GREGOR, a 1.5 m Gregory-type telescope for solar observation(*)

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Summary. — GREGOR is a high-resolution solar telescope with an aperture of 1.5 m. It will be equipped with an adaptive optics system and is designed for high-precision measurements of magnetic fields and plasma motions in the solar atmosphere and chromosphere with a resolution of 70 km on the Sun. GREGOR will replace the 30 years old Gregory Coudé Telescope at the Observatorio del Teide on Tenerife. We describe the optical design and the focal plane instrumentation. In concert with the other solar telescopes at Teide Observatory it will be useful for studying the dynamics of the solar atmosphere and of the underlying processes. GREGOR will also serve as a test bed for next-generation solar telescopes.

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1. – Introduction

Many processes on the Sun take place on scales of few 100 km or even below 100 km. Convective flows, waves, and plasma motions in and around magnetic fields need to be scrutinized on small spatial scales ond on short time scales to understand the physics of the solar atmosphere in quiet and active regions. Thus, large-aperture telescopes, with instrumentation for high photometric and polarimetric accuracy mesurements, are needed.

GREGOR—named after its Gregory-design—is an approved project. It will replace the Gregory-Coudé telescope (GCT, retiring after 30 years of service) at the Observatorio del Teide. GREGOR, built with modern technology, will be equipped with Adaptive

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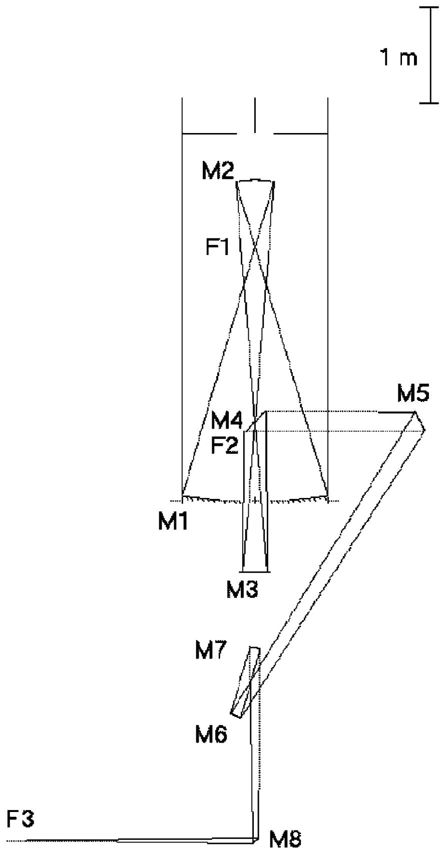

Fig. 1. – GREGOR, optical design.

Optics and is designed to allow spectro-polarimetric measurements of small-scale solar structures from near UV to IR. It will also serve as a test bed for large, next-generation solar telescopes.

2. – GREGOR

Figure 1 depicts the optical design of GREGOR. Its main charactersitics are

– ⌀ 1.5 m mirror M1;

– focal ratio at the tertiary focus F3 $f/40$;

– adaptive optics, "rubber" mirror M6;

– light-weight C/SiC mirrors (fig. 2), which possess a high thermal conductivity and thus allow an active control of the temperature;

– stiff light-weight structure;

– alt-azimuthal mount (fig. 3).

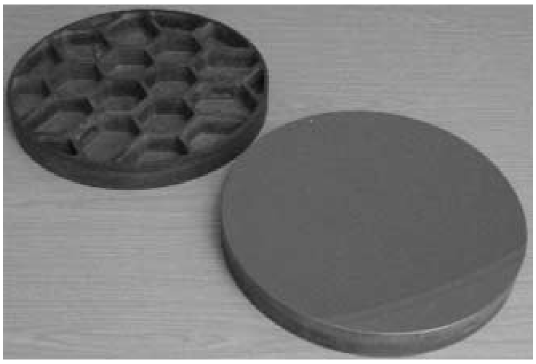

Fig. 2. – Front and back side of the M3 mirror showing the C/SiC light-weight structure ($\oslash$ 30 cm $\widehat{=}$ 2 kg).

3. – Focal instrumentation

The focal instrumentation comprises:

– polarimeters with modulators in the secondary focus F2;

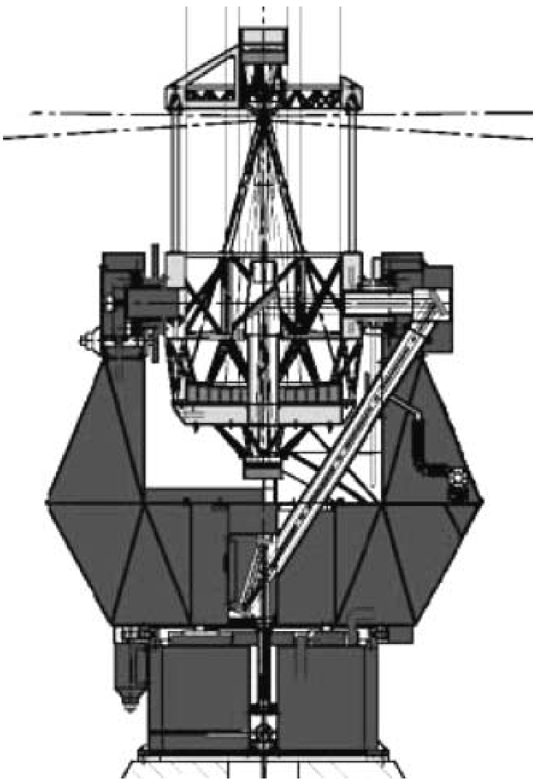

Fig. 3. – Telescope structure.

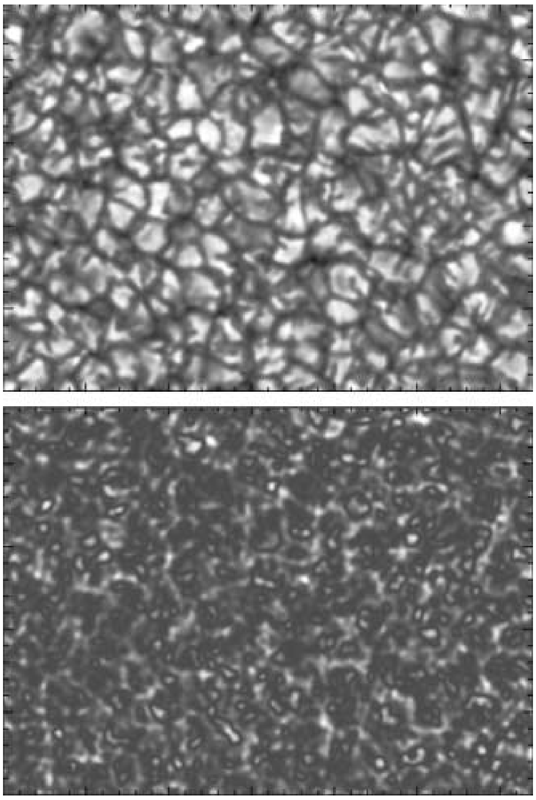

Fig. 4. – Granulation (upper panel) and granular velocities (lower panel) in Na D_2, image reconstruction [2]. Distance of tickmarks: $1''$.

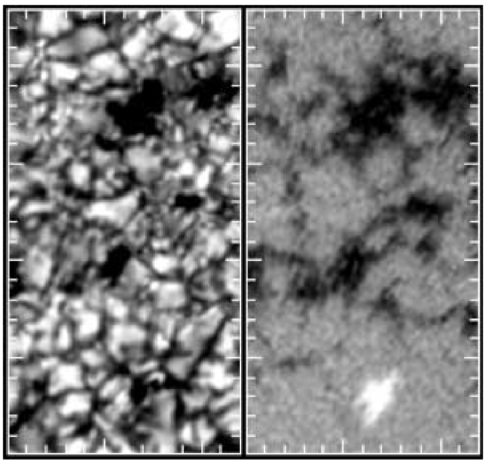

Fig. 5. – Abnormal granulation with pores (left) and magnetic fine structure (right) after Koschinsky *et al.* [3]. Distance of tickmarks: $1''$.

– existing spectrograph of the GCT with multi-line capability;

– detectors for infrared spectro-polarimetry. The spatial resolution at 1.5 μm is $0.2''$;

– POLIS, a *Po*larimetric *Li*ttrow *S*pectrometer for high-speed polarimetric spectroscopy in the visible and UV. Its spatial resolution is $0.07''$ at 500 nm, and it is an ideal instrument to study the relation between the photosphere and the chromosphere [1];

– filtergraph for

a) high-speed high spatial resolution imaging in continuum, G-band, Ca K, ... ;

b) slit-jaw imaging for the spectrograph;

– Fabry-Perot spectro-polarimeter which scans across spectral lines and allows fast, two-dimensional, narrow-band imaging and image reconstruction;

– optical bench for experiments.

4. – Science with GREGOR

We mention only few examples. The telescope will be an ideal instrument for infrared spectroscopy. Its adaptive optics system combined with established methods of image restoration will allow to observe and to study solar atmospheric dynamics with high spatial and temporal resolution. Figure 4 shows the resolution achieved so far with the Vacuum Tower Telescope (VTT) at the Teide Observatory.

Polarimetry with high precision and high spatial resolution will give insight into the dynamics of small-scale, low-flux magnetic structures. Figure 5 gives an example of results obtained with the VTT.

5. – Observatorio del Teide

The three solar telescopes, THEMIS, VTT, and GREGOR [4], will be a powerful triplet to address fundamental questions of solar/stellar atmospheric structure and dynamics, which include problems of plasma physics in gravitationally and thermally stratified media, of the Sun and the heliosphere, and of the relation between the Sun and the Earth. To exploit the advantage of having these facilities close together, we consider it important that *the three telescopes be connected by TV and data links* and that *the telescopes be often used in coordinated observing and science programs*.

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