A Deep Field Infrared Observatory Near the Lunar Pole

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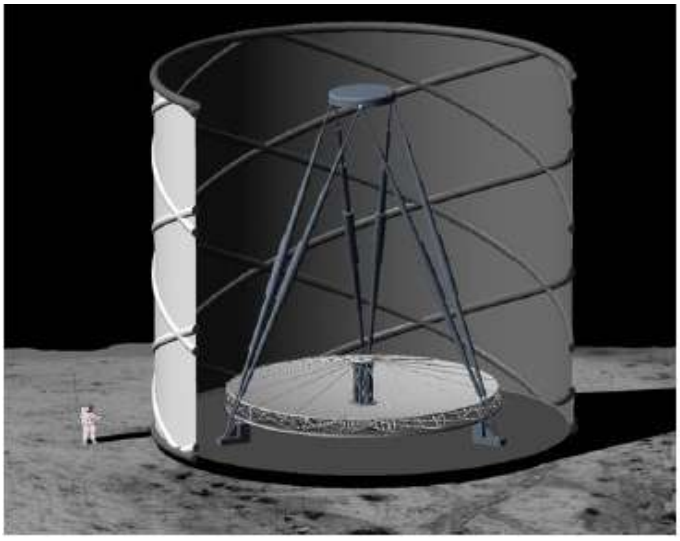
This proposal is to explore the feasibility and scientific potential of astronomical telescopes made with 20 – 100 m liquid primary mirrors at the South Pole of the Moon. Such telescopes, equipped with imaging and multiplexed spectroscopic instruments for a deep infrared survey, would be revolutionary in their power to study the distant universe, including the formation of the first stars and their assembly into galaxies. Already at 20 m diameter, the resolution would be 3 times higher than the James Webb Space Telescope (JWST), and, by integrating for a year, objects 100 times fainter could be reached.

Liquid mirror technology is ideally suited for this application, requiring only a gravitational field and uniform rotation to maintain exquisitely accurate surface figure over very large aperture. It is far simpler that the conventional alternative, a mirror made from solid surface segments, requiring mechanical and optical alignment maintained to 30 nm tolerance. On Earth, liquid mirrors are limited to ~ 6 m size by wind and are subject to atmospheric absorption and distortion. The Moon, though, provides the required gravity field with no such limitations. At the poles, the zenith-pointing mirror sees the same extragalactic field of view at all times, allowing very deep imaging and spectroscopy by integration for years on the same region. Simple radiation shielding can be used to cool the instrument for high infrared sensitivity, and solar power is available nearly continuously.

The goals of this study are to understand better the scientific potential, to explore the "tall tent poles" that must be overcome to make such a telescope practical, and to explore the value of human presence for erecting the telescope and for occasional instrument upgrades. This study will thus be of value in developing scientific exploration goals for NASA's planned return to the Moon.



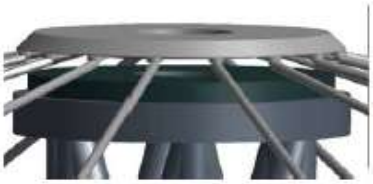


Figure 5.
(above) Detail of the superconducting levitation bearing that supports the spinning dish.

(left) Artist's impression of the 20 m telescope. The secondary mirror is erected by extending the six telescoping legs, and the sunshield by inflation. The scientific instruments are below the bearing pier, shielded by lunar soil.
(drawn by Tom Connors)