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Mapping the Region in the Nearest Star System to Search for Habitable Planets

Circumstellar planets within the alpha Centauri AB star system have been suggested through formation models and recent observations, and ACESat (Belikov et al. AAS Meeting #225, #311.01, 2015) is a proposed space mission designed to directly image Earth-sized planets in the habitable zones of both of these stars. The alpha Centauri system is billions of years old, so planets are only expected to be found in regions where their orbits are long-lived. We evaluate the extent of the regions within the alpha Centauri AB star system where small planets are able to orbit for billion-year timescales and we map the positions in the sky plane where planets on stable orbits about either stellar component may appear. We confirm the qualitative results of Wiegert & Holman (Astron. J. 113, 1445, 1997) regarding the approximate size of the regions of stable orbits, which are larger for retrograde orbits relative to the binary than for prograde orbits. Additionally, we find that mean motion resonances with the binary orbit leave an imprint on the limits of orbital stability, and the effects of the Lidov-Kozai mechanism are also readily apparent. Overall, orbits in the habitable zones near the plane of the binary are stable, whereas high-inclination orbits are short-lived.