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Novel Interferometer-Spectrometer for sensitive Doppler planet detection

by David Erskine, Jian Ge

A saturn-like planet at saturn-like distances creates a wobble in the velocity of a star of about 3 m/s, and Earth-like planets even less, about 0.1 m/s. Current spectrometers have velocity resolution of 3-10 m/s, which is insufficient to detect Saturn-like or smaller planets. Secondly, these spectrometers are not light efficient, allowing only bright stars to be measured. Thirdly, these instruments are not portable or space-launchable, and their highly individual character makes comparison of data during 10-30 year orbits problematic. We have built a novel instrument (called a fringing spectrometer) which is a hybrid of an interferometer and spectrometer, which is particularly well suited for accurately measuring small Doppler shifts in a light efficient manner, is portable and space-launchable, and was constructed from off-the-shelf components on hand. Other advantages include a 200x larger field of view compared to the Lick Observatory spectrometer, stability, and independence from slit vignetting vagaries. We are testing it on sunlight by seeking the 12 m/s @ 27 day effect of the moon tugging the Earth. (Jupiter on the sun is 12 m/s). We have built an algorithm to unwrap the phase of the interferogram to 1/10000 wave (corresponding to ~ 1 m/s Doppler velocity). This is a 20x improvement in the art over monochromatic interferograms and may lead to other applications in high precision metrology.

Keywords: Spectrometer, Doppler shift, Interferometer

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