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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND TECHNOLOGY RESUME

TITLE

The Radial Velocity Search for Extrasolar Planets

PERFORMING ORGANIZATION

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INVESTIGATOR'S NAME

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DESCRIPTION *(a. Brief statement on strategy of investigation; b. Progress and accomplishments of prior year; c. What will be accomplished this year, as well as how and why; and d. Summary bibliography)*

a. Strategy: We are measuring small changes in the line-of-sight velocities of stars to detect the oscillating reflex acceleration induced by large planets. Our intention is to observe enough stars for a long enough time to be able to make a statement of the probability of planets in a certain range of masses even if we detect no planetary perturbations. To make these measurements of Doppler shift with the required sensitivity, we designed, built, and thoroughly tested a new instrument specifically for this campaign of ground-based planet detection. The instrument is an optical spectrometer for which wavelengths are first calibrated by transmission through a tunable Fabry-Perot etalon interferometer. The intrinsic stability of the etalon and an image-scrambling fiber optic light feed provide great sensitivity to line-of-sight accelerations and immunity to systematic errors.

b. Accomplishments: We now have three years of consistent operation and calibration and are making many observations with uniform procedures every month. Formal observations began in September 1985 and a total of 6445 observations of 21 stars have been made on 241 nights to date (1988 May 27 UT). The interferometer is calibrated about 100 times per night with an accuracy of $\pm$ 6 meters/sec in Doppler shift. The standard deviation of a one-hour exposure on a typical solar-type star of blue magnitude 4.0 is $\pm$ 12 m/s. On a star with B = 5.5 the error is $\pm$ 30 m/s per observation. These random errors "average down" through an observing season, giving adequate accuracy for the search for planets. We already have published discoveries of a 2.2-day oscillation of the radial velocity of Arcturus, three modes of short-period oscillations in Pollux, and non-variability of the radial velocity of Eta Cas A, previously suspected to be a spectroscopic binary. We are also seeing slow velocity variations in some other stars, which is encouraging for the detection of orbital motion.

c. Anticipated Accomplishments: Our data show tantalizing hints of small velocity perturbations which should become definitive after two more years of observing. We propose to continue the observing program for at least another two years, to bring the length of our time series to five years. This is thought to be a minimum duration for finding planets massive enough to cause detectable changes in the Doppler shifts of stars.

d. Publications:

McMillan, R. S., Perry, M. L., Smith, P. H., and Merline, W. J. 1988, "The Optical Fiber Feed of the LPL Radial Velocity Spectrometer", Pub. A. S. P. Suppl. Ser., in press.

McMillan, R. S., and Smith, P. H. 1987, "Nonvariability of the Radial Velocity of Eta Cas A", Pub. A. S. P., 99, 849.

Smith, P. H., and McMillan, R. S. 1987a, "Short Period Oscillations in Alpha Boo, Beta Gem, and Alpha Tau", in Proc. IAU Symp. 132, The Impact of Very High Signal:Noise Spectroscopy on Stellar Physics, in press.

Smith, P. H., and McMillan, R. S. 1987b, "Accurate Accelerometry of Solar-Type Stars", in Proc. 27th Liege International Astrophysical Colloquium, Observational Astrophysics with High Precision Data, (Dordrecht: Reidel), in press.

Smith, P. H., McMillan, R. S., and Merline, W. J. 1987, "Evidence for Pulsations in the Doppler Shift of Arcturus", Ap. J. (Lett.), 317, L79.