THE HELIOMETRIC ASTROLABE, A NEW INSTRUMENT FOR SOLAR DIAMETER OBSERVATIONS

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ABSTRACT. The Observatório Nacional takes part in the Réseau de Suivi au Sol du Rayon Solaire (the international solar diameter monitoring network) which co-participates in the PICARD micro satellite, to be launched in 2008 to study the Earth climate and Sun variability relationship. A new instrument, a heliometer, was devised in order to minimize the atmospheric turbulence and reach data accuracy compatible with PICARD's. The heliometer principle of double images will be added to the astrolabe metrological quality, and fully digitized acquisition. The objective is to obtain two simultaneous images from the Sun, with fixed angular separation of about $30'$, which variation will contain the signature of the diameter variation.

1. INTRODUCTION

From 1998 to 2003, 16,511 measurements effective measurements were obtained by the Rio de Janeiro station of the international consortium for monitoring the solar diameter (R2S3), sweeping the heliolatitudes up to about 80°. Their standard deviation is 0".564, however, the evolution of the results is evident, in good report with the solar cycle and major burst events (Andrei et al., 2005).

At present, the solar diameter is measured along the vertical line of the observer, what restricts the heliolatitude range of observation. It is also worth to point out that the measure of the solar diameter through the reference to almucantar will always be an indirect measure. The differential refraction can be relevant, since the two borders are not observed simultaneously. Variations in refraction would imply in errors on the measure of the solar diameter.

2. THE PROPOSED HELIOMETRIC ASTROLABE

Heliometers are instruments designed to measure the solar diameter. The measurement technique relies on displacing the solar disk image by a known amount. Then the truly observed distance the limbs provides the measure of the diameter. Best results are obtained when the doubling is made larger than the diameter itself and variations are surveyed instead of the diameter itself. The double solar images to be obtained are morphologically alike to those obtained from the present instrument. On the other hand, the larger attained precision requires

improvements for topological description of the solar limb. At the same time, improvements are as well made on the determination of the loci of the solar limb points. The most crucial point relates to the definition of the center-to-limb darkening, in scales of the order of 1. The most recent measurements, air-borne made, reveal that the intensity drop only reaches to zero at a considerable distance from the visible boundary.

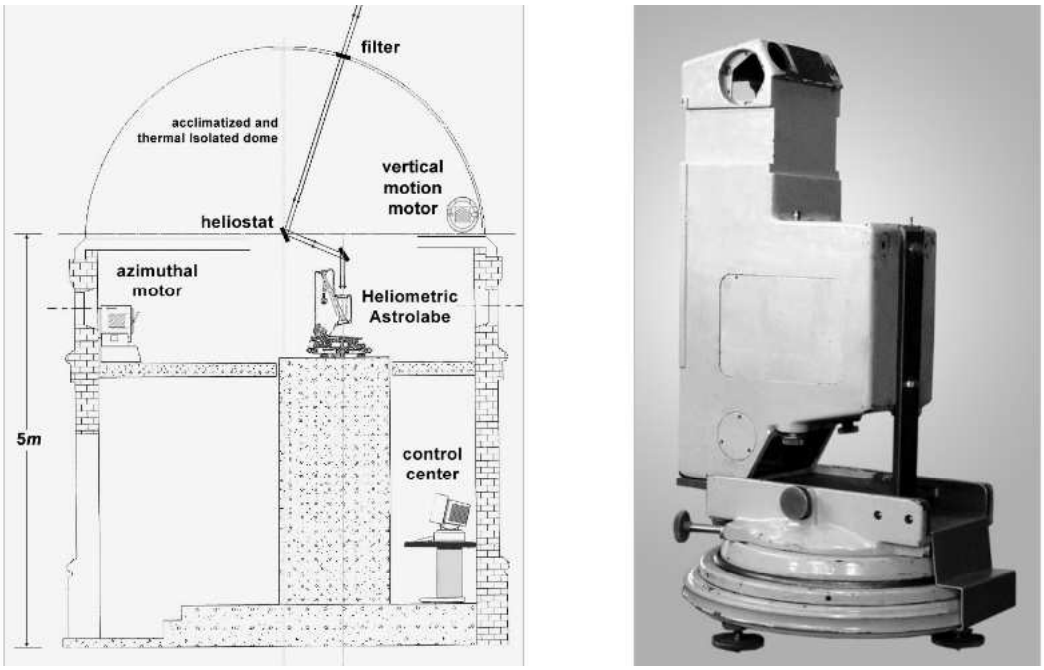

Figure 1: On the left a schematic view of the operation of the heliometric astrolabe. On the right, the instrument in its new attitude.

In the proposed technique several problems of the present method are avoided. The mercury basin is no longer necessary once the measurement is made directly from the distance between the opposite limbs, making the two image of the same quality. Since there is no more reference to the almucantar, the solar diameter measurements can be made at will towards any heliolatitude, enabling to obtain the solar figure in a very short interval of time (instead of months as presently). This is accomplished by spinning the divided objective around its focal axis (D'Ávila et al., 2005). Anomalous and differential refraction errors are effectively nullified, since the two (double) solar limbs are simultaneously observed. The instrument operation leads to automation and a very fast regimen of data acquisition, all day along. It is to be remarked that the proposed instrument will keep the output characteristics and can even keep the present data handling routines. This is a very important feature, which provides continuity to the measurements, and full comparison to the nearby solar astrolabe in the Observatório Nacional campus, as well as to the other stations of the Réseau de Suivi au Sol du Rayon Solaire international network of monitoring.

REFERENCES

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