

Gerbertian paths for the Jubilee

Costantino Sigismondi

(ICRA/Sapienza Università di Roma and ITIS G. Ferraris)

Abstract

Gerbert before becoming Pope Sylvester II came several times in Rome, as reported in his Letters and in the biography of Richerus. Eight places in Rome can be connected with Gerbertian memories. 1. The Cathedral of St. John in the Lateran where the gravestone of his tumb is still preserved near the Holy Door; 2. the “Basilica Hierusalem” (Santa Croce) where Gerbert had the stroke on May 3rd 1003 which lead him to death on May 12th; 3. the Aventine hill, with the church of the Knights of Malta in the place where the palace of the Ottonian Emperors was located; 4. the church of St. Bartholomew in the Tiber Island built in 997 under Otto III; 5. the Obelisk of Augustus in Montecitorio to remember the relationship between Gerbert, Astronomy and numbers which led the birth of the legends on Gerbert magician; 6. St. Mary Major end of the procession of August 15, 1000; 7. St. Paul outside the walls with the iconography of the Popes and 8. St. Peter's tumb end of all *Romaei* pilgrimages. This Gerbertian path in Rome suggests one way to accomplish the pilgrimage suggested by Pope Francis in the Bulla *Misericordiae Vultus* (14) of proclamation of the new Jubilee.

Introduction

At the turn of year 1000 Gerbert was Pope in Rome, and he was still adressed for his scientific authority with official letters as the one of Adelbold on the volume of the sphere.

He wanted to restore the prestige of the Lateran as the visible chair of the Bishop of Rome, and he succeeded in it with his culture, his books, his instruments, astronomical and mathematical, his fellows students, and, his faith and his vision of the Europe, unified by Christianity and by the Sacred Roman Empire oriented toward the second Rome, Byzanthium. Rome had again the role of Imperial city in the vision of Otto III and Gerbert, but not for the local families.

Rome Gerbert and the pilgrims

Rome is the Holy City since the primacy of the Bishop of Rome, the Pope, as successor of the Apostle Peter become a strong reality among the Christians. Already in the first century St. Ignatius of Antioch recognized the Pope having the *primacy of charity*, and the Christian community of the 'Eternal City' was the largest one in terms of number of people and of martyrs. Rome was the real cradle of Christianity for the first centuries, after the beginning in Palestine and Ellenistic world. Coming in Rome to pray "*ad limina apostolorum*" and on the tombs of martyrs become a practice well before the first Jubilee proclaimed by pope Boniface VIII on February 22, 1300.

In the biography of Gerbert written by Richerus of Reims (998) and in the Letters of Gerbert several times are mentioned his trips to Rome. In 971 he followed the bishop Atto of Vich¹, expert in Mathematics, from Catalonia; later he followed his Archbishop Adalberon of Reims to Rome. Richerus of Reims reported also their prayers at the tumb of the Apostoles, like all *Romaei* pilgrims used to do.

1. The Cathedral of the Lateran with the tumb of Gerbert

The Emperor Constantine built the first Basilica, the Cathedral of St. John in the Lateran, *the mother of all churches, Omnium Ecclesiarum Mater et Caput*, in the World.

Gerbert chosen his papal name of Sylverster II to remember and renovate the fruitful relationship between Constantine

1 Atto was killed in Rome on August 21, 971 in the Suburra in an assault. Gerbert impressed the Pope John XIII and Otto I with his knowledge in Music and Astronomy, but decided to leave Rome to Reims with the scholasticus Gerannus to continue the studies. The impression of this permanence in Rome had to be very negative both from the scientific and social point of view, but the opportunity to know the Imperial family had consequences for all his carreer.

and Pope Sylvester, between temporal and spiritual power, between Otto III and himself.² The Lateran symbolized all these things together with the *primacy of the papacy*; and he cared for its prestige³ and selected this church for his tomb.

The gravestone of Gerbert with a long inscription, made by Sergius IV, has been preserved by Francesco Borromini during the works for renovating the Basilica, wanted in 1648 by Innocent X for the Jubilee of 1650. This inscription decorates the second pillar of the right nave, the one of the Holy Door, firstly opened by Alexander VI in 1499, when this jubilee tradition started.

2. Santa Croce in Hierusalem

The inscriptions present in Santa Croce were recorded by ancient chroniqueurs and reported the legend of the death of Gerbert, who suffered a stroke while celebrating mass in this Basilica, called Hierusalem, built with some ground brought from Jerusalem by St. Helen, mother of the Emperor Constantine. This happened on May 3rd and Gerbert died on the 12th.⁴ A legend deals with the explanation of the place where Gerbert had the stroke³ and on the following decision to be buried in the Lateran.⁵

2 Obviously without imagining the sudden death of the young Emperor less than 3 years after his election as Pope.

3 G. De Spirito, *Silvestro II e il Laterano*, in *Archivum Bobiense Studia* IV, 727 (2001).

4 According to a legend Gerbert built a metal head, an *automa* capable to answer yes or not to every question, so he knew that he would not die if avoided to go in Jerusalem. The magic property of this head was possible thanks to the devil, to which he would have been grateful not only for this head, but also for his papacy... with the final loss of his soul. The prophecy of the metal head come true in the church called Jerusalem.

5 To avoid the devil having his body the legend tells that Gerbert ordered to cut in many pieces his body and to put it on a chariot driven by oxen

These legends survived until now, along with the magic properties of his tumb, dripping water during the election of a new pope. The Lateran's canonical Rasponi assisted in 1648 to the aforementioned works for the renovation of Lateran. He described the opening of the tomb of Sylvester II and his body was found intact, with the pontifical paraments and suddenly all vanished at the contact with the air, excepted the ring and the pastoral, disproving all these pulp and gore legends.

3. The Aventine hill and the Imperial palace in Rome at the time of Gerbert

The palace of the Ottonian Emperors was on the Aventine hill, and today there are no evident relics. Probably it was located where the Malta's Knights garden, church and palace are. The church of the Knights of Malta was made by the famous author of roman gravures Giovanni Battista Piranesi.

The Emperor Otto II died there in 983, december 7. He felt in depression after his military defeat at Capo Colonna (982). He saved his life, but lost all the princes and the soldiers. Otto II declined so rapidly, despite of his young age; that his son Otto III was sacred king at 3 years old while he was alive.⁶

A long period of regency was strongly protected by the archbishop of Reims and after directly by Gerbert until Otto III become adult at 16 years old. Gerbert frequented the palace when Otto I was emperor, and for the wedding of Otto II in 972 and later when Otto III was in Rome.

This long effort to maintain the imperial family has seen the correspondence between Gerbert and the Queen St. Adelaide

and to bury him where the oxen would stop. This happened in front of the Lateran.

- 6 A representation of Otto II, his wife Teophano and Otto III is in the museum of Cluny in Paris.

wife of Otto I (dead in 999) and Teophano, wife of Otto II. The dynasty which would unify Europe under a Christian Emperor should be preserved, but this project ended for the untimely death of Otto III in January 1002, in Paterno under the mount Soratte, for malarial fevers, during one of his displacements to maintain his military action on Italy from North to South.

In Rome he was not welcome by the people because of the local dominant family of Crescenzi: they preferred to maintain their power (often used on the Pope himself) instead of belonging to the Emperor who elected Rome as his seat, with the perspective of bringing newly this city in the center of the political history.

4. St. Bartholomew, Otto III, St. Adalbert and Poland

Related to the time of Gerbert in Rome is St. Bartholomew on the Tiber Island, built in 997 under Emperor Otto III, where there is also a memory of the martyrdom of St. Wojtech, Adalbert, the apostle of Poland.⁷

Gerbert knew personally Adalbert through the imperial court to which he was acquainted and when he became Pope, Gerbert-Sylvester II installed the first dioceses in Poland in year 1000, and Cracow, from which the Pope of year 2000 John Paul II came, was one of them.

5. Gerbert, Astronomy and the treasure of Augustus

A legend which mixes Astronomy, History and fantasy links Gerbert to Montecitorio square. This legend is grounded on the writings of Wilhelm of Malmesbury which depicted Gerbert as a magician in the *Historia Regum Anglorum*, and has

⁷ M. Pupillo, *St. Bartholomew's on the Tiber Island*, A. Guerini, Milano 1998.

been developed by others along the centuries: Gerbert would have discovered the treasure of Emperor Augustus thanks to his unique capability to interpret encrypted messages left from the past architects. The shadow cast by the Obelisk of Campus Martius helped him to understand the true location of the treasure of Augustus.⁸ Finally he visited this place in nighttime finding a golden world with statues that disappeared after an abrupt motion of his servant who tried to bring some gold. The legend is grounded on the astronomical knowledge of Gerbert who probably continued his astronomical observations from a tower⁹ of the Lateran and in 996 built in Magdeburg an astronomical clock, as Tietmarus reports in his chronicle of 1029.

In Montecitorio square the Obelisk of Augustus has been restored in 1792, because he felt down probably in 1048 after an Earthquake.¹⁰

6. St. Mary Major and Gerbert

As a Pope of year 1000 Gerbert made a night procession between St John and St Mary Major for the feast of the Assumption of Mary of 15 August, and this is the path to follow from the Lateran to the *Liberian Basilica*, built for the Christian people by the Pope with the money of the community “Xyxtus Episcopus Plebi Dei” is the dedication written by Sixtus III on the triumphal arch. Sixtus V made via Merulana between St. Mary Major and the Lateran.

8 C. Sigismondi, *La Sfera da Gerberto al Sacrobosco*, UPRA, Roma, 2008, p. 5.

9 E. Millosevich, *Dalla Torre di Babele al laboratorio di Groninga*, Scientia XII (1912) n. 25, quoted by G. Monaco, *L'Astronomia a Roma dalle originia al Novecento*, Osservatorio Astronomico di Roma, 2000, p. 48.

10 The fall of the Obelisk occurred 40 years before Wilhelm of Malmesbury writing. News about the Obelisk were in Plinius the Elder.

7. Saint Paul outside the walls, and the iconography of Gerbert

Among the four papal Basilicas, St Paul outside the walls is the place with the traditional iconography of the Popes. The figure of Gerbert is the standard mode to represent the philosopher, with pointed beard. A similar iconography is also used to represent St. Paul, the *doctor gentium*. In the *Evangeliarium* of Echternach, Gerbert is represented, probably by an eye witness, with white hairs, dressed as an Archbishop with the pallium and standing at the right side of the throne of Emperor Otto III, spiritually sustaining the temporal kingdom.

8. The Vatican Basilica and Gerbert

St. Peter, the Prince of the Apostles, suffered his martyrdom on the cross and was buried in the Vatican cemetery, and there after Constantine, a Basilica was built. There Gerbert had the occasion to leave traces of his fine intellectual work with the composition of the inscriptions on the gravestones of the Emperor Otto II and for the Pope Gregory the V, his predecessor. The tomb of Gregory the V is in the Vatican papal cemetery, the grotto under the Basilica.¹¹

Erminia Maria Santi, Gerbert and the Jubilees: a dedication of this volume to her memory

Erminia Maria Santi wrote in 2003 “Conversation on Gerbert and the Music”. She was always proud to be born in the holy year of the Redemption 1933. In a certain sense, which belongs indeed to Gerbert's views, her death is also related with a Holy Year. In fact Gerbert used the symbolism of number 273 in

11 A detailed study on this inscription with numerological contents hidden under the geometry of the text is in Flavio Nuvolone, *Gerbertus* vol. 1.

Carme Figuratum representing the days of pregnancy¹² and Sunday July 6, 2014 (her death) preceded of 273 days the Sunday of Easter April 5, 2015, and in the octave of Easter Pope Francis has published the *Bulla Misericordiae Vultus*, official proclamation of the new Jubilee 2015-2016.

The Gerbertian congress of 8th May, 2015 preceeds of 7 months the opening of the new Jubilee of the Divine Mercy (December 8, 2015) and follows of 10 months Erminia Maria's funeral (July 8 2014).

This new Jubilee is either a gift and a surprise for the Church but is also the fruit of the prayers of many persons like Erminia Maria Santi, in their unknown humbleness.

Erminia Maria Santi cared the publication of the previous number of GERBERTVS with her silent but real contribution of draft corrections.

Her presence in the Roman Congresses dedicated to Gerbert was constant, starting with her contribution to the Millennium Congress in the Lateran, where physically she could not attend because of a broken ankle recovery. She has helped the realization of this long series of 13 annual events with the corresponding publications which witnessed the work done and stimulated new work for the following meetings.

Erminia shared with us the dream to see Gerbert honored as Saint, and we rejoiced together when Pope Benedict XVI named him among the Popes of "Venerate Memory" who practiced astronomy (Angelus of Sunday 21 december 2008).

Erminia Maria is now in the condition to know Gerbert in person, in the dimension of the Resurrection in the glory of the Angels and the Saints, that she contemplated and meditated always in all her life.

12 F.G. Nuvolone, private communication.

Stelle e pianeti artificiali per esperimenti di ottica ondulatoria al telescopio

Costantino Sigismondi

(ICRA/Sapienza Università di Roma and ITIS G. Ferraris)

Abstract

Pointing a laser beam on a diaphragm of 1mm at 1m of distance can be obtained a diffraction pattern of about 2cm at 6m. The diaphragm reduces the angular opening of the beam to 200". The diffraction pattern angular opening results of 700", but the point-like nature of the source is far from being obtained with the diaphragm. An artificial star is obtained by using a metal sphere of 5mm, located at 50m of distance from us. When the sphere is illuminated in a cloudy day, the reflected light comes from all surface, yielding a source of 20" (artificial planet) while when the day is clear the light comes only from the Sun and the dimension of the reflected image is 2.5/100mm, and its angular dimension becomes 0.1" (artificial star). Observing with a telescope these sources it is possible to see stellar diffraction patterns in daytime, suitable for school lessons. The artificial planet does not show diffraction. The distinction between Uranus, Neptune and background stars can be successfully seen with a 76mm objective telescope: their angular dimensions, 3", are big enough to not have Airy rings, visible on same magnitude stars.

Introduzione

La diffrazione della luce permette ai raggi luminosi di aggirare gli ostacoli e perdere la loro collimazione nell'entrare nell'obiettivo di un telescopio. Una sorgente puntiforme posta a distanza infinita dall'obiettivo manda raggi paralleli all'asse ottico, e le regole dell'ottica geometrica mostrano come questi raggi vengano focalizzati in un solo punto, detto fuoco. La diffrazione rompe questo parallelismo generando una deflessione $\theta \approx \lambda/D^1$ che per un telescopio di $D=76\text{mm}$ in luce visibile, con $\lambda=520\text{ nm}$, vale $\theta \approx 7 \cdot 10^{-3}$ radianti cioè $\theta=0.4''$.

1 La formula esatta $\theta=1.22\lambda/D$ per il raggio del disco centrale di Airy.

Diffrazione e diametro angolare apparente

Una stella ha un diametro angolare molto inferiore al raggio del disco centrale di Airy $\theta=0.4''$,² ma la diffrazione genera un dischetto di queste dimensioni angolari, attorno a cui si può osservare anche un sottile primo anello di diffrazione di raggio doppio, ed altri anelli via via più deboli, se il telescopio è molto ben collimato e le condizioni osservative perfette.

Urano o Nettuno hanno un diametro angolare geometrico attorno a $3''$, 7 volte il disco di Airy per un telescopio di 76mm di apertura, non si osservano più i dischi di diffrazione.

Per il principio di sovrapposizione ogni punto del disco planetario produce una sua figura di diffrazione; il risultato della combinazione di tutti i dischi con relativi anelli è un disco di diametro $0.8''$ maggiore di quello geometrico del pianeta, ma la zona nera tra disco e primo anello che si potrebbe osservare al bordo del pianeta è ricoperta dagli anelli generati dai punti immediatamente interni al bordo planetario. Questo fa sì che gli anelli spariscano, e l'informazione sull'estensione angolare del pianeta maggiore di quella di una stella di pari magnitudine è evidente dalla mancanza dei dischi di Airy. Si può dimostrare graficamente che gli anelli di Airy si perdono per diametri angolari della sorgente $\theta > \lambda/D$.

-
- 2 La stella brillante più vicina, *Rigel Kent* o alfa Centauri, a 4.3 anni luce da noi, è poco più distante di 1 Parsec, da cui la distanza Terra-Sole, 1 UA, appare sotto un angolo di $1''$. Geometricamente la tangente di $1''$, pari ad $1/3600^\circ$, è pari al rapporto $1/206265=1\text{UA}/1\text{pc}$. Il diametro angolare medio del Sole è pari a $32'$ o $1920''$, alla distanza di alfa Centauri apparirebbe sotto un angolo di $0.007''$. Solo la stella supergigante *Betelgeuse* arriva ad un diametro angolare di $\theta=0.047''$, misurato con l'interferometro di 3m da Michelson e Pease al telescopio di Mt Wilson nel 1920. (Dorrit Hoffleit, *Bright Stars Catalogue*, Yale University Observatory, 1982, p. 391, e C. A. Chant, J. of the Royal Astron. Soc. of Canada, Vol. 15, 1921, p.133). La diffrazione da telescopi di diametro inferiore a 2m è maggiore del diametro angolare delle stelle.

I casi di Urano e Nettuno e dei satelliti di Giove e Saturno

Urano e Nettuno³ hanno diametri angolari tra 2" e 3" e sono perciò adatti per verificare la loro natura "planetaria" dall'assenza delle figure di Airy. Anche i quattro satelliti Galileiani e Titano di Saturno, Cerere e Vesta, tutti visibili anche con un telescopio di 76mm, sono corpi di diametro sufficientemente grande per verificare questa proprietà. Titano e Ganimede hanno $\theta=0.7''$ e $1.3''$, Cerere e Vesta $\theta=0.5''$ e $0.3''$.



Figura 1. A sinistra la Point-spread function, PSF, di un'apertura circolare, ossia la figura di diffrazione di una sorgente puntiforme vista attraverso l'obbiettivo circolare di un telescopio. Si è rappresentato solo il primo anello di diffrazione; il diametro del disco centrale di Airy vale $\theta \sim \lambda/D$. Sopra, da sinistra a destra si vede il risultato progressivo della sovrapposizione di PSF elementari per ciascun punto di una sorgente S1 di diametro angolare $\theta = \lambda/D$. Sotto la sorgente S2 ha un diametro angolare $\theta = 0.1\lambda/D$. S1 appare come un disco sfumato ai bordi largo 4 volte il diametro geometrico originale $\theta = 4\lambda/D$, nel caso di S2 gli anelli di diffrazione restano visibili; per un telescopio di 76mm di obbiettivo a $\lambda = 520 \text{ nm}$ $\theta = 0.1\lambda/D = 0.04''$. La stella Betelgeuse dal diametro angolare $\theta = 0.047''$ mostra gli anelli di diffrazione, mentre Titano $\theta = 0.7''$ no.

3 Osservati a Lanciano con un Newton 76/700 a 175x: sono identici alle stelle di uguale luminosità, tranne che per l'assenza di anelli di Airy.

Stelle artificiali per collimare i telescopi

Usando delle palline di acciaio di 5 mm di diametro a 50 metri di distanza, nel caso di cielo sereno, con cielo azzurro, l'immagine sulla sfera riflettente del Sole ha dimensioni $2.5/100$ mm, cioè $R/100$, dove R è il raggio della sferetta e $\theta \sim 1/100$ è l'angolo in radianti sotto cui si vede il Sole da Terra.

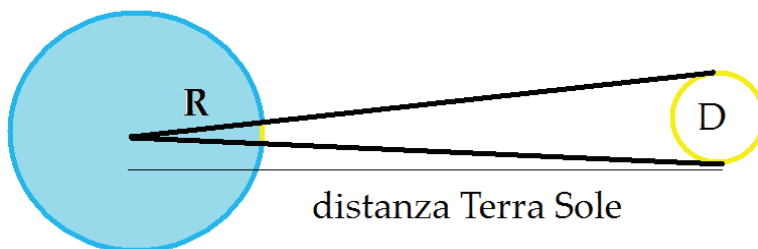


Fig. 2 La dimensione dell'immagine del Sole sulla sferetta di acciaio.

Nel caso di cielo nuvoloso, la luce del Sole è sparpagliata su tutto il cielo, e la sferetta riflette il cielo su tutta la sua superficie, dunque l'immagine luminosa è larga 5mm.

Nel caso con Sole l'immagine vista da 50m sottende un angolo di $\theta \sim 2.5/100/50000 \text{ rad} = 0.1''$, mentre con le nubi $\theta \sim 5/50000 \text{ rad} = 20''$. Così abbiamo una sorgente puntiforme quasi stellare, la "stella artificiale", che mostra la sua PSF ed una estesa di tipo planetario, con $\theta \sim 20''$, senza gli anelli di diffrazione. La collimazione dei telescopi stelle artificiali sfrutta la simmetria delle figure di diffrazione.

Conclusioni

L'osservazione degli anelli di diffrazione da sorgente puntiforme attraverso un obbiettivo di diametro dato è un'esperienza di ottica ondulatoria cruciale in Astronomia. Urano, Nettuno e i satelliti Galileiani e Titano non li mostrano per la loro dimensione angolare rilevante, rispetto alle stelle.