CIRCUMSTELLAR PHENOMENA AND THE POSITION OF T TAURI STARS IN THE COLOUR MAGNITUDE DIAGRAM

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ABSTRACT. On the basis of investigations concerning the character and the behaviour of circumstellar shells at T Tauri stars it is shown that the position of these objects in the colour magnitude diagram, below and above the main sequence, is caused by cosmogonic circumstellar effects originated by the mass loss of the stars.

1. INTRODUCTION

From photometric observations of T Tauri and Flare stars published by several authors it could be shown that these objects are situated below and above the main sequence in the colour magnitude diagram $M_V/(B-V)_0$ though, owing to their evolutionary ages and according to theory, their position should always be above the main sequence.

Aggregates where this phenomenon can be observed are for instance the Orion Nebula, the Taurus dark cloud, NGC 2264 and the Pleiades.

In this report it will be shown that this phenomenon can be explained by the character and the behaviour of circumstellar shells, which in the end are originated by the mass loss of the stars.

2. OBSERVATIONAL CORRELATIONS

From statistical investigations of circumstellar shells at T Tauri stars made at Sonneberg Observatory (1971, 1980, 1984) it could be inferred that the most important observational parameter of these objects is the strength of their Hα emission. It could be shown that the strength of Hα emission is closely connected with the individual mass loss rate of the objects as well as the circumstellar absorption obtained by star counts in their surroundings in the sense that high mass loss rates are correlated with strong Hα emission and strong circumstellar absorption.

L. V. Mirzoyan et al. (eds.), Flare Stars in Star Clusters, Associations and the Solar Vicinity, 215–218.

Small mass loss rates however go with weak Hα emission and weak absorption.

From studies in several T associations and Flare star aggregates of different ages it could further be shown that the strength of Hα emission is also a cosmogonic parameter. Hα emission is strong with stars in extremely young or young aggregates, but it decreases monotonically with age and becomes weak later than the logarithmic age log $\tau \geq 7.0$. Therefore, in old aggregates Hα emission should be very weak or not observable.

In this connection it is worth mentioning that the colour indices (B-V), (U-B) and (U-V), too, go with the strength of Hα emission. This relation is characterized by increasing colour indices with decreasing Hα emission or, considering the cosmogonic relation, with increasing ages of the objects. A similar behaviour results from index excesses, which are characterized by the differences between the observed colour indices (B-V) and those according to the spectral types. Here, with increasing evolutionary phases of the objects in the pre-main sequence stage the index excesses become smaller.

All those observational facts can be explained by the causal connection between the gas and dust shell phenomenon and the cosmogonic mass loss of the stars, which is the connection link between the stars and their shells and which appears in the early phase of the pre-main sequence stage and decreases, like the accompanying shell phenomena, during the evolution of the stars.

3. CONCLUSION

The correlations mentioned above, especially those that characterize light depressions and colour excesses caused by cosmogonic circumstellar effects, provide a possibility to reduce the observations free of interstellar absorption according to the strength of Hα emission to the stage where the circumstellar shell phenomena should be weak or totally absent in the same way as the Hα emission. The results obtained in this manner are shown in Fig. 1 and Fig. 2, where the positions of Hα objects of NGC 2264 in the colour magnitude diagram before and after the reduction are shown. From Fig. 2 it can be seen that in Fig. 1 most of the stars which are situated below the main sequence now appear above the main sequence, just at that place where we should find them according to their evolutionary phases in the pre-main sequence stage and according to the theory and where we find also stars without Hα emission (circles) but with position above the main sequence in the two colour diagram similiar to the Hα emission objects.

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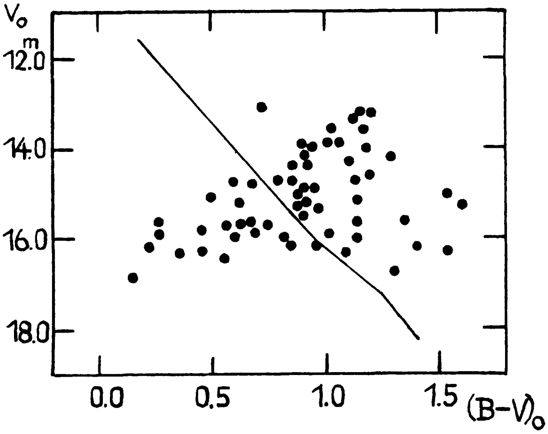

Figure 1. The position of Hα emission stars in the colour magnitude diagram of NGC 2264.

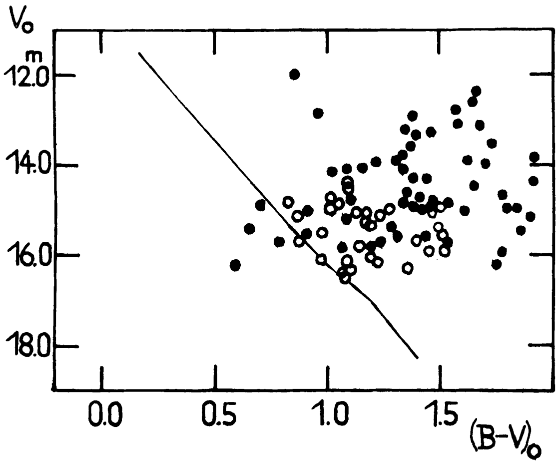

Figure 2. The position of Hα emission stars in the colour magnitude diagram after reducing the cosmogonic circumstellar effects.

Finally it should be mentioned that, as could be shown in a shell model, the circumstellar phenomena responsible for the discussed positions of T Tauri and Flare stars in the colour magnitude diagram are caused by the behaviour of the true shell parameters. These parameters are shell temperature, electron density, flux of Hα emission, specific fluxes in the X-ray and UV range originated by magnetobremsstrahlung, and the flux of dust radiation. They are all decreasing with increasing colour indices (U-V) and with increasing evolutionary phases in the pre-main sequence stage.

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MIRZOYAN: You have explained the existence of young red dwarf stars below the main sequence in the magnitude-colour diagram by the influence of circumstellar matter. In a paper by E. S. Parsamian and G.B. Ohanian in Astrofizika they showed that there are many flare stars in the Pleiades cluster that are located below the main sequence. This result does not seem to depend on circumstellar matter. What is the problem?

GÖTZ: If there is a dust shell around the stars there exists a light depression. In considering this effect the magnitudes become brighter. In the case that circumstellar matter is absent I cannot explain this problem.

LADA: There is another effect which can have the result of moving stars in NGC 2264 from below to above the main sequence, namely that there is variable extinction in the cluster. This cluster actually extends into a giant molecular cloud and many of the faint stars have appreciable extinction. When they are de-reddened properly, they do not lie below the main sequence.

GÖTZ: The circumstellar extinction, which was determined by star counts was considered in agreement with the strength of H-alpha emission.