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Observing Io at high resolution from the ground with LBT

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Abstract

LINC-NIRVANA (LN) is an imaging Fizeau interferometer, with wavelength coverage from 1.1 to 2.4 microns, scheduled for first light on the Large Binocular Telescope (LBT) in 2014. The classical on-axis AO mode of LN, called LINC mode will provide solar system researchers with 15, or in some cases even 10, milliarcsecond spatial resolution. Several projects are planned for using LINC to observe features on Jupiter's volcanic moon Io.

1. Introduction

LINC observations of Io will be similar to those conducted with current-generation instruments (e.g., NIRC2 at Keck). LINC will, however, exploit higher resolution (down to approximately 70 km on Io's surface) to go beyond what has already been achieved in these existing studies.

2. Higher resolution

Operating with a resolution limit of approximately 160 km on the Ionian surface, current-generation instruments have been used to monitor the intensity and location of volcanic eruptions and discover new hotspots [1], [2]. Figure 1 shows how a bilobal feature at the center of the volcano Pele, not discernable with the 160 km resolution available from current ground-based instruments, can be detected at the LINC resolution of 70 km. This study will be conducted in collaboration with LMIRcam [3], a complementary LBT instrument which covers the longer wavelengths (3-5 microns). For example, while some hot spots can be detected with LINC at K-band, 3-5 microns will be required for a more complete search. Possibly most intriguing are observations in J, H, and K bands of Io while in eclipse, as such measurements are sensitive to the highest eruption temperatures [4]. Also, under such conditions SO (at 1.7 micron) on Io can be mapped.
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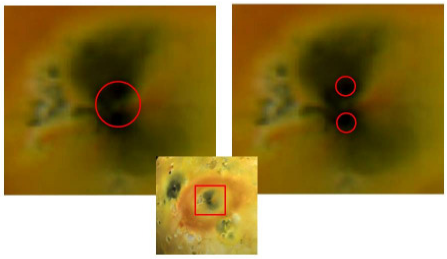

Figure 1: Bilobal feature at the center of the volcano Pele as viewed by Galileo at visible wavelengths. The red circle on the left reflects a single resolution element at the resolution of current ground-based instrumentation. On the right, the two circles reflect the resolution that will be achieved with LINC. Two resolution elements are shown for LINC to demonstrate that both lobes of this feature can be sampled independently. They are not in any way related to the binocular nature of the telescope.

3. Comparison with existing ground-based instrumentation

In our presentation, we will compare and contrast LINC with existing ground-based instrumentation which has been used to observe Io. For example, consider the question of pixel sampling with respect to LINC, as compared to that of the existing ground-based instrument NIRC2. NIRC2 has been the source of stunning Io observations since it was first commissioned in 2001 [5]. Both NIRC2 and LINC employ classical, on-axis AO systems, with science cameras spanning 10×10 arcsecond fields-of-view; one million 10-milliarcsecond pixels[1] in the case of NIRC2, four million 5-milliarcsecond pixels in the case of LINC. At 10 milliarcseconds per pixel, when

[1] NIRC2 provides selectable plate scales of 10, 20, and 40 milliarcseconds per pixel, however, the fine, 10 milliarcsecond-per-pixel, scale dominates its use for planetary science.

observing at the most effective wavelength band (i.e., K-band), the NIRC2 pixel size is oversampled (i.e., the approximately 50 milliarcsecond resolution achieved when observing Io is 5 times the pixel size and 2.5 times the lower limit set by Nyquist [6]). This 'over' sampling, however, has proven to be a valuable feature; it provides a post-processing benefit that, for the compact fields of interest to planetary scientists, far outweighs the loss in field of view. LINC will also be over-sampled in the K-band.[2] But the post-processing techniques used for LINC will differ greatly from those used for NIRC2. Will the LINC over-sampling provide the same benefit enjoyed by planetary scientists using NIRC2? In our presentation, we will address this question together with other, related, design trade-offs that might affect planetary scientists in their use of this instrument.

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[2] At K-band the LINC FWHM is predicted to be 17 milliarcseconds, which is 3.3 times the 5 milliarcsecond pixel size and 1.6 times the factor of two Nyquist sampling.