

On the Binariness of the F0p Magnetic Stars γ Equ and 49 Cam.

D.E. Mkrtychian¹, N.N. Samus², N.A. Gorynya², P. North³, A.P. Hatzes⁴

¹*Astronomical Observatory, Odessa State University, Shevchenko Park, Odessa, 270014, Ukraine*

²*Institute of Astronomy, Russian Academy of Sciences, Pyatnitskaya Str. 48, Moscow 109017, Russia*

³*Institut d'Astronomie de l'Universite de Lausanne, CH-1290 Chavannes-des-Bois, Switzerland*

⁴*McDonald Observatory, University of Texas at Austin, Austin, U.S.A.*

1. Radial velocities of the roAp star γ Equ

The magnetic field investigations of the rapidly-oscillating (ro)Ap star γ Equ show a very long magnetic (rotational) period of about 74 years (Leroy et al. 1994; Bychkov & Shtol 1997). No significant changes of radial velocities were detected during the history of investigations of this star. Recently, Scholz et al. (1997) (hereafter S97) reported a rapid increase of radial velocity (RV) of γ Equ from the mean value of -16.81 km s^{-1} up to a maximum at -4.28 km s^{-1} within the interval JD 2 449 608 – JD 2 450 356, and suggested that γ Equ is a long-period binary star with high eccentricity. Such a probable discovery of binary motion of γ Equ is very interesting, since it opens the possibility to compare asteroseismic parameters of the star with those obtained from the binary orbit.

In our previous publication on γ Equ (Mkrtychian et al. 1998) we have presented the results of 758 RV measurements of γ Equ obtained with cross-correlation RV spectrometers during 1994–1996. Our homogeneous RV measurements covered the epoch of JD 2 448 530 – JD 2 450 355, which largely overlaps the S97 data, and did not show any significant increase of RV at the time of the year 1996 when such a change occurred according to S97; they are constant within the errors.

In order to check further possible RV changes in γ Equ, we used two estimates of RV determined from spectra of the $H\alpha$ line obtained in 1994 and 1997 with the 2.7-m telescope of McDonald Observatory, within the program of search for rapid radial velocity variability in roAp stars (Hatzes et al. 1999). These estimates of radial velocities are $-15.83 \pm 0.3 \text{ km s}^{-1}$ at the date HJD 2 450 656.7156 and $-19.03 \pm 1.2 \text{ km s}^{-1}$ at HJD 2 449 608.6003; they were both based on the $H\alpha$ line and are close to the mean value for the period 1994–1996, i.e. $-16.83 \pm 0.038 \text{ km s}^{-1}$ (Mkrtychian et al. 1998).

In Fig. 1, we show the radial velocities obtained in 1994–1997.

The new data, together with older ones, confirm the constancy of the mean radial velocities of γ Equ during the years 1994–1998, within the errors.

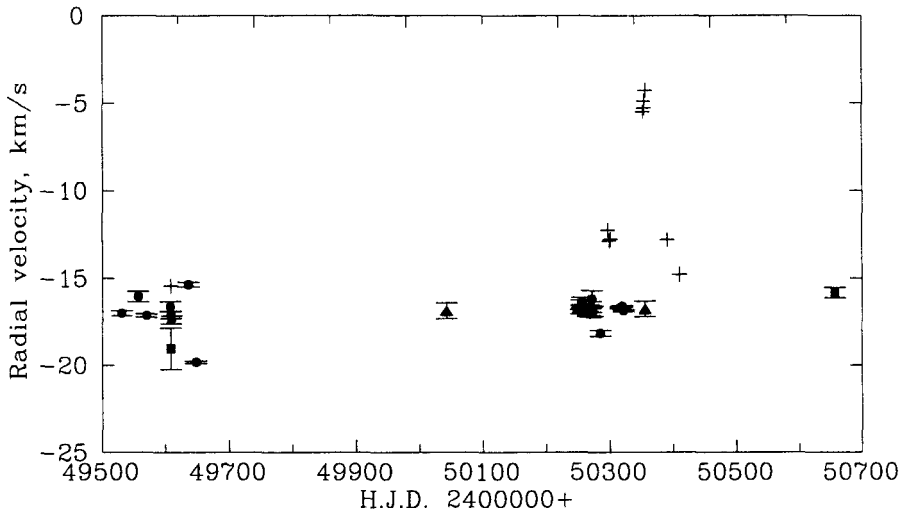


Figure 1. The 1994–1997 radial velocities of γ Equ; dots – RVS data, triangles – CORAVEL data, squares – McDonald data, crosses – Scholz et al. (1997) data

2. Radial velocities of the F0p star 49 Cam.

49 Cam was suspected to be a RV variable star during the year 1994, thanks to a joint program of search for RV variability in selected cool Ap stars (Mkrtychian et al. 1997), carried out by the Astronomical Institute (Moscow, Russia) and the Odessa Observatory (Ukraine). using the CORAVEL-type scanner (hereafter RVS) (Tokovinin 1987). The 1994 observations of 49 Cam show a significant departure of RV (approximately $+13 \text{ km s}^{-1}$) from the value $+1.4 \pm 1.5 \text{ km s}^{-1}$ given in Wilson's General Catalog of Radial Velocities (Wilson 1953; Young 1945) as well as from the available published RVs of 49 Cam such as $+5.3 \pm 0.3 \text{ km s}^{-1}$ (van den Heuvel 1971) and $+7.2 \pm 0.12 \text{ km s}^{-1}$ (Bonsack et al. 1974). Due to the suspected binarity of the star, the 1994 observations were continued in 1995. The new, 1995 RVS data show the unpredictable rapid decline of RVs from $+16.2$ to -0.9 km s^{-1} during one year (Mkrtychian et al. 1997). The latter RV value is close to values given by Young (1945) and Wilson (1953).

Earlier, 49 Cam had been observed by one of us (P.N.) in 1987–1992, during a program to search for binaries among cool Ap stars (North et al. 1998), using the CORAVEL scanner attached to the 1-m Swiss telescope at Observatoire de Haute Provence. The mean value of six RV estimations was equal to $+7.96 \pm 0.31 \text{ km s}^{-1}$, and is close to values given by Bonsack et al. (1974). To check further the variability of 49 Cam, observations were continued in 1996, 1997 and 1998 both at Sternberg Astronomical Institute (Moscow) and Haute Provence Observatory. All the 1987–1998 data are presented in Fig. 2.

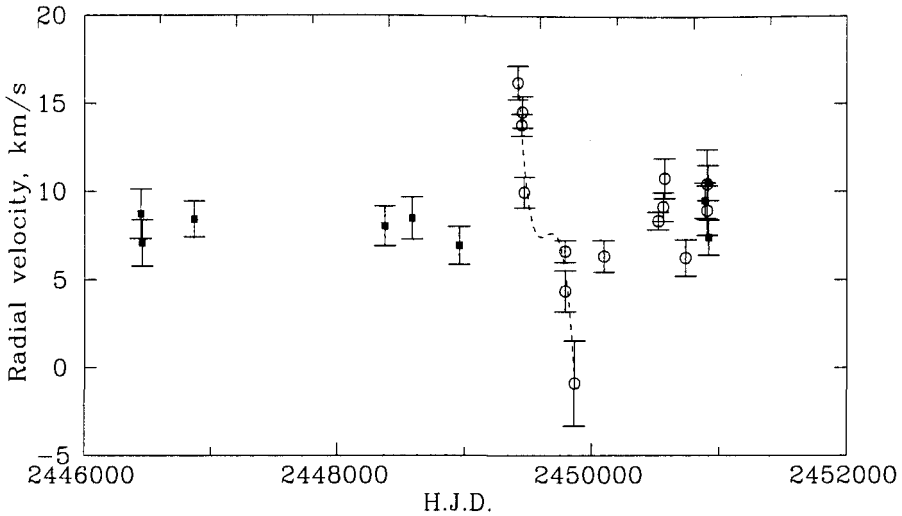


Figure 2. The 1987–1998 radial velocities of 49 Cam: circles – RVS data, squares – CORAVEL data.

The new data obtained after the sharp decline of RV in 1994–1995 both in Moscow (RVS) and OHP (CORAVEL) are grouped between $+6.3$ and $+10.76$ km s⁻¹, the mean value being $+8.55 \pm 0.45$ km s⁻¹, and are close to the mean value $+7.96 \pm 0.31$ km s⁻¹ relative to the 1987–1992 observing period. The nature of such a sharp drop and return to the present values of RV still remains unresolved. The independent evidence for an extremely low value of RV, $+1.5$ km s⁻¹, at an epoch earlier than 1945 (Young 1945) seems to confirm the repeatability of rapid and significant RV variations in 49 Cam. The monitoring of RV is worth continuing, in order to confirm the probable binarity of this star.

3. Conclusions

Based on 758 RV measurements of the roF0p star γ Equ made in 1994–1996, we do not confirm the long-term RV variability reported in the literature. Our new data covering the period 1994–1997 show that this star was constant, with the mean value -16.83 ± 0.038 km s⁻¹, which is close to the mean values reported over the history of investigations of this star. We conclude that there is as yet no evidence for a binary companion to γ Equ.

During observations of the F0p star 49 Cam made in 1994–1995, we detected a rapid drop of radial velocity from $+16.2$ to -0.9 km s⁻¹ (Mkrtichian et al. 1997). The new RV measurements of 49 Cam obtained in 1996–1998, as well as unpublished Haute-Provence data for 1986–1992, show that the mean values of RV outside the 1994–1995 time interval are respectively equal to 7.96 and 8.55

km s⁻¹ and are close to each other. The existing data are not sufficient yet to state with absolute confidence that 49 Cam is a binary star, so it is necessary to obtain further confirmations of periodic RV changes.

References

- Bychkov, V.D., & Shtol, V.G., 1997, in *Stellar Magnetic Fields*, Yu.V. Glagolevskij & I.I. Romanyuk, Moscow: Russian Academy of Sciences, 200
- Bonsack, W.K., Pilachowski, C.A., & Wolff, S.C. 1974, *ApJ*, 187, 265
- Hatzes, A.P., Kanaan, A., & Mkrtichian, D.E. 1999, these Proceedings
- Leroy, J.L., Bagnulo, S., Landolfi, M., & Landi Degl'Innocenti, E. 1994, *A&A*, 284, 174
- Mkrtichian, D.E., Samus, N.N., & Gorynya, N.A. 1997, in *Stellar Magnetic Fields*, Yu.V. Glagolevskij & I.I. Romanyuk, Moscow: Russian Academy of Sciences, 185
- Mkrtichian, D.E., Samus, N.N., Gorynya, N.A., Antipin, S.V., North, P., Rastorgouev, A.S., Glushkova, E.V., Smekhov, M.G., & Sachkov, M.E. 1998, *Inf. Bull. Var. Stars*, 4564
- North, P., Ginestet, N., Carquillat, J.-M., Carrier, F., & Udry, S. 1998, *Contr. Astron. Obs. Skalnaté Pleso*, 27, 179
- Scholz, G., Hildebrandt, G., Lehmann, H., Glagolevskij, Yu.V. 1997, *A&A*, 325, 529
- Tokovinin, A.A. 1987, *Soviet Astronomy*, 31, 98
- van den Heuvel, E.P.J. 1971, *A&A*, 11, 461
- Wilson, R.E. 1953, *General Catalogue of Stellar Radial Velocities*, Washington: Carnegie Institution of Washington.
- Young, R.K. 1945, *Publ. David Dunlap Obs.*, 1, 311