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The HADES RV Programme with HARPS-N@TNG GJ 3998: An early M-dwarf hosting a system of Super-Earths

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Many efforts to detect Earth-like planets around low-mass stars are presently devoted in almost every extra-solar planet search. M dwarfs are considered ideal targets for Doppler radial velocity searches because their low masses and luminosities make low-mass planets orbiting in their habitable zones more easily detectable than those around higher mass stars. Nonetheless, the statistics of frequency of low-mass planets hosted by low mass stars remains poorly constrained. Our M-dwarf radial velocity monitoring with HARPS-N within the GAPS (Global architectures of Planetary Systems) – ICE (Institut de Ciències de l'Espai/CSIC-IEEC) – IAC (Instituto de Astrofísica de Canarias) project can provide a major contribution to the widening of the current statistics through the in-depth analysis of accurate radial velocity observations in a narrow range of spectral sub-types (79 stars, between dM0 to dM3). Spectral accuracy will enable us to reach the precision needed to detect small planets with a few earth masses. Our survey will bring a contribute to the surveys devoted to the search for planets around M-dwarfs, mainly focused on the M-dwarf population of the northern emisphere, for which we will provide an estimate of the planet occurrence. We present here a long duration radial velocity monitoring of theM1 dwarf star GJ 3998 with HARPS-N to identify periodic signals in the data. Almost simultaneous photometric observations were carried out within the APACHE and EXORAP programs to characterize the stellar activity and to distinguish from the periodic signals those due to activity and to the presence of planetary companions. We run an MCMC simulation and use Bayesian model selection to determine the number of planets in this system, to estimate their orbital parameters and minimum masses and for a proper treatment of the activity noise. The radial velocities have a dispersion in excess of their internal errors due to at least four superimposed signals, with periods of 30.7, 13.7, 42.5 and 2.65 days. Our data are well described by a 2-planet Keplerian (13.7 d and 2.65 d) and 2 sinusoidal functions (stellar activity, 30.7 d and 42.5 d) fit. The analysis of spectral indices based on Ca II H & K and Hα lines demonstrates that the periods of 30.7 and 42.5 days are due to chromospheric inhomogeneities modulated by stellar rotation and differential rotation. This result is supported by photometry and is consistent with the results on differential rotation of M stars obtained with Kepler. The shorter periods of 13.74 ± 0.02 d and 2.6498 ± 0.0008 d are well explained with the presence of two planets, with minimum masses of 6.26 ± 0.79 M⊕ and 2.47 ± 0.27 M⊕ and distances of 0.089 AU and 0.029 AU from the host, respectively.

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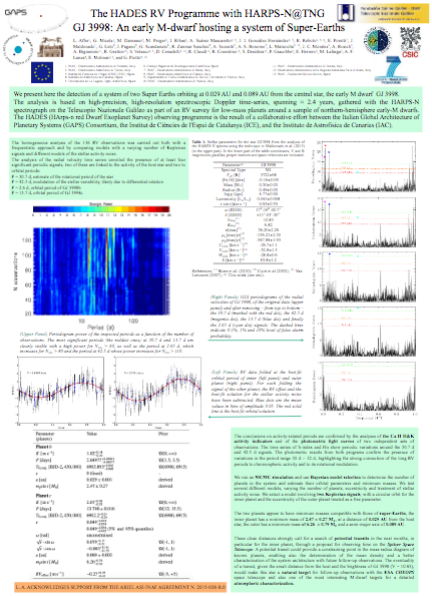

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