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POSSIBLE RCB-STAR DY Per: THE CURRENT DECLINE WILL BE DEEP AND NEEDS OBSERVATIONS

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The carbon star DY Per is unique in its light variations. On the long-period variations (JDmax = 2438521+792×E) in the photographic R(0.63)-magnitude range between 9.0 and 10.5, fast light declines similar to those of RCB type stars are superimposed. Since 1963 seventeen cycles of the light variation of the star have been observed (Alksnis, Larionov, Larionova, Shenavrin 2002 and references therein).

During the cycles 1 - 5, 7 - 9 and 16 no fast declines were observed - the star was in a quiescent state. However, in each of the cycles 10, 14, 15, 17 the star exposed one light decline event (typical decline), rather similar to each other, with the minimum of about R(0.63)=12.2 mag at phases 0.5 - 0.55 of the long period variation. During the other cycles - 6th, 11th, and 12th - the deep declines with the R(0.63)-minima of about 14 - 15 mag at phases 0.6 - 0.8 were noticed. The cycle 13 was exceptional - very narrow and with the minimum at R(0.63)=13.0 mag and at the phase 0.64. The deep declines were poorly observed, and up to now we knew nothing of the shape of the light curve for their decline phases.

It seems now that the current decline event of DY Per, which began in early January this year at the phase 0.2 of the 18th cycle, will be a deep one. If so, it will be the first deep decline event of DY Per for which the light curve of the decline phase is documented (Fig. 1). In May-June it looked like the star had reached its minimum light R(0.63)=13.0 at the phase 0.48, slightly too early for the typical decline event, and its light started to recover. In July, however, a new decline event commenced, and at Aug 24 the star had faded down to R(0.63)=13.4, already about 1 mag below the level and slightly after the phase of minima for typical decline events.

Light curve of DY Per in photographic b-magnitude are scarcely covered (Fig. 2), partly because of moonlight and summer night sky brightness. However, it is evident that at faint brightness of the star - R(0.63)>12 mag, b>16 mag - the rate of light decline is significantly smaller in b-magnitude as in R(0.63). Therefore the star, when it is very faint, is significantly bluer than at other phases (Fig. 3), similarly as it is observed for some RCB stars (Rosenbush 1996).

Although light declines of DY Per resemble those of RCB variables, there are differences. Light decline rates of DY Per 0.02 - 0.05 mag/d are at the slower end of the range for typical RCB stars, 0.03 - 0.28 mag/d. Decline events of DY Per began at a specific phase of long-period variations, thus time intervals between RCB-type light declines are multiples of the cycle length 792 d. If DY Per is a variable of RCB-type, it is the coolest of them, and, possibly its 792 d cycle is the longest analogous to pulsational variation of RCB-stars which have periods between 40 and 100 days (Clayton 1996).

Using the MACHO project photometry database Alcock, Allsman, Alves et al. (2001) in the search for RCB-variables in the LMC discovered also four stars (named DY Per type stars), which in their light curve behaviour as well as spectroscopically resemble to DY Per. Light curves for each of the four DY Per type stars in the Large Magellanic Cloud show one light decline event (two for the star 15.10675.10) and pulsational variation from 116 d (the star 15.10675.10) up to 208 d (the star 78.6460.7) (Fig 4). Light decline- and recovery rates of the LMC DY Per type stars, however, are smaller than those of DY Per, decline event profiles are very asymmetrical, except for the star 15.10675.10. The most conspicuous difference between DY Per and LMC DY Per type stars seems to be the very high activity of DY Per. Almost every 792 d cycle from 12th to 17th, except 16th, possibly, pulsational cycles for this 3500 K cool star (Keenan and Barnbaum 1997), triggered the onset of light decline event for DY Per (Fig.4), as for V854 Cen in 1990-91 the pulsational cycle of 43 days (Lawson, Cottrell, Gilmore and Kilmartin 1992).

Keenan and Barnbaum (1997) discuss the spectrum of DY Per near maximum light in detail: it shows some characteristics of RCB-stars - the high-speed ejection of matter, hydrogen deficiency, however, moderate, but shows no evidence of high luminosity. They also find that DY Per has an effective temperature several hundred degrees cooler than those of the coolest known RCB variables.

There are few spectral observations of cool RCB stars in deep decline - the low resolution spectrum of U Aqr by Bond et al. (1979), and a high resolution spectrum of S Aps (spectral type R3) by Goswami et al. (1997).

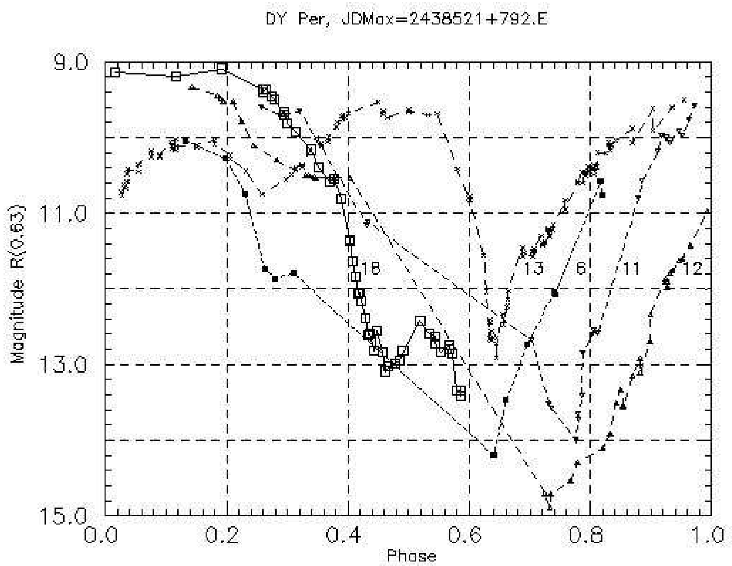

Figure 1. The light curve in the R(0.63) for the current decline event (cycle 18 - open squares) folded with the 792 d period, compared with the previously observed deep decline events in cycles 6 (full squares), 11 (reversed triangles), 12 (triangles) and with the unusual decline event in cycle 13 (crosses).

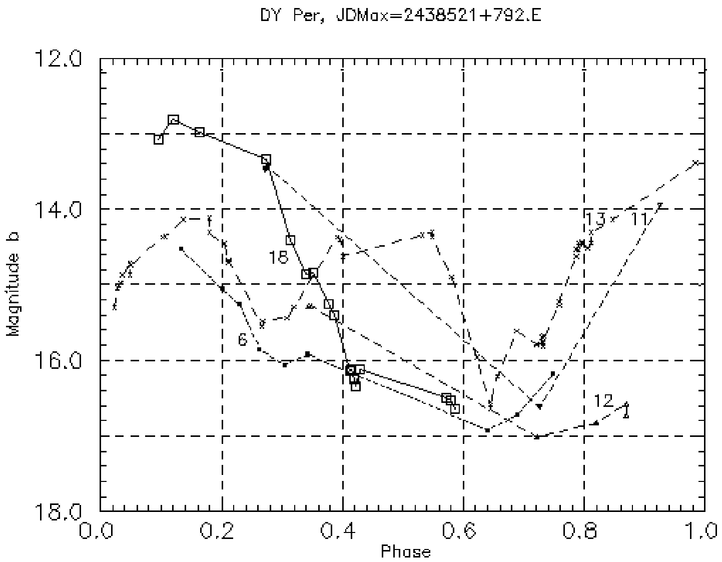

Figure 2. The same as in Fig. 1, but in blue light.

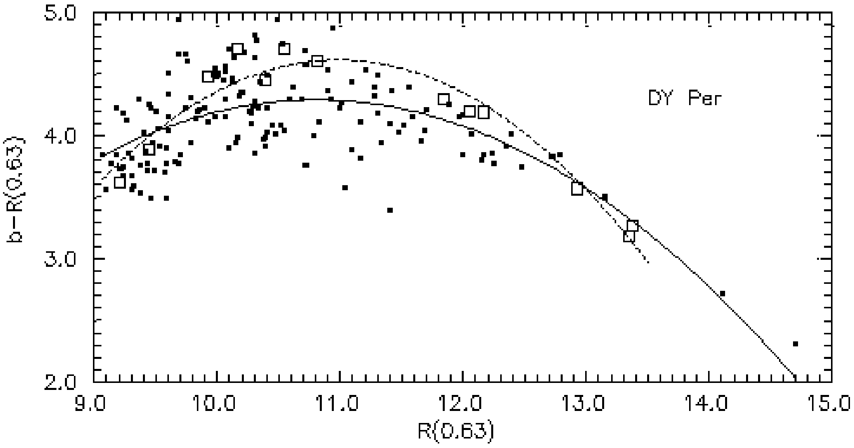

Figure 3. Color - magnitude diagram for the current decline of the cycle 18 (open squares), compared to the earlier data (full squares). Lines - second order polynomials.

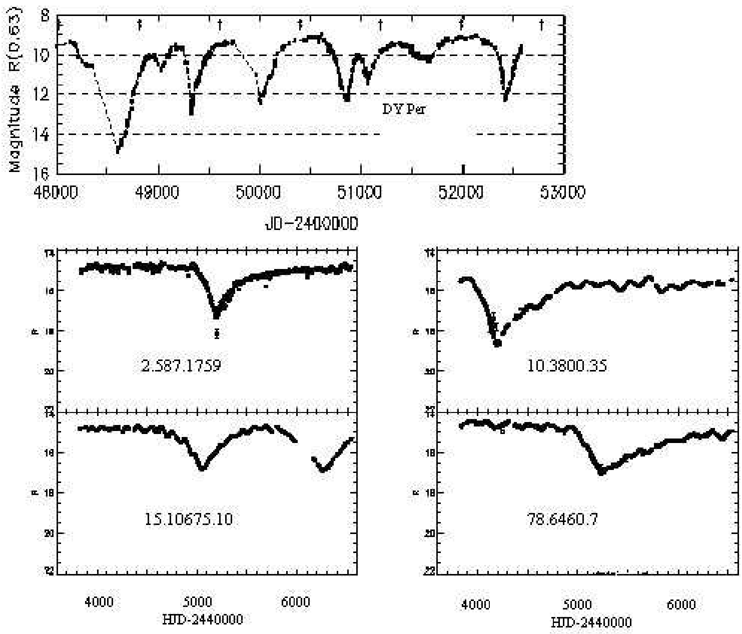

Figure 4. Red light curves of the four DY Per type stars in Large Magellanic Cloud after Alcock, Allsman, Alves et al. (2001) compared with that of DY Per. Time- and magnitude scales are nearly equal for all stars. Daggers mark time of maxima for the 792 d period variation of DY Per.

If we suppose that the recovery phase of the current decline event will be similar to those of the previous deep decline events, DY Per will stay at the present low (R(0.63)>13.4 mag, b>16.5 mag) or even lower light level at least for a couple of months. It would be very important to use the opportunity for the study of this state of the star by spectrographic, polarimetric and infrared observations to search at least for the reasons of the blueing of the star - presence of a companion which dominates the blue light near minimum (Alksnis and Jumike 1990), or bipolar flow, partly obscured by soot clouds as mentioned in the case of S Aps by Goswami et al. (1997).

References:

Alcock C., Allsman R.A., Alves D.R. et al. (The MACHO collaboration), 2001, *ApJ*, **554**, 298

Alksnis, A. and Jumike, Z., 1990, *Investigation of the Sun and Red Stars*, Riga, No. 33, 83

Alksnis, A., Larionov, V.M., Larionova, L.V. and Shenavrin, V.I., 2002, *Baltic Astronomy*, **11**, 487

Bond, H.E., Luck, R.E, and Newman, M.J., 1979, *ApJ*, **233**, 205

Clayton, G.C., 1996, *PASP*, **108**, 225

Goswami, A., Kameswara, Rao N., Lambert D.L., and Smith V.V., 1997, *PASP*, **109**, 270

Keenan P.C., Barnbaum C., 1997, *PASP*, **109**, 969

Lawson W.A., Cottrell P.L., Gilmore A.C. and Kilmartin P.M. 1992, *MNRAS*, **256**, 339

Rosenbush, A.E. 1996, *Astrophysics*, **39**, 78