Blazing the Trail: Resolving Terrestrial Planets with ELTs?

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Abstract

A picture is worth a thousand words (but a spectrum is worth a million).
We explore the potential of the next generation ELTs for discovery and characterization of (potentially habitable) terrestrial planets around a small sample of the very nearest stars. Very high spatial resolution imaging
of the thermal emission of planetary bodies with radius $>$ 1 R_earth is possible potentially in the habitable zone (under very demanding performance requirements). Using complementary techniques requiring very high spectral resolution, one can characterize the atmospheres of such bodies. Finally, with differential polarization imaging techniques, one can also study these objects in reflected light. It is likely that the first direct detection of a terrestrial planet around a nearby star will be done with ground-based ELTs before the end of the next decade. However, in order to study a large enough sample of terrestrial planets in the habitable zone around Sun-like stars to enable establishing the mean (and dispersion) of their properties, one must be able to extend the sample beyond 10 pc. That requires a) resolution corresponding to l/D $<$ 4 x 10-9 with wavefront control and stability enabling very high contrast at 10l/D; b) sensitivity greater than can be achieved with currently envisioned ground-based telescopes $<$ 40 meters diameter; and c) access to broad wavelength coverage at modest resolution for full characterization. These requirements define the parameters of space-based platforms with baselines of $>$ 300 meters at 10 mm and diameters $>$ 8 meters for 0.3 microns.

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