PRECISE RADIAL VELOCITIES OF F,G,K DWARFS

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ABSTRACT. We have monitored *changes* in the radial velocities of 24 bright F, G and K dwarf stars (known spectroscopic binaries excluded) for the past six years at CFHT by imposing the absorption lines of HF gas in the spectra to act as wavelength fiducials. The average external error in the Δ(velocities) which are based on some 16 stellar lines is 13 m/s corresponds to 0.6 micron in the spectrum or 0.04 of a diode spacing per line. Reductions are complete for 16 stars. There is no evidence for brown dwarf companions in the sample. Two previously unknown spectroscopic binaries were found, and seven stars show indications of significant, long-term, low-level velocity variations which could be interpreted as purturbations by companions of a few Jupiter masses with periods greater than 12 years except for γ Cep, which may have a period of 2.7 years, and ϵ Eri. Observing time has been guaranteed for at least two more years at CFHT.

1. THE PRECISION

The absorption lines imposed in a stellar spectrum by passing starlight through a captive gas can act as wavelength fiducials which are independent of the large systematic errors associated with conventional calibration techniques. We first proposed and demonstrated the feasibility of using HF as the absorbing gas in 1979 (Campbell and Walker 1979). The wide dynamic range of the Reticon diode array allows us to take single spectra with a signal to noise in excess of 1000 whichis sufficient to

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measure the positions of sharp lines with a resolution of the order of 0.01 of a diode spacing using the differencing technique developed by Fahlman and Glaspey (1973). In the coudé spectrograph of the CFHT at 4.8 A/mm this corresponds to about 10 m/s at λ 8700 (the wavelength of the (3,0) band of HF used in our technique).

If the technique is free from long term systematic errors, a precision of 10 m/s would be sufficient to detect the slow oscillations in radial velocity of solar or later type stars with Jupiter mass companions when viewed in their orbital plane. We began such an 'unseen' companion search in the winter of 1981 at CFHT and, apart from a gap of six months in 1982, the program continues to be given six pairs of night per annum. Details of the data reduction and the program can be found in Campbell, Walker, Pritchet, Long (1986).

The variation of the instrumental line profile from run to run is the principal instrumental effect which limits the long term accuracy of the technique. The variations are almost certainly due to the 4-grating mosaic in the spectrograph (Richardson, Brealey, Dancey 1971). The line profile is a composite from each of the four gratings. Not only does each grating gives a different image quality and dispersion but alignment is never exact nor completely stable which is serious because of the need to correct the HF line profiles for blends with weak stellar lines. The HF lines are about twice the width of the stellar lines and the instrumental profile. Although the effects of asysmmetry in the instrumental profile are modelled in the data analysis there are still residual off-sets of the order of 7 m/s between runs. In consequence we apply run to run corrections based on the average off-set of the Δ(velocities) using measurements for all of the stars observed in a run. In practice it is usually possible to observe 16 or more program stars during a clear run.

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DISCUSSION

MARCY Epsilon Eri is your best candidate for having a planetary companion. However, that star is well-known for being one of the most magnetically active. Have you made any efforts to see if the line profiles are changing with time, perhaps due to the Zeeman effect ?

WALKER I can't rule out such an effect. The unstable line profile means that our information about subtle changes in profile is not very secure. There is no correlation with chromospheric activity.

LIBBRECHT Can you tell me what are the frequency shifty of the HF lines with temperature and pressure in your cell, and are those shifts a problem ?

WALKER The cell is maintained at 100° C and the HF pressure by an ice water bath. We've measured the line shifts at large deviations in temperature and pressure, and we make small corrections for these effects. The corrections are small compared to the signal we're reporting, so they're not a problem.

ANDERSEN It may be a bit disappointing that, in Commission 30, we are perhaps most interested in your non-detections in connection with the establishment of the new system of IAU Radial Velocity Standards. I should be most interested to hear about the independent work by the Arizona group, too.

WALKER We hope to submit our data for publication later this year.