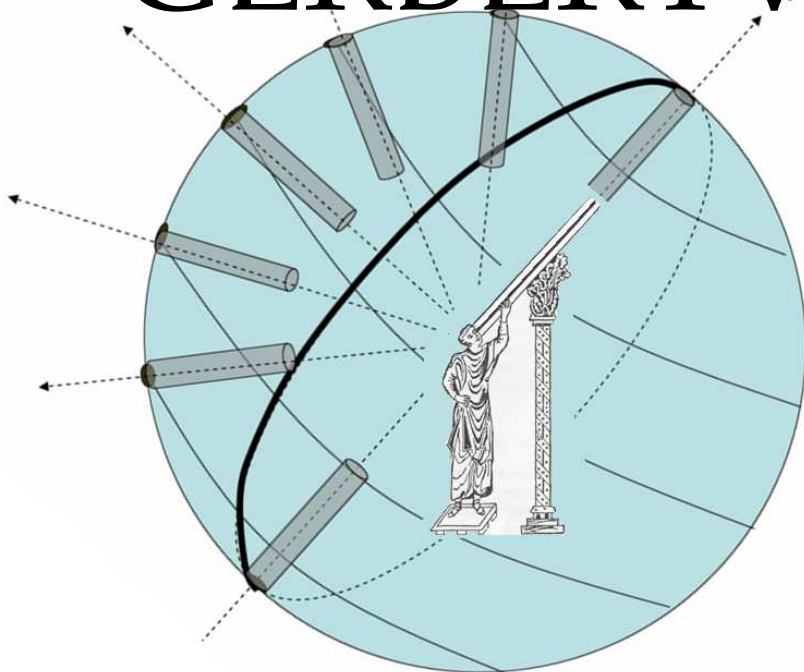


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Con il contributo di



Gerbert's acoustical and astronomical tubes

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Abstract

Gerbert of Aurillac dealt with tubes in astronomy and in acoustics. The celestial sphere he described to Constantine of Fleury in 978 has tubes for the accurate pointing of the North pole and for the observation of solstices and equinoxes days. After in 980 he built an organ for the emperor Otto II and wrote a treatise on the tuning of its tubes, *De Mensura Fistularum*, based on the number 12 of Pithagorean and Apostolic memory.

The Sphere of Gerbert with the astronomical tubes

Gerbert wrote to Constantine of Fleury in 978 a letter¹³ in which he describes in detail the procedure to point the star nearest to the North pole, to align the sphere equipped with at least five tubes to observe the North pole, the North polar circle, the two solstices and the equinoxes (equator).¹⁴ The use of tubes in astronomical observations remember to us the modern telescopes, but it is notheworthy that the first to discuss about tubes was Alhazen in his treatise on optics completed only two decades after the death of Gerbert in 1021.¹⁵

¹³ H. PRATT-LATTIN, *The Letters of Gerbert*, Columbia University Press, New York, 1961.

¹⁴ C. SIGISMONDI, *La Sfera di Gerberto*, Gerbertus **1**, 1-15 (2010).

¹⁵ IBN AL-HAYATHAM, *The Optics of Ibn al-Hayatham, books I-III, On direct vision*, A. I. Sabra, translator and editor, Warburg Institute, University of

In the Sphere of Gerbert there are at least 5 tubes (excluding the one aiming at the South pole and the southern polar circle which are invisible from the temperate latitudes of the Northern emisphere).

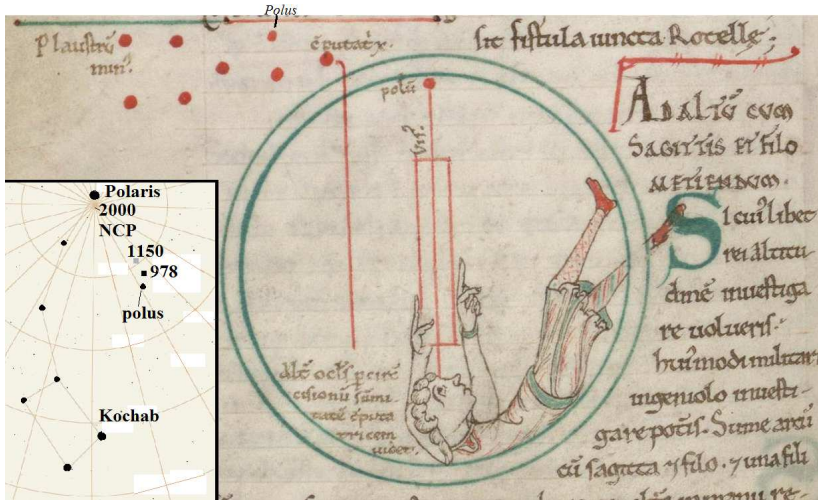


Fig. 1 This manuscript Avranches BN 235, f. 32, XII sec, shows the procedure of pointing the Gerbert's star, then named «polus» and here written with an abbreviation «polū». On its left the constellation of Ursa Minor «Paustriū min.s» with «c̃putat'x», Computatrix: the star nowadays named Polaris. Ursa Minor is drawn with seven relatively big disks and there is one smaller on the upper left of Computatrix: this is «polus», the Gerbert's star. In the left map are the positions of the North Celestial Pole in 978, 1150 (presumed date of the manuscript) and 2000 and of the star «polus».

London 1989.

The description of pointing to the celestial pole shows clearly that the instrument must have been accurately aligned with the true pole, materialized by a star of fifth magnitude: the *Gerbert's star*,¹⁶ at the limit of naked eye visibility. This procedure is so long (one or more night) to imagine that the instrument must have remained fixed after it.

Solstices and Equinoxes are points of the orbit of the Sun, so the sphere could be a tool for observing the Sun and probably determine the duration of the tropical year. The Sphere was much more than a tool merely used for teaching, given the accurate procedure of pointing it.

A fixed tube created by Nicola Cusano almost five centuries later, may have been used to determine the instant of the winter solstice¹⁷ and this shows how astronomy before the telescope, may still reveal some surprises.

Acoustical tubes and their tuning

Rogatus a pluribus, asked by his many students, Gerbert wrote a treatise on acoustic fistulae in 980: the *Mensura Fistularum*.

He knew the difference in behavior of the *fistulae*, acoustic tubes, compared with the acoustic strings, already studied by the Pythagoreans, and this treatise is intended to present the

¹⁶ Now this star is called HR4893 (in the Harvard Revised catalogue, reported also in the BSC Bright Stars Catalogue) and it is in the constellation of Camelopardalis.

¹⁷ G. DE DONÀ, *Nicola Cusano ed il foro astronomico del castello di Andraz*, Gerbertus 1, 251-169, 2010.

law that governs the length of the organ in two octaves, compared to the corresponding acoustic strings.

In modern physics we know that acoustic tubes, to be sung, require an "end correction" proportional to the diameter of the tube. This proportionality is the same for every note. The mathematical law is simple, but Gerbert preferred to create a law in which the proportions of tubes and strings should be calculated through a series of fractions linked to the number 12 and its multiples.¹⁸

For Gerbert it was more important to show that the acoustics, music, obeyed to mathematical laws that recalled the importance of number 12, the same of the Apostoles, rather than representing the phenomenon as nowadays we would have been done in a more simple and unambiguous way for both octaves the first and the second and any other octave. The idea of the World ruled by God through his Christ and the Church founded over the 12 Apostoles was more important for Gerbert than to simplify the formulae to calculate the correct length of the organ tubes.

More details on these subjects are available in the paper published on arXiv.org.¹⁹

¹⁸ C. SIGISMONDI, *Gerberto e la misura delle canne d'organo*, Archivum Bobiense **29**, 355-396 (2007), available also in electronic form on the arXiv.org repository since 2011 <http://arxiv.org/abs/1211.0438>

¹⁹ C. SIGISMONDI, <http://arxiv.org/abs/1201.6094>, *Gerbert of Aurillac: astronomy and geometry in tenth century Europe* (2012).