fermezza di carattere del nostro cesare, che noi spesso abbiamo constatata e che le genti conoscono. In poche parole vi sia una precisa indicazione del vostro consenso o dissenso, dando una sentenza che dica "bene" oppure "non bene". Per quanto sta in noi, fin dove ci sarà possibile, agiremo di conseguenza, una volta riconosciuta la vostra volontà. Esprima il signor vescovo Gerberto un parere sulla nostra innocenza a proposito di Brovingo e di Isembardo. Dicano Litefredo e Gerardo perché Rodolfo si impadronì del loro beneficio. Non sia considerato reo di lesa maestà colui per il quale fu sempre gloria lo stare per cesare e disonore lo stare contro cesare.

Rossi's translation

Al suo signore O[ttone] Cesare sempre augusto, G[erberto] un tempo libero.

Quando misuro il peso degli impegni pubblici dei regni, ho timore di occupare con i miei le orecchie del mio serenissimo signore. Dica il mio signore al proprio servo, con proprie missive al modo solito, in che modo si possa fare esibizione dell'impegno a servirlo. Sia tolta l'ambiguità dalle lettere, che non riproducono bene la serietà del nostro Cesare, a noi sempre manifesta, e conosciuta dalle genti. E quindi sarà per noi segno che voi siete favorevole o contrario l'aver proferito la frase "Bene" o "Non bene". Infatti quanto è in noi, che è possibile sia fatto, è consequenziale che noi lo facciamo, se conosceremo la vostra volontà. Che il signor vescovo Gerberto pronunci una sentenza sulla nostra innocenza rispetto a Broningo e Isimbardo. Spieghino Litefredo e Gerardo perché Rodolfo ha ricevuto il loro beneficio. Non sia giudicato reo di lesa maestà colui per il quale fu sempre gloria stare dalla parte di Cesare, ignominia stare contro di lui.

Sylvester II's papal privileges

Sylvester II's privileges do not appear in Panvini's translation, because they have not been written directly by Gerbert, being mainly the result of bureaucratic compilation by officials of the Holy See. They are however very significant remnants of Sylvester's time and activity, and in some special cases (which we shall consider in detail) they are documents of an important psychological and personal evolution of Gerbert, induced by his dramatic change of role and starting almost immediately after his ascent at the pontifical throne, as testified by the privileges themselves.

Undoubtedly some unavoidable structural elements mark a fundamental difference between these texts and Gerbert's letters. First of all, they are documents written (when the writer is explicitly mentioned) by the hand of *Petrus*, notary and secretary of the Holy Roman Church (eleven privileges out of thirty-one), of *Antonius*, regional notary and secretary of the H.R.C. (two privileges) or of *Johannes*, secretary of the H.R.C. (two privileges).

In many cases we do not even possess the original act, but only a copy (or the copy of a copy) preserved, and often willingly altered, by those who benefitted from the privilege.

Moreover these texts are largely built out of standardized *formulae*, not only in the opening title (usually SYLVESTER, BISHOP, SERVANT OF THE SERVANTS OF GOD) and in the greetings, but also in the listing of prizes and punishments, especially of spiritual nature, that are respectively associated with the violation and respect of the privilege itself.

In particular a very long sentence appearing already in the first privilege (April 999) is present, with minor variations, in a dozen documents and, when taking into account shorter versions of the same *anathema,* we easily reach the number of twenty occurrences. The sentence sounds:

If anyone, by rash boldness, however, shall attempt to contravene this document of our apostolic confirmation, though this seems impossible, let him be advised that he will have been held fast by the chain of the anathema of Our Lord and of Peter, prince of the apostles, to be consumed in the everlasting fire with the devil and his most vicious *retinue, and also with Judas, betrayer of Our Lord and Savior Jesus Christ, sent down into the Tartarean depths to perish with the wicked. May he who is, indeed, the guardian and respecter of this our privilege receive the grace of benediction and eternal life from the Lord.*[5]

It is impossible to recognize here the often involved but often fascinating style of Gerbert's letters, where his wide literary culture and his good knowledge of the classical texts available at the time are almost constantly apparent and determine a dense and never trivial way of writing, even in the short messages aiming at the fast transmission of an important information.

A literary analysis of these texts is therefore almost useless, except for the scholars studying the formalistic styles of the Roman *Curia*. It is instead very stimulating to study their content, both in order to understand the ecclesiastic policy of the Holy See around the year 1000 and to analyze Gerbert's mental evolution after becoming Pope.

We shall not belabour on a couple of messages (concerning the revolt of Orte and the stealing in Hadrian's tomb), that are only interesting in that they are indicating the great weakness of the Pope in the recurring Roman crises, marked also by the fact that some privileges, between the end of 1001 and the beginning of 1002, were released in Todi and not in Rome.

For what concerns ecclesiastical policy, the most present and interesting element is the tendency (certainly not peculiar of Sylvester's papacy, but definitely maintained and systematically sustained by him) to strengthen the autonomy of Benedictine monasteries by the concession of important exemptions from obligations deriving from the existence of an episcopal jurisdiction on the territories where abbeys were located. This policy is extended upon all areas of Christianity, as shown by privileges for Helmarshausen, Seeon, Quedlinburg, Lorsch, Fulda, Andlau in Germany, for Stavelot and Malmédy in Lothar's reign, for Déols, Langogne, Vezelay and Bourgueil in France, for Leno, Arezzo and San Salvatore dell'Amiata in Italy, for Sant Cugat in Catalonia. It usually amounts to recognizing possession of a large number of patrimonial estate, in granting freedom of the monks in their choice of an abbot and in exemption from control of the local bishop, as well as of all lay lords gravitating on the territory where the abbey is placed. The payment of a fee to Saint Peter, rather than an exaction, is a formal marker of direct dependence from Rome, and therefore it works as a guarantee of freedom from other powers.

[5] H. PRATT LATTIN (1961), p. 306

Still within the context of ecclesiastical policy, but with slightly different features, significantly dependent on the different territorial situations, Sylvester acknowledges also some feudal lordships, like that exercised by the bishop of Vercelli on Santhià county or by Count Daiferio's family on Terracina county. In both cases the strategic interest of the Church is apparent, but the solutions adopted are of a quite different nature: the first example is more "political", the second has a clearly "military" content. Similar considerations might be advanced regarding the very important privileges granted to the bishop of Urgel (who is even presently the Lord of Andorra, jointly with the Head of the French state, because of this and related documents) and to the bishop of Gerona.

A special attention towards Catalan bishoprics is certainly worth being noticed, and is confirmed also by the document addressed to Geribert, viscount of Barcelona. This attention may signal not only the strategic interest deriving from the nature of Catalonia as a frontier March at the border with the Islamic world, but also the ancient and deep link established by Gerbert with the Spanish Mark during his stay in the years 967-970.

Sylvester II also intervenes on those themes where the Pope may act as the supreme arbitrator of all religious questions. He always emphasizes strongly such role of the Pontiff, as in the case where an abbot should be suspended because of simony (a document showing also other reasons of interest), in the case of reinstatement of the bishop of Puy-en-Velay, in the message addressed to Odilon, abbot of Cluny, and concerning the validity of the acts of a deposed bishop, in the call to order of the bishop of Asti and in the messages to the Doge of Venice and to the Patriarch of Grado about the reform of the Venetian clergy.

We are now left with the task of examining a last small group of documents, also aimed at establishing the papal authority on issues of ecclesiastical discipline. We selected them because we are especially interested in their deep psychological meaning. All the acts we have selected carry a direct or indirect reference to the long human experience of Gerbert in France and particularly in Rheims. We have already mentioned an act, released in May 999, concerning the suspension of an abbot. Here we only want to recall from it a single sentence, sounding *Illos autem libros, in quibus specialem sententiam legimus, in Gallia relictos recolimus.* In these few words we still perceive all the regret of Gerbert, the intellectual who has been forced to leave his much beloved volumes in a country where he knows he will never go back.

Much more interesting is the letter written in December 999, where Sylvester II definitively confirms his old opponent Arnulph as archbishop of Rheims. Gerbert is now silent, and only the Pope is speaking. Pope Sylvester cannot (and is not willing to) contradict what has been sanctioned by his predecessors, even if those sentences were clearly adverse to the archbishop Gerbert. *Tua abdicatio Romano assensu caruit,* is Sylvester's statement, and his comment is *Est enim Petro ea summa facultas, ad quam nulla mortalium aequiparari valeat felicitas.*

Here the notary is writing at dictation by the Pope: each single word is carefully weighted, and we can also imagine the author's pain. Nevertheless, a moral judgement against Arnulph is clearly present and perceptible, and it is especially effective since it is completely committed to the *forum spirituale.* Sylvester's words are formally offering a guarantee of protection, but they are also burning insults: *sed nostra te ubique auctoritas muniat, etiamsi conscientiae reatus accurrat.*

Another message addressed to Arnulph contains the order not to deny the Eucharist to anybody who is dying repentant, even if he asked to be buried in the cemetery of St. Remi's monastery (a place obviously dear to Gerbert). Also this message appears to be filled with hinted reproofs to somebody who seems to be forgetting (because of some local power game) the basic Christian charity imposing not to leave a dying brother without religious assistance.

Last but not least, we want to consider the letter written between the end of 1001 and the beginning of 1002 to Ascelin bishop of Laon, in order to summon him to Rome at Easter time, in the occasion of a synod where the bishop should try to clear himself of the several imputations pending on his head. In particular, he was accused of an attempt to betray the archbishop Arnulph and to take him prisoner. Actually Ascelin was indeed the author of an undefined number of treasons and attempted treasons.

The most (in)famous and successful of Ascelin's treasons was the one that, in the year 991, allowed Hugues Capet to capture his opponent Charles of Lorraine and recover Laon, the virtual capital of the reign, thus consolidating his grip and his sovereignty on France. Much less successful was Ascelin's subsequent attempt to betray also Hugues, in 993, in favour of Otto III, with the purpose of taking possession of Rheims, at the time already disputed between Gerbert and Arnulph.

Nevertheless, the bishop of Laon appears to be as much unbeatable as incorrigible: in 995 he had already recovered his episcopal powers, and a few years later he was ready to attempt a new treason against Arnulph. A singular irony of history shows us the same Ascelin, almost thirty years later, writing the *Carmen ad Rotbertum regem*[6], where he sets forth the theory of the three orders of society (*oratores, bellatores* e *laboratores)*, the ideal foundation of the feudal society, and he convincingly praises a social system based on the sacredness and inviolability of the principle of mutual faithfulness between lords and vassals.

To this purpose I would like to quote, with some vanity, the final words of my pseudo-autobiographical novel on Gerbert's life:

When Ascelin's treason (no other name was possible, notwithstanding the great advantage coming from it to the whole country) appeared to me in all its impious greatness, I thought I would have been no more capable of speaking to him. However I soon considered (and I was probably not the only one to do this) that nobody was coming spotless out of that story, and that the bishop of Laon, assuming for himself the role of Judas, had accomplished an essential task in the Plan of Salvation: without Judas there is no Redemption, and without redemption every man is damned.

Is there possibly a place, in the Father's House, also for him who accepted to see his own name cursed without an end in order to allow the Kingdoms's Gates to be opened for all mankind?[7]

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[7] P. ROSSI (2008) , English translation by the Author

Pubblicazioni recenti su Gerberto d'Aurillac
Flavio G. Nuvolone

Résumé

Dans la série des publications récentes Gerbert ressort tel un sujet de grand intérêt: autant les sciences que les idéaux littéraires, philosophiques, politiques et religieux côtoient le "grand homme". Ce qui ne peut que bousculer certaines idées reçues et surannées et confirmer d'autres vues ou hypothèses d'historiens et scientifiques et pas des moindres. Mais qui aboutit aussi à intriguer les curieux et à éveiller les fantasques. De quoi conclure quant à la scientificité et à la vivacité des recherches actuelles.

Abstract

Among the recent publications Gerbert is raised as a subject of great interest: the sciences and the literary, philosophical, political and religious ideals are both verging the "great man". On the one hand, this fact hustles certain generally accepted and outdated ideas and confirms other historians and scientists' interesting views or assumptions; on the other hand this fact intrigues the onlookers and wakes up the whimsical persons. This allows to conclude about the scientificity and promptness of the current research.

Grazie per questo compito bibliografico, che ho cercato di articolare con un minimo di attenzione, altrimenti sarebbe scaduto in qualcosa di non necessariamente seducente.
Sono più di cinque lustri che mi occupo di Gerberto e non ho scelto un tale compito. Credo sussista un accedere ad attività ed interessi che senza essere scritto negli astri, nasce dal rispondere ad interpellazioni, vocazioni che si impongono al nostro vissuto da incontri con l'altro. L'altro non è solo il pericolo, o l'inferno come letture contemporanee o esistenzialiste l'hanno definito: è una persona, un interlocutore che merita attenzione.
Per questi cenni mi limito agli ultimi anni e dicendone davvero poco, soprattutto non argomentando eccessivamente.

Prendendo in mano *Culmina Romulea*[1] si ha un esempio dell'approdo a Roma di alcune novità non secondarie, d'altra parte ci permette di sottolineare l'operare di Costantino che da cinque anni imbrica Gerberto, e le corrispettive date biografiche, in illustrazioni astronomiche dei convegni romani; ne sono nate delle pubblicazioni come questa.
Ebbene tale volume riunisce diversi approdi, alcuni ovvii, altri più complessi, che sono sorti e si sono formati altrove. Così gli studi sulla Croce di Elna[2] e il Carme figurato[3] che lo mostrano poeta, cultore della Croce, maestro di corte e politico, e specialista dei numeri. Queste ricerche vengono da *Archivum Bobiense* che ha organizzato tre congressi gerbertiani[4] e immettono delle grosse novità, confermando ipotesi della vita e dell'educazione di Gerberto[5].

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[1] Cfr. C. SIGISMONDI (ed.), *CVLMINA ROMVLEA. Fede e Scienza in Gerberto, Papa Filosofo* (*Scienza e Fede, Saggi* 8), Roma 2008 [citato: SIGISMONDI 2008].

[2] Cfr. F. G. NUVOLONE, «Un giorno del 969 a Elna», in: SIGISMONDI, *ibid.*, p. 33-45.

[3] Cfr. F. G. NUVOLONE, «Quelques éléments d'introduction au *Carmen figuratum* de Gerbert d'Aurillac», in: SIGISMONDI, *ibid.*, p. 47-81.

[4] Cfr. M. TOSI (ed.), *Gerberto. Scienza, storia e mito*. Atti del Gerberti Symposium (Bobbio 25-27 luglio 1983) (*Archivum Bobiense, Studia* 2), Bobbio, 1985; F. G. NUVOLONE (ed.), *Gerberto d'Aurillac da Abate di Bobbio a Papa dell'Anno 1000*, Atti del Congresso internazionale Bobbio, Auditorium di S. Chiara, 28-30 settembre 2000 (*Archivum Bobiense, Studia* 4), Bobbio 2001; F. G. NUVOLONE (ed.), *Gerberto d'Aurillac - Silvestro II : linee per una sintesi*, Atti del Convegno Internazionale Bobbio, Auditorium di S. Chiara 11 settembre 2004 (*Archivum Bobiense - Studia* 5), Bobbio 2005 [citato: NUVOLONE 2005].

[5] Cfr. F. G. NUVOLONE, «Il *Carmen* figurato attribuito a Gerberto nel Ms Paris, BNF, lat. 776, f. 1V : una composizione redatta nell'Abbazia di San Colombano di Bobbio?», in: F. G. NUVOLONE (ed.), *"Gerbertus qui et Silvester" : minima gerbertiana da Piacenza a Lovanio e altri studi* (*Archivum Bobiense* 24, 2002), Bobbio 2003, p. 123-260; F. G. NUVOLONE, «Appunti sul *Carmen* figurato di Gerberto d'Aurillac e la sua attività a Bobbio», in: F. G. NUVOLONE (ed.), "*Liber de arca domni Athalani" : a trent'anni dalla fondazione degli*

Uno studio relativamente nuovo è assicurato dalla Prof.ssa Daniela Velestino[6], che innesta la lapide di S. Giovanni in Laterano in onore di Silvestro II, nel farsi, disfarsi e rifarsi storico architettonico del Campidoglio, e la compara a quella di Sergio IV.
Ed ancora i prof. Roberto Nardin[7] e Costantino Sigismondi[8] riraccontano il rapporto tra Gerberto e la concezione della musica — il problema dei rapporti armonici tra canne d'organo ed il monocordo, legato alla creazione e al suo piano unitario, appunto il rapporto tra scienza e fede —, e quello dell'uso dei beni. Il tutto immerso grazie alle prof.sse Laura Paladino[9] e Maria di Curzio[10], e alla partecipazione

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Archivi Storici Bobiensi, 1973-2003 (*Archivum Bobiense* 25, 2003), Bobbio 2004, p. 227-345; F. G. NUVOLONE, «La presenza delle cifre indo-arabe nel *Carmen figurato* di Gerberto», in: F. G. NUVOLONE (ed.), *"Vidi et gauisus sum", visione politica e pratica scientifica in Gerberto, e altri studi dal Tardo Impero alla Liberazione* (*Archivum Bobiense* 26), Bobbio 2005, p. 321-372; F. G. NUVOLONE, «Gerberto lascia delle impronte : iscrizione e monogramma - Ipotesi di lettura», in: F. G. NUVOLONE (ed.), *"Romanorum Christus". La Croce di luce palestinese, Nome e numeri sulla Tau di Gerberto, e altri studi fino alla Liberazione di Milano* (*Archivum Bobiense* 27/28. 2005-06), Bobbio 2007, p. 257-319; F. G. NUVOLONE, «Elna e l'iscrizione attribuita a Gerberto d'Aurillac : Gerberto si ricorda del Vescovo e delle Martiri?», in: F. G. NUVOLONE, *"Zh/sej", "che tu viva!". Dall'eredità scientifica pluriculturale della Catalogna, ai risvolti contemporanei* (*Archivum Bobiense* 29), Bobbio 2008, p. 319-352.

[6] Cfr. D. VELESTINO, «I "Culmina Romulea" e l'epigrafe di Silvestro II», in : SIGISMONDI 2008, p. 19-31.

[7] Cfr. R. NARDIN, «Indicazioni di vita monastica in Gerberto d'Aurillac, Un'indagine dall'Epistolario: l'attenzione ai beni», in: SIGISMONDI 2008, p. 129-134.

[8] Cfr. C. SIGISMONDI, «Gerberto e la misura delle canne d'organo», in: SIGISMONDI 2008, p. 85-92.

[9] Cfr. L. PALADINO, «Sulle orme del testimone, fino ai Culmina Romulea; una lezione di scienza e di fede alla scuola di Gerberto (Richero di Reims, Historia Francorum, III-IV, passim)», in: SIGISMONDI 2008, p. 99-115.

[10] Cfr. C. SIGISMONDI - M. DI CURZIO, «L'emisfera di Gerberto nella lettera a Costantino di Fleury (978)», in: SIGISMONDI 2008, p. 85-92, p. 93-97; M. DI CURZIO, «Epistolae selectae», in: SIGISMONDI 2008, p. 117-128.

dei loro Studenti, nella scuola e nell'apprendimento con la lettura dei testi. Lo studio di colui che era sopratutto un maestro teso a trasmettere quanto sapeva e ad imparare quanto ignorava[11].

Ricordo ancora rapidamente fuori di Roma, ma attorno a Gerberto, Paolo Rossi, Fabio Sigismondi, e Marco Zuccato, Massimo Oldoni, Pierre Riché, *Archivum Bobiense* 29 e 30.

Il prof. Paolo Rossi[12] ordinario di fisica teorica a Pisa, è persona culturalmente e socialmente impegnata. E nel campo delle fonti storiche procede analogamente con visione più globale affrontando la documentazione di un'epoca o gli scritti di un autore. Particolare attenzione merita la versione italiana delle Storie di Richero, che è la prima completa dopo quanto pubblicato da Laura Paladino su *Archivum Bobiense* l'anno scorso[13]. Fruisce d'un'introduzione, della versione italiana in base all'edizione dei *Monumenta*, di diverse tavole e d'un articolo del Collega Cacciari di Bologna[14] che situa utilmente Richero rispetto agli storici e alle ispirazioni.

Fabio Sigismondi ha elaborato uno studio introduttivo, una versione italiana e delle note di commento al *De Rationali et ratione ut*i di Gerberto[15], rilevando le novità che scaturiscono dall'analisi: meno un arzigogolare e più un innovare nei metodi e nei contenuti filosofici.

Marco Zuccato ha preceduto diversi studi e s'è dedicato alle fonti e alla portata dell'insegnamento scientifico di Gerberto, in particolare in Catalogna[16]. È uno studio essenziale, puntuale e coraggioso, che ha

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[11] Cfr. Ep. 44 (RICHÉ - CALLU 2008, p. 106-109): «Proinde in otio, in negotio, et docemus quod scimus et addiscimus quod nescimus».

[12] Cfr. P. ROSSI, RICHER DI SAINT REMI, *I quattro libri delle Storie (888-998), Instroduzione, traduzione e note*. Con un excursus di A. Cacciari, "Lo scrittoio di Richer" (*Fonti per la Storia dell'Alto Medioevo* 2), Pisa 2008.

[13] Cfr. L. C. PALADINO, «La biografia di Gerberto nella *Historia Francorum* di Richero di Reims», in: NUVOLONE 2007, p. 167-256.

[14] Cfr. A. CACCIARI, «Lo scrittoio di Richer», in: ROSSI 2008, p. 262-271.

[15] Cfr. F. SIGISMONDI, GERBERTO D'AURILLAC : *Il trattato "De Rationali et Ratione Uti" e la Logica del X secolo* (*Scienza e Fede, Saggi* 5), Roma 1997.

[16] M. ZUCCATO, *The earliest filtration of Arabic science to the Latin World: Gerbert d'Aurillac and the case of "Gotmar's circle"* Submitted in total fulfillment of the requirements of the degree of Doctor of Philosophy, The University of Melbourne, Department of History and Philosophy of Science, February 2005. Vederne la

scosso alcune idee classiche e sorpassate. Attendiamo la pubblicazione del volume, mentre abbiamo tre articoli pubblicati su *Archivum Bobiense*[17] e su *Speculum*[18].
Il Collega Massimo Oldoni ha appena dedicato un volume di *Nuovo Medioevo* alla figura e alla leggenda di Gerberto[19]: una ricca silloge di studi letterari e storici che evidenziano il formarsi, l'evolvere e l'arricchirsi della cronachistica.
Pierre Riché è un collega ed un amico d'un'età rispettabile, ma singolarmente attento ed aperto alla ricerca. Oltre alla terza ristampa della sua biografia di Gerberto[20] (e ad una serie impressionante di studi, ha curato l'edizione e la versione francese della Corrispondenza assieme a Jean-Pierre Callu nelle collezione di *Les Belles Lettres* in due volumi[21]. L'edizione è andata distrutta da un incendio del deposito dell'editrice: viene ora ristampata nel 2008 in un solo volume[22].
Concludo con *Archivum Bobiense*. L'anno scorso erano 25 anni dal primo Congresso Gerbertiano di Bobbio un fatto chiave che ha messo in contatto studiosi, pubblicazioni e interessi. Ebbene i volumi 29 e quello in stampa 30 della Rivista segnano dei punti d'arrivo notevoli per la figura di Gerberto da Aurillac fino al Papato. Essenzialmente

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presentazione in F. G. NUVOLONE, «Influenze "islamiche" nell'astronomia di Gerberto?», in: NUVOLONE 2005, p. 490-498.

17 Cfr. M. ZUCCATO, «Gerbert's Islamicate Celestial Globe», in: NUVOLONE 2005, p. 167-186. «Gerbert of Aurillac and Catalonia : "A doubtful matter", in: F.. G. NUVOLONE, *"Pescatore di uomini», Croce, spiritualità e comunicazione dal monachesimo precolombaniano al CDF* (*Archivum Bobiense* 30, 2008), Bobbio 2009, p. 197-203 [citato: NUVOLONE 2008].

18 Cfr. M. ZUCCATO, «Gerbert of Aurillac and a Tenth-Century Jewish Channel for the Transmission of Arabic Science to the West», *Speculum* 80, 2005, p. 742-763.

19 Cfr. M. OLDONI, *Gerberto e il suo fantasma. Tecniche della fantasia e della letteratura nel Medioevo* (*Nuovo Medioevo* 7), Napoli 2008.

20 Cfr. P. RICHE, *Gerbert d'Aurillac: le Pape de l'an mil*, Paris 2006 (trad. ital. Cinisello Balsamo 1988 dell'ed. francese 1987).

21 Cfr. P. RICHE - J. P. CALLU (ed.), GERBERT D'AURILLAC, *Correspondance*, I-II (*Les classiques de l'histoire de France au moyen âge* 35-36), Paris 1993.

22 Cfr. P. RICHE - J. P. CALLU (ed.), GERBERT D'AURILLAC. *Correspondance : Lettres 1 à 220 (avec 5 annexes), Texte établi, traduit et commenté* (*Les classiques de l'histoire de France au Moyen Âge* 45), Paris 2008.

uno studioso e un maestro, ma immerso pure nella spiritualitâ e nella cultura della sua epoca, ed acuto innovatore nell'una e nell'altra. E come tale da apprezzare.

Il volume 29, 2007[23] con Marta Materni, Costantino Sigismondi e il sottoscritto offre un ventaglio di valore: lo studio delle attività scientifiche[24], un esame sperimentale delle sue regole proporzionali acustiche tra canne d'organo e monocordo assai concludente[25], l'ancorarsi della Croce di Elna nel momento storico della presenza di Gerberto rispetto al Vescovo e al culto delle martiri di quella che era una città costantiniana[26].

Il volume 30, 2008[27], dalla copertina gerbertiana[28] che rileva Gerberto in tre momenti chiave: in Catalogna[29], a Reims, quando muore l'arcivescovo Adalberone, e a Roma alla morte di Gregorio V, entrambi suoi predecessori[30]. Due cronogrammi, poemi con indicazioni numerologiche e cronologiche criptate nel testo (utilizzando in genere le lettere a valore numerico latino), permettono di evidenziare il messaggio di Gerberto nelle due occasioni chiave. In

[23] Cfr. F. G. NUVOLONE, *"Zh/sej", "che tu viva!". Dall'eredità scientifica pluriculturale della Catalogna, ai risvolti contemporanei* (*Archivum Bobiense* 29), Bobbio 2008 [citato: Nuvolone 2008].

[24] Cfr. M. MATERNI, «Attività scientifiche di Gerberto d'Aurillac», in: NUVOLONE 2008, p. 225-317. Da sottolineare l'edizione originale, anche se meno completa: M. MATERNI, *Gerberto d'Aurillac : un maestro delle artes reales*, Fregane 2007.

[25] Cfr. C. SIGISMONDI, «Gerberto e la misura delle canne d'organo», in: NUVOLONE 2008, p. 355-396.

[26] Cfr. F. G. NUVOLONE, «Elna e l'iscrizione attribuita a Gerberto d'Aurillac : Gerberto si ricorda del Vescovo e delle Martiri?», in: NUVOLONE 2008, p. 319-352.

[27] Cfr. F. G. NUVOLONE, *«Pescatore di uomini», Croce, spiritualità e comunicazione dal monachesimo precolombaniano al CDF* (*Archivum Bobiense* 30, 2008), Bobbio 2009 [citato: Nuvolone 2009].

[28] Cfr. Si tratta infatti della pesca miracolosa di *Giovanni* 21, 1-14: episodio emblematico del ministero apostolico petrino ed episcopale, adombrato dalla quantità di lettere dell'epitaffio adalberoniano.

[29] Cfr. M. ZUCCATO, «Gerbert's Islamicate Celestial Globe», in: NUVOLONE 2005, p. 167-186. «Gerbert of Aurillac and Catalonia : "A doubtful matter"», in: NUVOLONE 2009, p. 197-203.

[30] Cfr. F. G. NUVOLONE, «Da Adalberone di Reims a Gregorio V - Epitaffi funebri e numerologia del "nostro" Gerberto», *ibid.*, p. 205-252.

particolare il tentativo, tramite epitaffi e carmi, di candidarsi sia al posto di Arcivescovo che di Pontefice. Infatti tali epitaffi erano certamente accompagnati da libretti dell'autore indirizzati a chi di dovere. Il secondo ad Ottone III, che poteva rilevare il rinvio al *Carme figurato*, inviato a corte per la sua incoronazione a re d'Italia nel 983. Ebbene si constata che la strofa finale, la 12a del *Carme* ha 540 lettere (la somma dei primi nove numeri, moltiplicata per 12: i numeri indici, svelati dal Carme, per il numero musicale per eccellenza, il 12)[31]; questo epitaffio ha 544 lettere: e cioè lo stesso calcolo con l'aggiunta del 4, valore "ipostatico" della Croce secondo Rabano Mauro[32], che viene rappresentata all'inizio di ogni verso, quindi 16 volte, il quadrato di 4, nello stile di Gerberto per portare alla perfezione la sottolineatzura di un'idea. Un modo per unire alla creazione, nel suo ordine e nella sua armonia, la Croce della Redenzione, contenuto della funzione e del messaggio del successore di Pietro. Ottone III se ne ricordò e, nell'ottica di Gerberto, sottoscrisse alla candidatura che era concepita nella prospettiva dell'impero cristiano. Un codicillo; singolarmente, questo epitaffio numerologico ha una struttura apparentata a quello ricostruito dalla Croce di Elna[33]: sia qui che a Elna la Croce, qui disegnata, a Elna indicata dalla Tau = T, entrava profondamente nella struttura del calcolo, in entrambi i casi iniziando i versi. Una sorpresa ulteriore offertaci da questo straordinario personaggio che utilizzava lettere e numeri come stilemi di un messaggio articolato, dotato di una particolare logicità nonostante la pluralità delle prospettive. E difatti le parentele sono anche altre. Un rilevamento che ha fatto dichiarare al più grande dei cultori di Gerberto ancora vivente, il Prof. Pierre Riché, di considerare chiusa una discussione durata 200 anni a dire l'importanza della nostra Rivista nello stessa storia delle scienze.

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[31] Vedere i dati in F. G. NUVOLONE, «Gerbert d'Aurillac et la politique impériale ottonienne en 983: une affaire de chiffres censurée par le moines?», in: C. CAROZZI - H. TAVIANI-CAROZZI (ed.), *Faire l'événement au Moyen Age: de l'événement au fait historique* (*Le temps de l'histoire*), Aix-en-Provence 2007, p. 253-254.

[32] Cfr. M. PERRIN (ed.), RABANI MAURI *In honorem sanctae Crucis* (*Corpus Christianorum, Continuatio Mediaeualis* 100 e 100A), Turnhout 1997, p. 71.

[33] Cfr. F. G. NUVOLONE, «Elna e l'iscrizione attribuita a Gerberto d'Aurillac : Gerberto si ricorda del Vescovo e delle Martiri?», in: NUVOLONE 2008, p. 319-352, in part. fig. 9.

Che Gerberto ragionasse e procedesse in questo modo compreso o meno o persino avversato, ha fatto nascere Leggende e storie diverse. Anche oggi, perché percepito straordinario, seducente oppure poco ordodosso, per non dire diabolico, c'è un rinato interesse romanzato. Due opere, due stili, due diverse dimensioni, quelle del Prof. Paolo Rossi[34] ancora, e del Dr Claudio Foti[35] Anche di questi, come degli studi precedenti, e d'altri qui non menzionati, sussistono recensioni nel volume 30 di *Archivum Bobiense*. Strumento di ricerca ma pure di informazione. E non posso che invitarvi a leggerle.

Concludiamo rilevando un panorama vivace e variato. Se ne trae:
• La figura di un personaggio inserito nelle arti e scienze d'una società pluriculturale d'un tempo e d'oggi.
• Non esita ad utilizzare tecniche diverse a livello compositivo e d'insegnamento.
• Fondamentale il valore della creazione e della sua rilettura, con sovrapposizione di più piani ermeneutici, ma in una visione unitaria.
• Donde pure il ricorrere di leggende ed approcci romanzati.

[34] Cfr. Paolo ROSSI, *Gerbert, Il tempo del ritorno*, presentazione di Franco CARDINI, Pisa, Edizioni ETS 2008 e la recensione di C. SIGISMONDI, «Racconti romanzati gerbertiani», in: NUVOLONE 2009, p. 534-536.
[35] Cfr. Claudio FOTI, *Ombre su Capo Marzio*, postfazione di Gianfranco DE TURRIS (*Le ali della Fantasia* 2), Roma, Edizioni Tabula Fati 2008, e recensione di F. G. NUVOLONE, *ibid.*, p. 561-563.

Pope Silvester II and King Seijong the Great: wisdom science and government

Costantino Sigismondi

Abstract

These prominent figures of European and Korean history, while never in contact, show interesting analogies. Sylvester II, former Benedictine monk born around 945, become Roman Pontiff, Pope of the whole Christianity, from 999 to 1003, after having been the most prominent scholar and teacher of his times in Europe. He left works on astronomy, geometry, philosophy, musical theory; he invented special instruments for displaying planetary systems, built "solar horologia" (solar watches) and introduced indo-arabic numbers to be used with the abacus. He built also organs, and used them in the liturgy. The disciplines of Quadrivium, the scientific ones, received a great impulse by his authority and they become part of cathedral schools' curricula. This was the cultural base of the forthcoming Universities.

The interests of King Seijong the Great (1397-1450) were surprisingly similar: builder of astronomical and musical instruments, and promoter of the Hangul, during his reign, he left a unique mark on the Korean culture.

Both relevant figures are evaluated also in the context of the international year of astronomy.

Silvester II (945 ca- 1003) and King Seijong the Great (1397-1450)

Introduction

How to present Gerbert of Aurillac-Silvester II to the Far Eastern world of South Korea? This Country is very much united with modern Western technology, but greatly separated from a cultural and historical point of view, so this is a very interesting task.
The occasion of the meeting in Seoul, organized by the Office of Science and Technology of the Italian Embassy, pushed me to propose this argument in the context of the international year of astronomy.
Galileo Galilei was the first argument for which I was invited to give a talk in Seoul. The place suggested by me was the Seijong University, where in 2005 I spent one month as a vistiting scholar form July 8 to August 5. And after having proposed to present King Seijong's scientific activity in comparison with Silvester II, the University organized a full day of studies inviting Prof. Nha Il-Seong, the maximum authority in history of Astronomy in Korea, president of the commission 41 on History of Astronomy, of IAU, International Astronomical Union.
In this way the polyedrical figure of Gerbert of Aurillac-Silvester II has worked as an extraordinary meeting point of the Western history with the Far Eastern one, thanks to the surprisingly closeness between him and King Seijong the Great, the most relevant historical figure for the Korean culture.
My previous month spent in Korea led me to approach the figure of King Seijong, to discover his interest in astronomy, music instruments, hydrology, literature with the remarkable invention of Hangul, the korean alphabet.
The analogies with Gerbert - Silvester II are amazing: he taught astronomy, he built instruments for didactical and observational purposes, he built organs, he wrote philosophy, he introduced first the indo-arabic numbers into Europe.
There are 400 years between Silvester II and Seijong, and also more than 8000 km, and also an historical insulation of Korea with respect to surrounding countries... but it is evident that very prominent personalities are boundless.
The source of my information on Seijong has been gathered mainly at the King Seijong Memorial Hall, already visited in 2005 and re-visited in 2009 before the conference. The books consulted deal with King Seijong[1], *hangul*[2],[3], and history of Korean Church[4], and helped me to

[1] KING SEIJONG MEMORIAL SOCIETY, *King Seijong the Great*, Seoul, Korea, 1970.
[2] NAM WOO LEE, The *King Seijong and the Korean Alphabet Basic-Learn Korean in 24 hours*, Seoul, Korea 2004.

have a pale idea on this interesting Country, with very gentle people. Sources on Korean history of Astronomy, before meeting prof. Nha Il-Seong who already authored an History of Korean Astronomy[5], were for me Paolo Maffei's book on Halley's Comet[6], and the figures of two other books in Korean [7], [8] and the volume on Astronomical Instruments and Archives from the Asia Pacific Region[9]. The contributions of prof. Nha and her doughters Sarah Lois Nha, represent the larger amount of information about Far Eastern Astronomy never published in Italy, and that is a great honour for me as an editor, to publish these papers in this volume dedicated mainly to Gerbert's astronomical studies, and stimulated by the annual conferences on his figure.

In the following paragraph I will outline the figure of King Seijong, with his scientific interests and some biographical sketches. Furthermore Gerbert of Aurillac will be presented in comparison with Seijong biography.

It is also remarkable that the days dedicated to King Seijong in Korea (the 15th of May) and to Gerbert of Aurillac in the anniversary of his death (12th of May) are very close each other.

It is interesting to note the coincidence of father Matteo Ricci, the famous Jesuit who introduced European astronomy and Christianity into China. He died on 11th May 1610. Matteo Ricci known as *Li Ma Tou*, is greatly honoured in China as the cultural bridge between Europe and China. This book is coming out in the same days of his fourth anniversary of death.

The week including 11, 12 and 15 of May seems perfectly suited to host studies for bridging Far Eastern culture and science with the European one.

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[3] RICHARD HARRIS, *Roadmap to Korean*, Hollim Corporation Publishers, Seoul, Korea, 2003.

[4] Rev. KIM CHANG-SEOK THADDEUS, *Lives of 103 Martyrs Saints of Korea*, Catholic Publishing House, Seoul, Korea 1984.

[5] NHA IL-SEONG, *History of Korean Astronomy*, Seoul National University Press, 2000.

[6] PAOLO MAFFEI, *La Cometa di Halley,* Mondadori, Milano, 1984.

[7] PARK CHANG BOM, *Carved in the sky of our history: the mystery of astronomical records contained in the Korean history*, Gimyoungsa, Seoul, Korea, 2002 (in coreano).

[8] AHN SANGHYEON, *Our constellation which we should know*, Hyeonamsa, Seoul, Korea, 2000 (in coreano).

[9] W. ORCHISTON, F. RICHARD STEPHENSON, S. DÉBARBAT AND NHA IL-SEONG editors, *Astronomical Instruments and Archives from the Asia Pacific Region*, Yonsei University Press, Seoul, 2004.

King Seijong the Great

King Seijong the Great is represented in the banknote of 10000 Won, the most used bill in Korea, equivalent roughly with our 10 euro. A copy of Guo Shoujing's Armillary Sphere built in 1439 upon Seijong’s will in his observatory is in the backside, as well as the map of the sky graved on the stone represented in Fig. 19 of Nha Il-Seong’s paper on the two observatories before Galileo[10].
Seijong was born on 15 May 1397[11], become King at the age of 22, and died on 8 April 1450.

[10] This map is the most famous relic of Korean history of Astronomy after Cheomseong-dae observatory in Kyongju City (Fig. III.1 of Nha & Nha paper). By the way is Prof. Nha who has given the greatest contribution to the studies on such a stony sky map.

[11] KING SEIJONG MEMORIAL SOCIETY, *King Seijong the Great*, p. 11; The King Seijong day is celebrated on May 15.

During the first four years of reign, some of the military powers were still exerced with his father Taejong who abdicated in favour of Seijong in 1418. He was the third son of Taejong, and he was not the designed successor to the throne, with great gifts for scholarly studies.
The brothers put themselves intentionally aside from the throne's succession, rudely behaving, and finally they were banished from the court and succeded into the intention of leaving Seijong becoming King.
During his kingship, Seijong won a war against Japanese pirats (1419), strengthening the Korean military force. Also on the Northern borders a military champaign against Manchu, driven by general Kim Jong-Seo (1433), kept several castels and shift the borders at the physical end of the Korean peninsula: where today is the border between North Korea and China.
The most interesting fact was the attitude of King Seijong toward the role of science and wisdom in his kingship. He created the Hall of Jade, where scholars could study night and day without having any other cares. There is a story about a scholar who felt asleep during the night study: surprised by the King who put his mantle on the scholar's shoulders in order to keep him warm.
During Seijong kingship several inventions have been realized.
In the King Seijong Memorial Hall, set up in Seoul by the King Seijong Memorial Society there is an exposition of replicas of the most famous instruments invented during Seijong time.

The Angbu-Ilgu emi-spherical sundial during the summer solstice days of 2009, in the gardens of Seijong University.

The most relevant are: in astronomy the Angbu-Ilgu emispheric sundial and other sundials and waterclocks; in meteorology the world's first rain-meter (or rain-gauge, 1442); in music a percussion instrument; in literature the *hangul* alphabet based upon the graphication of the various positions of the tongue in the mouth when a sound is pronounced.

Part of a waterclock reconstruction (left) and percussion musical instrument (right); photo by the author in the King Seijong Memorial Hall (2005).

Seijong encouraged farmers to organize their activities with an handbook the *Nongsa chiksŏl* realized by his scientists who gathered all necessary informations all around the Country to introduce new intensive agricolture in Korea; this book with the rain-meter allowed to control the agricole activities in all his Kingdom. He published also manuals in medicine, and reformed the chinese calendar making it suitable for Seoul's latitude.
King Sejong also oversaw, and perhaps participated himself, in the creation of the written language of *hangul* and announced it to the Korean people in the Hunminjeongeum (훈민정음), meaning "The verbally right sounds meant to teach the people."
With this innovation Seijong paved the way to eliminate analphabetization in Korea. It is possible to learn to read *hangul* in few hours, so everyone in Korea could read since 1446, the time of Seijong's publication of *hangul*. Before that time only high class people were literate. This was a great impact in Korean culture, and King Seijong expanded the publishing industry in Korea. A metal printing press had been used as early as 1234, during the Goryeo Dynasty, but in 1403 King Sejong initiated the use of an official press.

King Sejong also promoted the cultivation of paper mulberries for the development of paper quality[12].
King Sejong presided over the introduction of the 24 letter of Korean alphabet (14 consonants and 10 vowels), with the explicit goal being that Koreans from all classes would read and write. He also attempted to establish a cultural identity for his people through its unique script. Anyone could learn *hangul* in a matter of days. He created the *hangul* characters from scratch, and based each one on a simplified diagram of the patterns made by the mouth, tongue and teeth when making the sound related to the character. Words are built by writing the characters in a syllabic blocks. The blocks of letters are then strung together linearly.
Persons unfamiliar with *hangul* can typically pronounce Korean script accurately after only a few hours study.

In this image King Seijong is represent in front of the document of *hangul* publication. *Hangul* letters are shown in comparison with chinese ones.

[12] http://www.newworldencyclopedia.org/entry/King_Sejong

Pope Silvester II

The analogies with King Seijong in the biography of Gerbert of Aurillac - Silvester II are really interesting.

Gerbert was born around 945 in Aurillac (centre of France) become a benedictine monk. Unlike his colleagues he could travel out of his monastere, going in Catalonia to study Mathematics (969-971), and to Rome (971) and after in Reims (972 North of France) to the most important cathedral school of these times. There he become the most famous teacher of his times. When he was chosen as Pope in 999 he was already famous in all Europe for his wisdom and science.

He died on 12th May 1003.

His contributions can be summarized in the following points.

Government: the Christianity under his papacy spread to East Europe by his foundations of firs Hungarian and Polish dioceses (1000). During his life as a teacher (972-997), as a secretary of Reims' Archbishop (972-989), as an Archbishop himself (991 in Reims, 998 in Ravenna) and as a Pope (999-1003) he strongly supported the project to maintain united the whole Europe under christianity by all political and cultural means.

Astronomy: transmission to European christian cultural world of the astrolabe and first arabic astronomical traditions.

Music: he built organs and wrote a treatise on the lengths of organ pipes with respect to corresponding vibrating chords, as a function of their diameter.

Arithmetic: he introduced, with an abacus, the use of indo-arabic numbers in Europe more than 200 years before Leonardo Fibonacci (1202). He introduced also the use of the zero, even if this use remained among scholars.

Geometry: he wrote a treatise, which is basically the use of the astrolabe in geometrical context (repering angles and calculating distances and heights).

Philosophy: he wrote a treatise of logic "The rationali et ratione uti" on the use of reasoning.

Medicine: he was aware of the latin and arabic tradition, he answered to letters on medical inquiries without considering himself a medical doctor.

Conclusions and perspectives

The meeting between Gerbert and Korean culture, through the comparison with King Seijong has opened a new time of reciprocal knowledge between European and Korean culture. The proximity between King Seijong's day of 15 may and Gerbert's day of 12 may suggests further developments.

Astronomical Observatories in the Far Eastern World before Galileo

Nha Il-Seong and Nha Sarah Lois

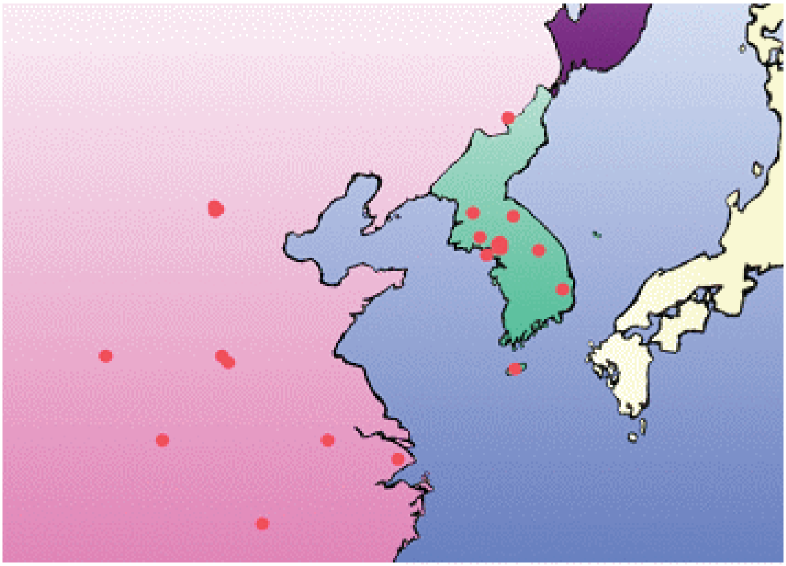
Abstract

We present a survey of old astronomical observing stations dating from the 2000 BC Xia Dynasty of China to the 15th century AD Joseon Dynasty of Korea. During our study of ancient and medieval astronomy in the two countries, we have accumulated much evidence pertaining to these old sites and buildings and their missions. Most observing stations have, of course, been ruined by time and war but there do survive numerous structural artifacts, written documents, star maps and observing equipment. The number of such observatories now known in the two countries exceeds 25 and we have sorted them into 3 categories: (1) those derelict ones understood to have been used for regular or sporadic observing because of surviving physical evidence; (2) those known only from historical citations; and (3) the ones which survive to the present. Here, they are discussed in chronological order within each group.

Introduction

Because of the long histories of Chinese and Korean civilizations, astronomical activity has frequently been conspicuous in Far Eastern cultures. During the intervals of occupation of Chinese lands by surrounding nations, astronomical activity became symbolically associated with the then-reigning dynasties. In smaller, more isolated Korea, on the other hand, indigenous observatories were sustained during 3 disjoint eras. Although the instrumentation developed in the two countries had much in common, individual observatories themselves evolved according to local needs and programs.

This presentation enumerates and summarizes the ancient observatories that are currently identified and notes that they are sufficiently numerous so that they may be sorted into 3 groups. Their locations are indicated on the accompanying map.



Distribution of old observatories and observing stations in China and Korea before Galileo

I. Observing stations established for regular or sporadic use

In ancient times, observation of stars was not rooted purely in scientific research but was more of the nature of a ceremonial event. It was believed that all creatures on Earth, including humans, are controlled by the heavens which offer messages to them from time to time by the motions of stars and other celestial phenomena.

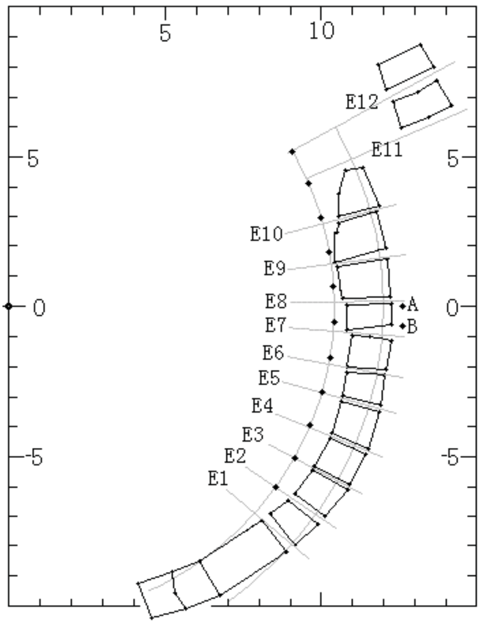
No matter whether astronomical observing be accounted a scientific or religious activity, ancient peoples in the Far East, just as in other parts of the world, sacrificed to heavenly gods in reverent ceremonies. The altar at such a location may be called an ancient observatory because there was no clear distinction between astronomy and astrology. As time went on, some of the locations were actually used as observational sites regularly or irregularly. We now describe in chronological order the traces of 10 examples of this kind of observatory.

We also call to the attention of the reader an uncommon detail: because each illustration is clearly and unambiguously associated with the language of the text, there is no specific remark about this association for any of the following figures.

I-1. Taosi Observatory

Location: Longshan culture sites near Taosi Village in Xiangfen County, the southern part of Shanxi Province, China. The location may be the capital of the Xia Dynasty.

Built: ca 5,000－4,000 BP



Information: Liu Ciyuan and his colleagues investigated the site and confirmed that it was an observatory used to determine the seasons by watching the sunrise.

Figure I-1. Large, partly-circular platform of Taosi Observatory. {From Liu C. *et al*. [1]}

I-2. Chamseong-dae 塹星臺 (Altar of Offerings to Heaven)
Location: Mt. Mani 摩尼山 in Kangwha Island, Korea
Built: ca. BC 2,000. Historic Relic No. 136
Information: It is believed that Tanggoon Wang-geom 檀君 王儉, a real or mythical founder of Korea in 2333 B.C., made offerings to stars here. The foundation is round and the upper part square symbolizing heaven and earth. In later times, particularly during the Joseon Dynasty (1392-1910), the altar, 5 m high by 2 m square and surrounded by a round base 4.5 m in diameter, was sporadically used as a station for the observation of solar and lunar eclipses, comets, and the star Canopus 老人星.
Today, the altar serves for igniting a fire from Sun for the annual domestic Olympics.

Figure I-2. Chamseong-dae on top of Mt. Mani, Kangwha Island. Left is a view from the distance, and at right a detail of the altar.

I-3. Ling-tai 靈台 of the East Han Dynasty

Location: Luoyang 洛陽, Henan Province, China
B
uilt: AD 56, the 1st year of the Zhongyuan reign period of East Han 東漢 (or Later Han 後漢)

Information: Excavation carried out during 1974-1975 revealed the scale of the site: a total area of 220x200 meters with a building base of 41x31 meters. When the famous astronomer Zhang Hen 張衡 worked here with his armillary sphere, the staff of the observatory numbered about 20 to 30.

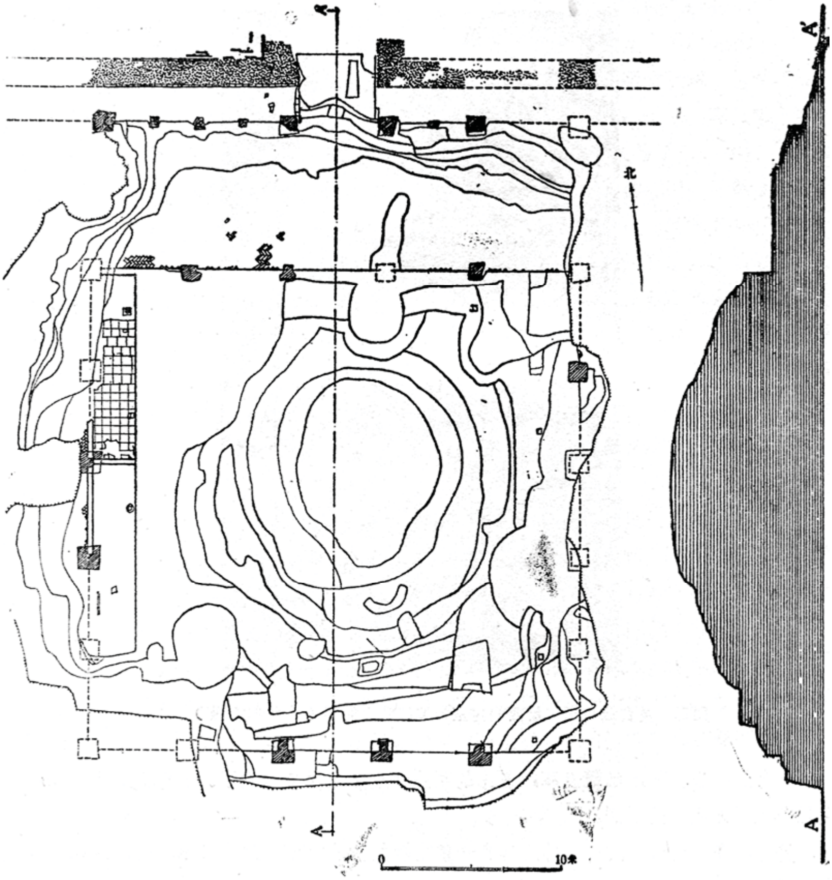


Figure I-3. Ling-tai of East Han. (From Lu Sixian and Li Di [2])

I-4. Zhougong Cejing-tai 周公測景台 of the Tang Dynasty
Location: Dengfeng Gocheng, Henan Province, China
Built: AD 723, the eleventh year of the Kaiyuan 開元 reign period of the Tang

Information: In 723, Nangong Shuo, Director of the observatory, set up a stone gnomon and started observations with it the next year. This gnomon is still well preserved having dimensions 1.64 m high, 0.45 m wide and 0.21 m thick. One surface of this gnomon shows an inscription of five characters.

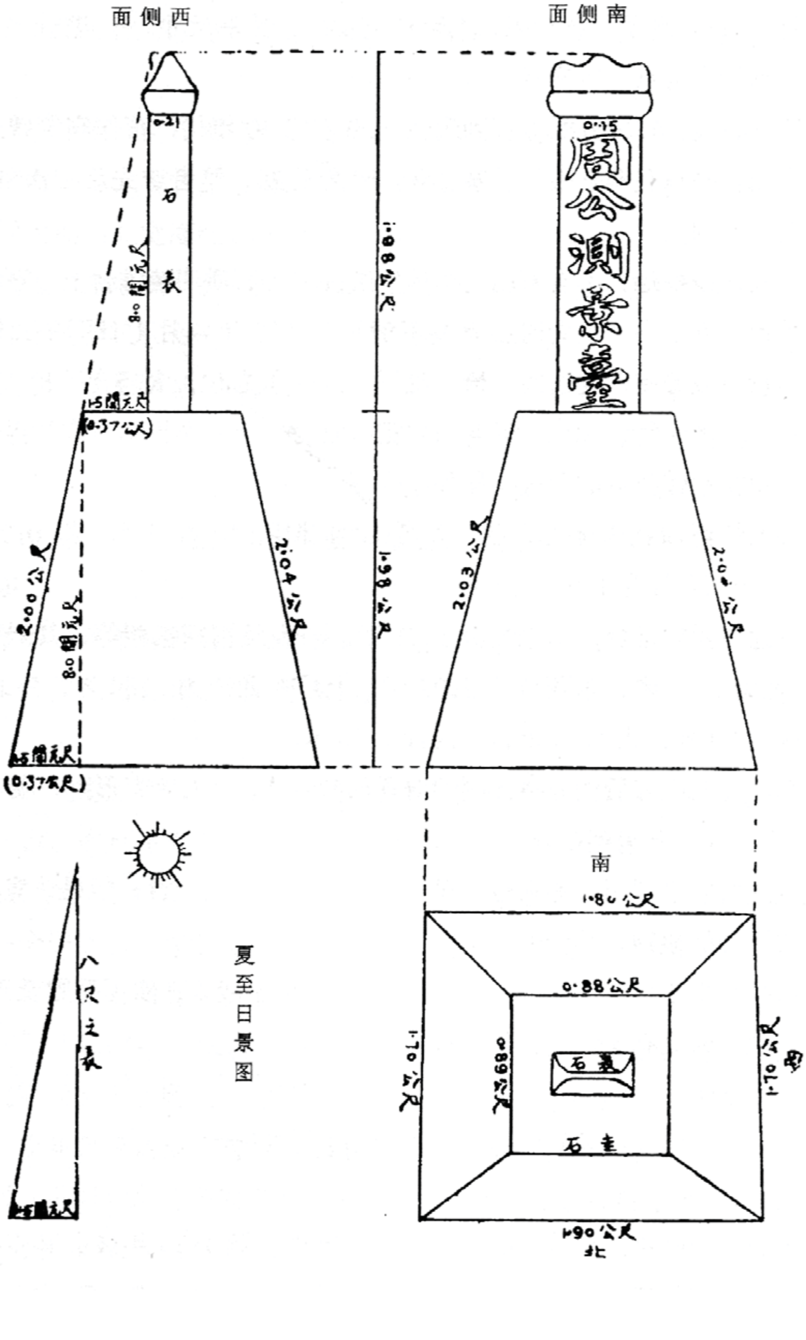


Figure I-4. Zhougong Cejing-tai of Tang Dynasty. (From Lu Sixian and Li Di [3])

I-5. Huihui Sitian-tai 回回司天台 of the Yuan Dynsaty
Location: Shangdu 上都, Inner Mongolia, China.
Built: In 1271, the 8th year of the Zhiyuan reign period.
Information: After Hu Bilie became the Yuan ruler in 1260, Arabian astronomers including Zhama Luding came to the Yuan court, and assisted in the establishment of an astronomical board. An observatory in Arabian style was constructed in 1271 and Zhama Luding was placed in charge of it.

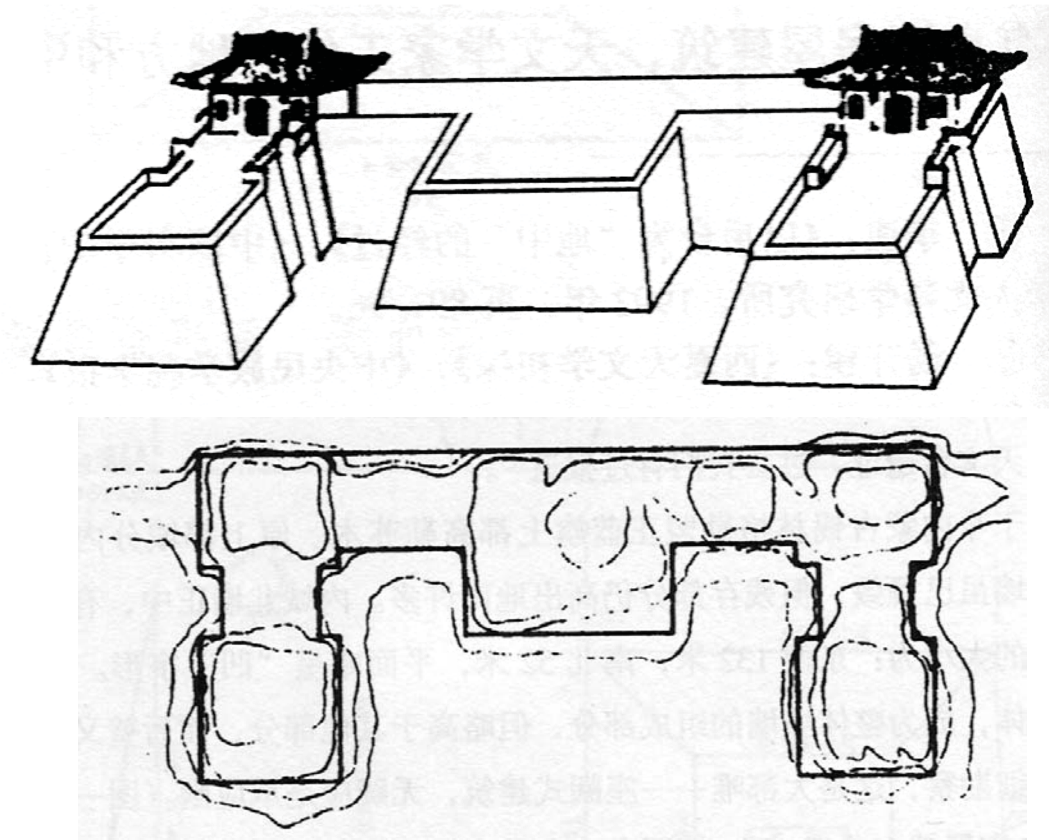


Figure I-5. Huihui Sitian-tai of Yuan Dynasty. (From Lu Sixian and Li Di [4])

I-6. Observation sites on Mt. Namsan 南山 and Mt. Samgak 三角山
Location: Center of Seoul City, Korea
Built: Used irregularly during the Joseon Dynasty (1393-1910)

Information: These mountains had most frequently been used for observation during the Joseon Dynasty because of their locations in the capital city. Mt. Namsan and Mt. Sam'gak are 262 meters and 837 meters above sea level, respectively, and have better views to the southern and northern horizons than does the top of the Royal Observatory in Kyongbok Palace.

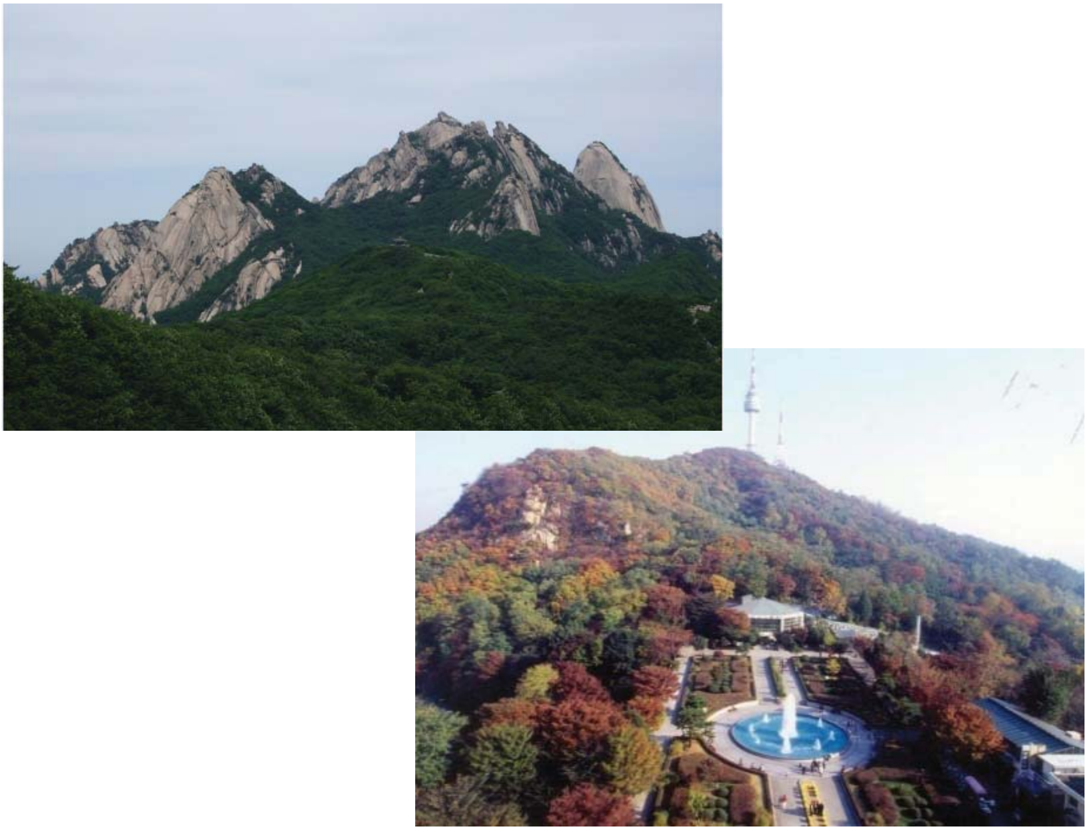


Figure I-6. Views of Mt. Namsan (left) and Mt. Sam'gak (right).

I-7. Observation sites on Mt. Baekdu 白頭山, Ilchool-bong 日出峯 of Mt. Diamond 金剛山 and Mt. Halla 漢羅山

Location: Mt. Baekdu, 2,749 m above sea level on the border between China and North Korea, is the highest peak in North Korea.

Diamond Mountain is in the center of the Korean peninsula facing the East Sea. It is formed of many peaks, among which Ilchul-bong, which literally means the Peak of Sun Rising, was used for observation frequently.

Mt. Halla, 1950 m above sea level, is located in the center of Jeju Island, which is the southernmost territory of South Korea.

Built: No permanent platforms were made and the mountains were used irregularly during the reign of King Sejong of the Joseon Dynasty, Korea

Information: Canopus is a very bright star in the southern hemisphere and is called Old Man in China and Korea. This star was believed to confer power on those who saw it. If someone did see this star, he would live longer and the reign period would be blessed. King Sejong, the fourth king of the Joseon Dynasty, himself wanted to see Canopus but had no success. He sent three groups of observers to four different places: Cheomseong-dan in Kangwha Island in the west as well as Mt. Baekdu in the north, Mt. Diamond near the east coast and Mt. Halla in Jeju Island to the south.

Figure I7/1. Mt. Baekdu holds a big lake surrounded by high peaks.

Figure I-7/2. Mt. Diamond.

Figure I-7/3. The appearance of Mt.

Halla viewed from the south.

II. Observatories recorded only in histories

Searching histories and other documents for astronomical references has uncovered information of 7 astronomical observatories. Many of these observatories played important roles when they were in service.

II-1. Koguryo Cheomseong-dae 高句麗瞻星坮 (Koguryo Observatory)

Location: Pyongyang City, North Korea

Built: In the later period of the Koguryo Kingdom, ca. 5-7 c.

Information:

(1)Record in Annals of the reign of King Sejong [5]:

"There are nine shrines and nine ponds inside the city wall. The shrines are places where stars fell. There is an observatory by the side by one of the ponds."

(2)Record in New Version of the Eastern Kingdom Maps [6]:

"The observatory remains are three miles south of the city."

(3)Pyongyang Jeondo 平壤全圖 (Map of Pyongyang), ca. 1700

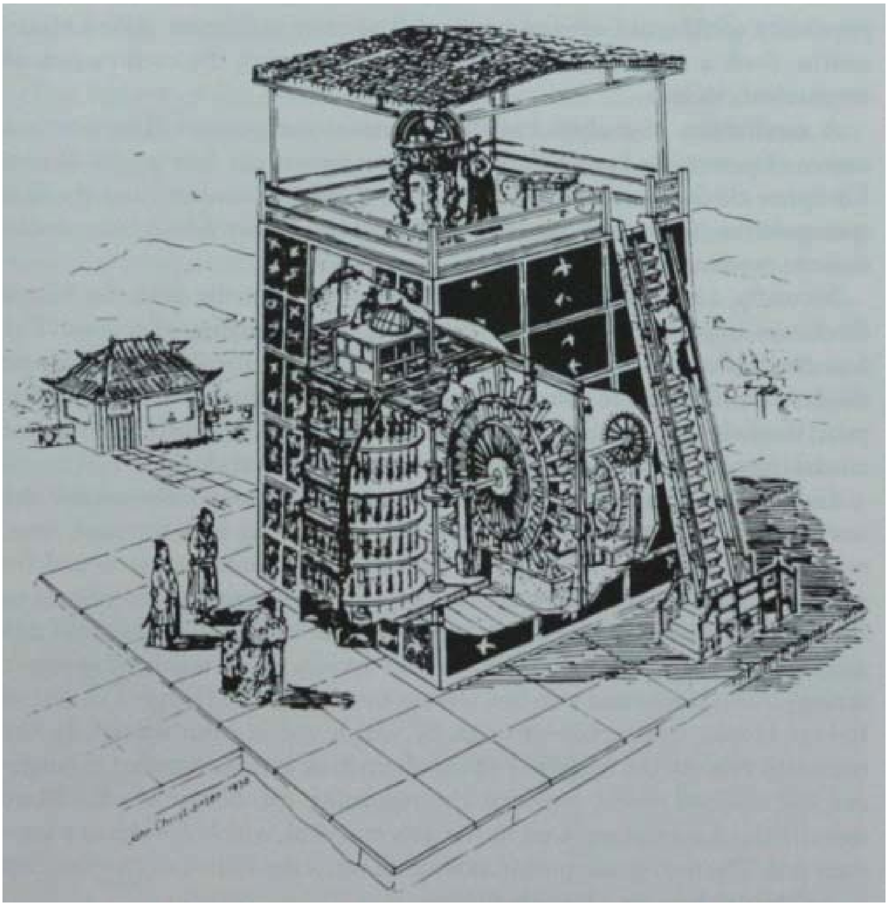
Figure II-1. Part of an old map of Pyongyang.

II-2. Shuiyun Yixiang-tai 水運儀象臺 (Water-driven Astronomical Clock Tower)

Location: Beijing, China

Built: 1086-1093 in the Northern Song 北宋 dynasty

Information: Su Song and Han Gonglian started design in 1086 and finalized completion in 1093. This was a large structure, 12 meters high and 7x7 meters wide, housing two instruments, an Armillary Sphere and a Celestial Globe, and also maintaining a time-announcing



system. The original was destroyed a long time ago, and a recent copy model is displayed at the Chinese History Museum in Beijing.

Figure II-2. A drawing of the Shuiyun Yixiang-tai, the water-driven Astronomical Clock Tower of the Song Dynasty.

It is known that Northern Song had four more observatories in Kaifeng 開封 but no trace of them has been found in any document.

II-3. Shitian-tai 司天臺 (Yuan Beijing Observatory)
Location: Beijing, China
Built: In 1279 designed by Guo Shoujing 郭守敬 and Wang Xun 王恂

Information: The rectangular observatory building was a three-floor structure with dimensions; 17.2 m high, 49.2 m long and 36.9 m wide. On the first floor there were the office of the director (south room), the calendar division (east room), the observation and time service division (west room) and instrument storage (north room). On the second floor, there were the laboratory and library. When not installed on the terraced roof, the instruments were located on this floor. There were also rooms for calendar publication and mathematics. Unfortunately this observatory has been ruined completely leaving no trace of its existence.

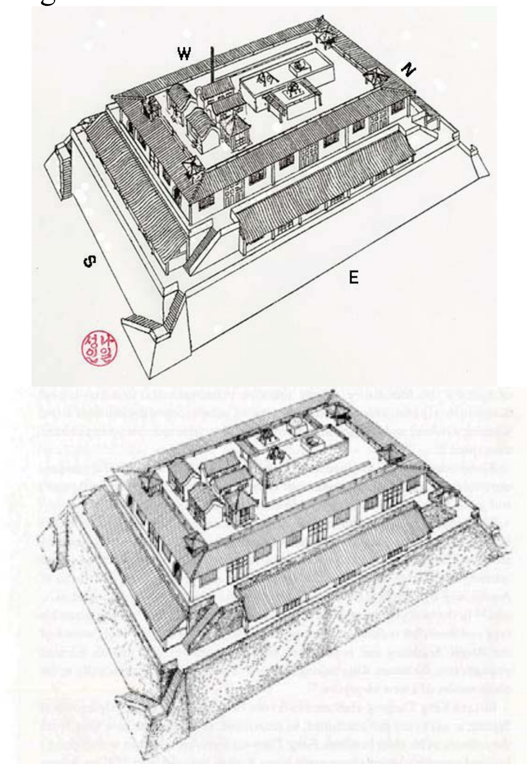


Figure II-3. Two drawings of the Yuan Beijing Observatory seem to have a unique origin because they are nearly identical. However, while the left drawing has a gnomon on the west-side of three instruments on the terraced roof, the right drawing shows a gnomon on the east-side of four instruments. Left sketch is from Li Qibin [7] somewhat altered by one of us (NIS), and the right one is from J. Needham, et al. [8]

II-4. Zhongdu Guanxing-tai 中都觀星臺 (Central Capital Observatory)

Location: Mt. Du-shan 獨山, Nanjing, China
Built: 1372, the fifth year of the first King of the Ming Dynasty
Information: There is a record [9]: "On ren-chen 壬辰 day of the seventh month in the seventh year(1374) of the reign Hongwo 洪武, the astronomical observatory was constructed in the Central Capital.

The director of the Astronomical Bureau Guan Yu 管豫 was sent to administer the facility." But Xu Zhen-tao [11/10] reports an earlier record of Ming *Taizu Shilu* on this observatory that "on Jia-yin 甲寅 day of the seventh month, in the fifth year(1372) of the reign Hongwu 洪武, Emperor ordered the building of an astronomical observatory on the mountain Du-shan 獨山". Regarding the equipment of this observatory he notes that on the top of Du-shan there were several instruments, such as Zuanji Yuheng 璇璣玉衡 (armillary sphere) and Tongpan 銅盤 (possibly a sundial).

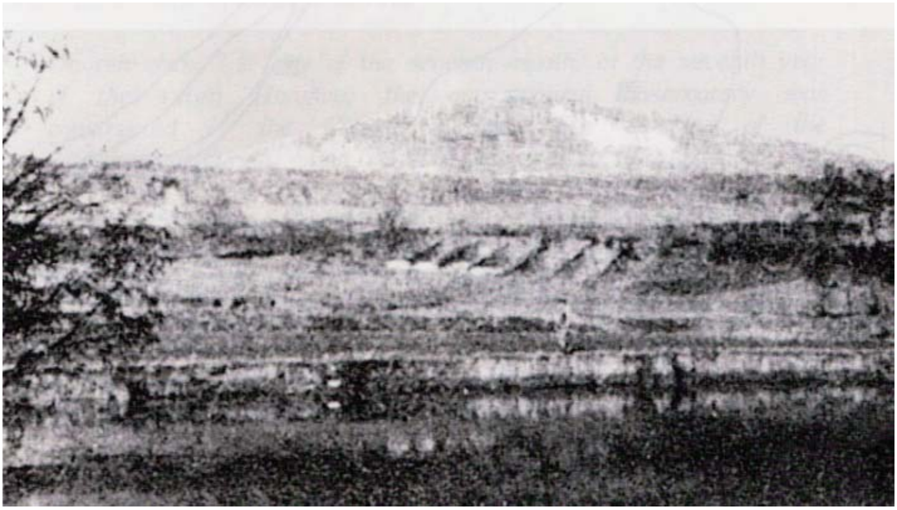


Figure II-4. A view of Mt. Du-shan. (From Xu Zhen-tao)

II-5. Nanjing Qintian-tai 南京欽天臺 (Nanjing Imperial Observatory)

Location: Mt. Jiming-shan 鷄鳴山, Nanjing, China
Built: 1385, the 18th year of the first King of the Ming Dynasty
Information: The official history of the Ming dynasty states that in the 18th year(1385) of the reign Hongwu, the second imperial observatory was built on the Mountain Jiming-shan 鷄鳴山." According to Xu Zhen-tao [11], the official history of the Ming dynasty and Matteo Ricci's book note four individual instruments. These are Hunyi 渾儀

(armillary sphere), Jianyi 簡儀 (simplified armillary), Huxiang 渾象 (celestial sphere) and Guibiao 圭表 (gnomon).

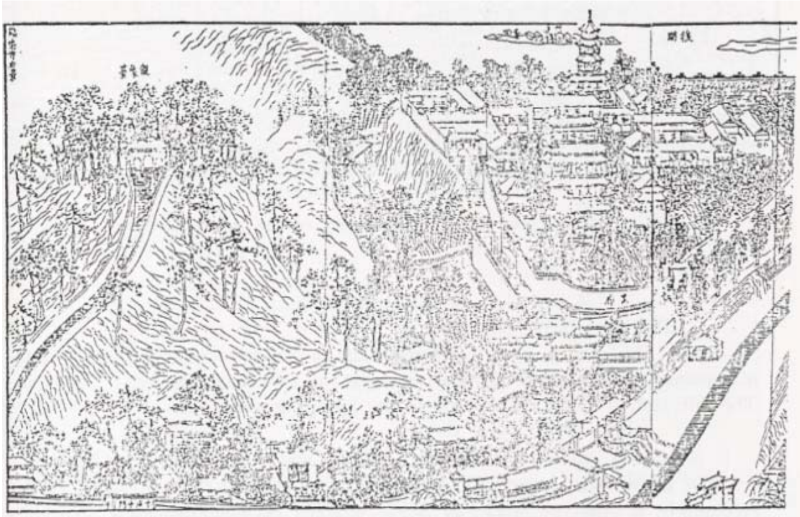


Figure II-5. Nanjing Imperial Observatory. (From Xu Zhen-tao)

II-6. Ganui-dae 簡儀臺 (Simplified Armillary Platform)

Location: In an area on the northern side of the Kyonghoe-ru Pavilion 慶會樓 in Kyongbok Palace 景福宮, Seoul, Korea

Built: In 1433. Sometimes the platform is called Dae-Ganui-dae 大簡儀臺 (Great Simplified Armillary Platform) in order to distinguish it from a number of So-Ganui-dae 小簡儀臺 (Small Simplified Armillary Platforms).

Information: This was the largest structure among all those of the Joseon Astronomical Bureau and was in use for the determination of positions of stars with the Simplified Armillary. But the structure was partly destroyed by Hideyashi Invasion and was demolished completely during the Japanese occupation around 1920.

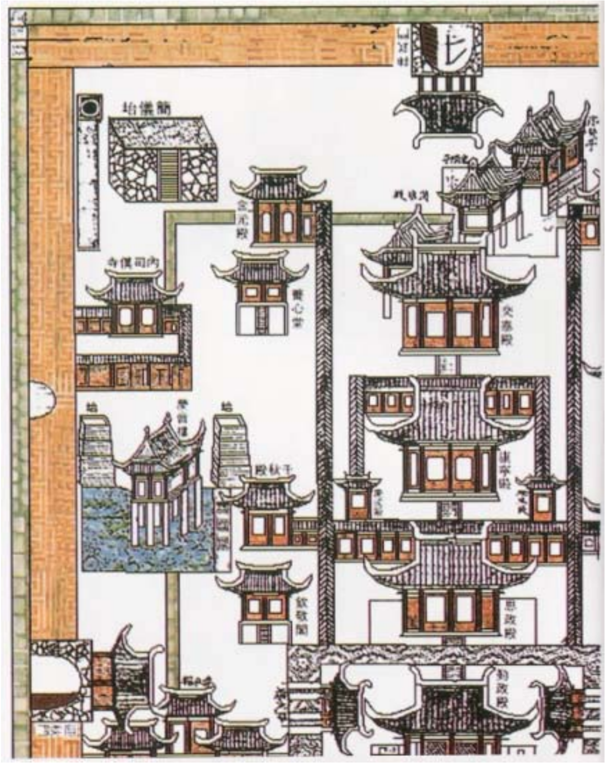


Figure II-6. Ganui-dae(Simplified Armillary Platform). This is a square box-shaped structure as seen on a right side of the long measuring scale of the high gnomon at the north-western corner of this old map of Kyongbok Palace.

II-7. Kyonghee Palace So-Ganui-dae 慶熙宮小簡儀臺 (Small Simplified Armillary Platform in Kyonghee Palace) or Kyonghee Palace Gwancheon-dae 慶熙宮觀天臺 (Small Observatory in Kyonghee Palace)

Location: Outside the Gaeyang Gate 開陽門 of Kyonghee Palace 慶熙宮 in Seoul, Korea

Built: In 1702, the 28th year of King Sukjong's reign. However, the original should have been made much earlier, possibly during King Sejong's reign.

Information: This was the last of three Small Simplified Armillary Platforms close to the Ganui-dae in Kyongbok Palace but was razed completely by the Japanese regime around 1920 when a high school 京城中學校 for Japanese boys was constructed. The other two have survived as is shown later in Figures III-5 and -6.

Figure II-7. A small observatory in Kyonghee Palace and the surrounding buildings in this old map 都城圖 were demolished completely.

III. Surviving observatories

At least six old astronomical observatories in China and Korea are well preserved to-day enhancing their value as cultural monuments.

III-1. Silla Cheomseong-dae 新羅瞻星臺 (Silla Observatory)

Location: Kyongju City, Korea
Built: During the reign period of Queen Seondeok (AD 632-647)

Information: This is a bottle-shaped structure with horizontally-laid cut-stones on a low platform, and is 9 m high. A square opening big enough for an entrance, 95 cm x 95 cm, is made in the south wall through which one can go up to an upper floor. The doubled stone layers on top of the tower (about 2.2 m x 2.2 m) have kept the upper cut-stones from breaking due to age and probably also served as holders for astronomical instruments. The number of cut-stones on the 27 horizontal courses matches (possibly accidentally) the number of days of a tropical year. This is the oldest astronomical observatory remaining today in the world.

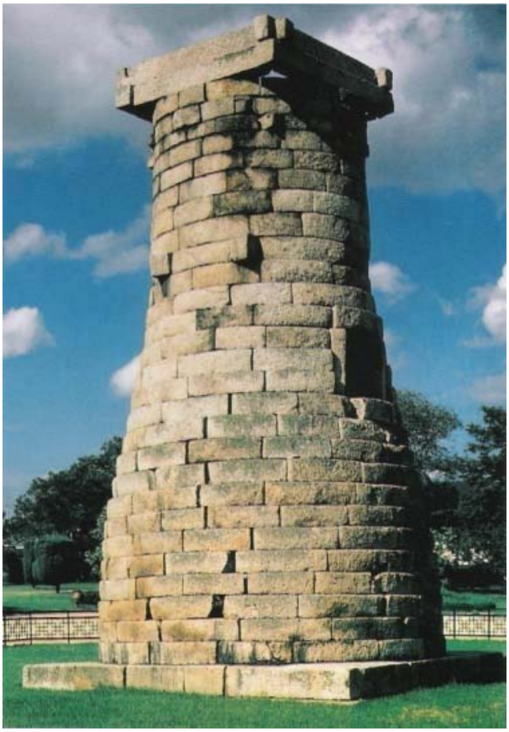


Figure III-1. Silla Cheomseong-dae in Kyongju City

III-2. Dengfeng Ceying-tai 登封測影臺 (Dengfeng Gnomon Observatory) or Dengfeng Guanxing-tai 登封觀星臺 (Dengfeng Observatory)

Location: Dengfeng Gocheng(登封県告成鎮北), Henan Province, China. This is about 1,000 km south-west of Beijing.

Built: The height of the gnomon is 40 yuan-foot(9.46 m) and the length of the north-south horizontal scale is 31.19 m. Note: 1 yuan-foot = 24.5 cm

Information: Dengfen Guanxing-tai is actually a High Gnomon. Bo Shuren [12] states that "in this instrument there are two rooms at the northern part of the top of a tower. Each room has a window facing the other room in an east-west direction. A horizontal wooden bar was originally placed between the two windows at a height of 40 Chinese feet above the face of the gnomon shadow template where the shadow of the gnomon was cast.

Figure III-2. Dengfeng Guanxing-tai in Henan Province

III-3. Yuanzhou Ancient Observatory 袁州古星台 (Yuanzhou Time-Service Station)

Location: Yichun 宜春 (Old name was Yuanzhou 袁州), Jiangxi Provence 江西省, China

Built: Teng Qianshu 滕强恕, a head of Yuanzhou, built this in the Jiading 嘉定 reign period (1208-1224) of the Song Dynasty.

Information: Luan Xin-Li and Bo Shuren [13] claim that it is the oldest extant local astronomical observatory concerned with time measurement. To the west of the center of the old district in the city of Yichun is a street running east-west called Drum Tower Street. In the middle of this thoroughfare is a high building extending across the street from south to north and having a central arch. This building is called the Yichun Drum Tower.

Figure III-3. View of Yuanzhou Ancient Observatory, Drum Tower. (From Luan Xin-Li and Bo Shuren)

III-4. Koryo Cheomseong-dae 高麗瞻星臺 (Koryo Observatory)

Location: West of the Palace Manwol-dae 滿月臺 (Full-moon Palace) in Songdo (the present Kaeseong City), North Korea

Built: The seventh year (1281) of King Choongyeol's reign period. The first floor has a size 3 m x 3 m.

Information: This observatory of the Koryo dynasty was introduced to the western world by Rufus [14]. After long inattention since Rufus's time, Choi and his collaborators have recently investigated it thoroughly [15]. The ceiling, 3m x 3m, is supported by five stone pillars at the four corners and the center. These pillars, 38-cm square and 2.45 meters high, are placed on rectangular stones, each 80-cm x 85-cm.

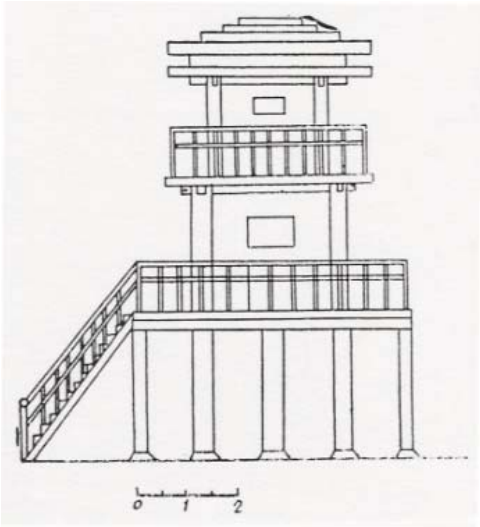


Figure III-4. Koryo Cheomseong-dae. The left is an reconstructed drawing by Choi, *et al*. and the right photo shows the present appearance of the structure.

III-5. Gwangwha-bang So-Gwanui-dae 廣化坊小簡儀臺 (Small Simplified Armillary Platform in Gwangwha-bang) or Gwangwha-bang Gwancheon-dae 廣化坊觀天臺 (Small Observatory in Gwangwha-bang)

Location: Outside the Gumho Gate of Changdeok Palace 昌德宮 in Seoul, Korea

Built: Built in the first part of the 15th century, particularly around 1434 when the Great Simplified Armillary Platform in Kyongbok Palace was under construction [16].

Information: This is the first of three Small Simplified Armillary Platforms close by the Ganui-dae in Kyongbok Palace. They are often called Gwancheon-dae 觀天臺 (Small Observatory). For this platform, dimensions are 3.5 m high and 2.4 m x 2.5 m wide and the stone structure preserves its original shape very well compared to the other two.

Figure III-5. Small Observatory in Gwangwha-bang, Seoul. This was annexed to the Great Ganui-dae in Kyongbok Palace. The left picture shows the present pillar and the right one was taken in 1935 (photo from Rufus [17])

III-6. Changgyong Palace So-Ganui-dae 昌慶宮小簡儀臺 (Small Simplified Armillary Platform in Chang'gyong Palace) or Chang'gyong Palace Gwancheon-dae 昌慶宮觀天臺 (Small Observatory in Chang'gyong Palace)

Location: Changgyong Palace 昌慶宮 in Seoul, Korea

Built: This observatory was built long before the heavy damage caused by the Hideyashi invasion in 1592-1598, but it was rebuilt in the 14th year (1688) of the reign period of King Sukjong, the 19th monarch of the Joseon Dynasty, when Nam Guman 南九萬 constructed the second office of astronomical bureau nearby.

Information: This is the second of three Small Simplified Armillary Platforms, which was near to the Ganui-dae in Kyongbok Palace. The platform has dimensions 3 m high and 2.9 m x 2.3 m wide and has a square stone-base in the center to support a Small Simplified Armillary.

Figure III-6. Small Observatory in Chang'gyong Palace, Seoul

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Two Historical Observatories before Galileo

Nha Il-Seong

Abstract

There are introduced two medieval observatories established before Galileo by Guo Shoujing of the Yuan dynasty of China and by King Sejong of the Joseon dynasty of Korea. The stations functioned two centuries apart in time and their main buildings have vanished leaving no physical traces. Nevertheless, the two observatories shared major instruments made by Guo Shoujing while he was in the position of a Royal Astronomer, and this relationship is acknowledged as the only mutual interaction among historical observatories in the region. *In toto*, 16 of Guo Shoujing's instruments are documented. More instruments were developed by King Sejong's astronomers, and all of these devices are introduced.

Introduction

The present author has surveyed old astronomical observing stations dating from 2000 BC to the 15th century AD in China and Korea. The number of such observatories now known exceeds 25 and the map in Figure 1 shows the location of many of them. Among them all, the establishments of Yuan Taishi-yuan 太司院 (Yuan Astronomical Bureau) and Seoun-gwan 書雲觀 (Joseon Astronomical Bureau) attract particular interest. The former bureau was established during the time of one of the most famous astronomers in Chinese history, Guo Shoujing 郭守敬(1276-1290 as a Royal Astronomer), and the latter during 1433-1441, the reign period of King Sejong the Great 世宗大王(1419-1450). Unlike other Astronomical Bureaus in Chinese and Korean histories, these two, Yuan and Joseon, had a close relationship with respect to their instruments even though they were made two centuries apart.

After Yuan (1206-1368) unified China and the new capital was set at Beijing in 1264, the astronomical bureau Taishi-yuan was then established and the observatory Shitian-tai 司天台 constructed in 1279. Guo Shoujing was in charge of making 16 astronomical instruments, of which 9 were discussed by his assistant Qi Luqian 齊履謙[1].

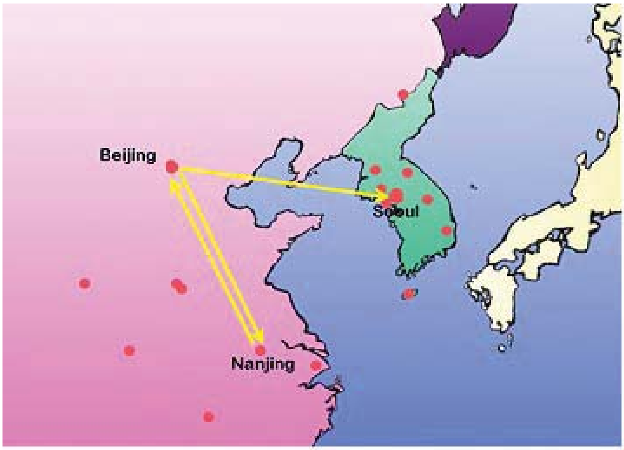

Figure 1. Distribution of old astronomical stations(●) before Galileo in China and Korea. The single yellow arrow indicates the influence of Guo Shoujing's instruments in Beijing on Seoun-gwan in Seoul two centuries later. The interactions between Beijing and Nanjing are described in the text.

The establishments of these observatories may be referenced for many readers by two European highlights, the great scholar Pope Silvester II in the 11th century and Galileo and Kepler in the 17th century. Table 1 shows these four eras that are roughly two centuries apart from the next or the previous one.

Table 1. Four historical eras

11th Century	13th Century	15th Century	17th Century
Pope Silvester II 999-1003	Guo Shoujing 1276[1)]-1290	King Sejong 1425[2)]-1450 + Ulugh Beg 1440[3)]-1449	Galileo Galilei 1609[4)]-1642 + Johannes Kepler 1609[5)]-1630

1) Guo Shoujing nominated as a Royal Astronomer
2) Expansion of Seoun-gwan 書雲觀, Astronomical Bureau
3) Built the 180 foot quardrant
4) Invention of the telescope
5) Published *Commentaries on the Motions of Mars*

Some of Guo Shoujing's instruments, including a Simplified Armillary, were eventually transported to Nanjing, capital city of the newly-born Ming dynasty (1368-1644). This happened around 1374 when the Ming's Central Capital Observatory 中都觀星台 was constructed on Mt. Du-shan 獨山 in the Central Capital. There were, in fact, several instruments, such as an armillary sphere and Tongpan (possibly a sundial) already at Nanjing by that time but Yuan's instruments were badly needed. However, despite intensive work by the Ming astronomers, those measuring instruments could not overcome the latitude difference of $\Delta\varphi \simeq 7°$ between Beijing and Nanjing. They were brought back to Beijing after the Ming capital was relocated to Beijing in 1421. During the course of these moves (about 1,300 km one-way) and because of the mechanical adjustment of component parts for latitude correction, some of the extremely heavy instruments weighing over several tons became damaged and ultimately useless. Finally, Guo Shoujing's instruments were completely melted down and re-cast into new instruments by astronomers of the Ming Astronomical Bureau leaving behind nothing but their

descriptions in Yuan history. It was about this time that King Sejong ordered the construction of instruments for his Astronomical Bureau and the models adopted were those of Guo Shoujing. Therefore, it is fortunate that nearly two centuries later most of Guo's instruments were revived in Korea by the efforts of the king and his astronomers [2]. However, we may, at this point, pose the question of how King Sejong's astronomers and technicians restored many instruments of Guo Shoujing without seeing them in person.
All the instruments of the two astronomical bureaus are listed in Table 2. The second column of this Table lists the names of Guo Shoujing's 16 instruments and the instruments invented by the Korean court astronomers. Columns 3 and 4 are self explanatory. The Romanized form of the name of each instrument is written according to its original Chinese or Korean pronunciation.

Table 2. List of instruments made during two independent periods; AD1276-1290 and AD1433-1441 for China and Korea, respectively.

No.	Chinese or Korean names with English equivalent	Taishi-yuan of China AD1276-1290	Seoun-gwan of Korea AD1433-1441
		Shitian-tai 司天台: Beijing Astronomical Observatory of Yuan	***Ganui-dae 簡儀臺: Observatory Platform for Simplified Armillary***
1	Jianyi 簡儀 Simplified Armillary	Guo's invention	The 1437 copy of Guo's
2	Pole Finder Part of Simplified Armillary	Guo's invention	No record
3	Vertical Revolving Instrument Part of Simplified Armillary	Guo's invention	---

4	Zhengfang-an 正方案 Direction-determining Square Board	Guo's invention	The 1437 copy of Guo's
5	Yangyi 仰儀 Upward-looking Instrument	Guo's instrument	---
6	Xinggui Dingshi-yi 星晷定時儀 Star-and-Sun Time-Determining Instrument	Guo's instrument	The 1437 copy of Guo's①
7	Zhengli-yi 證理儀 Principle-proving Instrument	Guo's instrument	---
8	Riyueshi-yi 日月食儀 Eclipse Instrument	Guo's instrument	---
9	Linglong-yi 玲龍儀 Exquisite Instrument	Guo's instrument	---
		Guanxing-tai 觀星台: ***High Gnomon***	
10	Gao-biao 高表 High Gnomon	Guo's instrument	The 1434 copy of Guo's
11	Jingfu 景符 Shadow Definer	Guo's invention	The 1434 copy of Guo's
12	Observing Table	Guo's instrument	---
		Portable	***Portable***
13	Wan-biao 丸表 Ball Gnomon	Guo's instrument	---
14	Xuanzheng-yi 懸正儀 Correcting-Instrument with Pendulum	Guo's instrument	The 1437 copy of Guo's②
15	Zuozheng-yi 座正儀	Guo's instrument	---

16	Instrument Correcting Base So Ilseong Jeongsi-ui 小日星定時儀 Small Sun-and-Star Time-Determining Instrument	---	Korean invention in 1437
17	Haeng-nu 行漏 Travel Clepsydra	---	Korean invention in 1437
18	Cheonpyong Ilgui 天平日晷 Horizontal Sundial	---	Korean invention in 1437
19	Jeongnam Ilgui 正南日晷 South-fixing Sundial	---	Korean invention in 1437
20	Ok-nu 玉漏 Jade Clepsydra	---	***Humgyong-gak* 欽敬閣*: Hall of Respectful Veneration*** Korean invention in 1437
21	Jagyok-nu 自擊漏 Automatic Striking Clepsydra	---	***Boru-gak* 報漏閣*: Clepsydra Pavilion*** Korean invention in 1433
22	Hunxiang 渾象 Celestial Globe	Guo's instrument	***Honui-Honsang-gak* 渾儀渾象閣*: Small Pavilion for Armillary Sphere* and Celestial Globe** The 1437 copy from Guo's
23	Honui 渾儀 Armillary Sphere	---	The 1437 new design
24	Angbu Ilgui 仰釜日晷 Scaphe Sundial	---	***Other Places*** Korean invention in 1434

25	Chugu-gi 測雨器 Rain Gauge	---	Korean invention in 1441
26	Sinbeob Cheonmun-do新法天文圖 Celestial Planisphere	---	Engraved in 1433

① *Sejong Sillok* has more detail description giving a slightly different name Ilseong Jeongsi-ui (日星定時儀), Sun-and-Stars Time-Determining Instrument.
② Named Hyonju Ilgui (懸珠日晷) in Korean.

Overview of two observatories

Yuan observatory

Taishi-yuan, the Yuan Astronomical Bureau, established during the time of Guo Shoujing (1276-1290), operated one big observatory named Shitian-tai, the Beijing Astronomical Observatory, which was built in 1279. The rectangular observatory building was a three-story structure with dimensions 17.2 m high, 49.2 m long and 36.9 m wide. Li Qibin [3] gives information of how rooms were arranged for specific purposes. According to him, on the first floor there were the office of the director (south room), the calendar division (east room), the observational and time service division (west room) and storage of instruments (north room). On the second floor, there were the laboratory and library. When not in use, the instruments were located on this floor. The instruments were installed on the terraced roof. There were also rooms for calendar publication and mathematics. Nine instruments, Nos. 1-9 in Table 2, were mounted on the terraced roof of this observatory. Some of these are indicated clearly in Figure 2, but unfortunately this observatory has been completely lost leaving no trace of its existence.

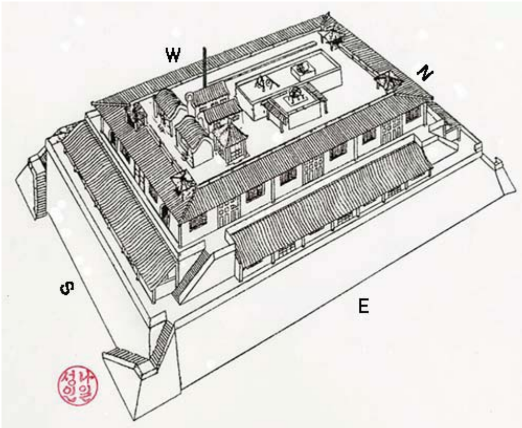

Figure 2. Shitian-tai, Main Observatory of Yuan in Beijing. Li Qibin's sketch has been modified slightly by Nha. There is another sketch by Needham, *et al.*, which is very similar to this one but differs in the number of instruments and the location of the gnomon on the terraced roof [4].

The Yuan Astronomical Board operated another structure too. This is the Dengfeng Observatory, No. 10 in Table 2, in Dengfeng County, Henan Province about 1,000 km south-west of Beijing. Because the structure itself is the gnomon, we will come back to this item when the instruments are explained individually.

Joseon observatories

Although the Yuan Astronomical Bureau operated only the one major observatory in Beijing and the other smaller one in Dengfeng, two centuries later the Joseon Astronomical Bureau ran a number of independent buildings and halls inside and outside Kyongbok Palace in Seoul. As an example, Ganui-dae, the Simplified Armillary Platform (9.5 m high, 14.4 m long and 8 m wide), was positioned in an isolated area on the northern side of a wall of the Kyonghoe-ru Pavilion after its construction in 1433. Its rectangular structure is barely seen on the north-western edge of Kyongbok Palace in a map of the 17th century (see Figure 3). The western section of this palace had many smaller houses and platforms for various instruments here and there as shown in this map. In addition to these, there were at least 4 more observing platforms in other palaces in Seoul (see Figures 5, 6 and 7).

There exists another, more detailed map for Ganui-dai (see Figure 4). In this map, the location of the platform is about the same as in Figure 3 but a high gnomon is sited to its west.

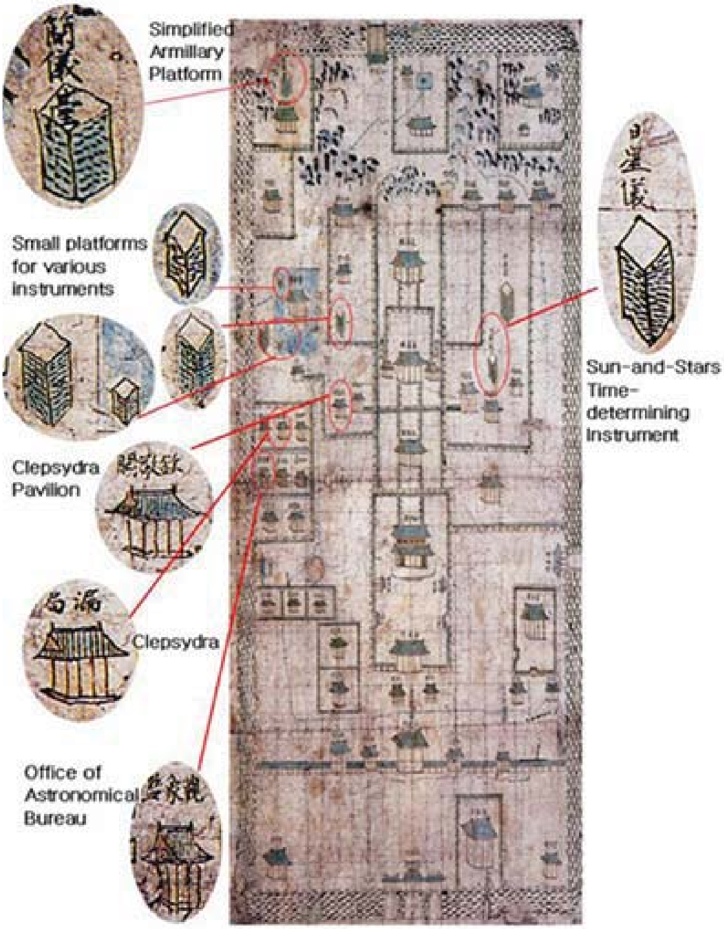

Figure 3. An old map of Kyongbok Palace. The Office of

Astronomical Bureau with four observing platforms around the Kyonhoe-ru Pavilion and two buildings for clepsydras are all located in the west part of the palace. A platform for the Sun-and-Stars Time-Determining Instrument is seen in the east part of the palace grounds.

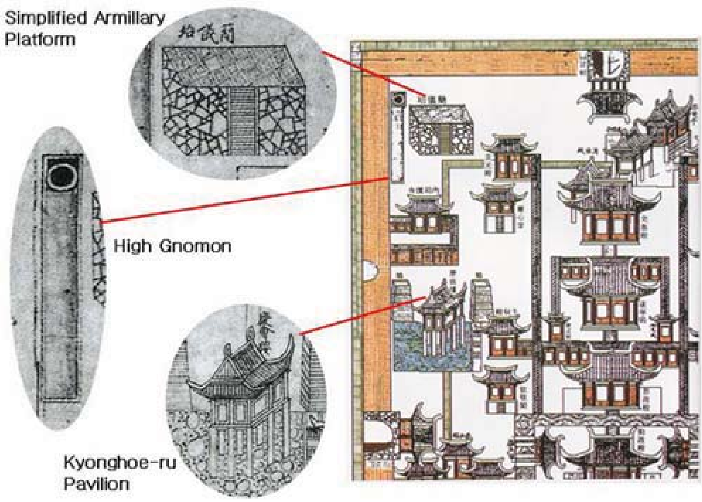

Figure 4. A map of the north-west corner of Kyongbok Palace. The square, box-shaped Ganui-dae, the Simplified Armillary Platform, is illustrated here better than in Figure 3 and is located by the long scale of the High Gnomon at the north-western corner of this map. Two observing towers are located to the sides of the Kyonghoe-ru Pavilion, which itself is inside an artificial pond.

Two small observatories, which were erected during 1433-1440 of King Sejong's reign period, have survived in two other palaces in Seoul. They are customarily called the So Ganui-dae (the Small Simplified Armillary Platform) and the Gwancheon-dae (the Small Observatory) because of their smaller size and because they are near to the Great Ganui-dai in Kyongbok Palace.

These are located east of Kyongbo Palace by about 2-3 km. One of these, seen in Figure 5, is in Changgyong Palace and has dimensions 3 m high and 2.9 m x 2.3 m horizontally for the platform, on which a stone-base for a Small Simplified Armillary is placed in the center.

Figure 5. The Small Simplified Armillary Platform in Changgyong Palace.

The second station, pictured twice in Figure 6, is in Gwangwha-bang just outside the Gumho Gate of Changdeok Palace in Seoul. It has platform dimensions, 3.5 m high and 2.4 m x 2.5 m horizontally, and the structure's original shape is preserved very well.

Figure 6. The Small Simplified Armillary Platform at Gwangwha-bang, Seoul. The left picture shows the present pillar and the right one was taken by Rufus [5] in 1935.

A third situation is known only from a map depicted in Figure 7. Its location was outside the Gaeyang Gate of Kyonghee Palace in Seoul. This structure was built sometime during the 1433–1440 interval and was distant from Kyongbok Palace by about 2 km to the south-west. It also was near Ganui-dae but was razed completely by the Japanese authorities around 1920 when a high school 京城中學校 for Japanese boys was constructed.

Figure 7. A small observatory and surrounding buildings of Kyonghee Palace shown on an old map, Doseong-do 都城圖. All structures have been razed completely.

Astronomical instruments

Selected instruments among the 26 listed in Table 2 are explained individually in the following.

Simplified Armillary: The first instrument in Table 2 is the Simplified Armillary invented by Guo Shoujing; Nos. 2-4 in Table 2 are auxiliary instruments to this one. Therefore, these four make a set for a single observing purpose. The simplified armillary is very heavy, as may be inferred from Figure 8, making it extremely difficult to align on its meridian. The Direction-Determining Square Board (No. 4 in Table 2) had to be set in order to determine the meridian in advance.

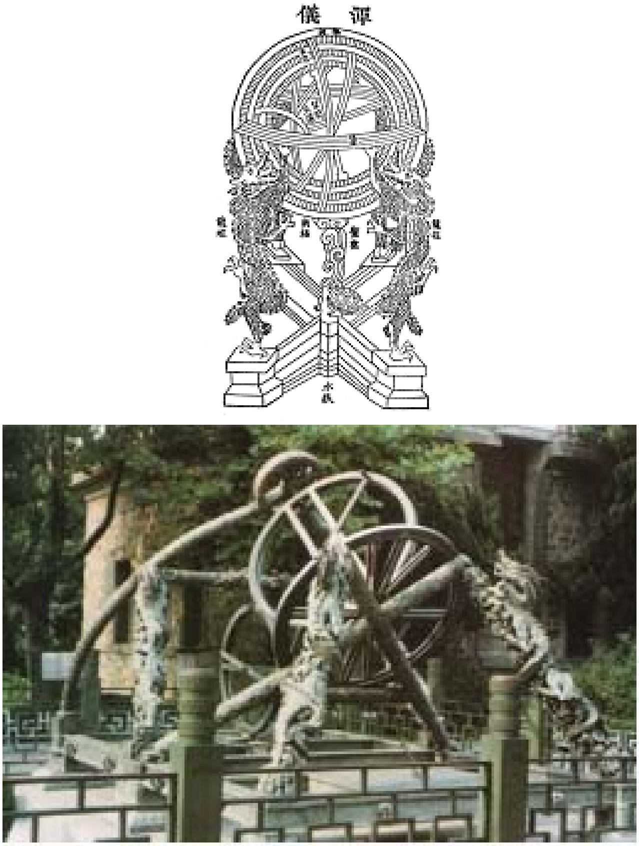

Figure 8. The left drawing is of a traditional armillary sphere from Su Song's model (ca. 1092). At the right is Huangfu Zhonghe's duplicate (1437) of Guo Shoujing's Simplified Armillary, which is now in the Purple Mountain Observatory in Nanjing.

Ilseong Jeongsi-ui, Sun-and-Stars Time-Determining Instrument: Guo Shoujing's Xinggui Dingshi-yi 星晷定時儀 was duplicated during the reign period of King Sejong with a slightly different name. It is a sort of sundial for daytime use and a star-dial at night and a number of these were dispatched to places in the assorted palaces. Its appearance is indicated in Figure 9.

Figure 9. A recent reproduction of the Ilseong Jeonsi-ui 日星定時儀, Sun-and-Stars Time-Determining Instrument from the reign period of King Sejong. The center of an old map of Changgyong Palace (right) shows this instrument mounted on top of a small platform.

High Gnomon: The building which was named Guanxing-tai, Astronomical Observatory, is itself Guo Shoujing's big gnomon of 1277. Its present location is in Dengfeng County, Henan Province, about 1,000 km south-west of Beijing and a photo of it appears in Figure 10. The height of the gnomon is 40-Yuan feet, equivalent to about 9.8 meters.

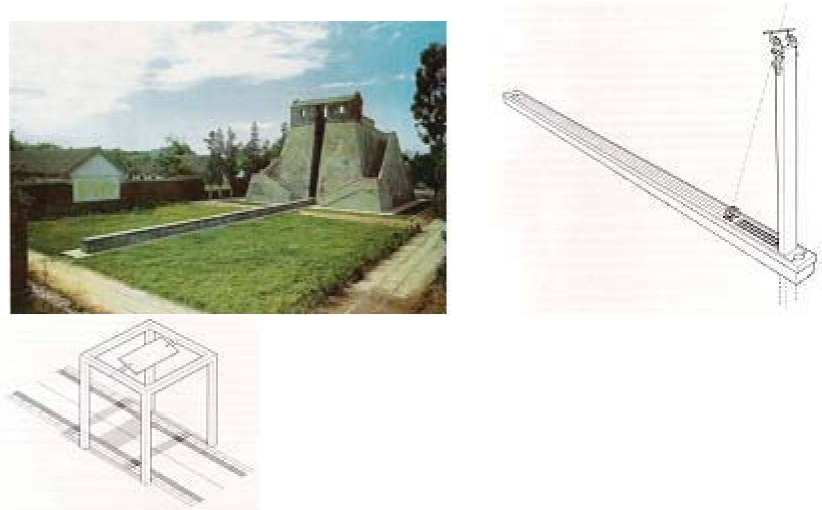

Figure 10. The High Gnomon (left), the Measuring Scale (center), and the Shadow Definer (right) of Guanxing-tai(觀星台) in Dengfeng County. The two drawings are from J. Needham *et al*. [6]. The position of an image of a rod on top of the gnomon can be measured with high precision by the Shadow Definer made of a small copper plate.

King Sejong made a duplicate of Guo Shoujing's second High Gnomon, which was mounted on the terraced roof of Shitian-tai in Beijing (see Figure 2). The Horizontal Scale of King Sejong's gnomon was 126 Joseon feet (about 26 meters) long, and the High Gnomon was 40 Joseon feet (about 8.28 meters) high. King Sejong's gnomon permitted improved leveling of the rod by ditched water and adjusted the orientation of the gnomon by aligning three balls, which can be seen hanging from the rod in the right photo of Figure 11.

Figure 11. A recent reproduction by Nha [7] at 10% scale of the recorded size of King Sejong's High Gnomon is shown (left). The Measuring Scale is 260 cm long and the height of the rod on the gnomon is 70 cm. (1 Yuan foot = 24.5 cm and 1 Joseon foot = 20.7 cm)

Xuanzheng-yi, A Correcting-Instrument with Pendulum: It is not clear whether the Korean Hyonju Ilgui 懸珠日晷 of King Sejong is another name for the Xuanzheng-yi of Guo Shoujing. No detailed statement has been recorded in the Histories of the Yuan Dynasty or in the Annals of the reign of King Sejong to settle this matter. A picture of a copy of the device is shown in Figure 12.

Figure 12. A Korean copy of the Xuanzheng-yi 懸正儀, Correcting-Instrument with Pendulum, by Guo Shoujing. Its Korean name is presumed to be Hyonju Ilgui 懸珠日晷.

Jagyok-nu 自擊漏, Automatic Striking Clepsydra: There is an interesting record of this clepsydra[8], which was made in the 16th year(1434) of King Sejong's reign:

> King Sejong said that the Automatic-Striking Clepsydra is now completed by Jang Yeongsil. Even though it has been done under my supervision, it would have never been possible without him. ……… I have heard that there was an Automatic-Striking Clepsydra also in Shundi reign (1333-1368) of Yuan, but it is my belief that it would not be comparable to Yeongsil's as far as the delicacy of its mechanics and the accuracy of timings are concerned.

The clepsydra, modeled in Figure 13, was a far more complicated device than is commonly known. Water from an upper vessel, trickling down to lower vessels, shook an iron ball into motion, making it drop through an opening to trigger a device that beat a metal drum for the hour and a gong for the minute. The advent of this timepiece was a welcome event for the timekeeper, who often dozed off during the night shift and awakening announced the wrong time.

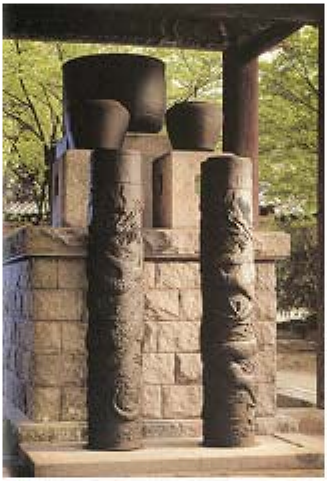

Figure 13. A recent restoration of King Sejong's Jagyok-nu, Automatic Striking Clepsydra, by Nam and his associates [9]. Surviving vessels of the 1536 copy of the original are now in the south-west corner of Deoksu Palace in Seoul (right) and appear in the right photo above.

Celestial Globe: Guo Shoujing's Celestial Globe was lost a long time ago, and the best known old globe is the 1673 one by the Jesuit astronomer Ferdinand Verbiest, S.J. It is now kept at the Beijing Ancient Observatory (see the left side of Figure 14). But this is very different from Guo's original.

On the other hand, King Sejong's Astronomical Bureau maintained an Armillary Sphere and a Celestial Globe together as a pair of instruments. These were housed since 1437 in the Small Pavilion 小閣 to the east of the Simplified Armillary Platform but no longer exist. A modern copy of the globe is shown to the right in Figure 14. Its circumference is 2.25 meters, and it was originally operated by running water so as to rotate exactly once a day. It is a pity, however, that no information survives to indicate exactly how the mechanism worked. Stars were marked on the surface of the globe marked as well as circles for latitude and longitude, the equator and the ecliptic.

Figure 14. The Celestial Globe of 1673 (left) by Verbiest during the Qing dynasty is very different from Guo Shoujing's. The right image is of a recent reproduction of Honsang, King Sejong's 1437 Celestial Globe, by Nha [10], made according to the description in the *Annals of the reign of King Sejong* [11]. It is now in storage at the National Gogoong Museum, Kyongbok Palace.

Armillary Sphere: In Chinese histories there is no record of an Armillary Sphere by Guo Shoujing's because he made his own Simplified Armillary instead. The records about the 1437 Celestial Globe are rather brief and there is no description of an Armillary Sphere, but the name is recorded in the Annals of the reign of King Sejong.

Figure 15. A modern copy of Guo Shoujing's Armillary Sphere 渾儀 from 1439 during the Ming dynasty. The upper-right insert shows Tycho's Armillary Sphere, which resembles the Ming one.

Scaphe Sundial: This sundial, called Angbu Ilgui 仰釜日晷, has a shape like a pot and has inscriptions of twelve double-hour gods for illiterate people. It was made in 1437 for the use of the court observatory but two more were set up in busy places in Seoul, one at Hejeong Bridge and the other in front of the Royal Ancestral Temple. People passing by could measure the shadow of Sun. Because of this, the scaphe sundial won honor as "the first public sundial" in history. This sundial maintains a near-constant shadow length of the pointer on the hemispherical surface throughout the day, and makes time and date determinations possible to high accuracy [12]. Copies of the these are found in Figure 16.

Figure 16. Angbu Ilgui 仰釜日晷, Scaphe Sundial, which was invented in the reign period of King Sejong. At the left is a copy from ca. the late 17th century and at right a recent copy from another model.

Chugu-gi 測雨器, Rain Gauge: After the first Rain Gauge was made successfully in 1441, a well-prepared statement about this device was given in the Annals of King Sejong [13] and many copies were distributed throughout the country to satisfy the king's desire for a good understanding of details about rainfall. The inner diameter of the gauge is 14.45 cm, which is also the average for such vessels in present use world-wide. Early records were burned during the Hideyoshi invasion and rain measurement was discontinued afterward. Something of the appearance of the originals may be seen in Figure 17.

Figure 17. The 1770 stone base (Treasure No. 842) and the 1837 copy (Treasure No. 561) of King Sejong's Rain Guage.

But, fortunately, in 1770 the missing gauges were restored and rainfall measurements resumed. For this reason, Seoul became the city with the longest accumulation of rainfall data and some evidences of this claim may be seen in Figure 18.

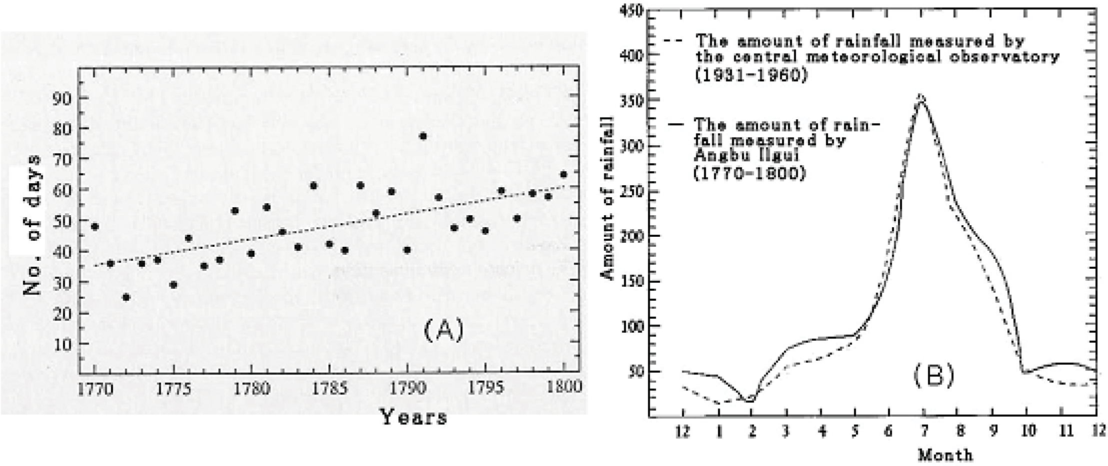

Figure 18. (A) The gradual increase with time of the annual number of rainfall days during 30 years and (B) the record of monthly rainfall in Seoul. In (B) the broken line represents the average monthly rainfall during 30 years of the 20th century and matches well the solid line obtained by the 1770 copy of Chugu-gi during 1770-1800. (A) and (B) are adapted from Nha [14] and [15].

Celestial Planisphere: In 1395, the fourth year of the reign of the first King of the Joseon Dynasty, a celestial planisphere with 1,467 stars was engraved on a large stone slab 211 cm high, 123 cm wide and 12 cm thick. In the 15th year of his reign (1433), King Sejong ordered the engraving of another celestial planisphere on the reverse side of this same stone slab [16]. This image is shown on the left of Figure 19.

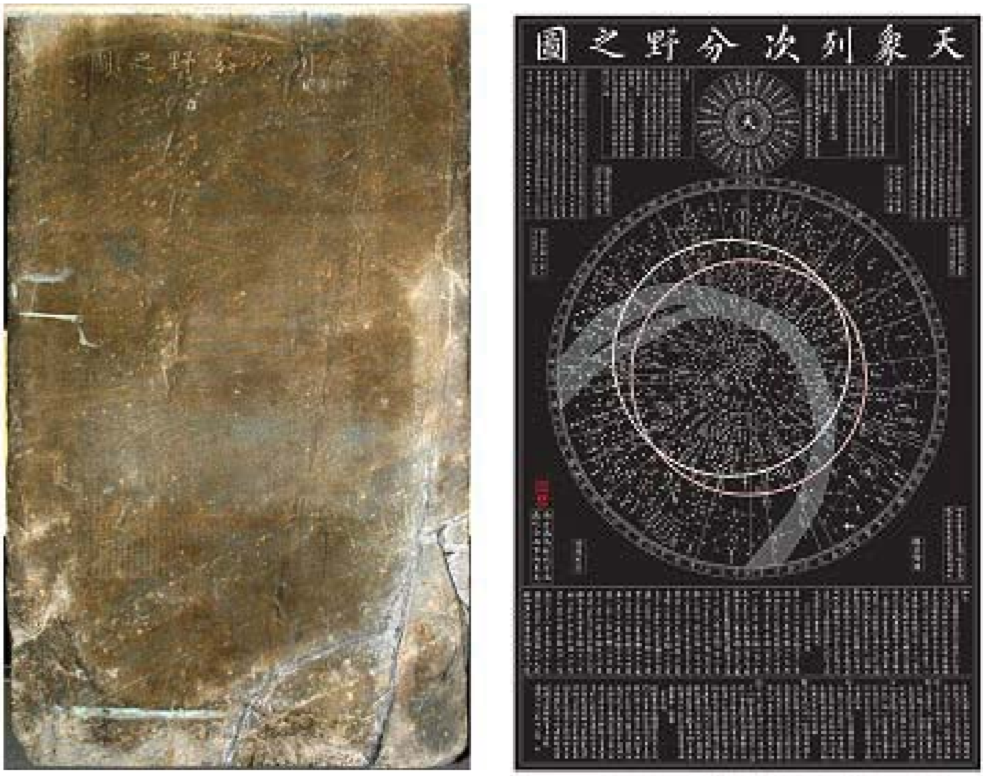

Figure 19. King Sejong's 1433 New Celestial Planisphere, engraved on the reverse side of the 1395 stone slab, is now kept in the National Gogoong Museum 國立故宮博物館 in Kyongbok Palace (left). At right is a recent restoration copy by Nha [17].

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University Press, p. 193, 2000.
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Gerbert of Aurillac and the astrolabe: an open historical problem

Marco Zuccato

Abstract

In this paper I seek to address and refute two arguments presented by Paul Kunitzsch and Julio Samsó against the possibility that Gerbert of Aurillac acquired knowledge of the astrolabe during his sojourn in Catalonia from 967 to 970. According to Kunitzsch studies on the astrolabe did not commence in al-Andalus (and therefore Catalonia) before 978. According to Samsó there is evidence that corroborates Kunitzsch's claim. This evidence emerges from the comparison between a star table (*h'*) included in the Latin *old corpus* on the astrolabe and a lost or still to be found star table compiled by Maslama after 978 of which we have a smaller version in MS, Paris, BNF, ar. 4821, fol. 81v. I show that studies on the astrolabe did commence in al-Andalus before 978 and that *al-Battānī zīj*, which was circulating in al-Andalus before 978, suffices to explain the derivation of *h'*. Therefore, the hypothesis of a lost or still to be found star table compiled by Maslama after 978 is redundant. I conclude that, that since the astrolabe was known and studied in al-Andalus before 978, the possibility that Gerbert acquired knowledge of the astrolabe in 967-970 is still open.

Introduction

In an article published in 1997, Paul Kunitzsch set forth an argument which seemed to offer a final solution to the thorny problem of whether Gerbert of Aurillac absorbed elements of Arabic science during his sojourn in Catalonia (967-970) and

Gerbert's alleged authorship of *De Utilitatibus astrolabii*,[1] one of the earliest Latin works on the astrolabe partially derived from Arabic sources, which is sometimes ascribed to Gerbert.[2] This work is included in an *old corpus* of texts related to the use and construction of the astrolabe the *quadrans vetustissimus* and the solid sphere.[3]
The German scholar claimed that the year 978 should be considered the *terminus post quem* for the introduction of the study of the astrolabe in al-Andalus. According to a reference included in MS Paris, BNF, ar. 4821, fol. 81v, in this year Maslama al-Majrīṭī compiled a star table which is directly connected to his studies on the astrolabe. It is the work of the school of Maslama that infused an interest in this astronomical instrument among Latin scholars.[4] Thus, there is a clear connection between the works on the astrolabe made by Maslama and his school and the Latin *old corpus*. Since we know that Gerbert resided in Catalonia from 967 to 970, it follows that he could not have absorbed any knowledge of Arabic science then because at that time studies on Arabic

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[1] KUNITZSCH, P., "Les Relations Scientifiques entre l'Occident et le Monde Arabe a l'époque de Gerbert", in *Gerbert l'Européen, Actes du colloque d'Aurillac 4-7 juin 1996*, Société des letters, sciences et arts "La Haute-Auvergne", Mémoires, 3, 1997, pp.193-203.
[2] BUBNOV N., *Gerberti postea Silvestri II papae opera mathematica (972-1003),* Berlin, 1899 (reprinted Hildesheim, 1963), p. 109 n.1, 112-113.
[3] On this corpus see in particular BUBNOV N., *Gerberti postea Silvestri II…*, MILLAS VALLICROSA, J.M., *Assaig d'història de les idees fisiques I matemàtiques a la Catalunya medieval*, Barcelona, 1931, and VAN DE VYVER, A. "Les premières traductions latines (Xe-XIe s.) de traits arabes sur l'astrolabe", in *Premier Congrès International de Géographie Historique,II: Mémoires*, Bruxelles, 1931, pp. 266-290.
[4] "Dans ce contexte, il traita aussi des problems de l'astrolabe ; une table d'étoiles établie de sa main date de 978. On peut penser que c'est bien le travail de Maslama et de son école sur l'astrolabe (dont le rayonnement se fit sentir jusqu'en Catalogne chrétienne) qui suscita l'intérêt des clercs latins de cette région pour cet instrument." In KUNITZSCH, P. , "Les Relations Scientifiques…", p. 196.

astrolabes had not begun yet.[5] Later, Gerbert tried to acquire some information from his Catalan correspondent on a portion of Arabic science that filtered to Catalonia (this emerges from the letter written to Lupitus Barchinonensis in 984)[6], but nonetheless even after 984, we find no traces of any Arabic influence in Gerbert's authentic writings.[7]
The argument presented by Paul Kunitzsch seemed particularly strong, especially when corroborated by additional evidence presented by Julio Samsó in an article published in 2000 in the volume of the Festschrift in honor of Paul Kunitzsch.[8] Samsó compared a star table included in the treatise *De mensura astrolabii* (named *h'* by Millàs Vallicrosa), a text of the Latin *old corpus* on the astrolabe, and a star table compiled by Maslama which appears in MS, Paris, BNF, ar. 4821, fol. 81v.[9] He concluded that "the star table of text *h'* derives from an Arabic original belonging to the school of Maslama, although not precisely from the extant star table compiled by Maslama

[5] "Cependant, il est vraisemblable qu'à cette époque les études d'astrolabes arabes n'y avaient pas encore commencé (la table d'étoiles de Maslama date de 978!)", KUNITZSCH, P. , "Les Relations Scientifiques…", p. 199.

[6] "Licet apud te nulla mea sint merita, nobilitas tamen ac affabilitas tua me adducit in te confidere, de te praesumere. Itaque librum de astrologia translatum a te mihi petenti dirige, et si quid mei voles in reconpensationem indubitate reposce," this is letter 24 in HAVET, J. *Lettres de Gerbert (983-987), publiées avec une introduction et des notes* (Paris, 1889). The English translation is by PRATT LATTIN, H. *The letters of Gerbert with his papal privileges as Sylvester II* (New York, 1961), p. 69

[7] "Gerbert n'est donc sans doute pas entré en contact avec la science arabe à Ripoll. Plus tard, il a manifestement essayé de s'informer sur elle (nous pensons à sa letter de 984 à Lupitus), mais aucune repercussion ne peut en être décelée dans ses écrits authentiques", KUNITZSCH, P. , "Les Relations Scientifiques…", p. 199.

[8] SAMSÓ, J. "Maslama al-Majrīṭī and the Star Table in the Treatise *De mensura astrolabii*", in *Sic Itur ad Astra, Studien zur Geschichte der Mathematik und Naturwissenschaften. Festschrift für den Arabisten Paul Kunitzsch zum 70. Geburstag. Herausgegeben von Menso Folkerts and Richard Lorch*, Harrassowitz Verlag, (Wiesbaden, 2000); pp. 506-522.

[9] For these star tables see SAMSO, J. "Maslama al-Majrīṭī and the Star Table…", pp. 516-522.

himself which I have used for the comparison: the original table had a minimum of 27 stars and it contained all the necessary elements to project those stars on the rete of an astrolabe."[10] The Catalan scholar believed that this "hypothetical table may have been compiled after the end of the year 367/978 if one accepts the reference in MS Paris, BN, ar. 4821, fol. 81v, which states that Maslama's table (type Ia) derived from observations made by our astronomer in that year".[11] Therefore "this could also give us a *terminus post quem* for the star table in text h'. The argument has been used by Kunitzsch, who believes that Gerbert of Aurillac, who stayed in Ripoll between 967 and 970, could not have been aware, at that time, of the texts of the 'Old Corpus' which probably reached him at a later date."[12]

The arguments presented can be summarized as follows: There is no evidence that studies on the astrolabe began in al-Andalus before the end of 978. Knowledge of the astrolabe reached the Latin West (Catalonia) through al-Andalus. Therefore, studies on the astrolabe in the Latin West could not have commenced before the end of 978. Thus, Gerbert could not have acquired any knowledge of the astrolabe during his sojourn in Catalonia (967-970).

The star table *h'* is derived from an Arabic star table (lost or still to be found) compiled by Maslama (or one of his disciples) after 978. Table *h'* is part of a treatise included in the Latin *old corpus* on the astrolabe (i.e. *De mensura astrolabii*). From this clue we can assume that the Latin *old corpus* on the astrolabe must have been compiled after 978. Therefore, Gerbert could not have acquired any knowledge of the *old corpus* on the astrolabe during his sojourn in Catalonia (967-970).

In this paper I aim to show that (a) is incorrect because based on partial information and (b) is both based on wrong assumptions and logically flawed. I conclude that the year 978 can no longer be considered a *terminus post quem* for the introduction of studies on the astrolabe in al-Andalus (and Catalonia).

[10] SAMSÓ, J. "Maslama al-Majrīṭī and the Star Table…", p. 512.
[11] SAMSÓ, J. "Maslama al-Majrīṭī and the Star Table…", p. 513.
[12] Ibid.

Therefore, the possibility that Gerbert acquired knowledge of the astrolabe during his sojourn in Spain (967-970) remains open.

The astrolabe in al-Andalus before 978

We possess good evidence that knowledge and use of the astrolabe was present at the Caliphal court of Cordoba during the reign of al-Ḥakam al-Mustanṣir bi-llāh (961-976). Indeed, Marie Geneviève Balty-Guesdon, in her unpublished doctoral thesis,[13] reports that the servant of al-Ḥakam (Ǧāriyat al-Ḥakam) “had acquired knowledge of calculus, but, as it seems, focused on astronomical computations”[14] i.e. “the use of the astrolabe”[15]
Therefore, since al-Ḥakam al-Mustanṣir bi-llāh reigned from 961 until 976, it necessarily follows that the astrolabe was known and used at the Caliphal court of Cordoba before the year 978. Furthermore, as I will explain below, the possibility that Maslama’s school began studies related to the astrolabe no sooner than the end of 978 is also quite unlikely. But even if this were the case, in the light of the above-mentioned testimony, it is clear that the statement of Paul Kunitzsch that “il est vraisemblable qu’à cette époque les études d’astrolabes arabes

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[13] Marie G. BALTY-GUESDON, *Médecins et hommes de sciences en Espagne Musulmane (IIe/VIIIe-Ve/XIe s.)*, Thèse pour le doctorat (arêté du 23 novembre 1988), Présentée par Marie Geneviève Balty-Guesdon sous la direction de Mohammed Arkoun, Universite de La Sorbonne Nouvelle – Paris III. 3 vols (unpublished doctoral thesis: Paris, 1992).

[14] “L’autre, appellée par les biographes La servant d’ al-Ḥakam (Ǧāriyat al-Ḥakam) (I,2 122) apprit aussi le calcul, mais, semble-t-il, plutôt du point de vue du calcul astronomique”. Balty-Guesdon, *Médecins et hommes de sciences…, p. 405.*

[15]“ Ǧāriyat al-Ḥakam. SCIENCES : ASTRON : ta’dīl, usage de l’astrolabe. DATES : étudie sous al-Ḥakam. ACTIVITES : Cordue. PROFESSION, CHARGES : au service d’ al-Ḥakam. MAITRES, ELEVES : MTR : Sulaymān ibn Aḥmad ibn Sulaymān al-Anṣārī (ta’dīl et usage de l’astrolabe). SOURCES : IAB 68 , DT VIII 285.” BALTY-GUESDON, *Médecins et hommes de sciences…,* p. 635.

n'y avaient pas encore commencé (la table d'étoiles de Maslama date de 978!)"[16] is incorrect and, as such, no longer tenable. [17]

Al-Battānī zīj in al-Andalus before 978.

The two star tables that Julio Samsó compared in the above-mentioned article present a number of differences. Table *h'* offers for each star the values for the *latitudo* and *altitudo.*[18] The version of Maslama's table in MS Paris, BNF, ar. 4821, give us for each star the values of the mediation and the declination as well as longitude and latitude. Furthermore, table *h'* includes twenty seven stars whereas Maslama's table includes twenty one stars. Samsó compared the values of the *latitudo* in *h'* with the values of the mediation in Maslama's table for seventeen stars and he obtained the following: a perfect coincidence in two cases, a correct rounding in eight cases, truncation in one case, difference of 1° in four cases, difference of 2° in one case and difference of 5° in one case, that is the star Qalb al-Asad (α Leonis).[19] He then compared the tabular values of the *altitudo* of the two tables through a recomputation and he obtained the

[16] KUNITZSCH, P. , "Les Relations Scientifiques…", p. 199.

[17] It should be added that a Latin astrolabe, most likely derived from an Arabic model, was circulating in Catalonia during the tenth century. This is the Destombes' astrolabe which is currently kept at the Institute du Monde Arabe in Paris. It seems that this astrolabe should be dated to the second half of the tenth century, even though it is not possible to establish the exact date of its construction. On the Destombes Astrolabe see Marcel Destombes, "Un astrolabe carolingien et l'origine de nos chiffres arabes," *Archives internationales d'histoire des sciences* 15 (1962), 3–45; and the large collection of studies in *Physis* 32 (1995), 191–450. See also Julio Samso´ , "El astrolabio 'carolingio' de Marcel DESTOMBES y la introduccio´n del astrolabio en la Catalunya medieval," in *Els astrolabis de la Reial Acade`mia i la cie`ncia a la Catalunya medieval,* Memorias de la Real Academia de Ciencias y Artes de Barcelona, 3rd ser., 60/10 (Barcelona, 2003), pp. 345–56.

[18] Julio SAMSó used the version of the table *h'* which appears in MS Paris BNF 7412, fol. 5v, which, he claimed, is the oldest version of this table. Another version of the table *h'* that appears in MS ACA Ripoll 225 includes values for the *altitude* which differ from the version of the Paris manuscript.

[19] SAMSó, J. "Maslama al-Majrīṭī and the Star Table…", p. 511.

following: seven stars can be considered “rounding cases”, one star can be considered a “special case” that, because of a “graphical metathesis” eventually could be also considered a “rounding case”, a difference of 1° in five cases, a difference of 2° in one case, a difference of 3° in one case, a difference of 4° in one case and a difference of 6° in one case.[20]
As we have seen, Samsó hypothesized the existence of an “original table belonging to the school of Maslama” which “had a minimum of 27 stars and it contained all the necessary elements to project those stars on the rete of an astrolabe” to explain the derivation of *h’*.[21] However, the Catalan scholar pointed out that this hypothetical table would derive from *al-Battānī zīj.*[22] This claim, in particular, is based on good evidence. First, MS Paris, BNF, ar. 4842, fol. 81v reads that Maslama made his observations towards the end of the year 367/978 “according to the method of al-Battānī”. Second, when we compare Maslama’s longitudes and latitudes for his twenty one stars with those included in al-Battānī’s table, we observe that: (a) the latitudes are the same (except for a few mistakes) and (b) the longitudes are obtained, in most cases, by adding a precessional constant of 1;30° to the longitudes of al-Battānī.[23] Therefore, Samsó argued quite convincingly that this precessional constant was also derived from al-Battānī.[24] The only significant difference emerges from the analysis of the precessional constant that Maslama used for the stars al-Ghumayṣā’ (α Canis Minoris) and Qalb al-Asad (α Leonis): here the value of the precessional constant becomes 1;40°. This agrees too well with Ibn al-Zarqālluh’s testimony that Maslama observed Qalb al-Asad in 367/978 and he obtained the longitude of 135;40°, that is exactly the same that we find in Maslama’s

[20] SAMSÓ, J. “Maslama al-Majrīṭī and the Star Table…”, pp.511-512.
[21] SAMSÓ, J. “Maslama al-Majrīṭī and the Star Table…”, p. 512.
[22] SAMSÓ, J. “Maslama al-Majrīṭī and the Star Table…”, p. 513.
[23] Ibid.
[24] Ibid.

table[25] .
Therefore, to summarize what expounded above, we know that Maslama relied on *al-Battānī zīj* for compiling his star table and that he probably made observations of Qalb al-Asad and perhaps also al-Ghumayṣā' towards the end of 978. Thus, from these observations he obtained a slightly different value of the precessional constant which he applied only to the two above-mentioned stars, keeping the value 1;30° for the other stars, possibly unwilling to contradict al-Battānī's authority. This, however, leads to the following considerations.
First, *al-Battānī zīj* was certainly circulating in al-Andalus in 978 and we have no indication that this work was not available to Andalusian scholars before that date. In fact, it is reasonable to believe that *al-Battānī's zīj* and its star tables were circulating in al-Andalus before 978 and that it was the study of that text that drove Maslama to make some astronomical observations, probably in order to corroborate the data included in *al-Battānī's zīj*.[26]
Second, even if we concede that Maslama observed Qalb al-Asad and possibly al-Ghumayṣā' towards the end of 978 and acquired new astronomical values for these two stars which he inserted in his table, we find no echo of all this in table *h'*. For instance, the difference in *latitudo* for the star Qalb al-Asad when we compare Maslama's table and *h'* amounts to 5°.[27] This is the largest discrepancy we find when comparing the *latitudo* of seventeen stars appearing in the two tables. As for the values of *altitudo* we have a "rounding case" for Qalb al-Asad and a discrepancy of 1° when comparing the altitudes of al-

[25] MILLAS VALLICROSA, J.M., *Estudios sobre Azarquiel*, (Madrid-Granada, 1943-50) pp. 309-310.
[26] This agrees also with what Julio SAMSó claimed elsewhere that al-Battānī's work was introduced in al-Andalus in the second half of the tenth century, with no mention of the *terminus post quem* of the year 978. See, SAMSó, J. *Las Ciencias de los Antiguos en Al-Andalus,* colleciones Mapfre (Madrid, 1992), p.92, : "Ptolomeo y al-Battānī debieron introducirse en al-Andalus en la segunda mitad del siglo X…".
[27] SAMSó, J. "Maslama al-Majrīṭī and the Star Table…", p. 511.

Ghumayṣā’ in the two tables.[28] If the author of *h’* was copying the values from Maslama’s table, then why do we have such discrepancies?
Furthermore an additional consideration should be put forward concerning the logical inconsistency of the above-mentioned argument (b). The treatise *De mensura astrolabii* that includes table *h’*, represents just a small portion of the texts included in the Latin *old corpus* on the astrolabe, and there is no evidence that it is the oldest treatise of the corpus. In fact, no evidence stands against the hypothesis that the other texts of the corpus were compiled before 978 and *De mensura astrolabii* could represent just a later addition to the corpus (perhaps dated to the eleventh century).

Conclusions

The astrolabe was used and studied in al-Andalus already during the reign of al-Ḥakam al-Mustanṣir bi-llāh (961-976).
This invalidates *tout court* Paul Kunitzsch’s statement that studies on the astrolabe began in al-Andalus after 978. Sometimes in the second half of the tenth century *al-Battānī zīj* arrived in al-Andalus, and it is likely that Maslama al-Majrīṭī possessed a copy of this work. It is also possible that a copy of *al-Battānī zīj* was first acquired for the library of al-Ḥakam al-Mustanṣir bi-llāh, a well known bibliophile who is credited to have created a library in Cordoba which included around 400.000 volumes.[29]
Perhaps in order to check some astronomical data included in *al-Battānī zīj*, Maslama made astronomical observations around the end of the year 978 “according to the method of al-Battānī” and -according to Julio Samsó- he compiled a star table of 27 stars in the same year. This table is now lost or still to be found but we have an echo of it in a smaller star table of 21 stars that appears in MS Paris, BNF, ar. 4821, fol. 81v.
Star table *h’* includes 27 stars, Maslama’s extant star table

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[28] SAMSÓ, J. “Maslama al-Majrīṭī and the Star Table…”, p. 512.
[29] See SAMSÓ, J. *Las Ciencias de los Antiguos en Al-Andalus*, pp. 46-47.

includes 21 stars. Of these, only 17 stars can be compared in the two tables. Nonetheless, Samsó claimed that there is a connection between table *h’* and a hypothetical star table of 27 stars compiled by Maslama after 978. It is clear that most of the data of Maslama’s table are derived or can be calculated from the information included in *al-Battānī zīj*, except for the longitudes of two stars: Qalb al-Asad and al-Ghumayṣā’. In 978 Maslama observed these two stars to collect new astronomical values that he inserted in his star table. However, there is no firm evidence that Maslama’s astronomical values for Qalb al-Asad and al-Ghumayṣā’ passed in star table *h’* . In fact, the astronomical values for these two stars present some discrepancies in *h’* when compared to Maslama’s extant star table of 21 stars. Therefore, I believe that *al-Battānī zīj* would be enough to explain the derivation of *h’* and the hypothesis concerning the existence of a lost or still to be found star table compiled by Maslama after 978 is redundant. As we have seen, it is very likely that *al-Battānī zīj* was circulating in al-Andalus before 978.

De mensura astrolabii that includes table *h’*, is just one of the texts of the *old corpus*. Even if one accepted that this treatise was composed after 978, this would not imply that the whole *old corpus* was compiled after 978.

Therefore, the year 978 can no longer be considered a *terminus post quem* for the introduction of studies on the astrolabe in al-Andalus and Catalonia. As a result, Gerbert might have acquired knowledge of the astrolabe during his stay in Catalonia between 967 and 970.

Imago Gerberti.
Un esemplare inedito della collezione numismatica Barberini*
Daniela Velestino

Il "piombo" Barberini

Nel Medagliere dei Musei Capitolini è conservata un'effigie di Silvestro II su tondello di piombo. Si tratta di un esemplare del diametro di 41 mm e di gr. 40,18 di peso, che raffigura sul dritto il papa rivolto a destra con piviale; sul bordo corre l'iscrizione *SILVESTER. II. P(ontifex). M* (*aximus*) (fig. 1)*,* il retro è liscio (fig. 2); la scabrosità della superficie ci induce a pensare ad un oggetto fuso e non realizzato tramite conio.

Figg. 1 e 2. Il "piombo" della collezione Barberini, dritto e rovescio (foto autrice).

L'immagine del Papa è quella di un uomo ormai avanti negli anni, con una capigliatura ridotta a pochi ciuffi di capelli sulla nuca, con un collo quasi taurino; l'arcata sopracciliare è ben evidenziata da sopracciglia folte e lunghi baffi scendono sulla barba a punta.

Questo “piombo” appartiene alle collezioni del Museo di Roma a Palazzo Braschi ed è contraddistinto dal n. d’inventario MR 6828. L’Amministrazione Comunale lo acquistò nel 1961 dalla principessa Henriette Barberini insieme ad uno splendido mobile medagliere in noce, tuttora esposto a Palazzo Braschi, con altre 228 monete, medaglie e “piombi” della nobile famiglia[1]. Nel 1976 l’esemplare fu trasferito in deposito nel Medagliere Capitolino[2], insieme ad alcune medaglie e “piombi” della medesima collezione[3].

I cosiddetti “piombi” Barberini del Medagliere Capitolino si riferiscono a pontefici vissuti tra l’VIII ed il XVII sec.[4] e a personaggi illustri, tra cui Martin Lutero, Alessandro Farnese, Sigismondo Pandolfo Malatesta, Massimiliano II d’Asburgo ed Emanuele Filiberto di Savoia[5].

Il documento numismatico di Silvestro II che qui presento non è stato finora oggetto di studio ed anche una sua precisa definizione tipologica può comportare incertezze.

In un lavoro recente sulla collezione numismatica di famiglia Francesca Barberini[6] tratta nel complesso l’argomento

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[1] *Museo di Roma, Acquisti* in *Bollettino dei Musei Comunali di Roma*, VIII, 1961, p. 51.

[2] Inv. MC. 11660, cassaforte 9, cassetto 19.

[3] Inv. MR nn. 6638-6866; per queste notizie ringrazio la collega Cristina Molinari che ha eseguito il riscontro inventariale del medagliere Barberini.

[4] Stefano III (768-772), Adriano I (772-795), Stefano VII (929-931), Giovanni XI (931-935), Giovanni XIV (983-984), Eugenio III (1145-1153), Adriano V (1276), Niccolò III (1277-1280), Giovanni XXII (1316-1334), Clemente VI (1342-1352), Urbano VI (1378-1389), Eugenio IV (1431-1447), Sisto IV (1471- 1484), Leone XI (1605). Sono tutti esemplari uniface tranne i pezzi riferibili a Giovanni XXII, Clemente VI e Leone XI.

[5] Anche questi esemplari in piombo sono uniface, eccetto quello di Massimiliano II.

[6] F. BARBERINI, *Lo studio delle medaglie: interessi numismatici nel collezionismo Barberini* in L. MOCHI ONORI, S. SCHUTZE, F. SOLINAS (curr.)

delle cosiddette "prove di medaglia"[7], pezzi in piombo appartenenti a diverse serie di restituzione[8], che presentano per

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Atti del Convegno *I Barberini e la cultura Europea del Seicento* (Palazzo Barberini alle Quattro Fontane, 7- 11 dicembre 2004), Roma 2007, pp. 411-420; per il nostro tipo di medaglia vd. pp. 415 - 417.
L'ingente collezione numismatica Barberini, attualmente in gran parte dispersa, era conservata in una stanza "museo", secondo l'uso tipico dei collezionisti seicenteschi, adiacente alla biblioteca del cardinale Francesco Barberini, che viveva nell'ala meridionale del palazzo alle Quattro Fontane. Questa "stanza delle meraviglie" era anche provvista di custode, che potesse mostrarla a richiesta a studiosi o viaggiatori illustri. La collezione era stata iniziata dal cardinale Maffeo, prima di giungere al soglio pontificio con il nome di Urbano VIII, e proseguita dal nipote, il cardinale Francesco (1597-1679), coadiuvato dai suoi antiquari Claude Menestrier prima e Leonardo Agostini poi, entrambi presentati a lui da Cassiano dal Pozzo. Per l'ubicazione e la descrizione del museo tramite inventari settecenteschi conservati nei manoscritti della Biblioteca Apostolica Vaticana cfr. F.BARBERINI, *art. cit.*, nota 5; per la descrizione e gli inventari del XVII sec. note 11 - 12.

[7] Cfr. F.BARBERINI, *art. cit.*, pp. 415 - 416, figg. 4 - 8. Il concetto di "prova" è diffuso in ambito monetale ma non in quello della medaglistica. Già agli inizi del Novecento erano state individuate da F. GNECCHI monete romane in bronzo, piombo e stagno con dritto o rovescio liscio, piano e non lavorato, che costituivano delle prove di conio di medaglioni, come quella esistente al Museo Archeologico di Bologna con le teste di M. Aurelio e L. Vero. Cfr. F. GNECCHI, *Bronzi unilaterali e prove di conio,* in *Rivista Italiana di Numismatica,* XX, 1907, pp. 32 - 47, tavv. II - IV, per il pezzo del Museo bolognese vd. a*rt.cit.*, tav. II, 8. L'antica pratica della prova di conio è giunta fino alla monetazione contemporanea, come testimoniano gli esemplari conservati nel Museo Numismatico della Zecca di Roma, che datano fino alla monetazione della Repubblica degli anni quaranta del Novecento.
Per quanto riguarda la corrispondenza tra questi "piombi" e le prove di medaglia segnalo un esempio dal catalogo degli oggetti del Museo Bartolomeo Borghesi messi in vendita alla fine dell'Ottocento (*Secondo catalogo del Museo Bartolomeo Borghesi. Medaglie artistiche, monete estere, suggelli e piombi*, Roma 1880, p. 7, nn. 45 e 46). Si tratta di due medaglie identiche del XV sec., una in bronzo (n. 45) e l'altra in piombo, in onore di *Andreas Mesanius, eques*, *consiliarius regis*, che potrebbero appunto costituire una prova e la sua realizzazione. Sempre nel medesimo catalogo sono presenti "piombi pontifici" (inv. nn. 1734 - 1752) relativi ad una serie papale di restituzione che presentava al dritto l'effigie papale e al rovescio le

teste di S. Pietro e S. Paolo con nel mezzo una croce. I papi raffigurati iniziano con Eugenio III (1145 - 1153) e terminano con Pio VI (1775 - 1798).

[8] Le serie di restituzione sono quelle serie di medaglie volte alla celebrazione di persone o eventi antecedenti alla coniazione delle prime medaglie (1438), che non sembrano emissioni ufficiali commissionate dai pontefici, ma commissioni di privati finalizzate al guadagno, spesso in concomitanza di celebrazioni particolari, come i giubilei, che comportavano grande afflusso di pellegrini. Da ciò, secondo A. MODESTI, *Corpus Numismatum omnium romanorum pontificum,* vol. I, Roma 2002, p. 19, la scarsa qualità artistica delle medaglie di tali serie.

Abbiamo due serie italiane di restituzione, pressoché coeve, di manifattura romana, collocabili nell'ultimo quarto del '500, dopo la chiusura del Concilio di Trento (1545 - 1563) (cfr. A. MODESTI, *op. cit*., p. 22); i rovesci si ritrovano nella edizione del 1630 della Storia dei Papi di ALONSO CHACON (A. CHACON, *Vitae et Res Gestae Pontificum Romanorum et S. E. R. Cardinalium ab initio nascentis Ecclesiae, usque ad hanc diem qua illam Urbanus VIII Max et Opt. Pontif. Regit,* Roma 1630) e questo ha costituito un elemento "*ante quem*" per la datazione. Esse includono i pontefici tra Pietro ed i primi anni del '400. Le medaglie sono fuse in bronzo e oricalco, una lega di rame, zinco e stagno. Si tratta di due serie originali, cioè non contaminate da combinazioni di dritti e rovesci mescolati, e complete, emissioni che coprono l'arco temporale cui abbiamo accennato.

In assenza di documenti specifici, la distinzione tra le due serie è basata sulla qualità delle immagini, superiore nella prima, e sulle raffigurazioni dei rovesci. Nella prima serie i rovesci sono solo tre (A. MODESTI, *op. cit.*, tav. II): le chiavi verticali e parallele, le chiavi decussate ed il busto di S. Pietro, la "Veronica". Nella seconda se ne contano dieci (A. MODESTI, *op. cit.*, tav. III), tra i quali ci interessa in particolare lo stemma papale senza insegne all'interno, che risulta il rovescio più comune di questa serie.

Queste due prime serie funsero da test del mercato, le serie successive furono molto più mirate a soddisfare le esigenze degli acquirenti.

La terza serie italiana, realizzata in occasione del giubileo del 1600, presenta nel rovescio lo stemma papale; le medaglie sono fuse in bronzo, hanno un diametro che si attesta attorno ai 43 mm ed uno spessore di circa la metà rispetto alle medaglie delle prime due serie. Sono ritratti i 235 pontefici fino a Clemente VIII (1592 - 1605), sotto il cui pontificato fu realizzata la serie, dato che il suo stemma appare molto dettagliato, secondo la consuetudine di omaggio al pontefice regnante (A. MODESTI, *op. cit*., p.30). La serie di restituzione iniziata a Roma nel 1664 sotto Alessandro VII, per iniziativa del Cardinale Francesco Barberini, è quella di Girolamo Paladino, "sigillaro" presso la corte pontificia; si tratta di 50 medaglie, coniate e non fuse, che lo più solo il dritto con l'immagine papale, mentre alcuni sono effigiati anche sul rovescio.

La definizione di "prova di medaglia" trova un parallelo nella numismatica antica in quelle che si considerano "prove di conio"[9], come pure monete di restituzione (cioè non coeve ai personaggi rappresentati) sono testimoniate nel periodo classico[10].

Nei pezzi in piombo del medagliere Barberini cui stiamo facendo riferimento si nota una diversità tra quelli che appaiono vere e proprie medaglie di uomini illustri, e quelli che si riferiscono ai papi, le "prove", appunto.

La Barberini sostiene che nel Seicento le "prove" di medaglia fossero utilizzate o per motivi di studio, non possedendo gli originali, oppure avessero il precipuo valore reale di prova per la realizzazione di coni. L'autrice riferisce di non aver rinvenuto documenti comprovanti l'effettiva realizzazione delle medaglie corrispondenti alle suddette "prove"della collezione Barberini: questo dato è da tener presente rispetto a quanto diremo più avanti circa una medaglia di Silvestro II del Museo Nazionale del Bargello.

Per quanto concerne le serie di restituzione, cui fa riferimento la nostra "prova", è noto che dalla seconda metà del Cinquecento fino al Novecento la medaglia di restituzione costituì una moda; in particolare le serie papali si affermarono tra la seconda metà del XVI sec. e l'inizio del XVIII. Esse comprendevano o l'intera serie dei pontefici a partire da Pietro oppure pontefici di un determinato momento storico; spesso era

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comprendono i pontefici da Martino V (1417-1431) a Paolo III (1534-1549). Vd. per l'inquadramento generale A. MODESTI, *op. cit.*, pp.17 ss. ed in particolare R. MARTINI, *Medaglie di restituzione papali (fine sec. XVI)*, in *Medaglia,* 22, 1987, pp. 7- 37; A. MODESTI, *La serie papale di restituzione di Girolamo Paladino*, in *Medaglia,* 23, 1988, pp. 7 - 57; A. MODESTI, *La serie di restituzione di Giovan Battista Pozzi*, in *Medaglia,* 27, 1992, pp. 12 – 31.

[10] F. GNECCHI, *A proposito di una nuova teoria sulle restituzioni*, estratto n. 45 della serie "*Appunti di Numismatica Romana",* dalla *Rivista Italiana di Numismatica,* I serie*,* 14, 1901.

inserita nella serie anche l'immagine di Cristo. Dal punto di vista iconografico le immagini papali potevano risultare talvolta inventate o per lo più tratte da ornati parietali, affreschi, mosaici o letteratura stampata[11].

Gli inventari seicenteschi della collezione Barberini non forniscono informazioni precise circa questi "piombi"; nell'*Indice* delle medaglie del Museo di Palazzo, conservato alla Biblioteca Vaticana[12], si trova la generica dicitura "serie di piombi di Papi"[13]. Nell'inventario eseguito alla morte del cardinale Francesco junior (1738) [14] si legge che le medaglie in piombo dei papi erano contenute in 16 tiratorini di un mobile, quindi erano una quantità superiore a quella giunta fino a noi. La stima delle medaglie della collezione, congiunta a tale inventario, e commissionata all'antiquario Francesco Ficoroni[15], conservata nel museo del Palazzo Barberini per avvalorare la quantità, qualità ed il valore economico della collezione stessa[16], non prende in considerazione questi esemplari, considerati evidentemente di scarso pregio rispetto agli altri e soprattutto di conseguente scarso valore economico.

La Barberini coglie in queste prove di medaglia una ripetitività nelle immagini papali, nel corredo epigrafico e nelle caratteristiche stilistiche che a suo giudizio avvicina gli

[11] La BARBERINI *(art. cit.*, nota 62) indica un'interessante bibliografia di riferimento per i medaglisti al tempo della formazione della raccolta Barberini: O. PANVINIO, *XXVIII Pontificum Maximorum elogia et immagine accuratissime ad vivum aeneis typeis delineatae,* Venezia 1575; G. B. DE CAVALIERI, *Romanorum Pontificum effigies, Joannis Bapt. Cavalleriis opera et studio aeneis tabulis incisa, aducta est in singulos pontifices brevis lucidatio ex diversis autoribus collecta,* Roma 1585; A.CHACON, *op. cit,* Roma 1630; A. CHACON, O. AGOSTINO, *Vitae et Res Gestae Pontificum Romanorum et S. R. E. Cardinalium ab initio nascentis ecclesiae, usque ad Clementem IX P. O. M.,* Roma 1677.

[12] BAV, Barb. Lat. 4312.

[13] La Dott.ssa Barberini mi ha informato del fatto che nella collezione privata della sua famiglia esistono altre prove simili relative a papi dei primi periodi del Cristianesimo.

[14] BAV, Arch. Barb. Indice II 2461, c. 394.

[15] BAV, Arch. Barb. Indice II, n. 320.

[16] F. BARBERINI, *art. cit.*, p. 412.

esemplari Barberini alla prima serie papale di restituzione[17], realizzata in Italia da un medaglista anonimo negli ultimi decenni del sec. XVI (cfr. nota 8).

Su suggerimento di A. MODESTI l'autrice considera i "piombi" Barberini come i modelli originali per la suddetta serie, acquistati con buona probabilità nella serie completa dal cardinale Francesco, nipote di Urbano VIII. Egli fu molto interessato alla prima epoca cristiana e promotore di iniziative connesse allo studio ed alla documentazione delle immagini papali, quali la riproduzione degli affreschi della basilica di S. Paolo fuori le mura[18], ancora oggi modello per le effigi dei pontefici, o gli scavi in catacomba che culminarono nella

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[17] Al Museo del Bargello di Firenze si conservano dei modelli in piombo della prima serie di restituzione cfr. F. BARBERINI, *art. cit.*, nota 66.

[18] Nel codice BAV, Barb. Lat. 4407 sono raccolte le copie delle effigi papali della Basilica; cfr. . F. BARBERINI, *art. cit.*, nota 68; per i ritratti nella basilica cfr. la testimonianza dell'ARMELLINI (M. ARMELLINI, *Le chiese di Roma dal secolo IV al XIX,* Roma 1982, rist. anastatica della 2ª ed. 1891, p. 933: "…Nell'architrave della nave maggiore vicino all'arco trionfale incominciava la serie dei ritratti dei papi, e continuava per tutto il lungo della medesima. Arrivata al fondo passava sul muro interiore della facciata, poi sul muro settentrionale. Ma nel secolo XVII non rimaneva più nulla dei medaglioni del muro occidentale; la maggior parte di quelli del settentrionale erano dispersi, e solo sul muro a mezzogiorno si conservano intatti fino ai nostri giorni, perché il grande incendio che incenerì la basilica il 17 luglio del 1823 li lasciò immuni. Nei nuovi restauri quei ritratti distaccati (cioè quelli originari rimasti) sono stati posti in serie nelle pareti dei corridoi del monastero; disgraziatamente quando furono distaccati non si curarono le iscrizioni che li accompagnavano. I superstiti sono 42, da S. Pietro ad Innocenzo I, compresovi Felice II. Non sono però propriamente ritratti, ma tipi ideali: quelli che erano nel muro settentrionale sono mantenuti in alcuni disegni del codice Barberino (nota 1: Cod. XLIX, 15, 16), dove furono eseguiti nel 1634 per ordine del card. Barberini, ma si trovano in grande disordine ed in mezzo a loro nel sesto posto di quella serie v'ha il ritratto dell'antipapa Lorenzo. Questa figura, siccome nota il De Rossi, è preziosa per stabilire la cronologia di quella insigne serie, giacchè non può essere stata posta che durante la pretese di questo antipapa, vivendo Simmaco nel secolo V; onde quei ritratti nel loro insieme debbono essere giudicati anteriori al secolo VI, e la congettura per ciò che li attribuisce a S. Leone il Grande deve esesere ripudiata, perché priva di fondamento").

edizione della “Roma sotterranea” del Bosio[19]. Il particolare interesse per l’iconografia dei primi pontefici è testimoniato anche dal fatto che il cardinale Francesco fece realizzare dall’incisore Girolamo Paladino, come documentato dal Du Molinet[20] e dall’Evelyn[21], quella serie di restituzione di medaglie papali a partire dal 1664 cui si è accennato, completata dopo la morte dell’artista (cfr. in dettaglio nota 8).

Un confronto fiorentino: la medaglia di Silvestro II al Museo Nazionale del Bargello

Nella collezione numismatica del Bargello è presente una medaglia fusa di bronzo di anonimo romano[22], attribuita all’inizio del ‘600 (Inv. 9709, Ø 40 mm.). Presenta sul dritto l’effigie di Silvestro II con la scritta *SILVESTER. II. P(ontifex). M* (*aximus*).; sul rovescio è lo stemma papale vuoto con le chiavi decussate e la tiara triregno (fig. 3), che abbiamo visto essere il rovescio più frequente nella seconda serie papale di restituzione (cfr. nota 8) e che ne costituisce un elemento pregnante circa l’attribuzione cronologica.

Il pontefice, rivolto a destra, è ritratto con piviale, a testa nuda. La capigliatura lascia scoperta quasi tutta la calotta cranica, le sopracciglia sono folte, così i baffi e la barba a punta: la somiglianza con il” piombo” Barberini è stringente e m’induce a pensare di non poter attribuire con certezza, come la

[19] A. BOSIO, *Roma sotterranea*, Roma 1632.

[20] C. DU MOLINET, *Historia Summorum Pontificum a Martino V ad Innocentium XI per eorum Numismata ab Anno MCCCCXVII ad Ann. MDCLXXVIII,* Parigi 1679.

[21] J. EVELYN, *Numismata: a discours of medals ancient and modern,* Londra1697.

[22] F. VANNEL, G. TODERI, *Medaglie italiane del Museo Nazionale del Bargello*, II, Firenze 2005, p. 117, n. 1041. Al Bargello sono testimoniate 9 serie di restituzione; la loro origine era stata inizialmente ipotizzata a Milano, data la consistente presenza di simili medaglie nella collezione del Castello Sforzesco, ma in realtà nel XVII sec. la zecca più importante in Italia fu quella pontificia.

Barberini, questi "piombi" alla prima serie di restituzione italiana.

Fig. 3. Una medaglia di Silvestro II al Museo Nazionale del Bargello (da F. VANNEL, G. TODERI, II, 2005).

Anzi, l'esemplare capitolino per il modellato della figura, abbastanza piatto, caratteristica che contraddistingue la seconda serie di restituzione italiana rispetto alla prima, farebbe propendere per l'attribuzione della "prova" Barberini preferibilmente alla seconda serie, testimoniata dalla medaglia fiorentina.

Anche un'altra medaglia della collezione Modesti-Boccia, recentemente acquisita dai Musei Vaticani[23], presenta identiche caratteristiche rispetto all'esemplare fiorentino: ritratto del pontefice, legenda del dritto ed immagine del rovescio sono identici, consentendo una medesima attribuzione alla seconda serie italiana di restituzione.

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[23] Archivio MODESTI, neg.135. Le medaglie di Silvestro II sono presenti in varie collezioni italiane e straniere; A. MODESTI fornisce (*op. cit.*, p. 49) una tabella in cui compaiono i tipi di rovesci di medaglie di restituzione del nostro papa da lui individuati.

Un primo sguardo all'iconografia di Silvestro II

Per ciò che concerne l'iconografia di Silvestro II sulle medaglie, il patrimonio numismatico fiorentino può essere d'esempio.

Nella serie delle medaglie anonime papali della collezione del Bargello, che parte da Pietro, si nota come un'identica immagine si ripeta per più pontefici, come testimoniato dagli esemplari di Silvestro I, Marco I, Clemente VII, Gregorio XIII, Sisto V, Giulio III, Pio V, Gregorio XIII, Urbano VII e Clemente VIII[24], coprendo un arco temporale che va dagli ultimi decenni del Quattrocento[25] a tutto il Cinquecento. Nel dritto delle medaglie i pontefici presentano la testa nuda, come nel nostro caso, con barba e baffi, oppure il camauro o la tiara; nei rovesci appaiono lo stemma o le chiavi del regno. Quanto detto rivela non un'attenzione reale alla ritrattistica, ma la ripetizione di un modello che prescinde dalla radice fisionomica.

Considerazioni conclusive e spunti di lavoro

La "prova" capitolina, posta a confronto con la medaglia del Bargello, induce ad ulteriori riflessioni circa l'ipotesi di Francesca Barberini che gli esemplari in piombo della collezione Barberini acquistati dal cardinale Francesco siano le prove per la coniazione della prima serie papale di restituzione. La questione della relazione alla prima o seconda serie resta aperta e si pone come stimolo di approfondimento in un ambito di studi, quale quello delle prove di medaglia, ancora poco indagato e che necessita di nuovi elementi di confronto.

Altro tema d'indagine, esposto nelle grandi linee al Congresso 2009, che nasce dal presente lavoro e che sarà materia di un prossimo contributo, è quello iconografico. In primo luogo è necessaria un'analisi più allargata sulle medaglie

[24] F. VANNEL, G. TODERI, *op. cit., passim.*

[25] Per l'iconografia a testa nuda si ricordi che barba e baffi son un'aggiunta del primo Cinquecento.

gerbertiane, perché in tale ambito si possono individuare due filoni rappresentativi di base (pontefice barbato a testa nuda o glabro con tiara); il confronto con le immagini di Silvestro II in altre forme d'arte (intaglio, pittura, scultura, affresco, incisione) consentirà poi di seguire lo sviluppo e l'intreccio dei modelli, cercando, ove possibile, di rintracciarne gli elementi d'origine.

Teaching and playing 1000 years ago, Rithmomachia

Jorge Nuno Silva [1]

Boethius

Anicius Manlius Severinus Boethius was born in Rome, around 480, in a powerful family, the Anicii.
His father, a successful politician, died early, leaving Boethius to be educated by Aurelius Symmachus, an expert in the Greek classics, who inspired his pupil to follow his footsteps.
The latter was a bright student, reaching, still at young age, a superior level in the seven liberal arts --- Logic, Rhetorics, Grammar, Arithmetic, Music, Geometry, and Astronomy.
Boethius planned the translation of several works of Aristotle and Plato, which he partially accomplished.
Arithmetic [3] was one of his own works (mainly a translation from Nicomachus of Gerasa [8]), as well a book on Geometry. They showed his understanding of the liberal arts as preparation to studying Philosophy. His works were in the academic *curricula* for centuries in Europe. Some of his texts were still used in the 18th century in European universities, Oxford among them.
His political career started well, being a consul like his father, but he fell victim of Theodoric's wrath and was executed around 525 AD.
In the introduction to *Arithmetic*, which he dedicated to Symmachus, Boethius explains his intention of publishing a text to each of the four components of the *quadrivium* --- Arithmetic, Music, Geometry, and Astronomy. These made up what Boethius called the fourfold path to philosophy.
From these only two survived: *Arithmetic* and *Music*. Both of them show a strong influence of Nicomachus (60--120 AD), a Pythagorean.

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In this mathematical tradition we don't find any structured explanations as we do in Euclid. The arithmetical results appear unproved and the mystic characteristics of numbers are emphasized. Even though *The Elements* of Euclid were written around 300 BC, it was Boethius' Pythagorean mathematics that dominated the teaching *curriculum* in the Middle Ages.

Arithmetic contains mainly definitions of kinds of numbers (even, odd, prime, composite, perfect, etc) and their relations. His classification of the relations between two numbers was based on ratios. Thus, two numbers can be in *multiplex* (like n:1), *superparticular* ((n+1):n), *superpartient* ((n+m):n, for some m>1).

He also considers means of two numbers, namely the arithmetic, geometric, and harmonic. Besides showing their relations to Music, Boethius claims that their major virtue resides in guiding the student's mind to God, highlighting the unity of arithmetic, philosophy and theology.

Boethius, in his *Arithmetic*, mentions that the ancient scholars, of which Pythagoras is the most important reference, used a quadruple way to philosophical knowledge. They were: arithmetic (the study of numbers in themselves), music (the study of the relations between numbers), geometry (the study of magnitudes), and astronomy (the study of moving magnitudes). Arithmetic is more than logistics and geometry lies above geodesics. The number has an independent existence, the mathematician just uncovers and contemplates it. The nature of these ideal entities --- the mathematical objects --- gives them a superior rank.

Then comes the classification of the numbers in several categories, as even-odd, prime-composite, evenly even (powers of 2), etc, along with characterizations of these classes.

The Sieve of Erathostenes is presented, as well as the Euclidean Algorithm for the Greatest Common Divisor. Consistently, no proofs of the methods are provided. As Nicomachus, Boethius defines perfect numbers and gives an expression to generate them. Perfect numbers are those that equal the sum of its proper divisors, like 6=1+2+3. In the *Elements* we can find a proof that this formula, $n=2^{p-1}(2^p-1)$ where 2^p-1 is prime, really generates

perfect numbers. Euler (1707-1783) showed that all the even perfect numbers are given by this formula (we still do not know whether there are any odd perfect numbers).
Boethius, as Nicomachus ahead of him, errs when he claims that the perfect numbers alternate the last digit between 6 and 8. The perfect numbers known in antiquity were 6, 28, 496, 8128.
After elaborating about several kinds of multiples, Boethius states a principle, which is quoted in most manuals of Rithmomachia: “Every inequality comes from equality”.
This is preceded by an introduction of Pythagorean character, identifying equality with Same and inequality with Other, which refer to Plato's *Timeaus*.
The associated process consists of constructing a matrix a_{ij}, with three columns, from the first row. The successive rows are obtained according to the following rules

$$a_{n\,1} = a_{n-1\,1}\ ,\ \ a_{n\,2} = a_{n-1\,1} + a_{n-1\,2}\ ,\ a_{n\,3} = a_{n-1\,1} + 2a_{n-1\,2} + a_{n-1\,3}\ .$$

An example Boethius offers, using $a_{1\,1} = a_{1\,2} = a_{1\,3} = 1$:

$$\begin{array}{ccc} 1 & 1 & 1 \\ 1 & 2 & 4 \\ 1 & 3 & 9 \\ . & . & . \\ . & . & . \\ . & . & . \end{array}$$

From the first row, which consists of a repeated number, we get the sequence of the doubles, then the one of the triples, and so on. Clearly, all multiples will eventually appear in these lists.
Boethius' reverse method can be described as follows. Start with three numbers in geometrical progression, a , ra , r^2a, construct a matrix a_{ij}, $(r-1) \times 3$, in which the first row is the given progression and the following rows are given by the rules: $a_{n\,1} = a_{n-1\,1}$, $a_{n\,2} = a_{n-1\,2} - a_{n-1\,1}$, $a_{n\,3} = a_{n-1\,3} - a_{n-1\,1} - 2(a_{n-1\,2} - a_{n-1\,1})$.

Accordingly, we get

$$\begin{array}{ccc} a & ra & r^2a \\ a & (r-1)a & (r-1)^2a \\ a & (r-2)a & (r-2)^2a \\ . & . & . \\ . & . & . \\ . & . & . \end{array}$$

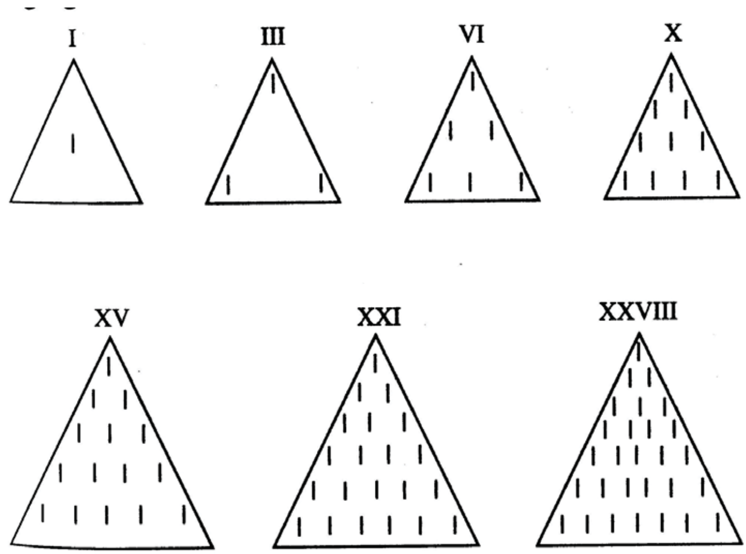
Thus, in the r-th row we will reach equality.
Boethius exemplifies, starting with the first row 8, 32, 128, which corresponds to the parameters
$a = 8$, $r = 4$:

$$\begin{array}{ccc} 8 & 32 & 128 \\ 8 & 24 & 72 \\ 8 & 16 & 32 \\ 8 & 8 & 8 \end{array}$$

The author later starts the study of the numbers in themselves, not in relation to each other.
In his opinion, aside from the inner interest, this knowledge will be useful when studying progressions.
Numbers can be linear, plane, and solid, having their nature attached to their geometrical figurate representation.
The unity, 1, has no dimensions. Linear numbers start with 2 and are those that can be obtained by the successive placing of a unit in the same line:

|| ||| |||| ||||| |||||| ||||||| ||||||||

Triangular numbers are the first to appear. According to Boethius, the first triangular number is 3, and then come the numbers that lie evenly along three equal sides.

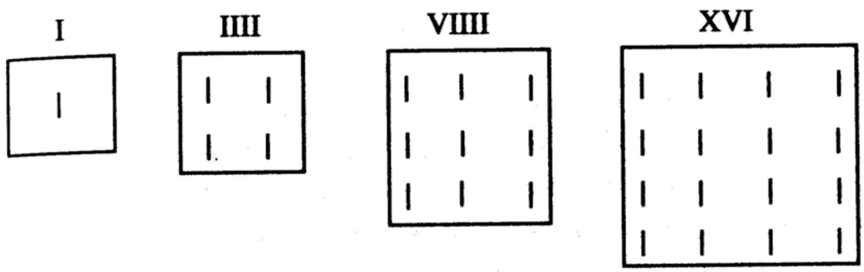


The generation rule for these numbers is given. In symbolic terms, we have

$$T_n=1 + \ldots + n$$

(Boethius considers 1 as a particular case of a triangular number).

The square number is the one that extends itself in four angles keeping equal sides.



Boethius shows a procedure to obtain the square numbers from the odd:

$$Q_n=1 + \ldots + 2n-1.$$

Next come the pentagonal, hexagonal, heptagonal. Boethius gives relations between these families of numbers and emphasizes the rôle of the triangular ones:

$$Q_n = T_n + T_{n-1}$$
$$P_n = S_n + T_{n-1}$$
$$Hex_n = P_n + T_n$$
$$Hep_n = Hex_n + T_{n-1}$$

Boethius also refers to the oblong numbers, $O_n = n(n+1)$, noting that, as the odd numbers generate the squares, the even generate the oblong, given that

$$O_n = 2 + \ldots + 2n.$$

For the author, everything is a mix of Same and Other, the two Platonic principles. Odd and even numbers play those roles in the world of numbers.
The study of proportions is advised because of its utility in music, astronomy, and geometry, besides being of great help in better understanding of the classics. According to Boethius, Plato, Aristotle and Pythagoras were familiar with the arithmetic, geometric and harmonic progressions.

In modern notation, Boethius' definitions are as follows.

The numbers $a < b < c$ are in progression arithmetic if $b-a = c-b$, geometric if $b/a = c/b$, and harmonic when $(c-b)/(b-a) = c/a$.
Besides the property of arithmetic progression that could be stated, in modern notation, as
$n(n+2r) < (n+r)^2$, Boethius characterizes the three progressions: being given three numbers in progression --- $a < b < c$ --- we have $b/a > c/b$ if the progression is arithmetic, $b/a = c/b$ if it is geometric, and $b/a > c/b$ if it is harmonic.

Boethius provides methods for, given two numbers (the extremes), obtain the middle term so to form a triple of numbers in progression. Given a and c, we find b using the formulas:

$b = (a + c)/2 \qquad b = \sqrt{ab} \qquad b = a(c-a)/(a+c) + a,$

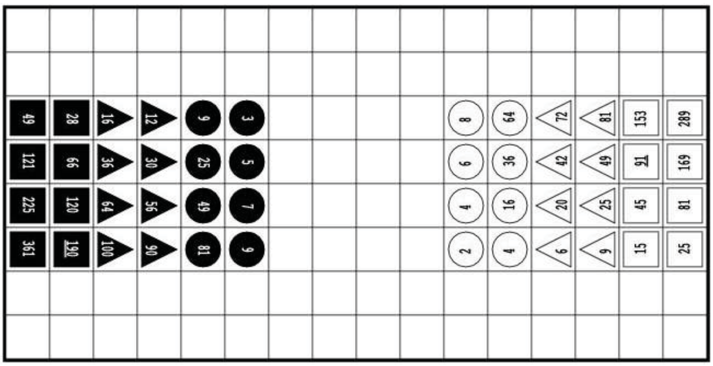
for arithmetic, geometric, and harmonic progressions, respectively.
However, Boethius introduces seven other progressions, as Nicomachus had done ahead of him. The main reason for this seems to be the aiming at the Platonic total of 10. Here we give their definitions and examples provided by Boethius.

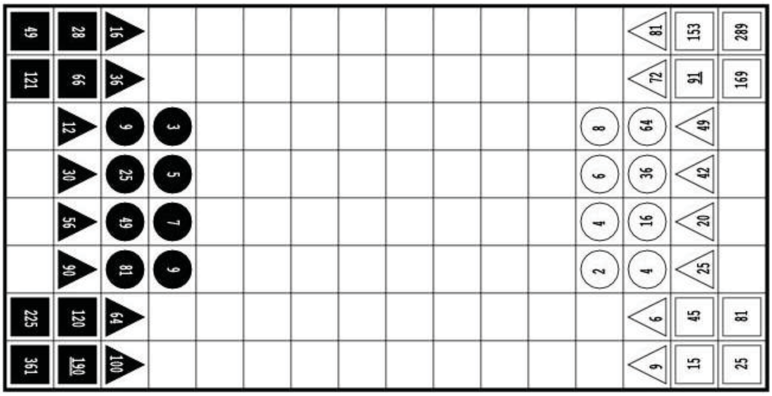
Name	**Definition**	**Example**
4th	(b-a)/(c-b)=c/a	3-5-6
5th	(b-a)/(c-b)=b/a	02-04-05
6th	(b-a)/(c-b)=c/b	1-4-6
7th	(c-a)/(b-a)=c/a	6-8-9
8th	(c-a)/(c-b)=c/a	6-7-9
9th	(c-a)/(b-a)=b/a	4-6-7
10th	(c-a)/(c-b)=b/a	3-5-8

Rithmomachia

This game seems to have been invented in the 11th century as a pedagogical device to help teach Boethius' Arithmetic. It spread through the north of Europe, reaching Italy only in the 15th century.
Its users were mainly the students, not only of arithmetic, but also of astronomy and astrology, who later took the game to other places.
Some *calculatores* paid attention to it as well. Besides its pedagogical value, people found out some other qualities to this game, like the positive influence on the spirit, helping to fight nostalgia, which connected the game with the area of medicine. However, its main rôle was that of pedagogical game for Boethius' arithmetic, being a kind of "application" of his mathematics.

Moyer's book [8] is the best reference for understanding the rout along which this game travelled in Europe, sharing its destiny with the very *quadrivium*.
Bell [2], classifies board games in six categories: race games, war games, positional games, Mancala games, dice games, and calculation games. These, Bell clarifies, are those based on the Pythagorean philosophy of numbers. The only example he provides is Rithmomachia. This philosophical attribute of the game clearly characterizes its personality. Chess, some five centuries older, had to wait still another five centuries to become the most played game among the European elites.
The description we give here is a short version of Barozzi's [1]. For more versions of the rules, see the major work by Borst [4], which compiles several manuscripts about this game.
The game unfolds on a checkered board 8 x 16, where two adversaries --- White (even) and Black (odd) --- control their armies of 24 numbered pieces. The starting position shows several relations and proportions.
We describe the way to reach the first of the following two positions. The second, which is the starting position for Rithmomachia, is easily obtained from the first one.





We treat the disposition of the white pieces, the black ones follow a similar pattern. On the right we place a modern general notation to explain the operations that occur in this process.
From the even numbers 2, 4, 6, 8 placed on circular pieces in the central cells of the sixth row, we deduce the remaining numbers. The second row, with circular pieces, shows the squares of the numbers in the first one.

2	4	6	8	n
4	16	36	64	n^2

The following row, with triangular pieces, gets its numbers by addition of the previous two.

2	4	6	8	n
4	16	36	64	n^2
6	20	42	72	$n(n+1)$

Next row has also triangular pieces. Each piece has a number which is the square of one more the number on the top disc.

2	4	6	8	n
4	16	36	64	n^2
6	20	42	72	$n(n+1)$
9	25	49	81	$(n+1)^2$

The pieces of the first row of square shapes get their numbers from addition of the previous two.

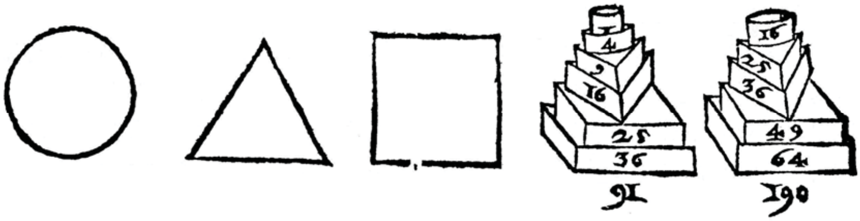
2	4	6	8	n
4	16	36	64	n^2
6	20	42	72	$n(n+1)$
9	25	49	81	$(n+1)^2$
15	45	91	153	$(n+1)(2n+1)$

The last operation is shown below.

2	4	6	8	n
4	16	36	64	n^2
6	20	42	72	$n(n+1)$
9	25	49	81	$(n+1)^2$
15	45	91	153	$(n+1)(2n+1)$
25	81	69	289	$(2n+1)^2$

There are two pieces (91 and 190), one of each color, that are replaced by special, solid objects --- the pyramids. These are sums of square numbers, each corresponding to one of the described shapes. In this version of the rules, the white pyramid has six storeys, numbered 1, 4, 9, 16, 25, 36. The black one has five: 4, 5, 6, 7, 8.

Note that 1+4+9+16+25+36 = 91 and 16+25+36+49+64=190.



Rithmomachia's pieces according to Barozzi's manual

The movements are easy: discs move orthogonally one square, triangles two cells diagonally, while squares move three steps, orthogonally. Pyramids move as the chess Queen, but are limited to four squares.

Captures can happen in several ways:

Equality: If a piece moves to a position from where it could, in a move, reach a cell occupied by an adversary piece with the same number, this one is taken. There is no replacement.

Arithmetic operation: If two pieces of the same player can move to a cell occupied by an adversary piece and if the number of this is equal to the sum or difference of the values of the numbers in the pieces of the first player, this one captures the piece of the other. Again, there is no replacement.

Siege: If one move surrounds an enemy piece in such a way that it cannot move, it is captured.

Pyramids can be captured by slices or whole. There are a few extra rules regarding the capture of pyramids that we will skip here.

Captured pieces should be turned and introduced in play immediately.

A player wins when he places, in the adversary's half board, three pieces in progression (any of the three), or four pieces showing a combination of two, or even the three, progressions.

Rithmomachia board (replica from the exhibition *Mathematical Games throughout the ages*, Museum of Science, University of Lisbon)

Gerbert and the invention of Rithmomachia

The works of Boethius, and its mathematical tradition, was elevated by Gerbert at the end of the tenth century. Gerbert shared the same metaphysical understanding of mathematics and believed, as Boethius did, that "the *quadrivium* led to the very summit of perfection" ([10, p.140]). Its study would get the student close to the original pattern in the creator's mind, which could only be formed by numbers.

It was Gerbert who gave the impulse to Boethius's works so that they stayed for several centuries in the *curricula*.

The kind of mathematical problems Gerbert and his student Constantine de Fleury were involved in solving (bringing three different numbers to equality) was taken from Boethius, and had philosophical relevance: reducing to unity. The reverse process was important as well: from unity construct different numbers. Gerbert's abacus does exactly this, being a device where from unity one could get different numbers and vice-versa, according to Navary [10].

Gerbert and Rithmomachia share more than a temporal coincidence. How are they linked together?...

Coughtrie [5], after studying several manuscripts with descriptions of our game, states that it is difficult to pinpoint its inventor, if there ever was a single one. She concludes that, if the invention was not collective, then its author should satisfy the conditions ([5, p. 121-122]):

1. He must have lived not earlier than 980.
2. He must have been a chess player, which at that time places him amongst the highest in rank at court or in a cathedral.
3. He must have been very well educated in the liberal arts with emphasis on the *quadrivium* --- the latter was quite exceptional in the tenth century --- and he must have been familiar with Gerbert's "appice".
4. He must have had the leisure time for such intensive study and at the same time have shared his interests with like-minded men.

It is obvious that Gerbert himself qualifies.

After analyzing several codices and their authors, Coughtrie considers Gerbert to be as a possible inventor of the game. Being "The greatest of all the scholars at the turn of the tenth to the eleventh century was almost certainly Gerbert of Aurilliac. He possessed all the characteristics required for the inventor of Rhythmomachia." ([5, p. 146]). She mentions his invention of the new method of calculation with "appice" and other teaching aids to popularize the study of mathematics and music, and the fact that Gerbert taught at Rheims, where he associated with intellectuals who enjoyed learning.
However, the letters of Gerbert [6] and his biography [13] never mention the game. There could be several reasons for that, even if Gerbert were its inventor, but the evidence is scarce. The familiarity with Gerbert's work and the time constraints lead us to look for this mysterious inventor among Gerbert's followers, that we intend to do in the near future.

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[10] Navary, J. V., "The leitmotiv in the mathematical thought of Gerbert of Aurillac", in *Journal of Medieval History* 1 (1975), 139-150.
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L'astronomia degli antichi nelle Lettere di Gerberto: un ponte tra Classicità e Medioevo, tra Oriente e Occidente

Laura C. Paladino

Da qualche anno mi dedico ad approfondire la figura e l'opera di Gerberto d'Aurillac, Papa Silvestro II[1]: in particolare, negli ultimi tempi, mi oriento a studiare la produzione epistolare del dottissimo personaggio, e il complesso sistema di citazioni e di rimandi eruditi in essa contenuto, che descrive potentemente l'orizzonte culturale e umano dell'autore, il suo spazio formativo, i suoi riferimenti stilistici, i modelli etici e di contenuto da lui preferiti, privilegiati e imitati, oltre che una peculiare modalità di fare cultura, che assegnava alla lettura, all'uso del testo scritto e al libro un ruolo fondamentale nell'approfondimento e nell'acquisizione della conoscenza.

Ho avuto già modo, negli anni scorsi, di sviscerare la molteplicità di richiami alla Sacra Scrittura che si rintracciano nelle lettere di Gerberto, con particolare riferimento ai libri dell'Antico Testamento e alla letteratura sapienziale, oltre che ai Vangeli e alle lettere cattoliche, e ho sottolineato per tale via il legame speciale che il giovane chierico, monaco e futuro Papa, intratteneva con i testi sacri, e il significato che ad essi attribuiva in relazione al loro ruolo magisteriale, oltre che etico-culturale[2]; in questa sede, tenendo conto specificamente dell'argomento del

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[1] Cfr. LAURA C. PALADINO, "*La biografia di Gerberto nella Historia Francorum di Richero di Reims, con commento e traduzione criticamente riveduta*", in Archivum Bobiense 27-28, 2005-2006, Bobbio 2007, 167-256

[2] Cfr. LAURA C. PALADINO, "Fides, Doctrina, Traditio: *Citazioni bibliche nelle lettere di Gerberto*", in *Doctissima Virgo: la sapienza di Gerberto, scienziato e papa*, a cura di C. Sigismondi, Roma, Scienza e Fede, Saggi, UPRA 2009, 141-158

convegno celebratosi nel 2009 presso la Basilica di Santa Maria degli Angeli a Roma, oltre che del tema precipuo cui è dedicato il presente volume, in cui compaiono gli atti di quel convegno, mi dedicherò ad approfondire, nel solco dei lavori precedenti, la specifica influenza che, sui carteggi gerbertiani, esercitarono le opere degli autori classici che si erano occupati di astronomia, nel tentativo di delineare come emergesse, anche nella dimensione privata di un personaggio destinato ad assumere grandissima rilevanza pubblica, una precisa competenza scientifica e specificamente astronomica, e come l'erudizione e l'eredità culturale latina permeassero di sé e fungessero da sfondo al lavoro di un uomo che si era formato in ambiti molteplici, e aveva voluto integrare la tradizione occidentale, di cui era portatore, con i suggerimenti che venivano da Oriente, e in particolare dall'avanzatissima e vivace cultura araba.

Come è noto, Gerberto non conosceva la lingua greca, e ciò è facilmente comprensibile alla luce dell'abitudine scolastica tipica di tutto il Medioevo: pertanto lo studioso poteva accedere ai classici più importanti del pensiero ellenico soltanto attraverso le traduzioni latine di essi redatte nella tarda antichità, e tale situazione risulta evidente dalle sue citazioni degli stessi, sovente accompagnate dall'indicazione del traduttore, del volgarizzatore o dell'epitomatore latino. Per la sopradetta ragione, Gerberto non potè leggere direttamente nessuno degli autori greci che si erano occupati di astronomia, e dovette affidarsi anche per essi alle traduzioni latine: per tale via, in particolare, conobbe, tra gli altri, Eratostene di Cirene[3], che cita

[3] Famosissimo scienziato e filologo ellenistico, vissuto tra il 276 e il 194 a.C., attivo alla corte dei Tolomei in Alessandria, città presso la cui biblioteca ricoprì il prestigioso incarico di bibliotecario direttore, Eratostene fu autore di significative misurazioni astronomiche (quali la misura dell'inclinazione dell'eclittica, quella della distanza Terra-Luna e Terra-Sole e il notissimo calcolo del meridiano terrestre) e di importanti opere di contenuto diverso (poesia, storia, geografia, matematica), tra cui un saggio sulle costellazioni, intitolato *Catasterismoi* e integralmente conservato.

nell'epistola 7, nella quale sono contenuti diversi riferimenti a numerosi astronomi antichi[4]. L'opera principale dell'astronomo greco, perduta, di cui è tramandato il titolo *Sulla misura della Terra*, dovette essere nota a Gerberto attraverso la divulgazione breve che ne fece, nel contesto del suo lavoro *De motu Circulari Corporum Caelestium*, noto anche come *Caelestia*, un astronomo assai più tardo, Cleomede, vissuto senz'altro dopo Posidonio e probabilmente prima di Tolomeo, ma del quale non abbiamo notizie certe, tranne quella fondamentale che lega a lui il titolo sopra citato. A questa opera Gerberto si riferisce esplicitamente nella epistola 161[5], densissima di citazioni tratte da opere antiche, alcune delle quali ad esplicito a contenuto astronomico[6].

Similmente Gerberto dovette conoscere solo attraverso gli intermediari latini anche Arato di Soli, autore, nella prima metà del III secolo a.C., di un'opera poetica a argomento astronomico famosissima, che godette di straordinaria fortuna nelle epoche successive[7], e in particolare nel mondo romano, dove fu

[4] La lettera, recante riferimenti a Orazio, Macrobio, Marziano Capella ed Eratostene, e indirizzata a Costantino di Fleury, fu scritta da Gerberto a Rheims nella prima metà del 980. I riferimenti numerici qui forniti per l'epistolario di Gerberto sono tutti individuati attraverso l'edizione della Pratt-Lattin, traduzione inglese dei carteggi gerbertiani.

[5] La lettera fu scritta da Gerberto a Rheims il 10 Marzo 989 ed è indirizzata a fratel Adamo. La numerazione delle lettere seguita in questo testo è quella di HARRIET PRATT LATTIN, *The Letters of Gerbert*, Columbia University Press (1961).

[6] Oltre a richiamare Cleomede, con un passo tratto dal *De Motu*, 1,6, nella epistola 161 Gerberto fa riferimenti a Boezio, al commento al *Timeo* di Platone redatto da Calcidio, al *De animae procreatione* di Plutarco, a un'operetta latina dal titolo *De mundi coelestis constitutione*, ai commentari al ciceroniano *Somnium Scipionis* scritti da Macrobio e ad alcuni passi di Marziano Capella, sui quali avrò modo di ritornare nel contesto del presente contributo.

[7] Un commentario ai Fenomeni di Arato di Soli è l'unica sopravvissuta, e pervenutaci integralmente, delle almeno quattordici opere, a carattere geografico ed astronomico, tutte perdute, di Ipparco di Nicea (o di Rodi), vissuto tra il 190 e il 120 a.C., insigne studioso ellenistico, il quale tra i primi

apprezzata al punto da essere volgarizzata anche da Cicerone nel I secolo a.C.[8]; si trattava di un poema epico didascalico, composto di 1154 esametri e noto sotto il titolo di *Fainomena*. Fu senz'altro l'influenza e la popolarità di quest'opera ad indurre Marco Manilio, un dotto latino attivo anch'egli tra il I secolo a.C. e il I d.C., a scrivere sul modello del poeta e scienziato ellenistico gli *Astronomica*, una analoga opera epico-didascalica, in cinque libri di esametri, che ci è pervenuta per intero, e che affronta variamente questioni di astronomia e astrologia, attingendo alla cultura erudita del tempo. A tale documento Gerberto si richiama esplicitamente nella lettera 162, da lui scritta, a nome del conte Federico, il 15 aprile 989 a Verdun, e indirizzata al re Ugo. Il passo citato in tale contesto è tratto dal libro II degli Astronomica, che era dedicato all'analisi delle caratteristiche dei segni dello zodiaco e alle possibilità offerte dalle loro congiunzioni.

L'opera di Arato mantenne la sua importanza anche durante l'impero, e, in epoca romano-cristiana, il testo fu epitomato e a tratti citato da Igino, un mitografo di cui poco si sa, ma che sembra essere stato attivo in età antonina (II-III secolo a.C.): tra le altre sue opere di carattere erudito e finalizzate alla conservazione delle tradizioni mitologiche del mondo greco, egli ebbe il merito di raccogliere, in un lavoro di quattro libri dal titolo *Astronomica*, tutte le leggende e i racconti ellenici legati al cielo, agli astri e alle costellazioni, conservandoci un importantissimo repertorio di miti significativi per comprendere l'origine e il valore profondo dell'astronomia antica, connessa

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si dedicò, tra l'altro, per ciò che specificamente concerne l'attività di astronomo, all'osservazione dei moti del Sole e della Luna.

[8] La traduzione ciceroniana ci è rimasta in un vasto numero di frammenti, e risulta, rispetto al testo di Arato, integralmente conservato, libera e personale. Il titolo attribuito da Cicerone alla propria opera fu *Aratea*, con evidente richiamo all'autore originale.

direttamente con i cicli delle stagioni e con l'osservazione dei fenomeni celesti.

A Igino Gerberto si richiama in tre epistole, la 2[9], la 233[10] e la 156[11], in cui esplicitamente fa riferimento alla traduzione latina di Arato; nella stessa epistola si rintraccia un rimando a Marziano Capella, un avvocato cartaginese di cultura e formazione pagana, appassionato delle dottrine neoplatoniche e neopitagoriche, che redasse a scopo didascalico per il figlio, in epoca tardo-antica (nel V secolo), un prosimetro a contenuto mitologico-allegorico in nove libri, dal titolo *De nuptiis Philologiae et Mercurii*, opera di straordinario ingegno che ebbe grandissima fortuna nel Medioevo, e che rappresentò, di fatto, l'anello di congiunzione tra la cultura classica ormai al tramonto e la nuova sensibilità dell'Età di Mezzo. Come è noto, infatti, il racconto delle nozze di Mercurio, dio del linguaggio e della parola, che, tra le immortali Sofia (dea della Sapienza) e Mantica (dea della divinazione) sceglie di sposare la vergine mortale Filologia, figlia di Fronesi (la saggezza) ed espressione della sapienza umana che viene lentamente purificata e resa immortale nel contatto con la divinità, altro non è se non una gigantesca allegoria finalizzata a sottolineare l'importanza della formazione della persona, impostata, in un'ottica trascendente, attraverso lo studio sui libri e secondo lo schema del trivio e del quadrivio, ossia secondo il modello educativo destinato a diventare preponderante nell'epoca medioevale: le sette arti liberali, infatti, nella trasposizione fantastica di Marziano, accompagnano, quali eleganti damigelle nuziali, la sposa; questa dal canto suo, prima di giungere al matrimonio, è stata abbellita da una serie di virtù: la hanno raggiunta le nove Muse, le quali,

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[9] La lettera, indirizzata a Costantino di Fleury, fu scritta a Rheims nel 978.

[10] La lettera, datata 25 febbraio-25 marzo 999, fu scritta probabilmente a Ravenna, dal momento che in quell'anno Gerberto ricopriva la carica di arcivescovo nella città, ed è indirizzata ad Adalboldo.

[11] L'epistola fu scritta a Rheims il 15 gennaio 989 ed è indirizzata al monaco Remigio.

ciascuna attraverso l'arte che le è propria, hanno elogiato la giovane e le sue nozze con Mercurio; le hanno poi fatto corona Prudenza, Giustizia, Temperanza e Fortezza, insieme a Filosofia e alle tre Grazie; infine Atanasia, dea della immortalità, ha liberato Filologia dalla sua dimensione terrena e le ha offerto il calice della immortalità, grazie alla quale la giovane ha potuto raggiungere il cielo ed essere accolta tra gli dei olimpici. Qui Mercurio, quali doni di nozze, le ha donato sette bellissime ancelle, le arti liberali. Ciascuna di esse, nei libri che seguono (III-IX), presenta se stessa e le sue doti: il libro VIII è dedicato all'astronomia, ed è da questo che Gerberto trae la maggior parti delle citazioni di Capella presenti nel suo epistolario.

Richiami al libro VIII del *De nuptiis* si rintracciano nelle lettere 7, 156 e 161[12], delle quali tutte si è detto[13]: è a tutti chiaro quale fascino potesse esercitare su una mente come quella di Gerberto l'opera di Marziano, di evidente sapore trascendente[14], così direttamente finalizzata all'esaltazione della ricerca umana ma attenta nel contempo a disegnarne la dipendenza e la subordinazione rispetto alla superiore perfezione della Sapienza divina; la stessa rilevanza delle arti liberali si rintraccerà, come è noto, nella filosofia di Severino Boezio, vero ponte tra la classicità e il medioevo, tra la cultura pagana e la nuova cultura cristiana: anche a lui, l'ultimo filosofo dell'antichità, si richiama spesso Gerberto, in numerose lettere, e in due casi, nell'epistola

[12] Oltre ad una citazione dal libro VIII, in questa lettera si rintraccia un riferimento al libro VI del *De Nuptiis*.
[13] Per completezza, in relazione a Marziano Capella, vanno ricordate pure le epistole 201 (scritta a Rheims il 31 Dicembre 995 e indirizzata a Wilderode, vescovo di Strasburgo) e 231 (redatta a Near Sasbach il 25 Ottobre 997 e destinata ad Ottone III), dove non si trova citato il libro VIII del *De nuptiis*, ma si rintracciano riferimenti rispettivamente ai libri V e VII.
[14] Va ricordato, a questo proposito, come le sette arti liberali rappresentino, per l'uomo tardoantico, altrettante tappe di un cammino ideale che l'uomo deve compiere per acquistare la Sapienza, che lo rende simile a Dio.

15[15] e nella 138[16], ne cita il perduto *De Astronomia*, che rappresentava una summa delle conoscenze astronomiche degli antichi e sottolineava il significato e l'importanza, oltre che la dignità di questa arte tra le altre del quadrivio[17].

La carrellata sopra descritta delinea le conoscenze astronomiche della cultura greca e latina recepite da Gerberto, nell'epoca della sua formazione e della sua attività di docente e studioso: esse rappresentano, a mio parere, un interessante raccordo con la dimensione più empirica che l'astronomia assunse con l'opera del Papa scienziato, e sottolineano una volta di più l'importanza che rivestì, per questo straordinario personaggio della storia europea, l'approfondimento culturale e il vaglio di tutte le fonti: una dimensione di studio che ha valorizzato, peculiarmente, la rilevanza dei classici in quanto portatori di ideali e sistemi di pensiero, indipendentemente dalla correttezza scientifica degli assunti e delle conclusioni.

Nell'anno in cui il Pontefice romano, Benedetto XVI, ha voluto riconoscere Gerberto suo predecessore "di venerata memoria"[18], aprendo la via per una rivalutazione non soltanto dell'attività culturale e scientifica dell'uomo che fu Papa a cavallo del 1000, ma anche dell'impegno autenticamente cristiano, al servizio della Chiesa e della sua santità, profuso dal Pontefice dotto, non è peregrino, a mio parere, ricordare come la

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[15] La lettera vide la luce a Bobbio, dove Gerberto era abate del monastero benedettino, il 22 Giugno 983, e fu inviata all'arcivescovo Adalberone di Reims.

[16] La lettera è datata 7 settembre 988 e fu scritta a Rheims da Gerberto, che la indirizzava al monaco Rainard. Vi si trova citato, oltre a Boezio, il commento di Vittorino al *De Inventione* di Cicerone e l'*Oftalmico* di Demostene.

[17] Oltre che in relazione al *De Astronomia*, Boezio si trova citato a proposito di altre sue opere, note a Gerberto e non sempre giunte fino a noi: nelle epistole 3, 22, 105, 142, 230, 231 è citato il perduto *De aritmetica*, mentre nella lettera 233 si trova citato il *De geometria* dello Pseudo Boezio.

[18] Cfr. BENEDETTO XVI, Angelus del 21 dicembre 2008.

sua attività si sia inscritta nella regola del suo padre fondatore, Benedetto da Norcia, all'ordine monastico originato dal quale Gerberto appartenne fin dall'inizio della sua consacrazione sacerdotale, e cui mantenne lealtà e riverenza per l'arco intero della sua vita, ereditandone, senz'altro, quella peculiare vocazione alla salvaguardia della cultura nell'ottica della fede. Tale vocazione, non va dimenticato, fece dei Benedettini, attraverso la loro opera di copiatura e conservazione bibliografica, i custodi dell'intero patrimonio umano e culturale dell'antichità, e li collocò a congiungere due mondi, due tradizioni, due culture, a ricondurli ad unità e ad integrarli in un nuovo modello di educazione, del quale Gerberto, il papa dei contatti interculturali e della ricerca, il papa della fede e della ragione, il papa della filologia, intesa pure come amore per i libri[19] e per la cultura scritta, rappresenta senz'altro l'ipostasi più completa.

[19] Gerberto ha posto in atto, negli anni della sua giovinezza e maturità, un'instancabile ricerca di libri rari, ricerca della quale resta traccia nelle sue lettere, in cui sovente fa richieste ai suoi amici più o meno influenti di testi di cui non è in possesso e che vorrebbe avere nella sua biblioteca: in questo, davvero, Gerberto può essere considerato un preumanista, con ben tre secoli di anticipo rispetto a qualunque altro letterato sia stato fregiato dalla critica di questa definizione.

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