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Wide-field astronomy at Dome C with a compact two-mirror, three-reflection telescope

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Abstract. We present a project for a wide–field, compact telescope that has been deisgned for observation in difficult sites, such as in the Antacrtic Plateau. The basic optics is an F/3 two-mirror system (2MTRT), in which the primary acts as 1st and 3rd reflecting surface. The *Amoretti* design provides a corrected and unvignetted 2° FOV and planarity of the focal plane. Three 2MTRT prototypes are described. We propose to put a robotic ∼60 cm 2MTRT au Dome C with the following main aims: discovery and tracking potentially hazarduous NEOs, asteroseimsological researchs of rich stellar fields, identification of GRBs.

Key words. Near Earth Objects – Surveys – Telescopes – γ-ray bursts

1. The IAS-2MTRT wide field telescope

Many designs of three-reflection telescopes (TRT) have been proposed in the past that should provide very extended and corrected fields of view (FOV). The *Amoretti* Two-Mirror Three-Reflection Telescope (2MTRT) project developed at IAS combines a very compact design with a wide (2°) well corrected FOV and planarity of the focal plane (Amoretti et al. 1989). The first and third reflecting surfaces are on the same blank (Figure 1, left), thus avoiding complex structures such as those proposed by Willstrop (1984) and Angel et al. (2000). Willstrop realized a 50 cm prototype allowing a curved 5^o FOV (see Willstrop 1995)).

A 30 cm 2MTRT prototype, with F/1.5 principal mirror and F/3 effective focal ratio (Figure 1, right) has been realized by Gianfranco Marcon adopting the scaled figuring coefficients of the 100 cm STARS project (Badiali & Amoretti 1997). Cylindrical baffles have been properly inserted to protect from the stray light. The optical tests are presented by Viotti et al. (2001). It is evident in the figure the small encumbrance of the telescope, a feature that makes it easier to handle in hostile sites such as the Antarctic Plateau.

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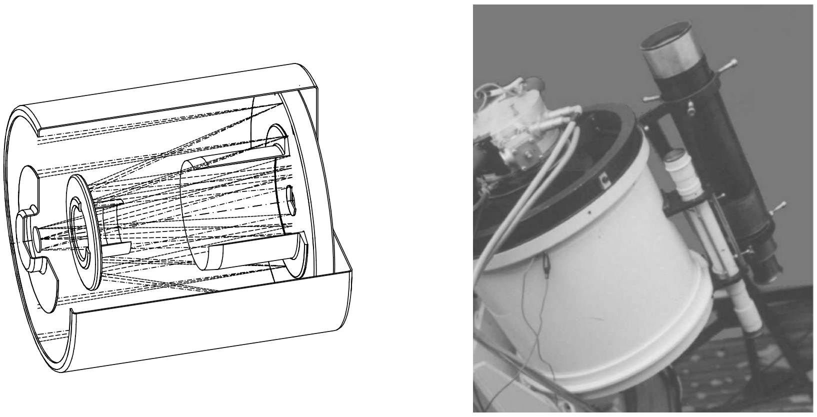

Fig. 1. *Left*: The optical configuration of the two–mirror, three reflection telescope with the baffles inserted. *Right*: The 30 cm 2MTRT prototype during the Monte Porzio tests with the 2k×2k CCD Peltier–cooled detector mounted back of the secondary mirror.

Another 30 cm F/3 2MTRT has been realized by LIOPTICS (Moscow) and is under optical testing. In this case, to prevent technical problems due to the different figurings of the two reflecting areas of the primary, the two surfaces were realized and polished separately and then glued together in place (Figure 2). Astronomical tests of this telescope are scheduled for the beginning of 2002.

New concept 2MTRT designs have been developed at the Laboratoire d'Optique, Observatoire de Marseille (LOOM) by G.R. Lemaitre, who proposed the figuring of the three reflecting surfaces using stress–polishing methods (Lemaitre 1996). The mirror is deformed by depressure then polished. The elastic relaxation after polishing produces the required mirror shape.

More recently, Lemaitre and collaborators have realized the optics of a 45 cm F/5 2MTRT based on active warping to correct for the off-axis aberrations (Figure 3). The principal mirror is mounted on a cell where a depression is formed causing the microwarping of the mirror that reaches the desired shape. The secondary has been obtained by elastic relaxation. Laboratory and astronomical testing the telescope is under way at LOOM and IAS.

2. Scientific objectives

Recent times have marked a fastly growing interest in wide field astronomy. This is firstly linked to the profound astrophysical impact of phenomena such as GRBs, NEOs and extraterrestrial planets. Secondly, the development of new techniques are now allowing the design, realization and effective astronomical use of complex optical systems such as the TRTs. One should also consider that in recent times a number of space projects have been proposed to face some outstanding problems. But it is also evident that the excellent observing conditions of the Antarctic Plateau may represent a valid (and cheeper) alternative to these projects, and in the meantime it is

Fig. 2. The 30 cm primary of the TRT telescope realized by LIOPTCS.

garanteed the possibility of performing researchs for many years.

We therefore propose to put a robotic 60 cm 2MTRT at Dome C equipped with optical and NIR detectors. The high compactness and flexibility of the system, the planarity of the focal plane and its easy access makes the telescope most suitable for this scope. The main scientific objectives of our project are:

• Discovery and follow-up of potentially hazarduous NEOs, especially at small angular distances from the Sun (Boattini et al. 2001; Carusi et al. 2000).

• Day-light uninterrupted monitoring of rich stellar fields for asteroseismological studies, and to investigate the stellar activity (Viotti et al. 1996), and other kinds of non–periodic variability associated with stellar instability and with the presence of orbiting/variable circumstellar dust clouds (e.g. Viotti 2002). Depending on the final telescope size, it will also be possible to detect serendipitely stellar micro–occultations due to planet transits.

Fig. 3. The backside of the primary and secondary mirrors of the 45 cm TRT realized at the Laboratoire d'Optique of the Observatoire de Marseille.

• Quick look of the sky area including the error box of satellite detected X–ray and γ–ray outbursts, for the source identifications and its follow-up.

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References

Amoretti, M., Badiali M., Preite-Martinez A. 1989, A&A 211, 250

Angel R., Lesser M., Sarlot R., Dunham T. 2000, in: Imaging the Universe in Three Dimensions. Astrophysics with Advanced Imaging Devices, W. van Breugel, J. Bland-Hawthorne eds., ASP Conf. Ser. 195, 81

Badiali M., Amoretti M. 1997, Applied Optics 36, 34, 8877

Boattini A., D'Abramo G., Forti G., Gal R. 2001, A&A 375, 293

Carusi A. et al. 2000, Spaceguard Integrated System for Potentially Hazarduous Objects, ESOC Contract 13265/98/D/IM

Lemaitre G.R. 1996, in: Optical Telescopes of Today and Tomorrow, Proc. SPIE 2871, 436

Viotti R.F. 2002, in: Stellar Structure and Habitable Planet Finding, ESA SP-485, 359

Viotti R., Vignato A., Nanni D., Maceroni C., Badiali M. 1996, Publ. Astron. Soc. Australia 13, 10

Viotti R., La Padula C.D., Nanni D., Vignato A. 2001, Astrophys. Space Sci. 276, 81

Willstrop R.V. 1984, MNRAS 210, 597

Willstrop R.V. 1995, Contemporary Physics 36, 389