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IMAGING TERRESTRIAL EXTRASOLAR PLANETS USING SUBMICRON INTERFEROMETRIC PLATFORMS

Abstract

Direct imaging of extrasolar planets is the holy grail of extrasolar planet exploration. Although current astronomical techniques are improving in leaps and bounds, systematic direct imaging of extrasolar planets, particularly terrestrial-type planets, has not yet been possible. Previous proposals such as the European Darwin interferometer faltered on the lack of technological maturity at the time. We present a technique that permits the control of relative position of a Darwin-type constellation to submicron/micron accuracies. With submicron relative positioning accuracy, interferometric methods offer extremely high-resolution imaging. According to Rayleigh criterion, the angular resolution, θ, is given by $\theta = 1.22\frac{\lambda}{D}$, where λ is the wavelength and D is the diameter of the aperture (telescope). With the implementation of near-infrared interferometric constellations, the free-flying telescopes combine into a 'virtual telescope' with diameter, D, of the utmost-separated apertures. With the apertures separated about 250m apart, it would be possible to resolve an exoplanet with an angular diameter (resolution) of up to 1 milli-arcsecond – as the case for Alpha Centauri C (Proxima Centauri). The technique is based on the employment of a suite of onboard manipulators that automatically adjust their configuration to maintain the constellation as a virtual optical bench, yielding sufficiently stable and accurate platforms for interferometric imaging. We have developed a mapping algorithm demonstrating the relationship between the robotic manipulators' configuration such that joint-level trajectories are deduced to move or re-position the end effectors, resulting in a successful approach to accurately control the relative spacing between the interferometric platforms. Each interferometric platform represents a spacecraft bus mount to which one or more manipulators are mounted. No fuel is expended except for the initial configuration manoeuvres. We assess the imaging resolution of Proxima Centauri b and the types of features that could be detected.