The MROI's capabilities for imaging geosynchronous satellites

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Abstract

Interferometry provides the only practicable way to image meter-scale structure in geosynchronous satellites. This capability represents a unique commercial opportunity for astronomical interferometry, but to date no interferometer has been able to image such a satellite. This article discusses the challenges of imaging such targets and presents results from the Magdalena Ridge Observatory Interferometer (MROI), which is located in the Magdalena Mountains in southern New Mexico. The MROI’s capabilities are examined in detail and their potential for geosynchronous imaging is illustrated.

Introduction

The Magdalena Ridge Observatory Interferometer (MROI) project is an international collaboration between the New Mexico Institute of Mining and Technology (NMIT) and the Cavendish Laboratory at the University of Cambridge in the UK. The MROI is the world’s most ambitious and sensitive optical/near-infrared imaging interferometer. The observatory site is located at an elevation of approximately 3,120 m (10,460 ft) above sea level in the Magdalena Mountains in southern New Mexico. One of MROI’s design features will be to provide a test for the commercial potential of geosynchronous satellite technology and to support space situational awareness.

MROI design features relevant to GEO imaging

- Much larger limiting magnitude than existing arrays (due to optimized optics).
- Optimal compact configuration for mid-infrared to visible imaging.
- Reconfigurable telescope, allows angular resolution to be changed from the size of the target to 1.0 arcsec.
- Beamsplitted tomography capable and dedicated fringe tracking instrument, for on-sky fringe tracking of an interferometer.

Sensitivity match to GEO targets

The use can estimate the apparent brightness of non-glinting targets illustrated by the fact that the Earth’s diameter is an order of magnitude larger than the diameter of the Earth's atmosphere. For a target with an angular size of 1 arcsec, the apparent brightness of the target is approximately 10 magnitudes higher than that of the target. This brightness increase is observed despite the fact that the target is much closer to the observer than the Sun.

Imaging performance

The MROI can achieve a limiting magnitude of 12.5 in the K band, which is the range of geosynchronous objects. Simulated datasets were prepared by evaluating the theoretical transfer function of the MROI, including the effects of atmospheric scintillation, and the geometrical layout of the array. The MROI is designed to achieve a sensitivity of 10^-14 in the K band, which is significantly better than current arrays. The MROI has also conducted imaging simulations for a range of assumed target brightnesses, including targets with a pair of solar panels spanning 20–30 m, as this range of scales exceeds the interferometric capability of current arrays.

Imaging performance (cont.)

For targets with a pair of solar panels spanning 20–30 m, the MROI is able to distinguish features with a diameter of approximately 70 cm. This is a significant improvement over current arrays, which are limited to分辨ability of several meters. The MROI's superior performance is due to its large number of telescopes and the use of advanced astronomical image reconstruction techniques.

Conclusions

We have outlined the key design features of the MROI and have concluded that it offers an unprecedented opportunity for geosynchronous satellite imaging. The MROI’s capabilities will be further enhanced by the installation of new equipment and the use of advanced imaging algorithms. The MROI is poised to become a leading player in the field of geosynchronous satellite imaging, and its success will have significant implications for the future of space situational awareness.

References