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SPECTROSCOPIC PLANETARY DETECTION

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Objective:

The goal of this investigation is to determine the extent to which planetary companions to solar-type stars can be detected by measuring the small Doppler reflex which their orbital motion induces in the spectrum of their parent star. Several research groups are actively engaged in making such measurements. A possible problem with such a method is that changes in stellar surface convection may produce spurious changes in stellar spectra, which mimic the effect of planetary companions. The report of the most recent NASA Planetary Detection Workshop called for an investigation of the Sun's integrated radial velocity behavior over the long term, so that solar-cycle effects can be identified and their impact on planetary detection efforts can be evaluated. Accordingly, we are measuring the spectrum of the Sun-as-a-star using Fourier transform and laser heterodyne spectroscopy to search for small Doppler shifts related to the solar cycle.

Accomplishments:

We began monitoring the Sun-as-a-star using the McMath Fourier transform spectrometer (FTS) on Kitt Peak in 1983. In 1985 we made our first measurement using the laser heterodyne technique. Our FTS measurements now extend for three years, with errors of order 3 meters/sec at a given epoch. Over this 3 year period, we have measured a 33 meter/sec change in the apparent velocity of integrated sunlight. The sense of the effect is that a greater blueshift is seen near solar minimum, which is consistent with expectations based on considering the changing morphology of solar granular convection. Presuming this effect is solar-cycle-related, it will mimic the Doppler reflex produced by a planetary companion of approximately two Jupiter masses, with an 11 year orbital period. Thus, Jupiter itself is below the threshold for detection by spectroscopic means, without an additional technique for discrimination. However, for planetary companions in shorter period orbits (P~3 years) the threshold for unambiguous detection is well below one Jupiter mass.

Proposed Research:

We will continue our measurements of integrated sunlight, in order to determine whether the effect we have observed reverses after solar minimum has passed. If so, it will strongly indicate that the effect is solar-cycle-related. We will then seek to determine what other observable properties of the Sun-as-a-star correlate with the velocity drift. The identification of such correlations will assist the stellar observers in discriminating between the velocity signatures of stellar activity cycles and the true Doppler reflex of planetary companions.

Publications:

"On the Convective Noise Floor for the Spectroscopic Detection of Low Mass Companions to Solar Type Stars," D. Deming. F. Espenak, D. E. Jennings and J. W. Brault, to appear in the proceedings of a workshop held at George Mason University (October 14-15, 1985) on "The Astrophysics of Brown Dwarfs," eds. Kafatos and Harrington (Cambridge University Press) 1986.

"On the Apparent Velocity of Integrated Sunlight," D. Deming, F. Espenak, D. E. Jennings and J. W. Brault, (1986), submitted to the Astrophysical Journal.