How to Directly Image a Habitable Planet Around Alpha Centauri with a _˜30-45cm Space Telescope

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Abstract

Several mission concepts are being studied to directly image planets around nearby stars. It is commonly thought that directly imaging a potentially habitable exoplanet around a Sun-like star requires space telescopes with apertures of at least 1m. A notable exception to this is Alpha Centauri (A and B), which is an extreme outlier among FGKM stars in terms of apparent habitable zone size: the habitable zones are _˜3x wider in apparent size than around any other FGKM star. This enables a _˜30-45cm visible light space telescope equipped with a modern high performance coronagraph or starshade to resolve the habitable zone at high contrast and directly image any potentially habitable planet that may exist in the system. The raw contrast requirements for such an instrument can be relaxed to 1e-8 if the mission spends 2 years collecting tens of thousands of images on the same target, enabling a factor of 500-1000 speckle suppression in post processing using a new technique called Orbital Difference Imaging (ODI). The raw light leak from both stars is controllable with a special wavefront control algorithm known as Multi-Star Wavefront Control (MSWC), which independently suppresses diffraction and aberrations from both stars using independent modes on the deformable mirror. This paper will present an analysis of the challenges involved with direct imaging of Alpha Centauri with a small telescope and how the above technologies are used together to solve them. We also show an example of a small coronagraphic mission concepts to take advantage of this opportunity called "ACESat: Alpha Centauri Exoplanet Sattellite" submitted to NASA's small Explorer (SMEX) program in December of 2014.

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