AXIAL ROTATION OF BY DRA-TYPE STARS AND RELATED OBJECTS

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ABSTRACT. Periods of the rotational modulation of the brightness of BY Dra-type stars, Pleiades spotted stars, naked T Tau stars and T Tau-type stars are compared with absolute bolometric stellar magnitudes. Arguments are given that the majority of BY Dra-type stars have the age of 10**8 years and relatively fast as well as slowly rotating objects are met between them.

1. INTRODUCTION

In this paper the recent works on the search for rotational modulation of the brightness of young dwarf late-type stars are summarized. The aim is to study the difference in periods of the axial rotation between stars pf different ages with masses nearly equal to the mass of the Sun. Four groups of stars are selected. The names of stars are given in Table 1.

Table 1. Names of stars

BY Dra type: HD 1835, FF And, HD 8358, CC Eri, VY Ari, HD 22403, EI Eri, V833 Tau, V1005 Ori, AB Dor, OU Gem, YY Gem, YZ CMi, HD 82558, DH Leo, DK Leo, HD 91816, BF CVn, DF UMa, EQ Vir, ζ Boo A, HD 143313, TZ CrB, V722 Her, BY Dra, V815 Her, V775 Her, V478 Lyr, AU Mic, FK Aqr, EV Lac, BD-16°6218, KZ And, II Peg
Pleiades spotted: HII 34, 152, 296, 324, 335, 625, 686, 727, 739, 879, 882, 1124, 1332, 1531, 1883, 2034, 2244, 2927, 3163
Naked T Tau: HP Tau/G2, V410 Tau, V819 Tau, V826 Tau, V827 Tau, V830 Tau, V836 Tau, HD 283447, HD 283572
T Tau-type: RY Tau, T Tau, UX Tau A, BP Tau, DN Tau, AA Tau, DH Tau, DI Tau, SY Cha, LH_{α} 332-20, RY Lup, ROX 21, ROX 29

2. THE STARS AND THEIR PROPERTIES

2.1. BY Dra-type stars

In this group are included according to [1-10] 11 single stars and 23 spectroscopic binaries of spectral types from G to M which are believed to differ not significantly in luminosity from those of main sequence

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stars, although for several stars only spectroscopic luminosities are known. For a few exceptions the masses are thought to be in the range of 0.5–1 M⊙. It should be noted that 8 spectroscopic binaries have been classified as RS CVn stars in [6].

In contrast to the other stars considered here the BY Dra-type stars do not constitute a spatial group of common origin. Therefore the age should be estimated for each star separately. The unusually high eccentricity of the orbit of BY Dra itself, the rather large radius of its main component and the non-synchronism of axial and orbital rotation have been considered as evidence of an age of about 10**8 years [11–13]. Indications of youth are also the presence of H,K Ca II and H emission lines in the spectra and the high lithium abundance which has been found in the following 7 stars: HD 1835, VY Ari, V1005 Ori, AB Dor, HD 82558, Boo A, V815 Her, V478 Lyr [2, 7, 13–19]. According to the information contained in [20],21 of 22 BY Dra-type stars with known space velocities belong to young-disk population stars with ages not exceeding 5 10**8 years. Thus it is highly likely that for the majority if not all BY Dra type stars the age is of the order of 10**8 years.

2.2. Pleiades spotted stars

The rotational modulation of brightness has been discovered for 18 stars belonging to the Pleiades cluster [21–23]. Spectral types and masses are approximately the same as for BY Dra-type stars, the mass is about 0.8 M⊙. The age of the Pleiades cluster is about 10**8 years.

2.3. Naked T Tau stars

The complete list of these stars and evaluation of their ages (1–40) 10**6 years are given in [24]. Here are considered 9 stars showing the rotational modulation [25–29]. Their spectral types are G1–M0, masses may be approximately equal to 1 M⊙.

2.4. T Tau-type stars

The information on 13 T Tau-type stars which show the rotational modulation of the brightness may be found in [27, 28, 30–32]. According to [33] masses and ages of these 13 stars are less than 1.2 M0 and 5 10**6 years.

3. DISCUSSION

One can see from Figure 1 that the photometric periods of these stars do not depend on the absolute bolometric magnitude. Differences between the four groups of stars will be discussed further. Note that for each of the groups the largest value of the period does not exceed 8–10 days.

The mean values of the bolometric magnitude are 6.4 for BY Dra-type stars, 6.7 for Pleiades spotted stars, 4.1 for naked T Tauri stars and 3.8 for T Tau-type stars. The range of these values correspond to the

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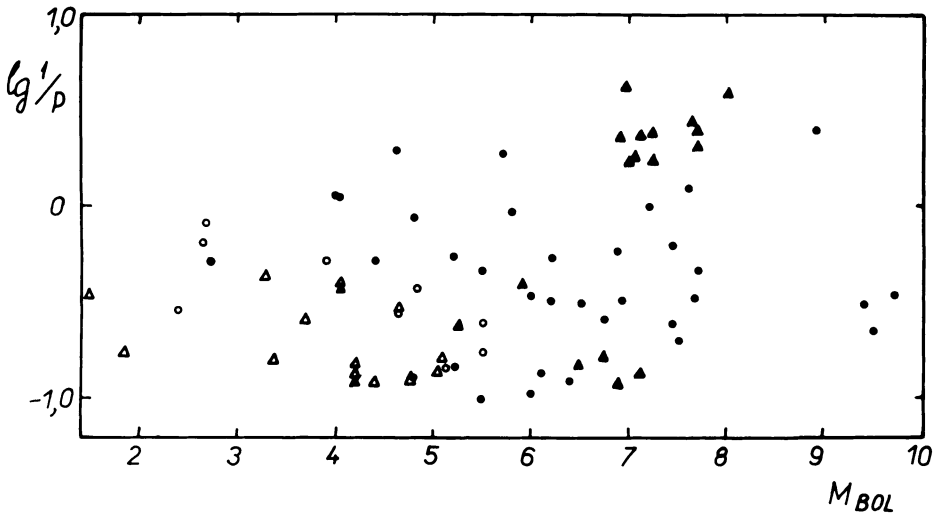

Figure 1. The relation between bolometric magnitudes and periods of stars. Filled circles=BY Dra-type stars, filled triangles= Pleiades spotted stars, open circles=naked T Tau stars, open triangles=T Tau-type stars.

evolutionary track of the 0.8 M⊙ star for 10**6 to 10**8 years. The agreement with estimated masses and ages of groups is rather good.

The differences of mean periods between the four groups are not large. The mean values of periods are 3.3 days for BY Dra-type stars, 2.65 days for Pleiades spotted stars, 3.4 days for naked T Tau stars, and 5.4 days for T Tau stars. However, within two groups the differences of extreme periods are striking: 0.5 days and 10 days for BY Dra-type stars, 0.24 days and 8 days for Pleiades spotted stars. One may suppose that the axial rotation of a star of 0.8 Mo changes drastically when its age is about 10**8 years. Such conclusion regarding the Pleiades spotted stars was drawn in [34]. On the other hand it is shown in this paper that for majority of BY Dra-type stars masses and ages are about 0.8 Mo, 10**8 years. Thus BY Dra-type stars as well as Pleiades spotted stars may be in the stage of evolution which is characterized by a strong change of the axial rotation. Partly the period differences within groups may be explained as an effect connected with the mass difference of stars entering the group. Probably the age of the star which exhibits the change of its period depends on the mass. The extreme periods are 2.3 days and 8.2 days for T Tau-type stars, 1.2 days and 6.99 days for naked T Tau stars.

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