PRECISE RADIAL VELOCITIES AND RADIAL VELOCITY STANDARDS

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ABSTRACT. By imposing absorption lines of HF in stellar spectra we can measure changes in r.v. with a precision of ~10m/s from a single spectrum, provided stellar line profiles are not distorted by atmospheric motions. The precision of absolute radial velocities is currently limited to ~100m/s by knowledge of rest wavelengths. Representative results are presented from our three, active PRV programs: velocity variations of δ Scuti stars; a search for unseen companions to late-type stars; and routine observations of certain IAU velocity 'standards'.

1. INTRODUCTION

Radial velocity and its variation are fundamental elements for any star. The recent detection of Solar oscillations has provided a new probe of its structure, and the larger scale oscillations of various classes of variable stars have been known for a long time. The solution of binary systems, particularly those with a large mass ratio, requires precise radial velocities. For a sufficiently high precision it should even be possible to measure dynamical parallaxes from the accelerations of nearby, 'non-variable' stars.

Compared to classical methods, our technique, which imposes the (3,0) band system of HF at 870nm in the stellar spectra, improves the precision with which radial velocity variations can be measured by two orders of magnitude. It has been described by Campbell and Walker (1979) and by Campbell, Walker, Johnson, Lester, Yang, and Auman (1981). The results discussed here were all obtained with the coudé spectrograph of the Canada France Hawaii 3.6m telescope. The detector is a refrigerated 1872 Reticon.

Line displacements are measured with a resolution of 10^{-3} of a diode spacing (= 0.015 microns = 2.4m/s). Our results to date suggest that we can achieve an external precision of ~10m/s for spectra with a S/N >1000/diode based on some 16 stellar lines.

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2. RESULTS

(a) δ Scuti variables: results for β Cas have already been published by Yang, Walker, Fahlman and Campbell (1982). In Figure 1 velocity curves derived from a mean of the Fe I lines and from the Ca II 866.2nm line are shown with only the data points for the Fe I lines plotted. The velocity residual between the two curves is also shown but at 8 times the scale. Apart from the obvious difference in velocity amplitude there appears to be a difference in phase between the two curves. Precision in this case is limited by the line profile variations accompanying the stellar pulsations and a S/N <1000 arising from the need to adequately sample the period. The data are for ρ Puppis

(b) Unseen companion search and IAU velocity standards: the program stars are listed in the table below. The I magnitude is the most appropriate for the 870nm region. The stars have been observed for three and a half years and the number of observations per star is listed in the last column. Figure 2 shows, combined, the results for one star from each program, β Virginis (triangles), and α Hydrae (crosses). Residual velocities from the mean are plotted for each star on each night where the mean velocities are: β Vir +4542m/s, α Hya -4601m/s.

Publication of the first results from this program is expected early in 1985.

Planetary Companion Program Stars

STAR	HR #	Sp Type	I	# OBSERVED
Tau Cet	0509	G8Vp	2.41	18
Iota Per	0937	GOV	3.25	11
Kappa Cet	0996	G5V	3.95	5
Epsil. Eri	1084	K2V	2.54	17
Omic.2 Eri	1325	K1V	3.29	11
Chi Ori	2047	GOV	3.61	8
Alpha CMi	2943	F5IV	-0.27	37
36 UMa	4112	F8V	4.10	12
Beta Vir	4540	F8V	2.86	19
Beta Com	4983	GOV	3.46	15
61 Vir	5019	G6V	3.82	12
Xi Boo	5544	G8V	3.75	6
36B Oph	6401	K1V	2.41	3
36A Oph	6402	KOV	3.99	4
70A Oph	6752	KOV		11
Sigma Dra	7462	KOV	3.66	12
Beta Aql	7602	G8IV	2.59	12
Gamma2 Del	7948	K1IV	2.84	9
Eta Cep	7957	KOIV	2.27	11
61A Cyg	8085	K5V	3.54	9
61B Cyg	8086	K7V	4.03	1
	8832	K3V	4.23	2
Gamma Cep	8974	KOIV	1.93	13

The IAU Radial Velocity standards

Alpha Ari	0617	K2III	0.54	16
Alpha Tau	1457	K5III	-1.31	21
Beta Gem	2990	KOIII	-0.11	13
Alpha Hya	3748	K4III	0.16	22
Alpha Boo	5340	K2III	-1.67	28
Delta Sag	6859	K2III	0.82	5
Epsil. Peg	8308	K2Ib	0.58	14

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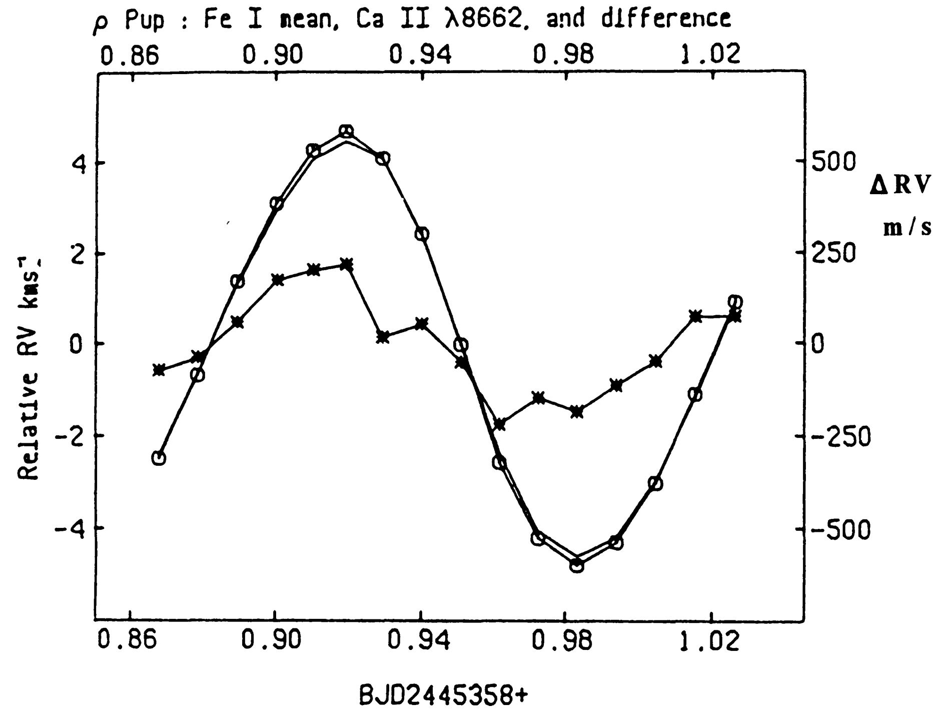

Fig. 1. Relative Velocity vs. Jusian Day for Rho Pup.

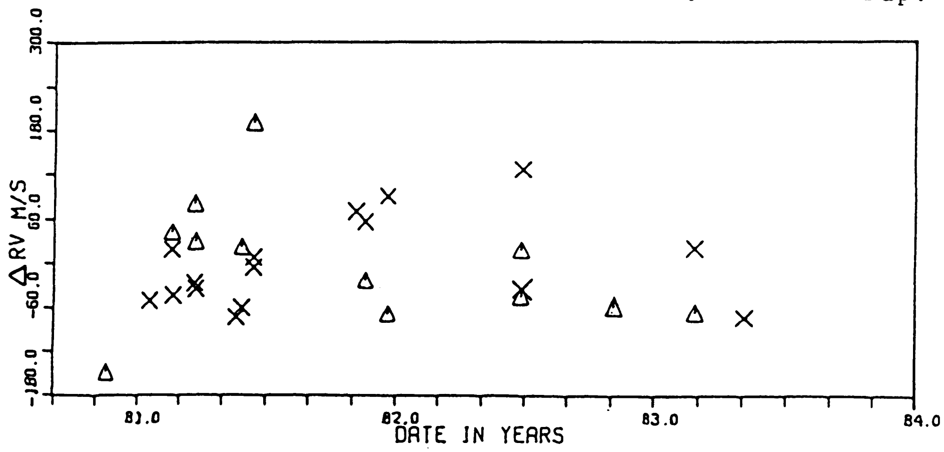

Fig. 2. Velocity Residuals.

REFERENCES

Campbell, B. and Walker, G.A.H. 1979, Publ. Astron. Soc. Pacific, 91, 540.

Campbell, B. Walker, G.A.H., Johnson, R., Lester, T., Yang, S. and Auman, J. 1981, Proc. S. P. I. E., 290, 215.

Yang, S., Walker, G.A.H., Fahlman, G.G., and Campbell, B. 1982, Publ. Astron. Soc. Pacific, 94, 317.

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