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The Dutch Open Telescope at the Roque de los Muchachos Observatory

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Abstract

We briefly describe the Dutch Open Telescope, whose innovative design tries to get the most out of the good La Palma seeing. © 1998 Elsevier Science B.V. All rights reserved.

1. An innovative solar telescope

The Dutch Open Telescope (DOT) is a 15-m high open framework tower with a telescope on top also of an – as far as possible – open construction (Fig. 1). In this way the wind can blow through the tower and the incoming primary lightbeam. The wind mixes the air and makes its temperature homogeneous. No warm air bubbles are forced upwards against the closed wall of a tower or building. During observations there is no dome above the telescope and no closed floor beneath it. When the wind speed is greater than about 5 m s^{-1}, the time of contact of the air with the tubes of the open framework is so short that the air has no time to warm up.

The Roque de los Muchachos Observatory (ORM) is an excellent site for testing this new principle of telescope construction for high-resolution images, because at the ORM there is often pretty strong wind combined with homogeneous temperature of the higher layers above the site. The particular circumstance that the wind comes from the northern direction over a gradually rising slope makes it possible to test the open principle with a relatively low tower 15 m in height. The telescope could be said to be suspended free in the air flow with no disturbing obstructions around it.

For protection against the sometimes very bad weather conditions at the ORM with ice and storms a tent-like construction surrounds the telescope. The construction is opened completely during observations, leaving the instrument fully exposed to the wind. A quickly removable and remountable closed floor will be made for protection against moisture when the instrument is in cloud. The tent construction did not give problems during its first winter with ice and storms. In the design of the tower, tent and telescope there are many new features which make the construction robust against wind vibrations during observations and able to withstand ice and storms.

The primary mirror of the DOT was tested interferometrically. The peak-to-valley deviation from a paraboloid is 55 nm, and the rms deviation is 11 nm. Fig. 2 shows some interferograms.

Two systems were developed for easy alignment of the optics: a mechanical gauge from the primary-mirror mount to the secondary optics mount and a laser system. For getting high-resolution images an optimum alignment of the secondary optics relative to the primary mirror is important.

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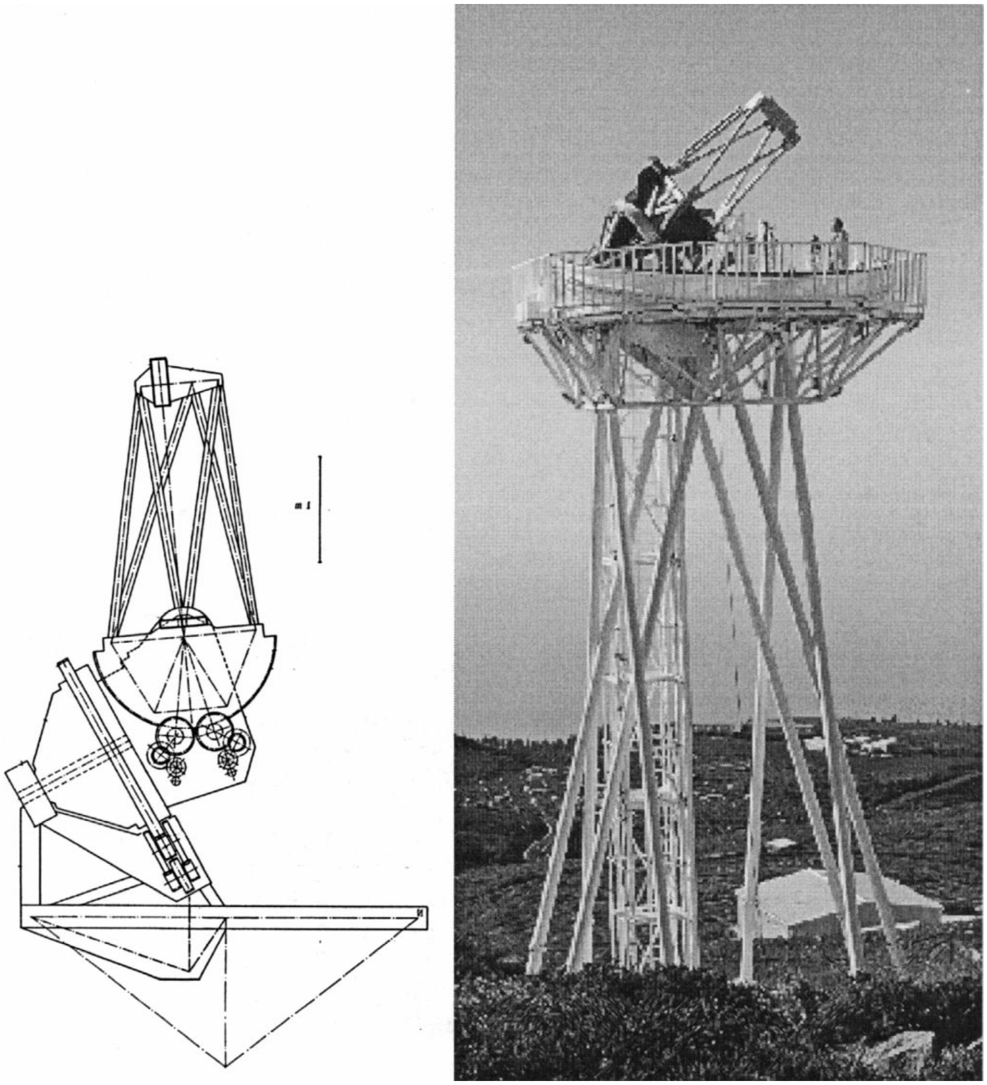

Fig. 1. Left: sketch of the DOT pointing at the Sun at noon on June 21 (La Palma). The bar measures 1 m. Right: the DOT on its tower, 1996 October (La Palma). North is to the right.

The optics were installed on the telescope on La Palma during the summer. For alignment the mechanical gauge was used first. Afterwards the laser unit was used, and it turned out that no further correction of the alignment was necessary. This was very convenient because the gauge is used without the optics in place, and then alignment is possible without the danger of dirtying the optics. Fig. 3 shows the primary mirror with the laser unit for alignment at its centre.

The primary-mirror mount is of a new design, which is stable against the fluctuating forces of the wind. This stability is necessary for the open design. The stiffness was successfully tested after completion of the mount.

The first star images showed diffraction rings of

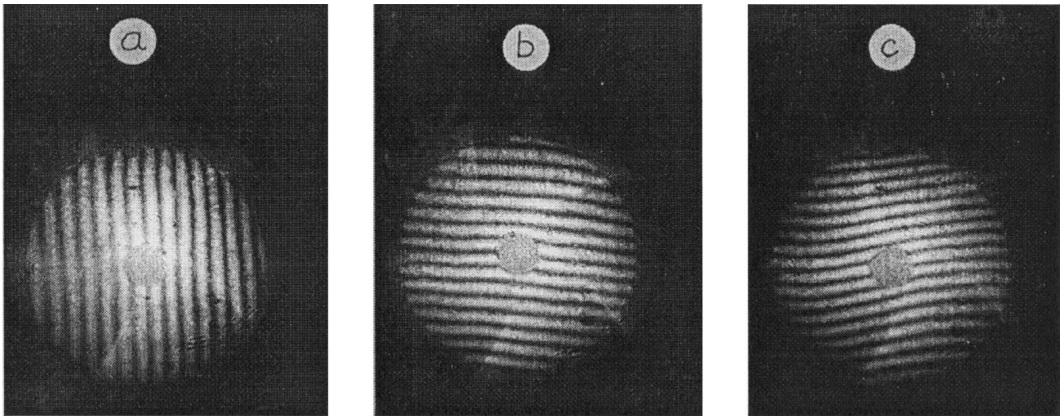

Fig. 2. Interferograms of the primary mirror. *a* and *b*: perpendicular interference fringes near the focus of the paraboloid. *c*: coma outside the region around the focal point of the paraboloid. The DOT field is small enough for no coma correction to be necessary.

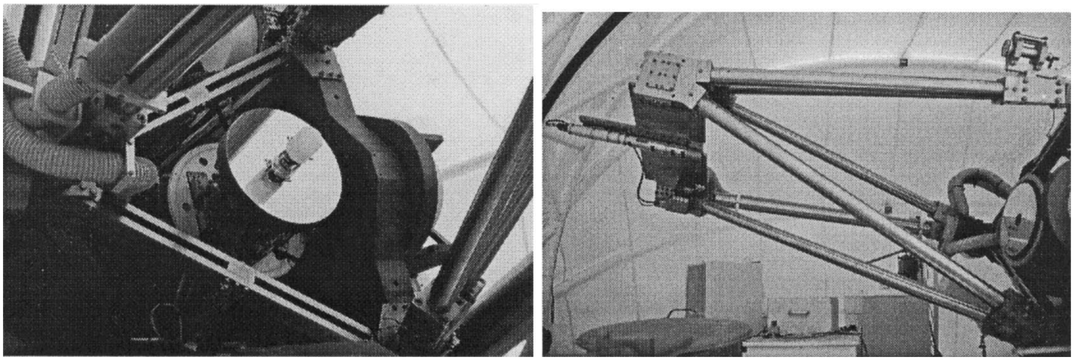

Fig. 3. Left: DOT mirror with alignment laser. The mechanical structure admits a 1-m mirror. Right: prime-focus structure. The thin tube on the left contains the secondary optics and the CCD camera. Note the tubes for air suction and water cooling of the prime-focus diaphragm.

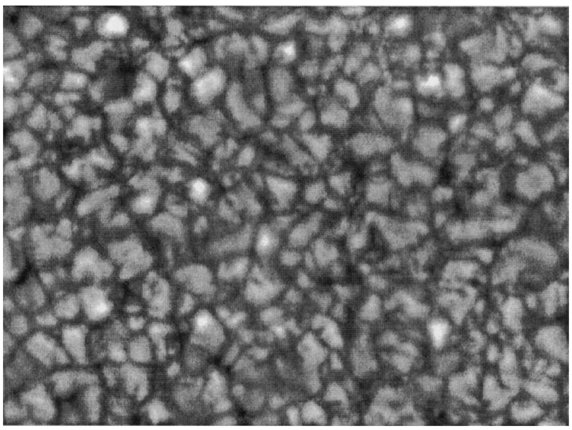

Fig. 4. Granulation image taken on 1997 November 26. Wavelength: 546 nm.

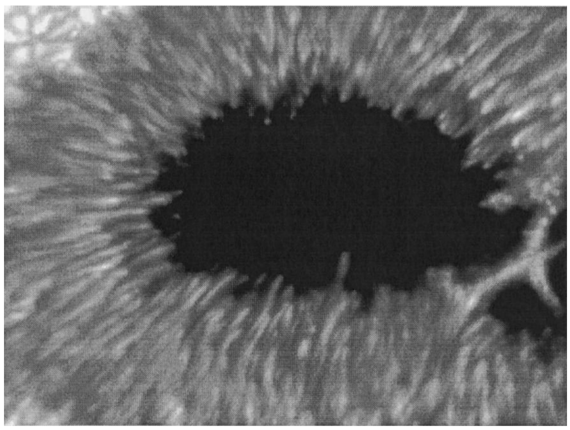

Fig. 5. Sunspot image taken on 1997 December 5. Wavelength: 546 nm. More images available at http://www.phys.uu.nl/~rutten/dot.

the expected diameter. This proved the quality and correct alignment of the optics.

Water cooling and air suction were installed at the primary focus for solar observations (Fig. 3). The first solar images (Figs. 4 and 5), made with a simple video camera, show details of the diffraction limit of the mirror.