Gert Sperling

Early Orchestration: The Pantheon as a Resonance Element

Conference Report

The Pantheon: "Symbol of the universe" and "The Interpretation in Northern Europe"

Pantheon, Rome, in the rooms of the Accademia di San Luca

23 September 2001 and 21 March 2002

In order to hear clearly the acoustic phenomena in the Rotunda of the Roman Pantheon, it is necessary is to close all openings and activate a single sound source. On 21 March 2002, meeting participants were allowed to carry out small acoustic experiments after the rotunda closed to the public, from 7:30 pm until 7:55 pm (at which time the automatic security alarm is activated); at the same time it was possible to observe the optical effects of reflected moonlight. I undertook a simple but effective acoustic experiment. I positioned myself at the centre of the Rotunda over the bronze ring in the floor, bent my head directly back so that the sound waves were directed at the dome and produced three notes in harmony, one after another: C-E-G (Do-Mi-Fa). The volume of the resulting sound was amazing, because it did not sound as though it were coming from a single untrained voice, but rather from a powerful opera singer. After the original notes faded an echo-like reverberation could be heard which had a completely different dimension of sound. The three notes were apparently reflected back to the listener from the surface of the dome. The notes were perceived, not one after the other, but as a harmonic chord, with the sounds layered on top of each other, as if some one had played a three-note chord on an instrument. In other words, they were heard in unison. By means of the architecture, the rotunda created a polyphonic chord out of three individual notes. The difference between a musical instrument and architecture is important: where in an instrument the single keys or strings each produce a note, and simultaneous strokes produce chords, in the rotunda a chord was created even though the individual notes were not sounded simultaneously. This can only be possible through the focussing and reflecting influence of the coffers. This phenomenon supports the hypothesis that the musical polyphony of Western European culture is based on the "harmonising" effect its architecture. Greek antiquity, Arabian, and Far Eastern music are all lacking polyphony.

It is easy to arrive at the conclusion that the effect of polyphony is achieved through the arrangement of the coffers, which, thanks to steep, short graduations on their upper halves together with slanting smaller graduation on the lower, are directly aimed at the spectator. Proof of this must still be verified using tape-recorder and oscillograph. The exact reverberation of sound in the Pantheon must be analysed to determine the acoustic consequences of the architectural design of the Rotunda and the dome.

But the phenomenon proves that the musical component of the ancient *quadrivium* based on arithmetic, music, geometry, and astronomy is capable of generating not only a numerical proportional architectural system but also a genuine musical effect: the Rotunda is capable of producing a genuine polyphony.

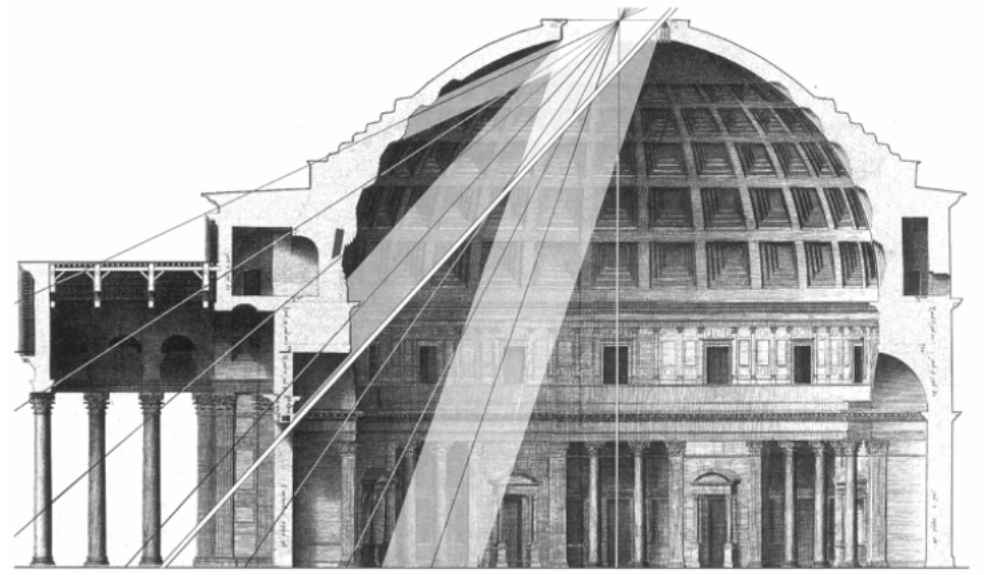

Fig. 1. The longitudinal section of the Pantheon to the east, indicating the angular sun rays. The basis of the figure is the longitudinal section by the architect Antoine Desgodetz, who in 1764 carried out a thorough survey, well before the alterations to the attic level by Paolo Posi in 1747 for Benedict XIV. The section shows the angular rays of the sun through the oculus into the interior of the Rotunda at different times of the year. The summer and winter solstices are shown, as well as day and night. A small beam that shines into the arch of the door deserves particular attention. Here the sun creates a small patch of light that announces the beginning and end of the half-yearly summer period.

It should also not be forgotten that the rays of the sun passing through the oculus of the Rotunda move along the meridian line over the course of the year (Fig. 1). Although this is not audible, it creates calculable harmonic mathematical intervals. During the summer, the sun's rays shine at noon on the floor; during the spring and autumn, they shine on the string courses above the inner row of columns and the attic; during the winter, they shine on the coffers of the dome. The rays act as the bridge of a monochord whose strings are represented by the string courses arranged in parallel rows. The positions of the sunbeams in the Pantheon precisely reproduce the intervals of proportion of the fifth, the fourth, the whole note and the octave. With regards to the position of the bridge of the monochord, the notes get higher as the bridge is moved so that its position shortens the string length, but the interval remains the same. This was demonstrated by the *helikon*, an ancient instrument similar to a guitar used to teach music theory. The notes get higher, but the intervals remain the same. The same phenomena is produced by the sunbeams as they strike the different levels of the Rotunda. The imaginary lines extended to the north are always intersected at the same interval, whether the angle of the sunbeam is high (summer) or low (winter).[1]

A useful indication of one scientific use of the Pantheon is the citation in the Oxyrhynchus Papyrus 412 (now in the Dept of Manuscripts, the British Museum) by Sextus Julius Africanus, a Christian who built a library in the Pantheon for Alexander Severus about 230-40 AD. In his own translation of the *Odyssey*, he refers to this, saying in the thirteenth verse that, "in Rome by the

thermal baths of Alexander [is] the beautiful library of the Pantheon, which I built myself for Caesar (as his appointed architect)."[2] Since Julius Africanus had spent a long period in Alexandria studying and writing papers on natural sciences, it can be hypothesized that the Pantheon library was in the Alexandrian style.

Fig. 2. Pantheon, vestibule to the west. The light reflection in the vestibule was taken at midday on 21 March 2002 exactly between day and night.

It should also be noted that the cult of the Arval Brethren was practiced in the Pantheon at that time. This involved the calculation of times for the planting and harvesting of crops, acts which at that time, as today, could be related to the religious calendar, indicating that astronomical questions were also considered. The mysterious but verifiable fact that the line from of the edge of the dome through the middle of the oculus produces an angle which is exactly the latitude of Rome (41.8°) and the angle of the ecliptic at that time (23.41°) touches on and accentuates all of the architectural elements from the pronaos and the Rotunda both internally and externally (Fig. 2).[3]. This supports the hypothesis that the library, situated in this southern sector, would have had a room for the observation of the sky. However, in order to view the circumpolar sky in the oculus an opening would have been required at the southern edge of the dome. Our investigation during the course of our meeting revealed a bricked-up rectangular slit roughly forty centimetres wide and three meters high, placed exactly on the southern part of the dome, not at all related to the other tension ring cracks filled in after the construction of the dome (Fig. 3).

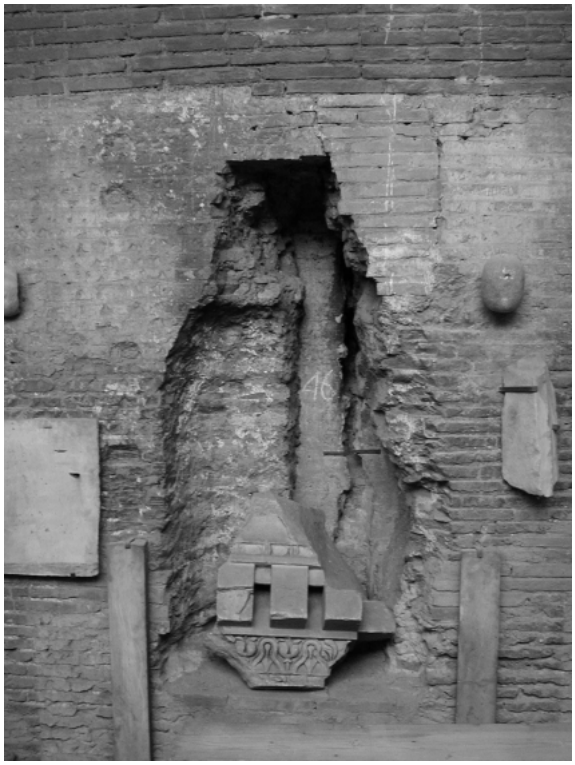

Fig. 3. Pantheon, upper floor, view to the east. The photograph shows the room of the nave which probably housed the Biblioteca Alexandrina in the third century. The Rotunda lies behind the brickwork filling the side arch to the north. The upper string course of the cornice of the Rotunda is at the height of this floor. This is where the dome springs, and in which, in the lower bricked-up opening at a depth of roughly two feet, an area of one-half square meter has been opened. building inspectors found a crack here in the cement covering which was caused by shrinkage during the construction of the dome. Above this point there is another vertical opening in the brickwork roughly 3 m. long and 1/2 m. deep. It was later bricked up in a way that is clearly different from the original construction. An opening to the dome might have been here. As the wall slit is placed very near to the south of the Rotunda, it would be perfectly positioned as an observation point to the north for measuring the circumpolar sky above the oculus. This observation post lying next to the room that is believed to have housed the Biblioteca Alexandrina, supports the hypothesis that the study of the universe was, from the very beginning, part of every important book collection.

These cracks are irregular and narrower in shape, and recorded as being in situ by Alberto Terenzio in 1930. They were also verified using a computer simulation by R. Mark and P. Hutchinson in 1986.[4] It can also be noted that the inner coffers (on the opposite side as well) are noticeably irregular and the material appears not to be as consistent as the others, which is another indication of a later closing of this particular opening.

This slit that we noted could really have been an observation void in the wall of the dome, allowing the position of stars to be fixed using a diaopter mounted on glass plates or also to determine more accurately the movement of the position of the beginning of spring along the

ecliptic (precession). The precession led to the rise and fall of the zodiac signs in the so-called Platonic Year (roughly 26.000 years). A reassessment of this hypothesis is subject to obtaining permission to drill a hole for a photoscope or even completely open the slit itself.

Editor's Note

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Notes

1. Compare the illustration by Gert Sperling, *Das Pantheon in Rom: Abbild und Mass des Kosmos*, p. 267 f.
2. Quoted in W. Wischmeyer, *Von Golgatha bis Ponte Molle*, Göttingen, 1992, p. 45.
3. Cf. Gert Sperling, *Das Pantheon in Rom: Abbild und Mass des Kosmos*, pic. 113, p. 203.
4. R. Mark and P. Hutchinson, "On the Structure of the Roman Pantheon", *Art Bulletin* 68, March 1986, p. 22-34.

About the Author

Presbyterian minister Gert Sperling has researched topics concerning the Pantheon for over thirty years. He is well known from his many reports on the subject. His most complete work is his book, *Das Pantheon in Rom: Abbild und Mass des Kosmos* (Munich/Neuried: ars una Verlag, 1999).