Abstract. High-resolution spectroscopic monitoring of the Na I D lines in the T Tau-type star RY Tau results in the discovery of relatively cool gas clouds ascending and descending inside the stellar wind on a time-scale of few days and co-rotating with the star. Radial velocity of the clouds varies from $-100$ to $+100$ km s$^{-1}$, which is twice as large as the $v \sin i$ of the star.

1. Introduction

T Tau-type stars are the pre-Main-Sequence objects of about 1 to 3 solar masses, distinguished by emission chromospheric-like spectrum and irregular variability of stellar and circumstellar origin. There are many observational data indirectly indicating that magnetic fields play a major role in the activity of T Tau stars: the chromospheric and transition region spectra in visible and UV ranges, the flares of X-ray radiation, the asymmetrical structure of stellar winds, etc. In the last few years a number of papers have been devoted to discussing accretion discs as the energy source for activity of T Tau stars (see, e.g., Bertout, 1988).

In this paper I present the results of high-resolution spectroscopic monitoring of the Na I D lines in the T Tau star RY Tau. The observations were carried out to investigate the character of the gas motion (accretion or ejection) around the star.

2. Observations and Results

RY Tau is one of the brightest T Tau-type variables. It has an emission spectrum of moderate intensity and an underlying absorption spectrum classified as K1. Its bolometric luminosity is $17 L_\odot$, which gives a value for the stellar radius of $5 R_\odot$ and an estimation of mass of about $2.3 M_\odot$ (Cohen and Kuhi, 1979). During the last decade, the $V$ magnitude of the star was variable within $9.5-11.6$ (Zaitseva et al., 1985). Unlike many other T Tauri stars, RY Tau is a fast rotator, $v \sin i = 55 \pm 5$ km s$^{-1}$ (this paper).

Spectroscopic observations of RY Tau were made at the 2.6 m Shajn reflector of the Crimean Astrophysical Observatory. The CCD-camera of the Helsinki University was used at the Coudé spectrograph. With the entrance slit of 1", the spectral resolution was 0.37 Å. The spectral region from 5872 to 5902 Å was selected for the monitoring programme. It includes He I 5876 (D$_3$), Na I 5890/5896 (D$_{1,2}$), Ni I 5893, Ti II 5896, and other lines. This spectral region was observed earlier in other T Tau stars by Mundt (1984) and Hartmann (1982), but no monitoring programmes were performed.


The observations of RY Tau were carried out during 1987–1988. One or two spectra in the region of the D lines were taken during a night. Sometimes, H\alpha region was observed too. After reduction of the spectra the S/N ratio was about 30. The data set consists of 21 spectra of the D lines region taken from 24 October, 1987 to 20 April, 1988. One fragment of the data is given in Figure 1(a). The following features are noted.

The Na I D lines are most in absorption and consist of three different components:

- narrow absorption of interstellar origin,
- broad absorption of photospheric origin (its profile corresponds to the rotational velocity of the star),

Fig. 1. (a) Fraction of the data set: spectra of RY Tau in the region of Na I and He I lines. (b) Differential spectra, derived by subtraction of the average spectrum of RY Tau from each individual spectrum of the star. The residual absorptions of Na I are variable in profile, intensity, and radial velocity.