LIGHT CURVE OF NOVAE IN THE "OUTBURST AMPLITUDE, ENVELOPE RADIUS" COORDINATES AS THE BASIS FOR THE CLASSIFICATION OF NOVAE ON TYPES

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ABSTRACT. The representation of light curves of novae in the "outburst amplitude, envelope radius" coordinates reveals the existence of five types of novae. In addition to the outburst amplitude and shape of the whole light curve, every type is possibly characterized by the shape of ejected envelope and some other common physical characteristics. The outburst amplitude in the range from 12 to 15^m in the DQ Her type is likely to depend on the inclination of the binary orbit and therefore on the inclination of the dust belt that reaches its maximum optical thickness on a distance of about 5.9×10^{14} cm. The dust condensation at a definite belt inclination can lead to a temporal increase of a nova visual light up to 2^m (V 1668 Cyg, DN Gem) at the transition instead of its decline.

Key words: Novae: light curves.

From the review of photometric and spectral development of novae we come to the conclusion that this development occurs on the scale of the ejected envelope radius more simple than on the time scale (Rosenbush 1996a) and this can be used for classification of novae (Rosenbush 1996b). The transition stage of a outburst on the scale of nova envelope radius always corresponds to the radius range (2.8-40)$\times10^{14}$ cm. If the dust condensation occurs at the transition, which takes place in a number of novae, this dust shell reaches its maximum optical thickness at a radius of about $(5.9\pm3)\times10^{14}$ cm. As a velocity of ejected envelope is often not known, the logarithmic time scale can be used: $\lg r = \lg t + \lg v_{exp}$. Hereafter we will use the lgt scale. We suggest to use the outburst amplitude as the basis of the second scale. Below we will attempt to summarize and to exploit these results, adding new data recently obtained.

The representation of light curves on these scales for about 50 of about 200 novae known to the present showed almost single distribution of them on 5 groups: CP Pup, GQ Mus, DQ Her with the subgroup of novae without dust, RR Pic, and PU Vul or symbiotic novae. It seems that symbiotic novae represent a transition from classic novae to symbiotic stars, i.e., to novae with a very small outburst amplitude: 5-6^m and less (V 1016 Cyg, HM Sge, etc.). It is possible that the neon novae of the V 1974 Cyg type form a separate group, but the visual light curve is similar to the DQ Her group, and additional IR light curve or spectral data are necessary for a certain classification. The necessity of separating the CP Lac subgroup from the DQ Her group is connected with certain pecularities: a more smooth light curve, the absence of dust, and a higher outburst amplitude than in the DQ Her group. It is quite possible that some recurrent novae with a smooth light curve are the prolongation of this subgroup toward low outburst amplitude.

In the first instance, the distinction of novae groups is the outburst amplitude (Table 1), and the shapes of light curves distinguish at the same amplitude. The proposed separation in types reflects also the distinction of other characteristics. Apparently an ejected envelope has unique observed shape typical for every group. Novae with very identical light curves are found within a group: RR Pic and V 4077 Sgr, PU Vul without temporal light decline and RR Tel. Therefore we may expect a likeness of other characteristics also, including the characteristics before the outburst.

One can also to determine the type of old novae only by their visual light curves. The type of modern novae is possible to define from the outburst amplitude already after first days of the outburst. Additional data (spectroscopy, IR photometry) help us to make certain selection in a doubtful case. This classification allows us to expect further behaviour of a nova with some range of confidence and therefore to plan our observations.

The dust condensation at the same radius of ejected envelope points to the equality of temperatures and luminosities of nova remnants. The existence of a common light curve on which a nova comes earlier or later, except for the GQ Mus group (the X-ray novae?), means the existence of a parameter that determines the whole outburst development. The outburst energy can be this parameter.

The comparison of nova visual light curves with the group typical curve gives us a possibility to estimate

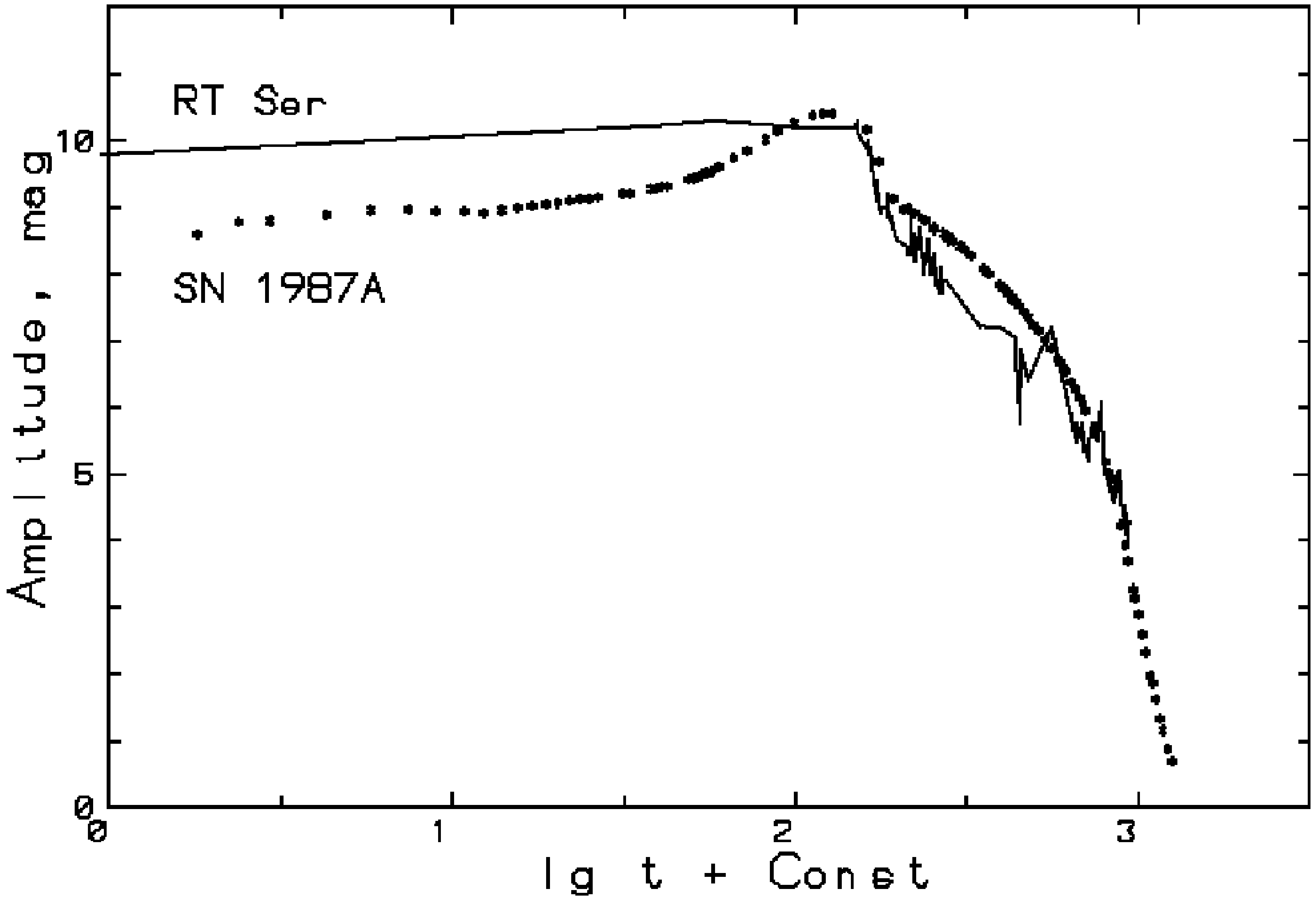

Figure 1. Light curve of RT Ser and SN 1987A. The ordinate is the outburst amplitude of SN 1987A.

the ejection velocity of the envelope.

The division of novae in groups by the outburst amplitude means also the absence of the "absolute magnitude, light decline rate" relation. It is associated rather with the outburst amplitude, the presence of heterogeneities in the envelope, and their orientation with respect to the line of sight. The DQ Her type novae with the smooth light curve at the transition stage have the outburst amplitude in the main higher than novae with the RCB type minimum. These minima are observed when the dust belt is oriented along the line of sight.

The brightness of a nova remnant is very likely to decline proportionally to lg t as well.

Table 1. Novae groups

Novae type	Amplitude outburst	Novae
DQ Her	$12 - 15^m$	with RCB minimum and/ or IR excess, DN Gem
CP Lac	15-18	V1500 Cyg, V446 Her
CP Pup	12-14.5	GK Per, V603 Aql, V476 Cyg, Q Cyg
GQ Mus (the X-ray novae?)	15-16	V351 Pup, EL Aql
	9.5-10.5	CT Ser,V1301Aql,V518 Per,V841Oph,V616 Mon
V1974 Cyg	14	V368 Aql,QU Vul V528 Aql, V693 CrA,
RR Pic	10-11	V1819 Cyg, HR Del, V4077 Sgr, N Cas 1995, DO Aql,PW Vul,V356 Aql
Symbiotic	7-8	RR Tel, RT Ser

For a further discussion on the use of this approach to the study of light curves of eruptive variables, we give a comparison of two objects unique in their way: RT Ser and SN 1987A (Fig.1). Some differences may be explained by pecularities of the energy distribution in the spectra of these objects because of the different energy categories.

References

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