

Activity of T Tauri type stars and objects similar to them

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Pre-Main Sequence (PMS) stars are important objects for study of the early stages of the stellar evolution and for testing the stellar evolution scenarios. PMS stars with low masses ($M \leq 2M_{\odot}$) are named T Tauri stars. The first systematic study of such young stellar objects, as a separate class with prototype the star T Tauri, was made by Joy (1945).

PMS stars are rare among field stars, because during the PMS evolutionary phase the stars spend less than 1% of its life. Depending on their initial mass, these stars reach the main sequence for different time scales. One of the most important features of the PMS stars is their photometric variability. The long-term multicolour photometric observations of such stars are very important for their exact classification. These observations are directed to fields with active star formation, in order to detect and classify their variability in terms of amplitude, time scale and periodicity.

The main purpose of the dissertation is on the basis of long-term light curves, to classify the variability of 28 PMS stars and to be draw conclusions about the physical mechanisms initiating observed changes in their brightness. 22 of the investigated stars are located in the dense molecular cloud L935, known as 'Gulf of Mexico', in the field between the North America (NGC 7000) and Pelican (IC 5070) nebulae and 6 stars are located in the dark clouds, in the vicinity of the reflection nebula NGC 7129.

The multicolour photometric observations that we present were performed from 1993 to 2015 in two astronomical observatories, with four telescopes. These are the 2-m Ritchey-Chrétien-Coudé, the 50/70-cm Schmidt and the 60-cm Cassegrain telescopes of the Rozhen National Astronomical Observatory of the Bulgarian Academy of Sciences and the 1.3-m Ritchey-Chrétien telescope of the Skinakas Observatory of the University of Crete (Greece). The observations were performed with eight different types of CCD cameras. All frames were taken through a standard Johnson-Cousins set of filters ($UBVR_cI_c$). The total number of nights used for observations is 785. The photometric data were reduced by IDL package (standard subroutine DAOPHOT).

We carried out a periodicity search for investigated stars with PERSEA Version 2.6 (written by G. Maciejewski on the ANOVA technique, Schwarzenberg-Cherny 1996) and PERIOD04 (Lenz & Breger 2005) softwares.

The main results and conclusions of our investigation can be summarized as follows (Poljančič Beljan et al. 2014; Ibryamov et al. 2014; 2015a; 2015b; Ibryamov & Semkov 2016):

1. We constructed multicolour light curves of the stars from our study for period of nearly 20 years. They were classified on the basis of their light curves, colour indices versus the stellar magnitude diagrams, and their location on the 2MASS diagram.
2. We studied 22 stars in the field of 'Gulf of Mexico', which were classified as follows:
 - 3 stars (V521 Cyg, FHO 27 and FHO 28) show indications for UXor-type variability;
 - 11 stars (V752 Cyg, V1539 Cyg, V1716 Cyg, FHO 26, FHO 29, LkH α 186, LkH α 187, LkH α 191, [KW97] 53-17, [KW97] 53-22 and [KW97] 53-23) show characteristics for classical T Tauri stars;
 - 3 stars (V1538 Cyg, V1929 Cyg and [KW97] 53-20) are probably weak-line T Tauri stars;
 - 2 stars (LkH α 189 and [KW97] 53-11) show characteristics for both type T Tauri stars and spectral observations are needed for their exact classification;
 - 3 stars (V1957 Cyg, V2051 Cyg and [KW97] 53-36) likely are evolved PMS stars or post-T Tauri stars.
3. We studied 6 stars in the vicinity of the reflection nebula NGC 7129, which were classified as follows:
 - 1 star (V350 Cep) shows indications for EXor and/or FUor-type variability;
 - 3 stars (V391 Cep, NGC 7129 S V2 and 2MASS J21403576+6635000) show characteristics for classical T Tauri stars;
 - 1 star (NGC 7129 S V3) shows characteristics for UXor-type variability;
 - 1 star (NGC 7129 S V1) is likely a weak-line T Tauri star.
4. Periodicity is registered for 3 of the investigated stars. The star V1716 Cyg indicates 4.15-day period, V1929 Cyg indicates 0.43-day period and LkH α 189 indicates 2.45-day period. The found periods are typical rotational periods for T Tauri stars.
5. In the vicinity of NGC 7129 we found one variable star unknown to the present. It was classified as classical T Tauri star.

References

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