Characterizing planetary systems with SPIRou & SOPHIE: Detection of a sub-Neptune in a 6 day period orbit around the M dwarf Gl 410

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Abstract

The search of exoplanets around nearby M dwarfs is a crucial milestone to perform the census of planetary systems in the vicinity of our Solar System. Since 2018 our team is carrying a radial-velocity blind search program for planets around nearby M dwarfs with the near-IR spectro-polarimeter and velocimeter SPIRou at the CFHT and the optical velocimeter SOPHIE at the OHP in France. In this talk, we present our results on Gl 410, a 0.55 $M_\odot$ 480±150 Myr old active M dwarf distant 12 pc. We use the line-by-line (LBL) technique to measure the RVs with SPIRou and the template matching method with SOPHIE. Three different methods, two based in principal component analysis (PCA), are used to clean the SPIRou RVs for systematics. Gaussian processes (GP) modeling is applied to correct the SOPHIE RVs for stellar activity. The ℓ_1 and apodize sine periodogram (ASP) analysis is used to search for planetary signals in the SPIRou data taking into account activity indicators. We analyse TESS data and search for planetary transits. We report the detection of a $M\sin(i)$=8.4±1.3 $M_\oplus$ sub-Neptune planet at a period of 6.020±0.004 days in circular orbit with SPIRou. The same signal, although with lower significance, is also retrieved in the SOPHIE RV data after correction for activity using a GP trained on SPIRou's longitudinal magnetic field (B_ℓ) measurements. TESS data indicates that the planet is not transiting. We find within the SPIRou wPCA RVs tentative evidence for two additional planetary signals at 2.99 and 18.7 days. In conclusion, infrared RVs are a powerful method to detect extrasolar planets around active M dwarfs, care should be taken however to correct/filter systematics generated by residuals of the telluric correction or small structures in the detector plane. The LBL technique combined with PCA offers a promising way to reach this objective. The simultaneous detection of planets in the optical and the infrared provides a test-bed to test strategies to correct for stellar activity jitter in the optical RV time-series. Further monitoring of Gl 410 is necessary.