SIDEREAL YEARS — CATALOGUE USES IN ARCHAEOASTRONOMY
How astrometry can help in solving archaeoastronomical problems

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In ancient societies the Sun was the natural time marker in daytime and base for the calendar. At night, however, the stars, their movements, risings and settings, disappearence and reappearence served quite obviously as time-keepers, and people were not always conscious that they measured time using two slightly but fundamentally different clockworks.

A sidereal year, the period in which the Earth completes a revolution relative to a fixed point in the ecliptic, is longer than a complete revolution from equinox to equinox: the solar tropical year. In astronomical practice of ancient cultures instead of this unobservable point on the ecliptic a visible "fixed" star was observed: a complete revolution of the Earth relative to the same fixed star. On a historic time scale the length of the sidereal year varies and its variation is determined by the proper motion and the precession of the star chosen as time marker.

In one period of the Egyptian history the heliacal rising of the Sirius occurred at the same time as the summer solstice and by coincidence at the same time of the Nile inundation. From this time on Sirius — a star of considerable proper motion and far outside the ecliptic — became extremely important to Egyptians. Its heliacal rising has been watched and the time interval between two heliacal rises measured. The calendar was calibrated and the year began with the heliacal rising of Sirius, although heliacal rising and summer solstice have slowly got out of step.

Let us see some data concerning the length of the tropic solar year in the past. It has slightly shortening character [1].

Gregorian year	*length of the tropical year*
– 3000	365.24249964 *d*
– 1500	365.24240755 *d*
+ 1	365.24231545 *d*
+1500	365.24222335 *d*

The tropical solar year should have been 365.24244 days in –2000 B.C., and the sidereal year determined by successive heliacal rises of the Sirius about 365.25059 days at 30 degrees northern latitude (it is the ancient Memphis where observations took place in Egypt), thus by about 11 minutes longer. In the Gregorian reform of the calendar the length of the Julian year was diminished by this

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amount in order to "correct" the "error" of the ancient observers and to obtain the true length of the tropical solar year [2].

It is unbelievable, however, that such a big failure could have been made by skilled ancient observers and that by coincidence their error equals to the difference between the "Sirius year" and the tropical solar year. It is much more likely that Julius Cesar in performing his calendar reform introduced the Sirius year of 365.25 d length. He consulted an Egyptian astronomer, Sosigenes from Alexandria, familiar with Egyptian time reckoning. Julius Cesar, being a politician, did not care of the nature of the year recommended to him. Presumably had no idea of the precession of the equinoxes. My suggestion is that the Julian year has been the sidereal year of Sirius.

If it is so, Christian churches which got out of the authority of Rome, among them *e.g.* the Russian Orthodox Church, are not using an "incorrectly determined" solar year but a correct Sirius year. The variation of the Sirius year in time should be calculated by means of accurate star catalogue to settle the problem finally.

Going farther from Europe, but in the same belt of geographic latitude, exciting problems of Chinese history face us. From ancient Chinese documents one can guess the existence of a very early peasant calendar based on heliacal rising of the "Fire Star" (very probably Antares) at the spring equinox [3]. These archaic records of Chinese chronicles, however, claim that certain spring festivities called "Pure Brightness" (ch'ing ming) were held about two weeks later in the country (at the beginning of April) than the beginning of spring in the official (solar) calendar. The records are from historical past, from about the middle of the dynasty Chou (11th to 3rd century B.C.). This "being late" of the popular festivities preserves an earlier situation, when heliacal rise of Antares and spring equinox coincided. When did the heliacal rise of Antares mark the spring equinox and when did the chronicles depicting this delay between the "official" (solar) and the traditional peasant (sidereal) calendar originate? Calculating the length of the Antares year and its variation in time this question can be settled.

Among the oldest variants of Chinese characters — from the last centuries of the second millennium B.C — the constellation Scorpion (Ch'en) and Orion (Shen) are represented "pictorially". The central three stars of the Scorpion and three stars of Orion (probably its belt) are related to different Chou time principalities defending the people but being hostile to one another, *i.e.* a symbol of a fratricidal war. The visibility of these constellations, their regular appearence or disappearence recorded in mythic agricultural tradition may establish the probable extent in geographic latitude of ancient Chinese civilization.

These few examples may outline what kind of problems are to be solved in archaeoastronomy. Going back to far historic (or prehistoric) times and using only precessed coordinates we can't obtain correct results in determining the exact date of a certain heavenly phenomenon. Astrometry delivering exact coordinates and proper motions has a key role in archaeoastronomical calculations. Futhermore, astrometry is in the position to answer the question, how long one may venture to go back into the remote past, when dealing with archaeoastronomical problems while still getting reliable results.

References

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