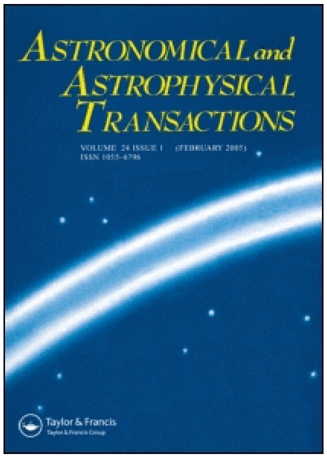

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THE EXTRAORDINARY InT VARIABLE STAR RY TAURI

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Simultaneous photoelectric and polarimetric BVR measurements of RY Tau were made from December, 1987 to March, 1993, after the star's extraordinary brightness increase on October, 1983. The presence of a correlation between polarization and photometric variability was found near the new light maximum of the star. But when the star becomes fainter than some brightness level, the correlation disappears and peculiarities of the P parameter behaviour resemble those before the RY Tau "flash". The position angle varied from 0° to 40° without any correlations with photometric variability or with polarization value. The interpretation of the observed phenomena was made by comparison with a "flash" of another T Tauri star, DR Tau "flash". We assumed the presence of two young stars in the direction of RY Tau. One of them is the well-known object. It is a probable close binary system. Another one is the YY Ori type companion which flashed.

KEY WORDS Pre-main-sequence stellar evolution, T Tau type stars, polarimetry and photometry

1 INTRODUCTION

The idea of the intrinsic linear polarization in T Tau type stars (InT, TTS) was first suggested by Vardanian (1964). Numerous polarization measurements were made by Bastien (1982, 1985) for TTS brighter than the 13*th* magnitude. The obtained data allowed him to suspect, for example, a statistical dependence of polarization degrees on reddening values of these objects.

Some of the bright representatives of InT variable stars were investigated more thoroughly. The observational results show the dispersion of the numerical values and varieties of behaviour of the linear polarization parameters, e.g. in the course of brightness variability, for different objects. The identification of polarized light sources is difficult, because according to the generally accepted ideas TTS are rather complex systems which consist of central bodies and their envelopes. Moreover, in some cases InT variable stars are components of visual binary stars (Herbig and Bell, 1988). The available lists of such objects may not be considered as comprehensive ones. They may be extended using high resolution methods (Simon *et al.*, 1992). If the angular distance between companions is relatively small, then the total flux is measured with an ordinary field diaphragm. Herbig (1977) also noted the possibility of there existing close binary systems consisting of extremely young stars. Up to now, spectroscopic binarity of some InT variable stars has been found (see Mundt *et al.*, 1983; Andersen *et al.*, 1989; Mathieu *et al.*, 1989; Reipurth *et al.*, 1990).

It is clear that there are a few reasons for the observed dispersion of P and θ parameters and of the absence of unique dependences of polarization of T Tauri stars on, e.g., their brightness. If we do not consider the influence of interstellar matter now, the main reasons are spatial orientation of the TTS and a relative contribution of independently working mechanisms. In particular, diversity in the TTS class may arise due to differences in the strength of photospheric processes, structure of envelopes (including flows in binary systems or near single stars), ionization degree, the strength the geometry of magnetic field, etc. It is also clear that the combined properties of a certain InT variable star are determined by its evolutionary status. The data obtained with different methods allowed Walker (1972) and Herbig (1978) to outline the age sequence of TTS. After the gravitational collapse phase and before the main sequence, a star passes two stages at least. Each of them has a personal set of nonstationarity sources. There are YY Ori and T Tau type star stages of evolution (Walker, 1972; Herbig, 1978; Kardopolov, 1995).

Thus a search for common correlations in the behaviour of the linear polarization parameters of TTS is to be carried out with due account of their relative age. There is also evidence for sudden transition of TTS to some new condition. In particular, extraordinary brightness increases were registered for DR Tau and RY Tau. In this paper we discuss some properties of RY Tau.

2 THE MAIN RESULTS OF OBSERVATIONS FOR RY TAU

2.1 Brightness Variability

According to spectral and morfological properties, RY Tau is a typical representative of InT variable stars (Herbig and Bell, 1988). It is projected on the region of active star formation in Taurus–Auriga dark cloud and is connected with a variable cometary nebula (Herbig, 1961). But until October, 1983 the kind of brightness variations of RY Tau sensibly differed from other investigated TTS (Kholopov, 1954; Herbst and Stine, 1984) and it was difficult to classify it from photometry. Note that, in spite of great dispersion, the positive slope of the color/magnitude diagrams is seen distinctly enough below the dashed line in Figure 1. This connection between color indices and brightness of RY Tau is not typical for an InT variable star.

The sets of multicolor wide band photoelectric measurements was discussed in detail earlier and allowed to find definite regularities of the behaviour of TTS color indices (Kardopolov *et al.*, 1987, 1988). The color/magnitude relations for YY Ori type stars, for example, possess negative slopes, i.e. these stars become generally redder when the star light is decreasing. At the same time, the numerical values of color indices for TTS with the T Tau-type photometric activity practically do

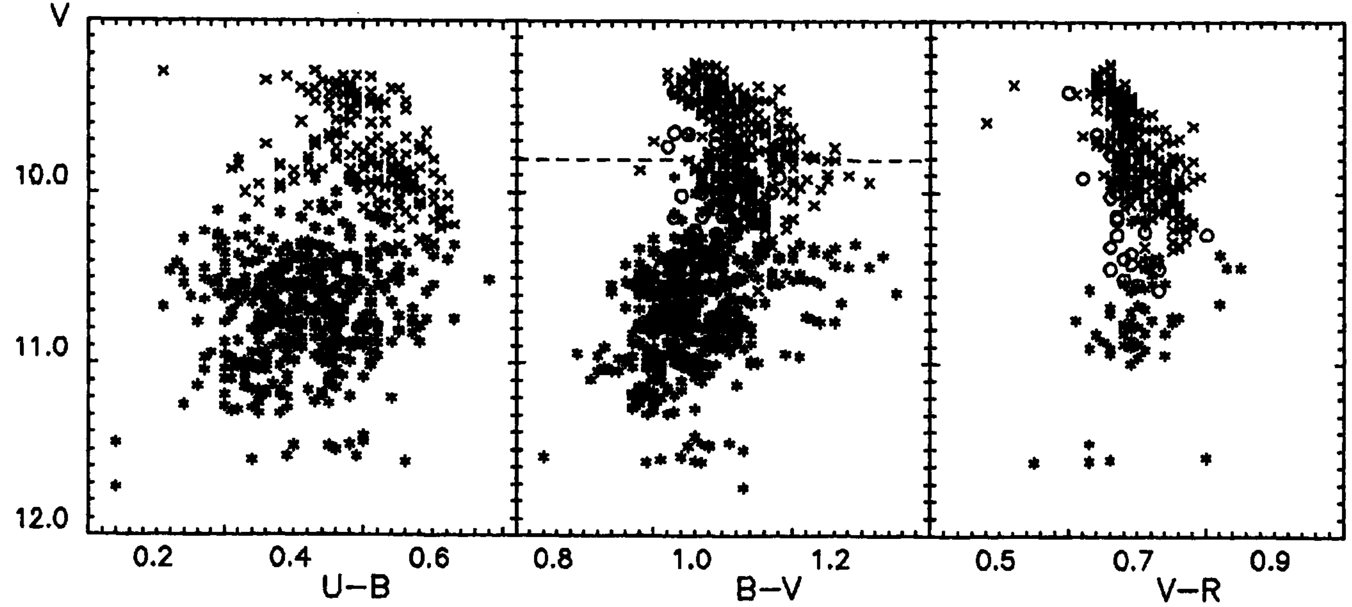

Figure 1 Color/magnitude diagrams for RY Tau. The published photometric data obtained before and after 1983 October are plotted by dots and crosses, respectively. Our results are plotted by open circles. The dashed line is the maximal brightness level of the star before its "flash".

not depend on brightness level. Therefore, in the color/magnitude diagrams for the objects the observations fill up a band which is practically parallel to the abscissa.

According to many-year photoelectric measurements, the V filter brightness amplitude of RY Tau was approximately 2^m, i.e. it was similar to the YY Ori type objects. But the typical regularities were not observed in the color/magnitude diagrams containing all available observational data. When we examined relatively short pieces of the star's light curve (for seasons, i.e. for certain brightness levels), RY Tau exhibited activity similar to T Tau (Kardopolov *et al.*, 1987, 1988). Note, however, that this uncertainty might be connected with close binarity of RY Tau (Herbig, 1977; Nurmanova, 1982; Gnedin and Red'kina, 1985).

At the end of 1983 – in the beginning of 1984 the extraordinary increase of brightness of RY Tau occured (Herbst and Stine, 1984; Zajtseva *et al.*, 1985). As a result of the "flash", the star's color/magnitude diagram shape became similar to YY Ori type stars. Until now, the new character of RY Tau photometric variability seems to pertain. It was the second observed case (after DR Tau) when a TTS increased brightness suddenly and irreversibly. Both these phenomena were not explained by detailed model calculations. Therefore one can suggest speculatively that October, 1983, was the turning moment when a TTS invisible earlier (because of the RY Tau light)increased radiation like DR Tau. Otherwise, it came into the YY Ori stage (Kardopolov and Rspaev, 1990).

Consequently, there is a probability that the "flash" of the earlier invisible companion was taken for a "flash" of RY Tau itself. If the suggested scenario is correct, the known YY Ori stage correlations must appear. The negative slopes are clearly seen on the color/magnitude diagrams for RY Tau (near the new brightness maximum). Figure 1 shows the above-mentioned phenomena; the published photometric data obtained before and after 1983 October are plotted by dots and crosses, respectively (Dombrovsky *et al.*, 1973; Dombrovsky and Polyakova, 1974; Abuladze *et al.*, 1975; Zajtseva, 1982; Herbst *et al.*, 1983; Herbst and Stine, 1984; Rydgren *et al.*, 1984; Kardopolov and Filip'ev, 1985; Kiselev *et al.*, 1985; Vrba *et al.*, 1986; Herbig and Goodrich, 1986; Herbst *et al.*, 1987; Herbst and Levreault, 1990). The observed maximum level of the star brightness before the "flash" equals to $9\overset{m}{.}91$ in V filter (Dombrovsky *et al.*, 1973) and is denoted by the dashed line in Figure 1. It should be noted that after October, 1983, RY Tau sometimes was fainter than $9\overset{m}{.}9$. For example, a minimum of about $10\overset{m}{.}7$ in V band was registered (Herbst *et al.*, 1987). It is also in agreement with the suggested scenario (as we shall see).

2.2 Linear Polarization before the "flash"

The polarimetric measurements covered the total range of RY Tau brightness variations until October, 1983. Their general results are as follows.

(i) Time variations of P and θ values were observed in the wide wavelength range of the stellar spectrum (Vardanian, 1964; Dombrovsky *et al.*, 1973; Breger, 1974; Dombrovsky and Polyakova, 1974; Abuladze *et al.*, 1975; Bastien and

Landstreet, 1979; Efimov, 1980; Hough *et al.*, 1981; Bastien, 1982; Schulte–Ladbeck, 1983; Moneti *et al.*, 1984).

(ii) The amplitude of P value variations is high enough (up to 4.5% in V filter).

(iii) The dependence of RY Tau linear polarization degree on its brightness is absent, like for other investigated InT variable stars with the photometric activity analogous to T Tau (Abuladze *et al.*, 1975; Grinin *et al.*, 1980). But some authors (Dombrovsky and Polyakova, 1974; Efimov, 1980; Zajtseva, 1982) reported certain regularities.

(iv) The variations of the wave function shape were unusually large in value and rapid in time (Breger, 1974; Bastien and Landstreet, 1979; Efimov, 1980). To interpret this feature of radiation of RY Tau Efimov (1980) suggested the presence of two types of scattering in the envelope. These are Thomson scattering when the RY Tau brightness is high and the scattering on dust during low light due to screening by dust inhomogeneities.

(v) The position angle changed and, as a result, the location of the observed points on the Stokes parameters plane is not described by a linear law. The polarization vector rotation was assumed (Bastien and Landstreet, 1979; Schulte–Ladbeck, 1983). It does not contradict either the conception of close binarity of the star (Herbig, 1977; Nurmanova, 1982; Gnedin and Red'kina, 1985) or the assumption about orbital motion of system dust clouds (Bastien and Landstreet, 1979; Schulte–Ladbeck, 1983).

2.3 Our Measurements of Radiation Parameters

RY Tau was observed with the single-channel electropolarimeter (Kurchakov and Rspaev, 1985) at the 1-m telescope of the Assy–Turgen mountain station in B, V, and R bands. The linear polarization parameters of the star were measured with simultaneous photometric calibration to the standard "a" (Shpychka *et al.*, 1976; Kardopolov and Filip'ev, 1985). The size of diaphragm was 16″. The observations were begun on December, 1987 (i.e. four years after the star's "flash") and covered the period till March, 1993. The results are presented in Table 1 where columns include: the mean moment of measurement, the brightness and color index values obtained with the typical photometric precision (see Kardopolov and Filip'ev, 1985; Grinin *et al.*, 1991), the values of polarization and positional angle with their rms errors. The brackets denote that the real error of the values mentioned above may be larger than the calculated one, for instance, due to the presence of a systematic error.

Our results of the photoelectric measurements are plotted by open circles in Figure 1. For the period of observations, the brightness of RY Tau changed within $1\overset{m}{.}2$ in V filter. Several times the star was fainter than the maximum level registered up to October, 1983 (dashed line in Figure 1). The contribution of the polarized light was equal to 1%–5%. The dependences of the measured values of P_λ on brightness in B, V, and R bands are given in Figure 2. It is distinctly seen that

Table 1. The results of BVR observations of RY Tau after the "flash"

244...	V	$B-V$	$V-R$	$P_B\%$	θ°_B	$P_V\%$	θ°_V	$P_R\%$	θ°_R
7147.14	10.09	1.11	0.69	2.11±0.23	36±3	2.22±0.36	42±5	2.39±0.17	42±2
7205.15	9.75	0.97	0.67	3.43 0.28	36 2	2.90 0.41	37 4	3.22 0.18	33 2
7206.16	9.76	0.99	0.68	2.82 0.40	34 4	2.83 0.28	40 3	2.74 0.14	36 1
7213.19	9.87	1.04	0.66	2.30 0.42	25 5	1.84 0.35	36 5	2.82 0.07	35 1
7443.31	10.24	1.01	0.67	1.78 0.30	30 5	1.47 0.21	21 4	1.43 0.18	26 4
7444.33	10.25	0.97	0.67	0.79 0.22	23 8	0.87 0.30	26 10	0.96 0.20	17 6
7445.30	10.23	1.04	0.67	1.08 0.38	28 8	0.68 0.28	7 12	1.04 0.22	24 6
7446.31	10.10	1.03	0.67	1.47 0.26	1 5	1.55 0.24	6 4	2.02 0.13	17 2
7475.32	9.51	0.97	0.60	2.32 0.17	8 2	2.20 0.23	13 3	2.45 0.16	10 2
7556.16	10.01	1.12	0.62	3.15 0.20	1 2	2.59 0.24	3 3	2.16 0.10	2 1
7800.41	9.81	1.03	0.68	2.36 0.14	9 2	2.06 0.26	11 4	1.99 0.21	20 3
7803.43	9.76	1.03	0.64	2.32 0.37	7 5	3.14 0.26	4 2	2.75 0.11	12 5
7915.18	9.82	1.12	0.67	2.41 0.36	8 4	2.74 0.32	0 3	2.43 0.12	4 1
7922.16	10.34	1.03	0.80	2.46 0.35	24 4	2.67 0.29	17 3	2.96 0.25	14 2
8187.37	10.51	1.00	0.71	(2.02 0.42	41 6)	2.79 0.40	17 4	3.11 0.14	20 1
8237.21	10.12	0.98	0.66	3.12 0.37	19 3	2.91 0.28	23 3	2.70 0.20	19 2
8240.21	10.10	1.01	0.67	2.41 0.23	21 3	2.84 0.24	22 2	2.61 0.25	14 3
8266.13	10.09	1.05	0.67	2.57 0.24	29 3	2.58 0.38	25 4	2.46 0.27	14 3
8308.14	9.83	0.96	0.69	3.26 0.24	25 2	3.54 0.31	21 3	3.35 0.15	21 1
8536.37	10.38		0.77			2.65 0.25	179 3	4.14 0.32	179 2
8569.27	10.32	1.00	0.71	5.29 0.25	19 4	4.37 0.43	11 3	5.88 0.21	9 1
8570.27	10.34	1.00	0.67	3.96 0.41	7 3	4.95 0.47	15 3	5.06 0.26	9 1
8571.27	10.41	1.03	0.66	3.89 0.39	15 3	4.25 0.23	11 2	5.26 0.16	8 1
8920.30	10.48	0.99	0.68	2.19 0.29	24 4	2.38 0.33	17 4	3.13 0.26	13 2
8921.37	10.51	0.97	0.69	1.38 0.33	18 7	1.96 0.36	9 5	2.76 0.23	8 2
8944.31	10.63	1.04	0.70	4.03 0.45	18 3	3.32 0.30	14 3	3.90 0.25	15 2
8945.28	10.60	1.06	0.68	2.26 0.43	18 5	2.95 0.28	19 3	3.22 0.28	14 2
8951.27	10.54	0.99	0.73	2.51 0.66	36 8	3.07 0.45	22 4	3.23 0.23	20 2
8952.28	10.45	1.01	0.69	1.98 0.40	31 6	2.30 0.35	35 4	3.00 0.29	23 3
8977.18	10.66	0.99	0.73	1.80 0.29	23 5	3.07 0.37	20 3	4.03 0.28	20 2
9066.12	10.51	1.00	0.69	(4.24 0.66	28 4)	2.63 0.40	12 4	2.97 0.30	23 3
9067.13	10.54	0.95	0.66	2.95 0.56	24 5	2.19 0.38	28 5	3.24 0.25	27 2

the behaviour of the P_λ parameter in all three filters is ambiguous. On average, the linear polarization values rise with the increase of brightness during the bright state of RY Tau. This regularity is shown by the solid line (drawn through averaged data points) on the $V - P_V$ graph. It is necessary to note that the appearance of a correlation is also in agreement with the suggested scenario.

But when the star becomes fainter than a certain level, the correlations vanish (open circles in Figure 2). The positional angle varied from 0° to 40°, and it did not correlate either with brightness or with polarization values of RY Tau (Table 1).

3 DISCUSSION

3.1 On RY Tau Polarization Mechanisms Before October, 1983

Besides interstellar matter, it is reasonable to consider other possible sources of the observed linear polarization of RY Tau before October, 1983, namely, the reflection nebula B96 the variable star is projected on, the circumstellar medium, photospheres a star or of components (if we deal with a close binary or multiple system). Different authors mainly prefer the dust component of the stellar envelope (Bastien and Landstreet, 1979; Efimov, 1980; Hough *et al.*, 1981; Bastien, 1982; Schulte-Ladbeck, 1983). In particular, the relatively large value of circular polarization for RY Tau (V/I to +6) is probably caused by multiple scattering on spherical grains (Nadeau and Bastien, 1986). At the same time, according to Efimov (1980), the absence of dependences of the P_λ values on brightness and variations of the wave function shape show that dust inhomogeneities (if they exist) cannot be the only source of intrinsic polarization for RY Tau. And there is no reason to consider them as the main cause of the photometric variability of the star.

The relation between polarization value and reddening degree. We shall try to find some additional evidence for the contribution of dust component to the observed polarization of RY Tau. In Figure 3, the behaviour of RY Tau polarization degree vs color index ($B - V$) is shown. The systematic synchronous measurements of the star's brightness in UBVR and of the P and θ parameters were carried out by Dombrovsky *et al.* (1973) and Dombrovsky and Polyakova (1974). The P variation data in the wide "blue band" are the most numerous. Therefore, the observations in the blue region of spectrum and in the B filter are the base of Figure 3. The results of Dombrovsky and coauthors are plotted by dots. The crosses are the data of the practically simultaneous measurements of the other authors from Table 2. The open circles correspond to similar symbols in Figure 2.

There is no distinct correlation in Figure 3. By chance, the crosses are along a straight line (the data were obtained in different seasons and by different authors). But the tendency of the rise of the polarized light contribution with reddening increase is apparently real (in spite of the scatter of observations in Figure 3). Using the results of the linear polarization measurements for several dozens of InT variable stars, Bastien (1982, 1985) showed that there was a statistical relation between P numerical values and values of reddening excess for these objects. He

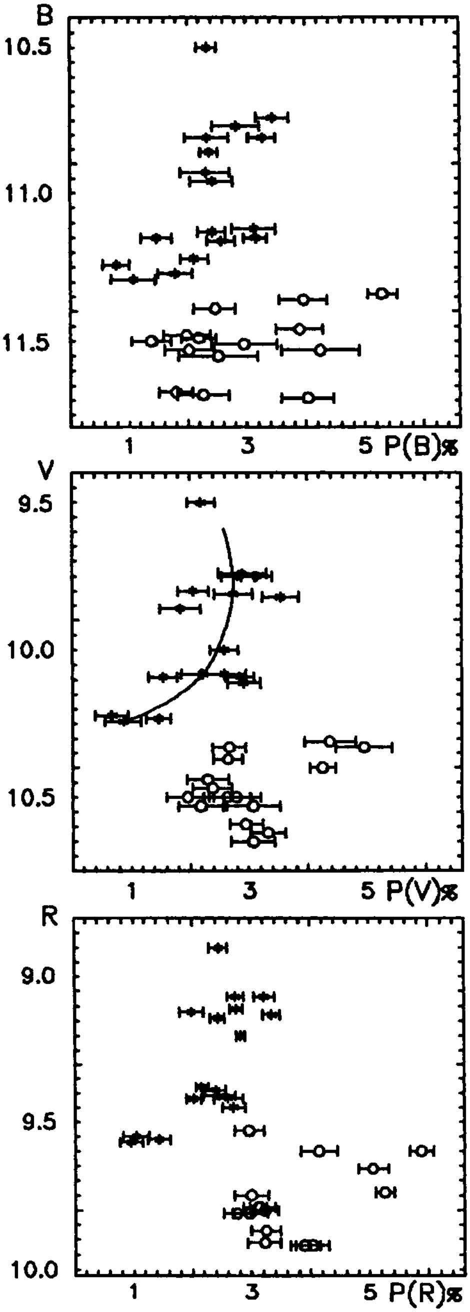

Figure 2 The relations between the linear polarization of RY Tau and B, V, and R brightness, according to our measurements. The correlation near the new star brightness maximum is shown by the solid line.

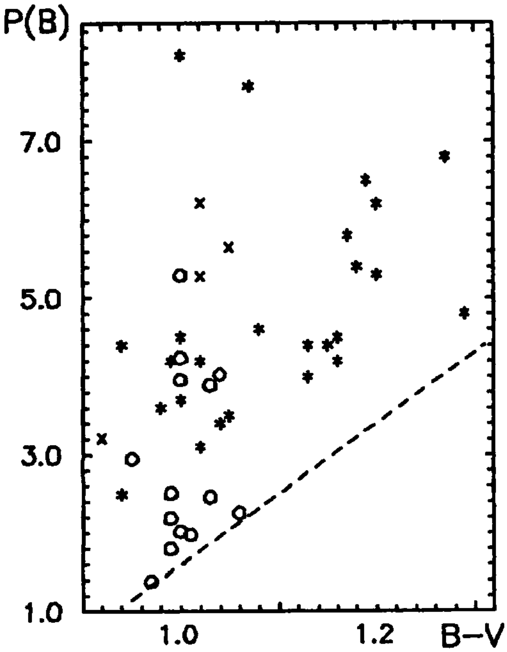

Figure 3 The linear polarization of RY Tau versus $(B-V)$ color index (Asterisks: Dombrovsky *et al.* (1973), Dombrovsky and Polyakova (1974); circles: our observations below the lower level of the star brightness; crosses: data from Table 2).

attributed the correlation to the dust circumstellar envelopes. According to this conclusion, the regularity in Figure 3 can be explained as a result of extinction by dust matter in the vicinity of RY Tau.

Efimov (1980) did not rule out that the observed intrinsic polarization of the star might be (and to a great degree) determined by the dust component of the nebula B96 which RY Tau is connected with. It was established that in some cases the polarized light in the radiation of reflecting nebula cores achieved 4% and more (Pavlova and Rspaev, 1985, 1986). But note that the fact of the P_λ parameters variability being dependent on the star's reddening (Figure 3) gives evidence in favour of dust blobs in the immediate vicinity of RY Tau.

Table 2. Photoelectric and polarimetric data for RY Tau

244...	V	$B-V$	*References*	P_B%	*References*
3496	11.57	1.02	Zajtseva (1982)	5.277	Efimov (1980)
3551	10.88	0.92	Zajtseva (1982)	3.215	Efimov (1980)
4892	10.99	1.05	Herbst *et al.* (1983)	5.65	Schulte-Ladbeck (1983)
4904	10.95	1.02	Kardopolov and Filip'ev (1985)	6.21	Schulte-Ladbeck (1983)

It is necessary to add, first, that, according to the detailed hypothesis of TTS hydromagnetic activity (Gershberg, 1982), the development of local magnetic fields to the temperature decrease in certain regions of InT variable star photospheres. The possibility to register cold regions on the surface of RY Tau was discussed by Kiselev *et al.* (1985). Second, if RY Tau is a close binary system (Herbig, 1977; Nurmanova, 1982; Gnedin and Red'kina, 1985), the appearance of spots due to the mutual radiative heating of the companions, the accretion of the overflowing matter, etc. can be expected.

It is necessary to note, however, that there is no clear evidence for close binarity of RY Tau either from photometric or from polarimetric observations. But apparently it is necessary to take into account this possibility. It is well-known that the light from a photosphere with nonuniform surface brightness is polarized (Dolginov *et al.*, 1979). Stellar rotation (orbital motion of close binary companions) will lead to the appearance of a periodic component in P parameter variations (see Menard and Bastien, 1992). The interconnection of the polarization degree with the reddening value must be observed in the case of spots. But interaction with dust seems to be the predominant mechanism of the $P_B - (B - V)$ relation, from considerations of the efficiency of the discussed sources (Dolginov *et al.*, 1979).

Masking factors. Figure 3 shows that there are some other factors which are masking the above-mentioned relation. The use of a nonstandard photometric system (Dombrovsky *et al.*, 1973; Dombrovsky and Polyakova, 1974) and the measurement errors cannot lead to the observed dispersion. The main uncertainty is most likely caused by superposition of several polarization mechanisms, comparable in efficiency. Efimov (1980) pointed out one of them, the Thomson scattering. At the same time, the polarization in U band in the case of pure Thomson scattering must be lower than the really observed one, for example, due to the effect of depolarization by excessive radiation of the envelope in the Balmer jump region (Schulte–Ladbeck, 1983).

The necessary slope of the relation between P_λ and λ in short wavelength region of the spectrum is provided by the model suggested by Gnedin *et al.* (1988) where a combination of Thomson and Rayleigh scatterings was used. But, for RY Tau, the shape of wave function may change (sometimes within a few days) from a very steep ($P \sim \lambda^{-4}$) to a practically flat one (Efimov, 1980; Schulte–Ladbeck, 1983). These changes require strong variations of the *gas (fine dust)/electrons* ratio. In order to explain the observed fluctuations, avoiding herewith apparent contradictions, Gnedin *et al.* (1988) considered the influence of a dipole magnetic field and estimated the role of local magnetic fields.

The interpretation of the observations of RY Tau in the deep minima according to the Grinin's (1988) model also gives evidence in favour of Rayleigh scattering. The model is based on the assumption of a nonspherical envelope around a young star with denser clouds embedded in it. Polarization of light arizes mainly in the envelope. The relative contribution of the radiation scattered in accordance with the Rayleigh law will increase during an occultation of the star by a dust inhomogeneity. Therefore the star will appear bluer, and its linear polarization, larger.

The interval of RY Tau brightness variations from $10^m.10$ to $11^m.82$ in V filter (Dombrovsky *et al.*, 1973; Dombrovsky and Polyakova, 1974) corresponds to the numerical values of $P_B\%$ and $(B - V)$ in Figure 3. According to Dombrovsky and his colleagues, very deep minima were observed on JD 2439856 and JD 2439865 (the data points with $P \simeq 8\%$). At the same time, for many years strong fadings of RY Tau were not accompanied by sensible growth of the $(B - V)$ color index (Figure 1). On JD 2439856 the $(U - B)$ color index decreased (Dombrovsky *et al.*, 1973). Otherwise, the photometric and polarimetric measurements in deep minima do not contradict the assumption of Rayleigh scattering in the vicinity of RY Tau. One of the probable reasons for the deep fadings of the star might be mutual eclipse of the companions of a close binary system in their orbital motion (Herbig, 1977; Nurmanova, 1982; Gnedin and Red'kina, 1985).

So the observed dispersion in Figure 3 may be partially caused by simultaneous action of different scattering mechanisms. In general case, the degree of masking must depend on the number, location, and power variations of individual sources of polarization. We can add that the lack of dependence of the P parameter behaviour on brightness is observed in two more InT variable stars with the T Tau type activity studied in detail – in T Tau itself (Abuladze *et al.*, 1975) and in DI Cep (Grinin *et al.*, 1980). There are reasons to expect that the evolutionary status of young objects with identical behaviour of brightness is the same if we imply the presence of the age sequence for InT variable stars (Kardopolov *et al.*, 1987; 1988; Kardopolov, 1995). The mechanisms of the intrinsic polarization of RY Tau (before the "flash" and with corrections for probable close binarity), T Tau, and DI Cep are not an exception and, in a way, are similar.

3.2 The Reguliarities After the "Flash"

Now let us return to Figure 2. The polarization behaviour of RY Tau apparently did not change in the state of decreased brightness (open circles). The numerical values of P do not depend on the star's brightness, as they did not before 1983 October. One can think that the set of the mechanisms in action before the "flash" could remain acting. At the same time, beginning from some level (dots), a distinct correlation of polarization with brightness is observed. The linear polarization values grow with the star brightness increasing (on average).

Remember that the "flash" was reflected in the star's photometric behaviour (Herbst and Stine, 1984; Kardopolov and Rspaev, 1990a). Namely, the shape of the color/magnitude diagrams for RY Tau became resembling those for YY Ori type variable stars. Thus, the results of polarimetric observations confirm that the processes which stimulated the increase of light flux in the end of 1983 – the beginning of 1984 affected sensibly other characteristics of the star continuum radiation, too. The possible reasons for all these phenomena will be discussed in the next section. But first it is necessary to make some remarks concerning the obtained correlation.

The relations of P_λ on m_λ in Figure 2 (dots) can be attributed to a new mechanism of the observed linear polarization. Note once again that its action manifested itself on a background of the extraordinary increase of the star's brightness and of

Table 3. The linear polarization of the stars in the RY Tau field

The star	α^2000	δ^2000	V	$B-V$	$P_V\,\%$	θ_V°	n
"a"[1]	$4^h21^m55^s$	$+28^\circ16.4$	10.65	0.53	4.86±0.15	5±1	9
BD+28 648[2]	4 22 55	+28 23.9	8.33	0.50	2.73 0.08	10 1	4
No. 1	4 21 37	+28 25.0	9.45	1.41	3.72 0.10	12 1	6
No. 2[3]	4 21 47	+28 26.7	12.69	0.87	3.83 0.48	18 4	7

Note. [1] Shpychka *et al.* (1976).

[2] Visual double star with separation about 10″. The coordinates of the brighter (southern) component are given. The companion's V magnitudes are $8^{\rm m}.62$ and $9^{\rm m}.92$. Their linear polarization parameters are practically equal.

[3] The star's linear polarization may be variable.

the change of the character of its activity in continuum (near the new maximum, the variable star has became a TTS photometric analog of YY Ori stars). This is apparently not a chance coincidence. It is not ruled out that the additional source of polarization is closely connect with the YY Ori stage, the existence of which was substantiated by Walker (1972). To confirm (or to refute) this assumption, it is necessary to compare our observations with analogous simultaneous measurements of other similar objects. Unfortunately such observations are still not numerous, i.e. our possibilities for comparison are strongly limited.

Recently similar data were obtained for the InT variable star BM And (Kardopolov and Rspaev, 1990b; Grinin *et al.*, 1991), which is also a TTS of the photometric subgroup of YY Ori (Kardopolov *et al.*, 1987, 1988). For this star, an inverse relation, i.e. an increase of polarization degree during fading, has been registered. This would make the conclusion about the absence of common correlations tempting. However, it is too early to make a decisive conclusion without an estimate of the probable contribution of interstellar matter in the observed polarization.

Grinin *et al.* (1991) estimated the value of the interstellar component towards BM And. Its influence is not sufficient to change the general slope of the star's relations of P_λ on m_λ. In the RY Tau case the situation is more complicated. According to independent estimations (Vardanian, 1964; Efimov, 1980), the contribution of interstellar matter in the observed polarization of RY Tau is large enough and is equal to 2.69% in V band, if the reddening law is assumed to be normal and the ratio P/A_V is 1.432. The positional angle of the electric vector is adopted to be equal to 27°. It is clear that when the numerical values of the intrinsic and interstellar polarizations are comparable, the requirements to the precision of interstellar polarization parameters increase.

Continuing the work started by Efimov (1980), we have attempted (along with RY Tau observations) to investigate the linear polarization in the RY Tau field. Fainter stars are planned to be measured. The first results are given in Table 3, they show that the value $P_V = 2.68\%$ may be underestimated. It is also not excluded that the position angle of the electric vector of the interstellar polarization component towards RY Tau can be about 10°.

We do not risk to calculate the interstellar contribution in the RY Tau case because of the uncertainty of its parameter values, deficiency of new data, and the probable complex nature of the RY Tau system itself (see below). Let us compare, however, the P_V estimations from Vardanian (1964), Efimov (1980), and Table 3 with polarization values in the dates denoted by dots in Figure 2. If we nevertheless make the correction, then the slope of the relations obtained from our observations would be opposite. Otherwise, the general behaviour of the dependence of intrinsic polarization variations on brightness for RY Tau (near the new brightness maximum after the "flash") and for BM And is most likely the same. It should be noted that the very fact of the correlations between P_λ and m_λ for InT variable stars showing the YY Ori type photometric activity (unlike the TTS of the T Tau subclass) presumably testifies in favour of a special polarization mechanism in these objects.

4 CONCEIVABLE INTERPRETATION

It is necessary to find a reasonable explaination of the following reliable facts.

(i) Recently RY Tau has increased its light flux. Near the new maximum, the nature of activity in continuum has changed. Besides that, systematic fadings of the star to the brightness before its "flash" are observed.

(ii) A relation between polarization degree and photometric variability is present near the new maximum of RY Tau. But the correlation vanishes when the star becomes fainter than a certain level, and the changes of the parameter P become arbitrarily, like they were before 1983 October.

To understand the above-mentioned features, we call attention to one extraordinary object more. The InT variable star DR Tau also underwent such a transformation several years ago. According to both spectral and photometric properties, it is attributed to YY Ori type variable stars (Bertout and Yorke, 1978; Kardopolov *et al.*, 1988). The "flash" amplitude for DR Tau is almost equal to 4^m. The star's brightness increase lasted for several years (Chavarria, 1979). In spite of the presence of large brightness fluctuations (the amplitude of DR Tau reaches $2\overset{m}{.}3$ in V filter), no fadings to the prior level are observed (Chavarria, 1979; Götz, 1980; Rydgren *et al.*, 1984; Herbig and Goodrich, 1986; Walker, 1987).

The behaviour of RY Tau could be understood if, for example, two young objects (constituting a complex not resolved for an observer) are located towards it. One of them is the star with the T Tau type photometric activity, i.e. the probable close binary system (Herbig, 1977; Nurmanova, 1982; Gnedin and Red'kina, 1985) which was investigated earlier and remained without change. The second object is the InT variable star that flashed; is not connected physically with the suspected close binary system.

At the end of 1983 – in the beginning of 1984, the last stage of the "new" companion's "flash" was registered. We do not know the full amplitude of the "flash" because the component is almost on the line of sight of the bright object well-known as RY Tau. After 1983 October this TTS ("invisible" before that) is predominant in the complex near its maximum brightness. So the new character of brightness fluctuations and the dependences of linear polarization values on light variations are observed. And when brightness of the nonresolved companion decreases, RY Tau returns to the previous type of activity in continuum.

Remember further that the amplitude of RY Tau before the "flash" reached 2^m in V band. When the brightness of the possible binary system (well-known before October 1983 as RY Tau) decreased, the brightness of the whole complex could fall to the level below $9^{m}_{\cdot}9$ in V filter (Figure 1). In particular, after October 1983, a minimum of about $10^{m}_{\cdot}7$ in V filter was registered (Herbst *et al.*, 1987). If our scenario is correct, the amplitude of brightness fluctuations of the "new" object is at least $1^{m}_{\cdot}3$ (Figure 1). It is clear that the deepest fadings of the "new" companion are lost against the bright background of RY Tau itself. It is logical to think therefore that the light variability amplitudes of DR Tau and of the "new" companion of RY Tau (after their "flashes") are comparable. We can suppose that the companion is a YY Ori type TTS, because the unresolved component of the RY Tau complex shows YY Ori-like color/magnitude diagrams and dependences of linear polarization values on light fluctuations.

Thus, as a result of the "flashes" of RY Tau and DR Tau, some common features became apparent. Therefore it may be supposed that the brightness of both DR Tau and RY Tau increased due to the same processes. But the transition of the "new" component of RY Tau to the YY Ori-like continuum activity took place on the comparatively brighter background (the true amplitude and the duration of the "flash" of the InT variable star are not known). Due to this, differences in the scale of phenomena may occur.

Influence of photometric binarity, i.e. the presence of nonseparated components, was discussed by Kakaras and Straižys (1969) and Kakaras (1969a). The probability of such objects, according to Kakaras' (1969b), is low enough. Therefore our assumption about the number of components in the RY Tau complex can seem artificial. However, it possesses rather obvious advantages because it allows to combine two phenomena (the "flashes" of RY Tau and DR Tau) and to search a common explanation for them.

5 CONCLUSIONS

The simultaneous photometry and polarimetry allowed to establish that the "flash" of RY Tau had influenced both the nature of the star brightness variations and the behaviour of its linear polarization. One can say that the appearance of one more source of polarized light has been established. In addition to that, the return to the former type of activity is also observed. The general pattern and details of the registered features can be explained by the assumption that RY Tau belongs to photometric binary objects.

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