Recognizing and characterizing terrestrial planets

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Abstract

In order to image and characterize the reflected light from terrestrial planets in the habitable zones of solar-type stars, it will be necessary to not only separate the planet from instrumental artifacts such as speckles, but also to recognize the planet against a host of background sources. We discuss strategies that may mitigate these concerns and both enhance our ability to detect and recognize planets, while simultaneously offering characterization. To reach the brightness levels of Earth-like planets at modest distances from our Solar System, 10 pc and beyond, it will be necessary to reach depths equivalent to the deepest of the "deep fields" currently observed by HST, or fainter. With such magnitude limits, there are not only distant Galactic stars to contend with, but also a myriad extragalactic sources. The scope of this problem is outlined and ways to deal with it. The use of an integral field spectrograph offers exceptional post-processing versatility that may be used to aid in the identification of planets, while also, for some observing configurations, enhanced capabilities for speckle discrimination. With the addition of polarimetry, the ability to recognize planets shining purely by reflected light is improved, and a new suite of useful diagnostics become available, including potential recognition of the presence of liquid water. Effective characterization in a reasonable amount of time, governed by the astrophysical constraints of planets' orbits, requires substantial numbers of photons, which drives mission concepts towards larger apertures, and the need for stability, towards space. The instrumentation choice can profoundly influence the architecture of the mission as a whole.

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