SUPERNOVA 1989B IN M66: AN UNUSUAL TYPE I SUPERNOVA?

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Abstract

The visual light curve and absolute magnitude of SN 1989B are discussed.

In early 1989, the spiral galaxy M66 (NGC 3627) was probably one of the most intensively watched celestial objects. This was caused by an event spectacular in every galaxy - a supernova. Thanks to M66's favorable position during the first months of the year, the development of SN 1989B was followed by many observers worldwide. The aim of this work is to compare SN 1989B with other supernovae of its kind.

During the very first days after its discovery (Green 1989; Marsden 1989) something peculiar became clear: the supernova seemed to display an unusually faint maximum brightness (Figure 1). When SN 1989B was discovered, its brightness was still rising. Maximum was reached in a "plateau" lasting from February 2 to February 12, 1989, at magnitude V = 12.0 , B = 12.6.

The radial velocity given for M66 is 583 km s^{-1} (Hirshfeld and Sinnott 1985). This is just large enough to apply Hubble's relation for distance calculation. Taking the quite recent value of 67 km s^{-1} Mpc^{-1} (van den Bergh 1989) a distance of 8.7 Mpc is found. This value resembles results found by other methods (Burnham 1978). At that distance, however, SN 1989B should have become as bright as magnitude B=10.0, since normal Type I supernovae reach an absolute magnitude of M_B = -19.1. SN 1989B seemed to have reached a mere -17.1 magnitude instead.

The reason for this low luminosity may be interstellar reddening in M66 itself. Infrared observations indicated this earlier (Appleton and Robson 1989), but no quantitative details were given. A more helpful tool is the comparison of B-V color indices for both unreddened and reddened Type I supernovae during maximum. While normally B-V amounts to -0.1 magnitude shortly after maximum, a B-V of 0.6 magnitude was deduced for SN 1989B (Lavery 1989). With these two values it is now possible to calculate the true interstellar extinction within M66: using the empirical relation:

$$E = (3.1 \pm 0.1)\, E_{B-V} \qquad (1)$$

where E stands for the extinction found and E_{B-V} for the difference between reddened and unreddened color indices (Unsöld and Baschek 1988), 2.2 magnitude is found for SN 1989B. This is just the difference needed to compensate the observed low luminosity of about 2 magnitudes. Unfortunately there was only one single B-observation published — a rather weak support for this study.

What really makes SN 1989B unusual is the form of its light curve. Normally, Type I supernovae have a very similar brightness development. In fact, it is possible to

combine their light curves after having them corrected for their distances, into two mean light curves, for either a "fast" or a "slow" kind (Barbon *et al.* 1973).

SN 1989B, however, differs from both kinds of Type I supernovae. Normally, they take 25-40 days to decrease by 3 magnitudes. SN 1989 took 60 days, so it was considerably slower. To depict this, the light curves of SN 1989B and Type I supernovae have been overlayed in Figure 2. This figure also displays another major difference. In the case of SN 1989B, the so-called "point of inflection" is missing. At this point the decline suddenly becomes much shallower. SN 1989B's brightness is decreasing much more slowly than is typical for Type I supernovae.

The origin of SN 1989B's behavior is not yet known. It is not clear whether it was caused by any abnormal physical properties of the progenitor or a light-echo in the dust-rich vicinity of the supernova, which may also have "lifted" its brightness. The solution of these questions is beyond the task of this work. Here is where the amateur astronomer's work ends and where the professional's starts. My aim was to present an extensive light curve of SN 1989B obtained by the means of international cooperation. It once again shows how amateurs can supply valuable observations.

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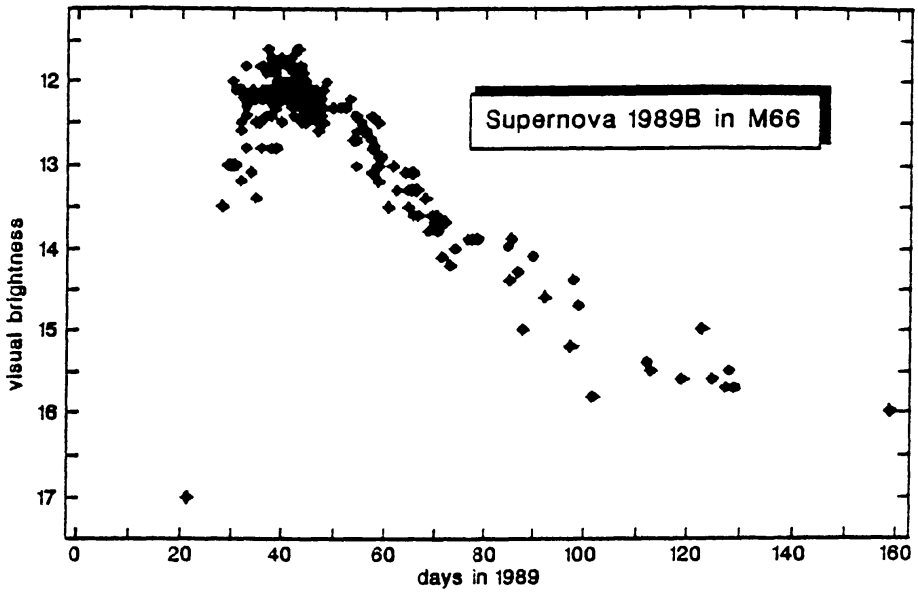

Figure 1. Visual light curve for SN 1989B based on data from papers by Korth (1989), Hurst (1989), Marsden (1989), and Green (1989).

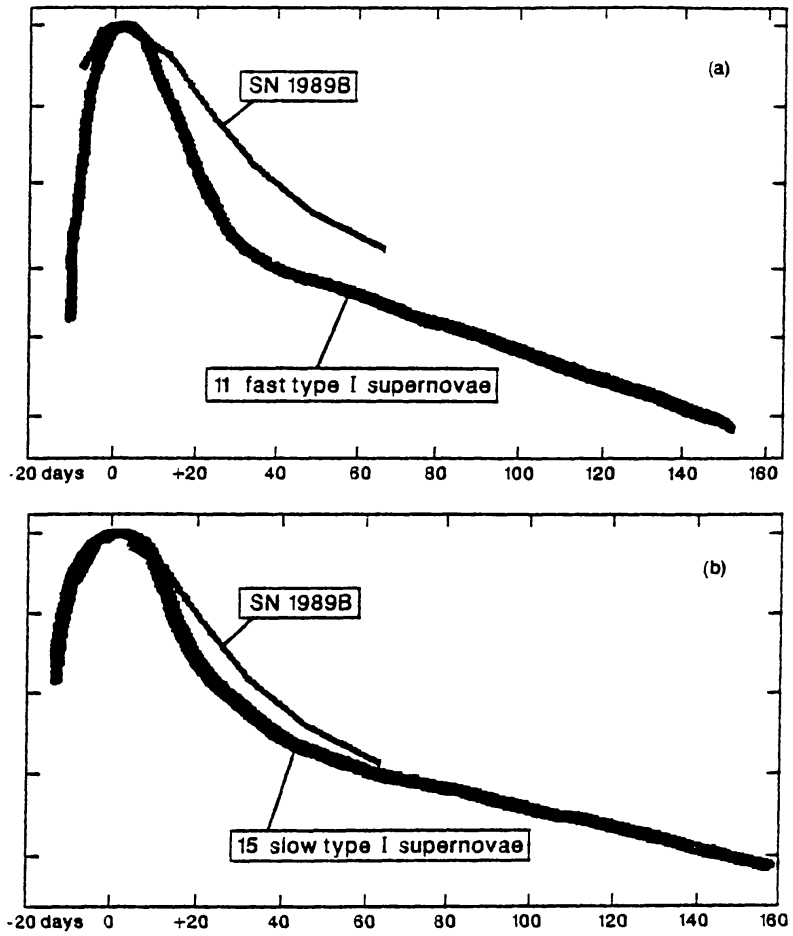

Figure 2. The smoothed light curve of SN 1989B compared with "fast" and "slow" Type I supernovae.