Surveys with the 4-m International Liquid Mirror Telescope

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Abstract. The working principle of liquid mirror telescopes (LMTs) is first reminded as well as their advantages and disadvantages over classical telescopes. For several obvious reasons (access to regions near the south galactic pole, galactic center, good image quality, ...), a best site location for such a LMT is somewhere in the Atacama desert. At latitudes near -22 - -29 degree, a deep (B = 24 mag.) LMT survey will approximately cover 90 square degrees at high galactic latitude, specially useful for gravitational lensing studies, for the identification of various classes of interesting extragalactic objects (cf. clusters, supernovae, etc. at high redshift) and subsequent follow-up observations with 8m-class telescopes. A short description of the handling of data products is also presented.

1 Telescope Technical Description

The surface of a reflecting rotating liquid takes the shape of a paraboloid which is the ideal surface for the primary mirror of an astronomical telescope. The focal length F of the mirror is related to the gravity g and the angular velocity of the turntable ω by $F = g/2\omega^2$. The container and the bearing rest on a three-point mount that aligns the axis of rotation parallel to the gravitational field of the Earth (Figure 1). The container must be light and rigid. A thin layer (0.5 mm to 1 mm) of mercury is then spread on the container. Figure 2 shows the entire telescope system. Comparing the LMT to a conventional telescope, we see that they are similar with the exception of the mount. The top parts are identical, consisting in a focusing system and a detector. There is some cost saving in the upper end structure since it does not have to be tilted. The largest cost savings obviously come from the mount which consists in a simple tripod. While a LMT can only observe at zenith a strip of constant declination, its observing efficiency compared to that of a classical telescope is very high (no slew, no field acquisition, no lost readout times). The tracking will be done with the TDI technique. Obviously, low-resolution spectroscopy can be carried out with interference filters. A semi-classical on-axis glass corrector capable of about $30' \times 30'$ degree field will be used. It will remove the TDI (Time Delay Integration also known as the drift scan technique) distortion. With a classical corrector,

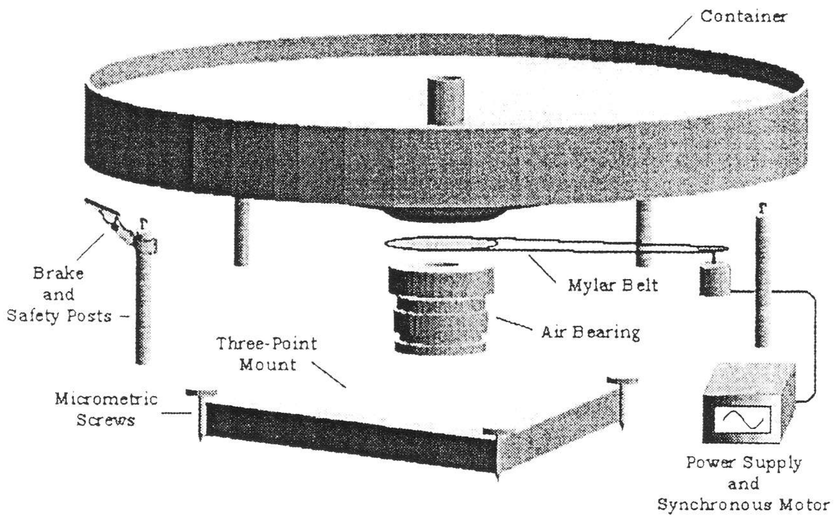

Fig. 1. Exploded view of the basic mirror setup

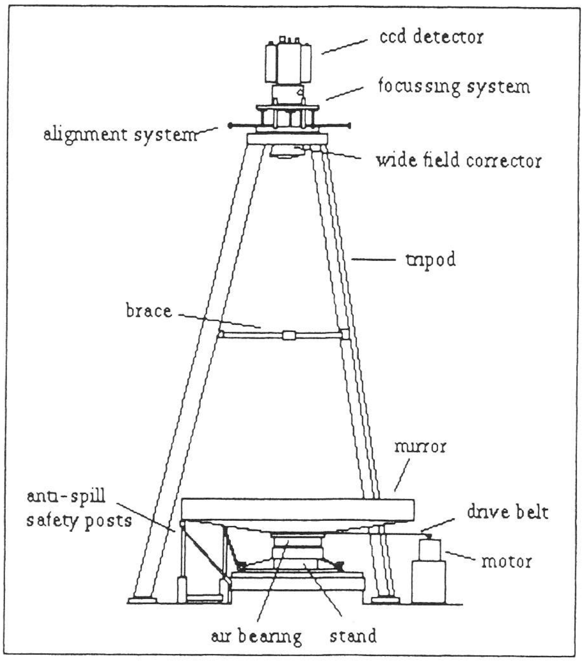

Fig. 2. Entire telescope system

the TDI technique degrades the images. This comes from the fact that the TDI technique moves the pixels on the CCD at a constant speed on a straight line while the images in the sky move at different speeds along slightly curved trajectories. The deformation depends on the latitude of the observatory (it is zero at the equator and increases with latitude).

2 Science with the International Liquid Mirror Telescope

The observational strategy for studies of gravitational lensing effects with a LMT rather consists in first surveying a sky area as deep and as wide as possible for interesting targets (cf. quasar candidates using color and variability criteria) and then select gravitational lens candidates among them. The extent of the field of view is of course primarily dictated by the number and/or the size of the thin CCDs placed at the LMT prime focus. For the case of multiply imaged quasars, we find that direct imagery with the 4m International Liquid Mirror Telescope (ILMT) will lead to the detection of approximately 50 new gravitational lens systems ($\Omega_0 = 1$, $\Lambda_0 = 0$). The natural possibility to photometrically monitor these with a great accuracy, at daily intervals, offers a unique opportunity to define a sub-sample of interesting lenses with reliable geometrical parameters, time delay measurements and/or micro-lensing signatures for further astrophysical and cosmological applications. Such a survey will in addition provide unique data for studies of the galactic structure and stellar populations, including the detection of micro-lensed galactic objects, accurate measurements of stellar proper motions and trigonometric parallaxes useful for the detection of faint red, white and brown dwarfs, halo stars, etc. The ILMT will be located in the Atacama desert and should be operational in 2002. At such geographical latitudes and due to the rotation of the Earth, the field of view of the ILMT will also scan the Galaxy from the Southern Pole to the bulge and the central regions. Very precise photometric and astrometric data of millions of stars will be obtained in the drift scan mode night after night, so that microlensing events will inevitably be detected towards the bulge of the Galaxy.

3 Data Analysis and Computational Aspects

From the data analysis point of view, such a project requires sophisticated algorithms and a huge computing and storage infrastructure in order to generate an exhaustive catalog of detected sources. Fortunately, we can benefit from Computer Science's legacy relying on Artificial Intelligence (A.I) techniques (pattern recognition using neural networks, fuzzy logic, decision trees,...), thus, allowing accurate categorization of the objects and of their photometric and astrometric history (time series). Furthermore, clever management and analysis of catalog/image databases will be made available through powerful data-mining tools. Finally, a challenging ON-LINE data analysis policy is likely to provide a bunch of short duration events/targets which in turn, could be a major interest for large southern hemisphere observatories , e.g. VLT/ESO, Virtual Observatory project, etc. A more detailed description of the ILMT project is available at the URL: http://vela.astro.ulg.ac.be/lmt/