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SOLAR DIAMETER MEASUREMENTS

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RESUMO. É discutida uma série de observações do Sol realizadas com o Astrolábio do Observatório Abrahão de Moraes da Universidade de São Paulo. Uma análise harmônica a partir de 96 valores médios mensais do semi-diâmetro revela a existência de uma oscilação de baixa frequência de aproximadamente 1000 dias.

ABSTRACT. A series of observations of the Sun made with a prismatic astrolabe is discussed. A Fourier analysis applied to the time-series of apparent solar radius shows a period of oscilation of about 1,000 days that dominates these data.

Key words: ASTROMETRY — SUN-STRUCTURE

1. INTRODUCTION

Observations of the Sun with the prismatic astrolabe in the University of São Paulo "Abrahão de Moraes" Observatory at Valinhos (ϕ = 23°00'.1, λ = $3^h07^m52^s$W) have been made since 1974 (Leister, 1979).

In the interval from Sept. 1974 to Dec. 1987 we collected about 2,000 observations of the limbs of the Sun in the current programme, which includes fundamental stars (Benevides et al., 1979).

The basic principle of the astrolabe, which relies on the method of equal elevations, has been described elsewhere (Débarbat et al., 1970).

The instrument was adapted for solar observations. The single equilateral prism was replaced by reflector vitro ceramics prisms for observations at 45° and 30° zenith distance.

The procedure consists of timing the point at which a directly received image coincides with one that is reflected off a level mercury surface, when the upper (or inner) edge of the Sun crosses the almucantar fixed by the prism angle.

The primary goal of these observations is to determine the correction of the orbital elements of the movement of the Earth, and the orientation of the reference system (FK4) (Leister, 1989).

The accuracy obtained of the results has led us to investigate whether this type of observation could contribute to determine the value of the Sun's diameter. The diameter value is obtained from the difference between the zenith distances of the solar centres corresponding to the instants of sucessive limb crossings by the same almucantar. This kind of observations has the advantage that these measurements are not affect by effects caused by differential refraction.

With the use of two different reflector prisms it was possible to observe at two different zenith distances, allowing to sweep, at Valinhos, the apparent orbit of the Sun during a period of about 10 months per year.

2. DATA REDUCTION PROCEDURE

The method of the data reduction is based upon the comparison between the observed zenith distance by means of the transit time and the zenith distance defined by the prism.

Let t be the mean of transit times for upper and lower limbs. The corresponding sideral time and the dinamical time are θ and T. The observed zenith distance is given by:

$$z_o = \cos^{-1}\{ \sin(\phi+\Delta\phi)\sin\delta(T) + \cos(\phi+\Delta\phi)\cos\delta(T)\cos[\theta+\Delta t-\alpha(T)]\} + \rho\omega\sin z + SD$$

where $\alpha(T)$ and $\delta(T)$ are the equatorial coordinates at instant T.
ϕ, the conventional latitude,
$\Delta\phi$ and Δt the latitude and clock corrections obtained from FK4 stars observations at night,
ρ, the vector radius of the observations station,
ω, the paralax,
z, the calculated zenith distance refers to the timing of the upper and inner edges of the Sun with the almucantar.

The instrumental zenith distance is given by

$z = \beta$ + instrumental correction + refraction

where β is the prism angle.

The observed radius of the Sun is half the difference between the zenith distances of the upper and inner solar edges.

3. RESULTS

The time-series made the Valinhos astrolabe began in 1974 and became at two zenith distance from 1982 onwards.

The figure 1 shows the monthly semi-diameters calculated from the time-series for the period 1982-1987. The error-bars corresponding to the monthly semi-diameters are close to the error on each individual measurement that is 0".4. The observations were made by two observers and there is a satisfactory coherence between themselves (the systematic difference is less than 0".1 on each observation).

A Fourier analysis was made of this time-series, a number of periodicities are present above the 2σ level, with one of the most prominent signals occuring near 1,000 days (Leister, 1989). The amplitude is of $\pm$ 0".20 and is in phase with the signal present in the CERGA astrolabe series (Laclare, 1987).

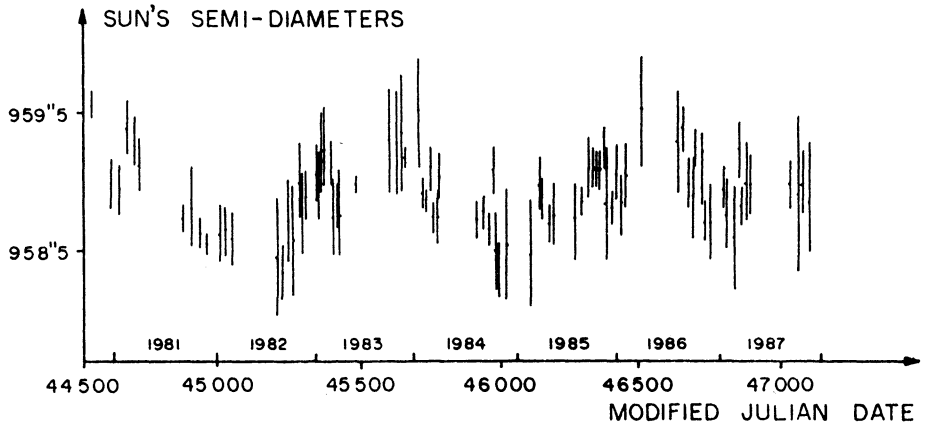

Fig. 1 - Monthly mean semi-diameters

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