‘My Life is like the Summer Rose’ Maurizio Tosi e l’Archeologia come modo di vivere

Papers in honour of Maurizio Tosi for his 70th birthday

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THE IMPORTANCE OF ARCHAEOASTRONOMY IN ARCHAEOLOGICAL EXCAVATIONS

Mario CODEBÒ
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In 2002 I organized the international congress 'Archeoastronomia: un dibattito tra archeologi ed astronomi alla ricerca di un metodo comune' for the Istituto Internazionale di Studi Liguri (= IISL). On that occasion I met Maurizio Tosi.

The congress had two sessions: the first was held in Genova (February 8th-9th, 2002); the second in Sanremo (November 1st-3rd, 2002). We wanted archaeologists and astronomers to meet and discuss about problems, doubts and suspicions that this new discipline is always arousing. To use the words of Roberto Maggi, at that time the director of the Soprintendenza per i Beni Archeologici della Liguria, they wanted to "sniff each other".

For the Genova session, according to a suggestion of Maggi himself, Maurizio had to give a presentation with the title 'Social complexity, political projects and uses of firmament'. Unfortunately, at the very last moment he was not able to attend, because his first child was just born! So he gave his presentation a few months later in Sanremo, where he arrived with the whole family.

His attendance was extremely important, giving to the congress a wider anthropological approach and an international cultural dimension, not yet emerged, to the discussion. He also talked about how difficult it is to work in some situations or in the countries where "...you cannot stay for more than 48 hours, because someone shoots you after that time".

Shortly, Maurizio enriched the congress with his cultural soundness and his charming personality - just read his numerous interventions in the above mentioned proceedings of the congress, published in Bordighera in 2009 by the Istituto Internazionale di Studi Liguri. Since then Archeoastronomia Ligustica (that is, Henry De Santis and I) found a very promising field of research and cooperation in the archaeological missions directed by Maurizio, which are all over the world.

Sigmund Freud used to say "The destruction of Pompei really started since its excavation" (Freud 1909: 23). As everybody knows, archaeological excavations destroy the archaeological deposit and, sometimes, even the archaeological evidence. Therefore, it is important to think about the future preservation of what is found; otherwise, precious information would be lost forever.

If we do not do something effective for the acknowledgement and the preservation of possible astronomical alignments, they are going to be cancelled. The excavation of the Copper Age necropolis of St.-Martin-dé-Corléans (in Aosta, Italy), which began in 1969 and lasted until 1990, is a very good case-study of the problems involved in this kind of research. During the last year of the excavation, the archaeoastronomers Giuliano Romano and Guido Cossard made a survey, discovering eighteen different astronomical alignments which were created during the whole life of the site - from 3100 to 1900 BC. They can be subdivided as follows:

1) four alignments towards minimal standstill of the moonset;
2) two alignments towards maximal standstill of the moonset;
3) one alignment towards the maximal standstill of the moonrising;
4) two alignments towards sunrise at winter solstice;
5) four alignments towards sunset at winter solstice;
6) one alignment towards sunrise on May 1st and August 15th, which are the dates of the two holy days Beltane and Lammas, celebrated by Celtic populations 2000 years later;
7) two alignments towards the rising of Betelgeuse (*Alpha Orionis*);
8) three alignments towards the setting of Deneb (*Alpha Cycnii*) at that time.

In addition, they found that when the area began to be inhabited, there was an alignment of wooden poles to a point on the horizon before the main function of which was: during its minimal standstill, every 6798 days (corresponding to 18,61 years, i.e., 18 years and 223 days), the moon setting seemed (and still seems now!) as if it is rolling down the mountain's profile, and then was hidden for a few moments by the only rocky peak. This alignment became the cardinal axis along which all the subsequent burials were aligned, including the furrows of the ritual plowing and the alignments of anthropomorphic stelae (in Italian *statue-stele*) (Cossard *et al.* 1991).

In brief, the archaeoastronomical survey showed that there was a tight and deep interpenetration of cultural, funerary and astronomical elements. I can say that, without that survey, half of the information potential of the site would remain unknown (Codebò 2006: 249-252). Needless to say, Saint-Martin-de-Corléan could provide such information because its structures were not *destroyed* during the excavation.

I worked in the excavation of the early Christian cemetery of Piazza della Conciliazione in Acqui Terme (near Alessandria, Italy). The director of the excavation, Carlo Varaldo, charged me expressly to take the archaeo-astronomical measurements.

Probably this is the first Italian excavation in which the archaeo-astronomical survey was planned from the very beginning. The situation is quite different compared to Saint-Martin-de-Corléans: almost all tombs - except few stone cist burial graves - were burial graves with a tile roof (in Italian *copertura alla cappuccina*), and therefore I had to measure all of them - one by one - before they were destroyed by the progress of the excavation. At any rate, we did something else to document it: something that should be done in any archaeological excavation with the presence of an archaeo-astronomer on the field.

Since the finds of this type of excavation usually are recorded with great precision, taking account of their mutual position (but only if this is done properly), it is enough to give the right orientation to the plan to reconstruct the original orientation of each single structure even after a long time. The precise orientation of the plan or map of an excavation can be calculated only using astronomical or satellite methods. It cannot be done with a magnetic compass, because this instrument (which in any case must be prismatic with a direct reading of at least 1°) is prone to local anomalies and to magnetic declination, which can vary at random in a period of time.

During the excavation of Acqui Terme I was able to orient the plan with utmost accuracy using three simple basic rules:

1) measuring the orientation of the 'stone cist graves', which were not destroyed by the excavation;
2) measuring the astronomical orientation of the perimeter of the whole area, which was marked with iron poles linked to the grid of the excavation;
3) identifying the north-south axis: in order to do so, I used astronomical noon (which can also be called 'true' or 'local'), and then I have centered the origin of the Carthesian axes of the whole plan on this astronomical axis.

This last method can be easily applied and can be used even by people who are not familiar with archaeo-astronomical survey. It is enough to identify the north-south axis, from 0° to 180°, which corresponds to the local meridian, that every day is crossed by the sun in the moment of astronomical noon.

In fact the noon that we read on our clocks is the noon of the central meridian of the local time zone; in Italy this is the meridian that passes through the summit of Etna (Sicily). Time zones were designed in such a way that the difference between the time at their center and the time at their borders cannot exceed 30 minutes. All points between the outer borders of the time zone and its central meridian have a 'true time' (i.e., the astronomical or local time or sun hour angle, which differs from the 'mean time') that equals the distance between that same point and the central meridian, expressed in time units or arc units.

For example, the border between Italy and France (in the western Alps) is set at thirty minutes (= 7,5°) west of the Etna meridian, when the clocks are showing the same mean time. This means that when the clock reads a hour (any hour, for example noon) on the French-Italian border, the true time is 30 minutes in advance: in that point true time is still 11:30, and the sun will pass above the local meridian at 12:30 mean time.

In the boreal hemisphere, each time that the sun is crossing the local meridian in any location, it is determining the astronomical noon; in that moment its azimuth is 180°00'00" and its reciprocal azimuth is 360° = 0° (in the austral hemisphere it is the opposite). To find out the time shown on the clock that corresponds to the astronomical noon in a definite location, a simple procedure must be followed:

1) using time units to calculate the longitude of the place from the Greenwich meridian (positive if it is to the east of it; negative if it is to the west of it);
2) to subtract this value from the longitude of the central meridian of the local time zone from Greenwich (these longitudes always are multiple of 15° = 1 hour). A value that cannot exceed thirty minutes will be obtained; it will be 'minus' if the site is located to the east of the central meridian of the local time zone, and 'plus' if the site is to the west of it. This value is called 'local constant' (Zagar 1984: 115-116);
3) to add the local constant with its sign (minus or plus) at 12h 00m 00s;
4) to add, with its sign (plus or minus), the true time equation ET_v, or to subtract, with its sign, the mean time equation ET_m.

The time equation ET (Flora 1987: 199-200) reaches a maximum value of sixteen minutes, and it is the algebraic difference between the mean time tm, conventionally defined as 24h 00m 00s, and the true time tv, or true hour angle H of the sun, both calculated from the upper meridian. We can conventionally distinguish two types of ET:

1) the equation of mean time $ET_m = tv - tm$;
2) the equation of true time $ET_v = tm - tv$.

The equation of time can be calculated with some algorithms (Smart 1976: 146-150; Meeus 1990: 93-94; 2005: 183-187), or can be directly taken from the ephemerides, which record it day by day: the nautical ephemerides for midnight and noon; the astronomical ephemerides only for midnight. For all the other hours it is enough to interpolate.

Using these few data it is possible to calculate the moment of astronomical noon:

12h + (± local constant) + (± ET_v)

12h + (± local constant) – (± ET_m)

At this point we must drive a vertical pole into the ground (using a plumb line or a torical spirit-level to check if it is perfectly vertical). Standing away from it as far as possible, we must expect that the sun passes in front of it at the moment of astronomical noon we calculated in advance. At that moment, we will drive into another ground pole, exactly aligned with the first one and with the center of the sun disk, at the time of astronomical noon: the axis that can be defined with this method is the local meridian, which means the north-south axis 0°00'00"-180°00'00".

The whole map of the excavation must be referred to this axis, and in doing so we will obtain the exact alignment in the space of the plan and of all the archaeological finds drawn within the plan itself. Therefore, it will always be possible to identify the astronomical alignments of the excavated structures, even after a long time and when the excavation will be definitively closed. But the plan must be drawn with extreme precision.

As an example, here I describe the calculations I made to find out astronomical noon on August 11th, 1997 in the early Christian cemetery of Acqui Terme (Italy), in Piazza della Conciliazione:

map IGMI. 1:25000: latitude 44°40'25,5"N; longitude 3°59'00,3"W from M. Mario; height 160 m above sea level.

Longitude of M. Mario from Greenwich: 12°27'08,4"E.

Longitude of Piazza della Conciliazione from Greenwich: 12°27'08,4" - 3°59'00,3" = 8°28'08,1"E.

Longitude of the Etna meridian from Greenwich: 15°E = 1h E.

Local constant: 15° - 8°28'08,1" = 6°31'51,9" = 0h 26m 07,46s.

ET_v 11/08/1997 UT 12h 00m 00s (nautical ephemerides I.I.M.) = 0h 05m 09s.

Astronomical noon on August 11th, 1997 in Piazza della Conciliazione:

12h 00m 00s + 0h 26m 07,46s + 0h 05m 09s = 12h 31m 16,46s.

Unfortunately, even in recent times, excavations did not take into account the possible existence of astronomical alignments; therefore, if they existed, they were destroyed.

This happened in 1905, during the excavation of the nine ‘statue-stelae’ of Lunigiana (Italy), which were found in Pontevecchio (Ambrosi 1972: 44-63; Codebò 2006: 269). At that time Ubaldo Mazzini wrote: “They were driven into the middle of a squared area whose soil was black and soft... they were standing one after the other, at close distance one from the another, along a row going from East to West” (Ambrosi 1972: 45-46).

These stelae have remained in situ for four years before they were moved to the museum of the city of La Spezia, but nobody measured their exact orientation or the alignment they formed; the plan and the archaeological finds were not oriented. Therefore, today we cannot understand if they had an astronomical meaning. They probably had, considering the positive results concerning the alignments of the anthropomorphic menhirs of Saint-Martin-de-Corléans. Those data are lost forever! In this connection, it should also be pointed out that *even a negative data is still a data*: at least it proves that a monument - or the ancient people that created it - were *not* interested in astronomy.

A second example is the excavation of the anthropomorphic menhir called ‘Minucciano III’ in Lunigiana (Maggi 1994: 89-100). It was evident that it was aligned with another stele, ‘Minucciano II’, and probably also with ‘Minucciano I’, but their orientation was not measured with precision. Tiziano Mannoni, who directed the excavation together with A.C. Ambrosi, was a passionate supporter of archaeoastronomy (Codebò 2002). Few months before his death, he still regretted that on that occasion nobody paid attention to the possible astronomical value of the find. We agree that this was due to the fact that archaeoastronomy was completely unknown in Liguria until the end of the 1990, when the first studies started to be made (Codebò 1993; Berti *et al.* 1996; Codebò 1997).

Thanks to the joined efforts of archaeologists and astronomers (Anonymous 1986-1987; Fano Santi 1991; Accademia Nazionale dei Lincei 1995; 1998; 2001; Codebò 2002) and thanks also to the birth of the Società Archeoastronomica Italiana (SIA) and of the Société Européenne pour l'Astronomie dans la Culture (SEAC), those works of fiction (‘archaeofiction’), which in the past - and today too - damaged the credibility of this discipline, were set aside and archaeoastronomy is becoming increasingly important among the disciplines related to archaeology. Now archaeologists are taking advantage of the knowledge of archaeoastronomers. This is also happening in the expeditions directed by Maurizio Tosi, to which Archeoastronomia Ligustica is participating. We thank him wholeheartedly for his foresight and trust!

Archaeologists have therefore to remember that astronomical alignments are genuine finds of material culture and that their destruction is a loss of archaeological documentation[1].

[1] I thank Fabrizio Benente, Barbara Cerasetti, Guido Cossard, Mauro Darchi, Marina De Franceschini, Henry De Santis, Stefania Della Scala, Severino Fossati, Angelo Ghiretti, Enrico Giannichedda, Roberto Maggi, Tiziano Mannoni†, Franco Mezzena, Giulio Predieri, Giuliano Romano, Elena Salvo, Maurizio Tosi, Carlo Varaldo.

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