LONG-TERM PHOTOMETRIC INVESTIGATION OF FK COM

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FK Com is the prototype of a small group of G-K stars, which evolutionary status is not yet clear. FK Com is a G2III to G7III star, apparently a single giant with extremely rapid rotation, *vsini*=162.5 km/s (10). This star exhibits strong chromospheric activity, similar to the chromospheric activity of the RS CVn stars. Strong emission has been observed in H_α and *CaII H+K* lines (3, 4). The H_α emission is variable (12). Chromospheric flares have been observed in H_α (6, 17) and in broad band filters. FK Com exhibits also light variations, due to photospheric spot activity. Chugainov (1) was the first to report photometric variability, which he attributed to rotational modulation by photospheric spots. Chugainov (1) also determined the photometric period, P = 2^d.412, which is the period of rotation. FK Com has been detected also with ROSAT in the X-rays by Welty and Ramsey (14) and in the radio (8, 7). It is generally believed that the strong activity of FK Com is due to its rapid rotation. However, the rapid rotation is a real problem, considering the evolutionary status of the star.

Two hypotheses have been proposed, to explain the rapid rotation of FK Com. According to Walter and Basri (5), FK Com is accreting material from a small and unseen companion. The second hypothesis suggests that FK Com is a relic of a coalesced close binary star (2). Attempts to reveal the unseen companion, however, failed (10).

There is an intense photometric record of FK Com, with contributions by many authors. The light curve shows a variable amplitude and shape, on a time-scale of months. From a long-term photometric study Jetsu et al (11, 13) determined an averaged photometric period, P = 2^d.4002466. They also showed that the spot distribution is consistent with the existence of two long-lived active longitudes on the photosphere, which are apart by 180°. Jetsu et al (11) proposed that the active longitudes on FK Com are alternately activated, i.e. a

"flip-flop". The essential question with the "flip-flop" is how the change of the light curve is achieved. One possibility is that spots do not essentially move on the photosphere and the growth at one active longitude is related to the decay of the spot at the opposite longitude. The second possibility is the assumption of latitudinal drift and differential rotation (9).

Doppler imaging is powerful method to reveal the surface inhomogeneities. In a series of papers, Korhonen et al (16, 18, 19, 20), using Doppler imaging, studied FK Com and reached contradictory results: solid body rotation or differential rotation.

FK Com has been studied photometrically with the 60cm telescope of the National Astronomical Observatory Rozhen during the past 18 years. Fig 1 shows the light curves of FK Com in the V-band in 2000-2004. Fig 2 shows the light variation of FK Com during the past 25 years. Observations were taken from the literature and our own data, obtained in Rozhen. The dispersion of data in each observing season depicts the real amplitude of variation during that season (min to max variation). All light curves are constructed with the ephemeris:

HJD = 2439252.895+2^{d}.4002466xE Jetsu et al., (11)

The search for periods with the long-term data set (Fig 2) revealed no definitive periodicities. It is, however, quite obvious that a long-term variation in the light of FK Com is real: in the min light, in the max light and in the amplitude of rotational modulation. In Fig 3, we plotted the phase of min light for the different observing seasons versus the year. Each point on that figure depicts the position of the light curve (76 different light curves altogether) on the phase diagram. It is interesting to note that the first part of the diagram shows three jumps (1982 – 1992) in the phase of min light, i.e. the "flip-flop". After 1994 the diagram is much more complex, showing evidence of both the "flip-flop" as well as phases between 0.5 and 1.0. Intermediate phases between 0.5 and 1.0 may be due to a real latitudinal drift of the spots, between the positions of the two active longitudes. A differential rotation, corresponding to that latitudinal drift could be the cause of the drift in phase in Fig 3. Assuming that interpretation of Fig 3, we could determine the range of variation of the photometric period, which is: $P_{min}=2^{d}.397071$ and $P_{max}=2^{d}.404288$. Thus as an estimate of the differential rotation from Fig 3 we have $\Delta P/P = 0.003$. This is

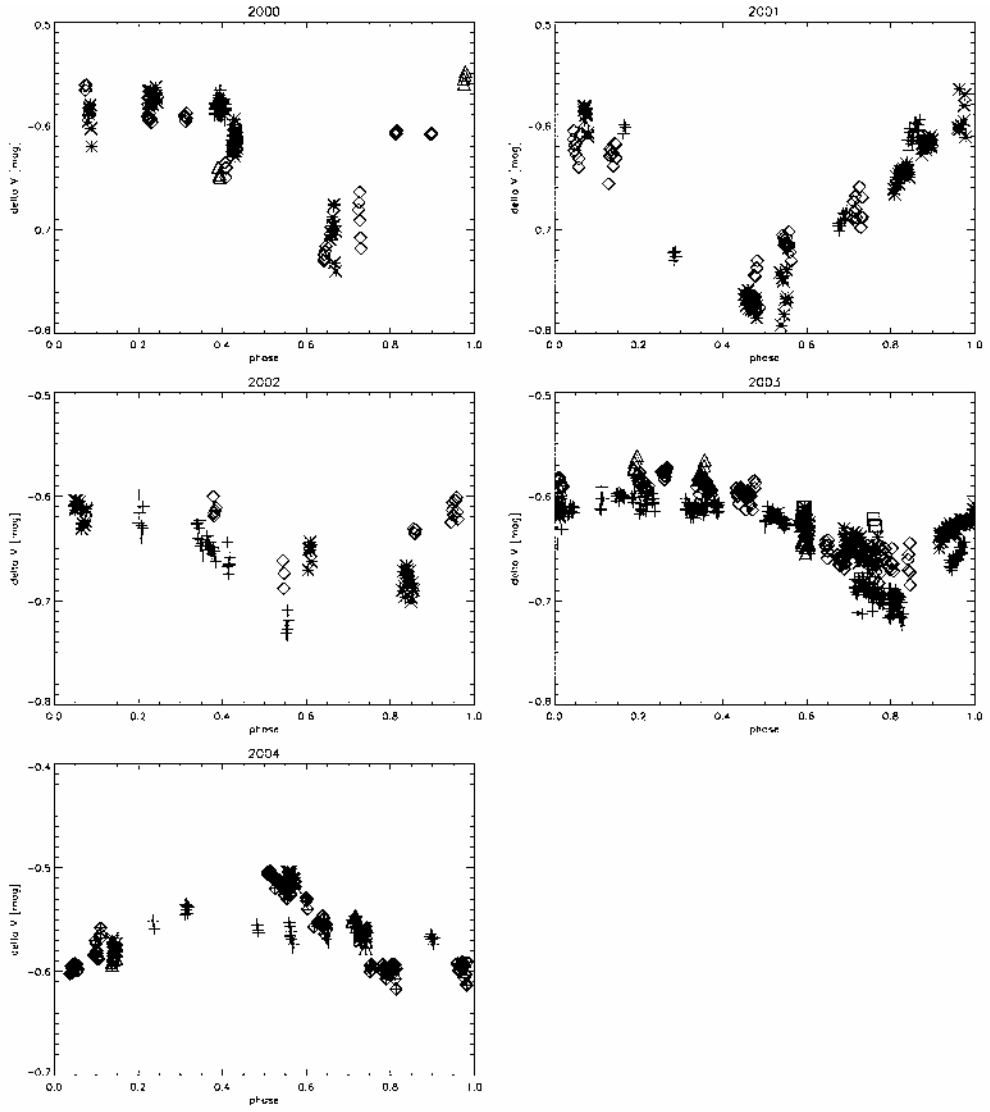

Fig 1. Light curves of FK Com in the V band. With different signs are denoted parts of the light curve from different months. The magnitude difference is:

much smaller in comparison with the respective value for the Sun (~0.2). Our estimate of the differential rotation of FK Com is different from the value

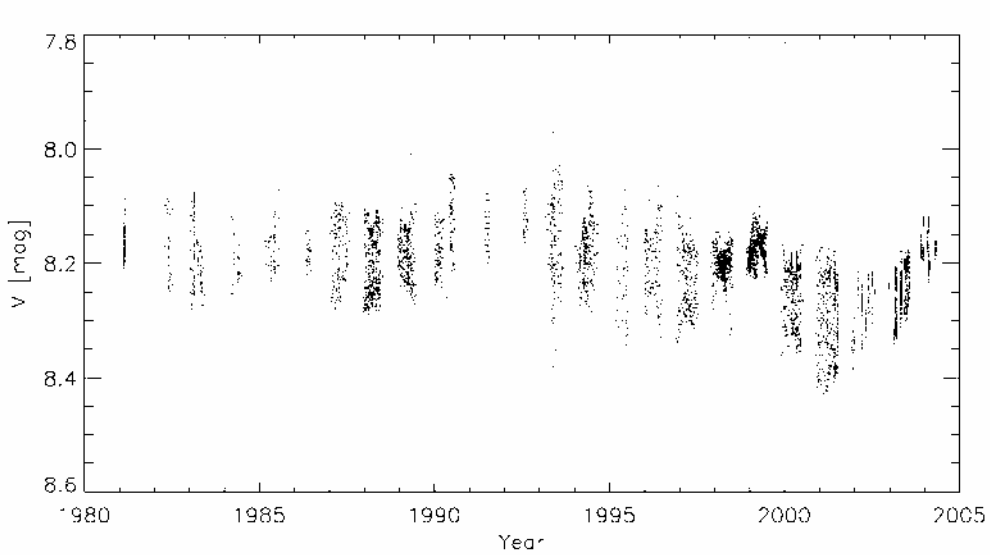

Fig 2. The long-term photometric variations of FK Com. The spread of data for each season denotes min to max variation of the rotational modulation

obtained by Korhonen et al. (20) but is similar to reported values for other BY Dra and RS CVn stars.

Fig 3 shows quite clearly periodicity in the “flip-flop”, reported also by Korhonen et al (19). The analyses of data on Fig 3 with the PERIOD98 Program of the Wien University (15) reveals a cycle of 5.9 years. It means that it takes about 3 years to “switch-over” from one active longitude to the other one. In the period 1998-2000, our Fig 3 shows also light curves, which do not follow the general trend of the “flipping” (marked by crosses). The reason for these deviations is not yet clear and needs further investigation. Similar “flipping” of active longitudes has been observed also in other stars (RS CVn) and still needs a theoretical explanation.

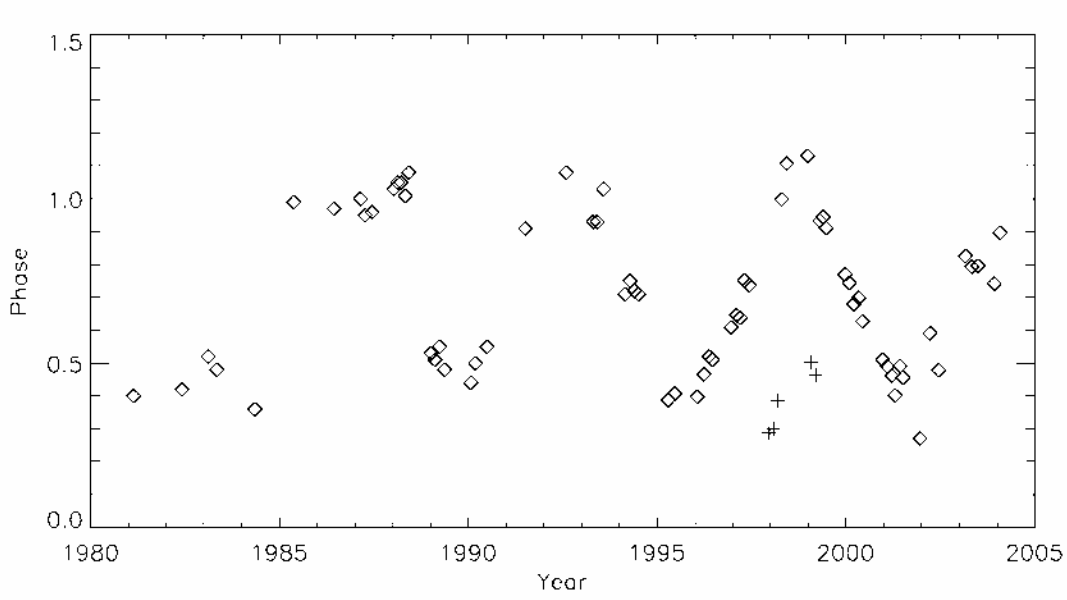

Fig 3. The phases of FK Com min light over the time: 1980 - 2004

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