Radial-velocity Variations of Late-type Variables

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Abstract. Low-amplitude, radial-velocity variations of bright late-type stars were monitored at the 1.22-m telescope of the Dominion Astrophysical Observatory (DAO) with the hydrogen fluoride (HF) absorption-cell technique. Many of the stars appear to be semi-regular red variables (SRb and SRc) and irregular red variables (Lb). The radial-velocity amplitudes range from a few tens of metres per second to a few kilometres per second while the timescales of the variations appear to range from a few tens of days to a few hundreds of days. These irregular-looking velocities are analysed for multiperiodicities. There are also variations in the chromospheric Ca II 8662 index for a few of the variables.

1. Introduction

In conventional radial-velocity techniques, wavelength calibration in stellar spectra is limited by collimation and guiding errors. These errors can be largely eliminated by imposing absorption lines of known wavelengths directly onto the stellar spectra. One set of suitable absorption lines belong to the R-branch of the (3-0) vibration-rotation band of hydrogen fluoride (HF). The technique (Campbell & Walker 1979) involves placing an absorption cell filled with HF gas into the stellar beam. The monel absorption cell and its sapphire windows are maintained at 100°C in order to avoid polymerisation of the HF molecules. Connected to the cell is a resevoir of liquid HF maintained at 0°C to ensure a constant and stable vapour pressure. Meanwhile, a Reticon detector is utilised to provide the necessary high-signal-to-noise spectra.

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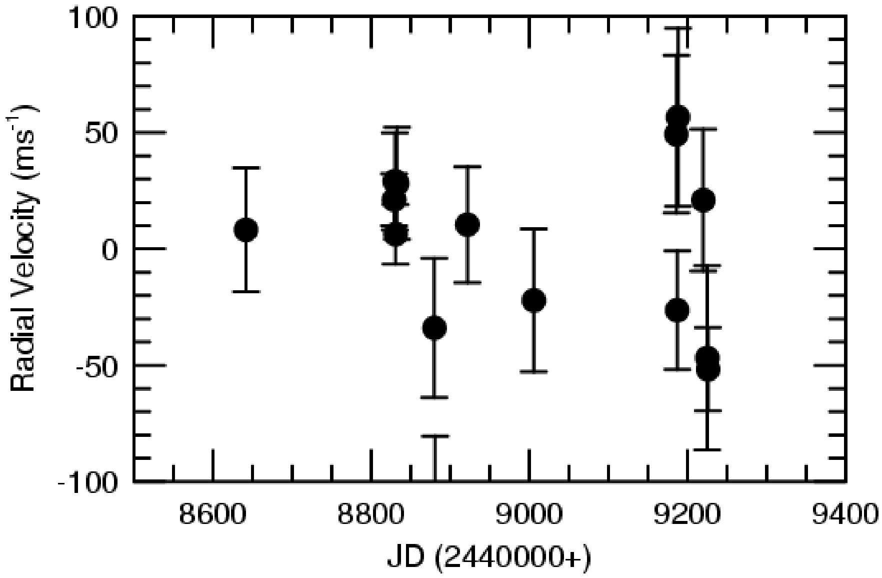

Figure 1. Scatter of α Ari velocities before application of run-to-run corrections.

2. Observations

The HF system is designed such that the cell can be easily moved in or out of the stellar beam. This enables the observations of spectra to be made with or without the imposed HF absorption lines. The spectrograph is centred a λ8700 and has a reciprocal dispersion of 4.8 A/mm, giving a plate factor of about 0.071 A/pixel and a coverage of 130A on the 1872-pixel Reticon (Walker et al. 1985). In measuring a relative radial velocity for a spectrum, the effect of line blending between the stellar and HF lines can be minimised using numerical division by the reference stellar and/or HF spectra. The velocity-reduction procedure has been described in Campbell et al. (1986).

The original HF system was used in a 12-year programme at the Canada-France-Hawaii Telescope (CFHT) to monitor GK dwarfs for signatures of extra-solar planets (Campbell et al. 1988, Walker et al. 1992, Walker et al. 1995). After the discovery that all the IAU radial-velocity standards used in the CFHT programme are variable (Walker et al. 1989), a second HF cell was installed at the DAO 1.2m telescope to monitor the small-amplitude, radial-velocity variations in bright, late-type stars (see also Larson et al., this volume).

3. Results

The scatter in the velocities of α Ari (Figure 1) provides an indication of the external errors even before any run-to-run correction (of the order of 40 m/s) is

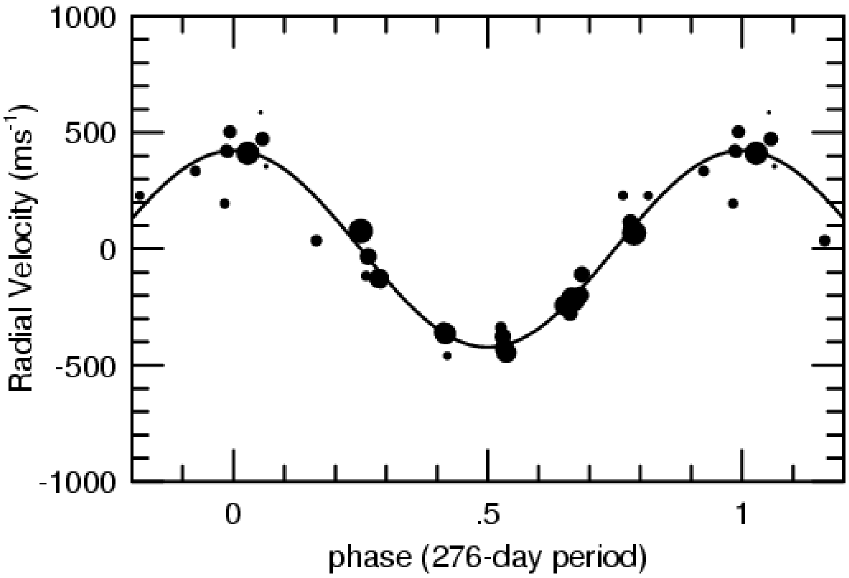

Figure 2. μ Gem velocities phased with one of three periods (after prewhitening the other two periods and phase-plotting only the one remaining period). The area of a point is inversely proportional to the square of its internal error.

applied. Due to slight fringing from one of the sapphire windows, these external errors are larger than the 13 m/s achieved with the HF system at CFHT. The DAO HF obervations were made between 1991 and 1995. A telluric-line method has been used at DAO to measure radial velocities since 1995 (see Greimel & Yang, this volume).

Most of the observed M-type giants and supergiants appear to be variable. In fact, many of these stars are probably semiregular (SRb and SRc) and irregular (Lb) red variables. As an example, Figure 2 shows the velocities of μ Gem phased with one in a set of three probable multiple periods. Generally, there are many almost-as-good-a-fit multiperiodic period-sets that would fit the observations for many of the program stars. Morever, these spectroscopic periods are generally different than known photometric periods (e.g. Percy & Fleming 1992, Percy et al. 1993, Percy et al. 1994, Cristian et al. 1995, Percy et al. 1996). Many more additional observations will be needed to distinguish between the various multiperiodic solutions and uncover true periods. Of course, any irregular or chaotic variation would also complicate the problem.

The HF dataset also yield information on the simultaneous variability in the stellar temperature (Bohlender et al. 1992) and Ca II index (Larson et al. 1993). As an example, Figure 3 shows both the velocities and Ca II indices for μ Cep phased to similar periods.

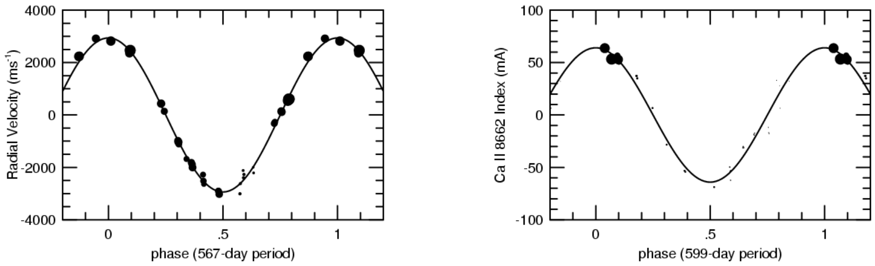

Figure 3. Phase plots of the μ Cep velocities and Ca II indices. Other periods have been prewhitened from the phased data points.

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