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Advantages of a Lunar Cryogenic Astronomical Observatory

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ESA and collaborating agencies are preparing to establish a Moon Village at a south polar site. Robotic precursor missions will include resource prospecting in permanently shadowed cold traps. The environment there is favorable for infrared and millimeter-wave astronomy. In this paper we examine the evolutionary development of a cryogenic observatory, beginning with small telescopes robotically installed and operated in conjunction with prospecting precursor missions, and continuing into later phases supported from the Moon Village. Relay communications into and out of the cold traps may be shared or else provided by dedicated links. Candidate locations can be selected with the help of data from the Lunar Reconnaissance Orbiter. The first telescope will be primarily a proof-of-concept demonstrator but it can have scientific and applications uses too, supplementing other space-based survey instruments observing astrophysical objects and potentially hazardous asteroids and comets. A south polar site sees only half or the sky but that half includes the galactic center and many other interesting targets. The telescopes can stare at any object for as long as desired, providing monitoring capabilities for transiting or radial velocity planet searches, like NASA's TESS mission. In addition such telescopes are opening the prospect of gathering spectroscopic data on exoplanet atmospheres and cool stars – from UV information to assess the activity of a star to VIS to IR spectral data of the atmosphere and even atmospheric biosignatures. Preliminary design of the first telescope might be funded under a NASA call for lunar science payload concepts. An important additional product can be educational and outreach uses of the observatory, especially for the benefit of people in the developing world who can do southern hemisphere follow-up observations.