Analysis of Transits and Habitability of Exoplanets with Pico dos Dias Observatory (OPD/LNA)

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Abstract

The topic of the existence of life outside Earth has driven astrophysical research, with emphasis on the search for extraterrestrial life on exoplanets. The Habitable Zone (HZ) is a key concept that indicates the orbital range in which the temperature at the surface of a planet with an atmosphere can allow liquid water, accounting for inner and outer edges of 100 and 0 °C, in order. Although the definition of HZ is terrestrial-biased, the real limits for the cosmic life are still unknown, and hence the characterization of exoplanets, in relation to their interiors, surfaces and atmospheres is mandatory. Using differential photometry to detect transits is an efficient technique to identify and characterize these worlds, enabling the estimation of parameters such as the planetary radius with respect to its star and its orbital period. In 2024 and 2025, we observed planetary transits at Pico dos Dias Observatory (LNA) with the 1,6m Perkin-Elmer telescope and the SPARC4 instrument (griz bands of SDSS). The targets were selected via ExoClock, prioritizing terrestrial planets of red dwarf stars (spectral types K and M), pertinent for the search of potential habitable exoplanets, e.g. L 98-59d and GJ 1132 b. Gas giants, such as Qatar-2b, were also observed in order to optimize the available telescope time. Applying the codes BATMAN (Kreidberg, 2015) and ECLIPSE (Valio, 2003), we confirmed the features of super-Earth of L 98-59d, with Rp = 1,70±0,05 R⊕ in the g band, as well as the Earth dimensions of GJ 1132b, with Rp = 1,405±0,034 R⊕ in the g and i bands. Furthermore, a stellar spot was detected in Qatar-2, with Rs = 1,49±0,28 x 104 km and Ts = 3647±327 K, in r and i. This information contributes to the accurate characterization of exoplanets and to the basis of knowledge about the planetary population, enlightening future investigations about habitability.