

Habitability in Binary Systems: The Role of UV Reduction and Magnetic Protection

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Abstract

The number of planets found in binary systems is growing rapidly and the discovery of many more planets in binary systems appears inevitable. We use the newly refined and more restrictive, single star habitable zone (HZ) models of Kopparapu et al. (2013) and include planetary magnetic protection calculations in order to investigate binary star habitability. Here we present results on circumstellar or S-type planets, which are planets orbiting a single star member of a binary. P-type planets, on the other hand, orbit the center of mass of the binary. Stable planetary orbits exist in HZs for both types of binaries as long as the semi-major axis of the planet is either greater than (P-type) or less than (S-type) a few times the semi-major axis of the binary. We define two types of S-type binaries for this investigation. The SA-type is a circumstellar planet orbiting the binary's primary star. In this case, the limits of habitability are dominated by the primary being only slightly affected by the presence of the lower mass companion. Thus, the SA-type planets have habitability characteristics, including magnetic protection, similar to single stars of the same type. The SB-type is a circumstellar planet orbiting the secondary star in a wide binary. An SB-type planet needs to orbit slightly outside the secondary's single star HZ and remain within the primary's single star HZ at all times. We explore the parameter space for which this is possible. We have found that planets lying in the combined HZ of SB binaries can be magnetically protected against the effects of stellar winds from both primary and secondary stars in a limited number of cases. We conclude that habitable conditions exist for a subset of SA-type, and a smaller subset of SB-type binaries. However, circumbinary planets (P-types) provide the most intriguing possibilities for the existence of complex life due to the effect of synchronization of binaries with periods in the 20-30 day range which allows for planets with significant magnetic protection.

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