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EXTENDED HABITABLE ZONE AND BIOSIGNATURE DETECTION OF M-DWARF PLANETS

Abstract

Because of their high abundance and relative ease of detecting HZ- planets around them, M-dwarfs have been the target of several surveys in the past decade, including the Kepler and TESS missions and the CARMENES and the MUSCLES projects.

We apply the semi-analytical climate model for locked and synchronous planes of M-dwarfs (Wandel 2018, Wandel and Tal-Or 2019) to suggest that the Habitable Zone around M-stars is significantly wider than previously thought. This is extremely relevant to understanding the evolution and biological potential of exoplanets, as M-dwarfs dominate planetary systems by number and their small masses and radii make their transiting planets comparatively easy to detect and characterize, in particular to look for bio-signatures.

Earlier works assessed the potential habitability of such planets (e.g. Tarter et al., 2007; Gale and Wandel, 2017). Obstacles to life around M-dwarfs may be tidally locked weather (e.g. Kopparapu et al., 2016), atmospheric and water erosion (Leconte et al., 2015; Lingam and Loeb, 2017), but is has been argued that habitable planets of M-dwarfs may conserve or regain water and atmosphere (e.g. Wandel and Gale, 2020 and references therein). The recent discovery of water vapor in the atmosphere of K2-18b (Tsiaras et al. 2019), a potentially habitable planet of an M-dwarf, demonstrated that at least in some cases the atmosphere and even water can survive, eventually supporting the extended HZ-model.

The James Web Space Telescope is expected to be able to detect biosignatures such as Oxygen and Methane using the transit atmospheric method applied in the water detection in K2-18b. We will present criteria to identify the most promising targets for such biosignature detections, as well as an algorithm for the interpretation of the eventual results to estimate the abundance of biotic exoplanets and the biological parameter in the Drake equation.