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Planetary science with the Large Binocular Telescope: Viewing the Solar System with a 23-meter aperture

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Abstract

At the Nantes EPSC in 2011 we gave the first report of our plans to exploit the 23m aperture of the Large Binocular Telescope (LBT) to observe volcanoes on Io at M-band [1]. Then at the Nantes EPSC in 2015 we presented our completion of that effort [2] along with a progress report on three further analyses of that data collected during 2015, including an occultation of Loki by Europa. Here in section 1, we provide a progress report on those efforts which further exploit the 23m mode of LBT.

At the 2015 Nantes EPSC we also revealed plans to use a new multi-conjugate adaptive optics (MCAO) mode for observations of Jupiter's full disk. At that time the LBT MCAO System, LINC-NIRVANA [3]. In section 2 we report status and plans for that system, including a recent technical demonstration.

Lastly, in sections 3 and 4 we present two coming LBT facilities that will provide unique capabilities for studies in planetary science, binocular imaging and spectroscopy in un-phased, 12m mode for faint small bodies, and visible light AO for high resolution at shorter wavelengths.

1. Phased Binocular (23m mode)

In Fizeau 23 meter mode, LBT is capable of providing 100 km resolution on the surface of Io at M-band [2]. Now in a recent publication [4], this resolution has been improved by an order of magnitude. As reported in that publication, this LBT capability has lead to an understanding of the processes that result in varying, cyclic brightening episodes that have been observed, but not understood in depth until now.

2. Un-phased Binocular (12m mode)

On UT 18-Mar-2017 we observed with LBT 2016 HO3, earth's newest Quasi-satellite [5], and obtained a light curve and visible wavelength spectra [6]. For both of these observations we obtained reasonable signal to noise of this faint object thanks to the collecting area of a 12-meter telescope (i.e., by combining the light from both LBT 8.4 meter mirrors, un-phased, in a seeing-limited mode).

3. MCAO (2x8m mode)

In 2008 Jupiter observations were taken with the MCAO demonstrator (MAD) system in 2008 [7]. Now, nearly 10 years later we are poised to improve on this demonstration using a permanent facility with a similar capability. In a technical demonstration on UT 30-March-2017 LINC-NIRVANA (L-N) [8], which is just beginning commissioning, demonstrated acquisition and closed loop AO with multiple stars; indicating that first light for this instrument, and then an observation of Jupiter's full disk, could take place as early as 2018.

4. Visible AO (8m mode)

Visible wavelength adaptive optics (Vis-AO), decreases the correctible wavelength from the current state of the art, H- & K-band (1.6 & 2.2 microns), to B- & R-band (0.4 & 0.7 microns). Visible-light AO observation of main belt asteroids (MBA) using the only currently productive visible light AO system [9] have showed promise. The Shark-Vis system [10] planned for LBT will provide sharper shape resolution via contours that has been possible to date (see figure x).

5. Conclusion

With more glass on a single mount, LBT provides unique capabilities for planetary science for both high angular resolution at infrared wavelengths now (including Fizeau interferometry for a 23m mode), and visible wavelengths in the near future. For faint objects, the un-phased mode yielding the collecting area of a 12-meter telescope is useful for obtaining both light curves and spectra of small bodies.

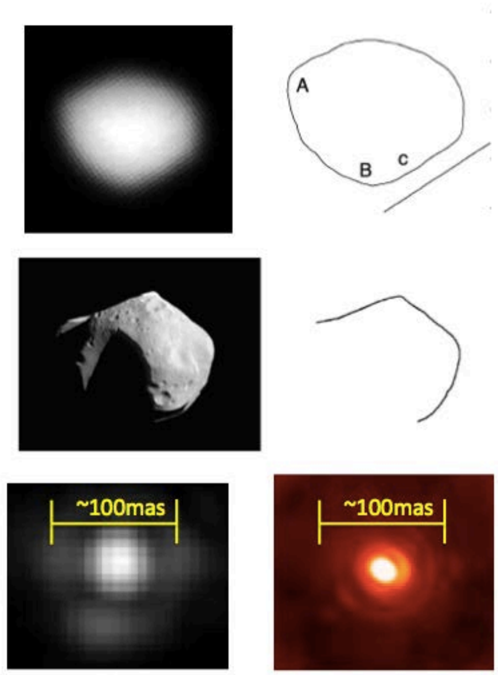

Figure 1. In this figure we show a sample image and its contour for (511) Davida from K-band imaging taken with a 10-meter telescope (first row), a figure from our 2007 analysis [11] posing the possibility of a large impact feature as seen in similar contours from spacecraft image of Mathilde (second row). With the improved resolution, as indicated by the respective PSF (third row), we hope to conclude whether or not this facet is a likely impact feature using the Shark-VIS system on LBT.

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