Individual Light Curve Fits of SN Ia and H_0

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1. Models for SN Ia

In order to study the question whether the appearance of SN Ia should be uniform from theoretical point of view, we present light curves (LC) for a broad variety of models using our elaborated LC scheme, including implicit LTE-radiation transport, expansion opacities, MC-γ transport, etc. For more details see Khokhlov (1991), Höflich *et al.* (1992), Höflich *et al.* (1993), Khokhlov *et al.* (1993), and Müller *et al.* (1993).

We consider a set of 19 SN Ia explosion models, which encompass all currently discussed explosion scenarios. The set consists of three deflagration models (DF1, DF1MIX, W7 $\circ$), two detonation models (DET1, DET2 $*$), two delayed detonation models (N21, N32 $\bullet$), detonations in low density white dwarfs (CO095, CO10, CO11 $\star$), six pulsating delayed detonation models (PDD3, PDD5-9 $\triangle$) and three tamped detonation models (DET2ENV2, DET2ENV4, DET2ENV6 $\triangle$). We also included the widely-used deflagration model W7 of Nomoto *et al.* (1984)

Different explosion models can be discriminated well by the slopes of the LCs and changes of spectral features (e.g. line shifts $\Rightarrow$ expansion velocities). The differences can be understood in terms of the expansion rate of the ejecta, the total energy release, the distribution of the radioactive matter, and the total mass and density structure of the envelope.

2. Comparison with Observations and H_0

We found that fast rising LCs (e.g. SN 1972e, SN 1981b, SN 1986g) can be explained by "delayed detonation" models. However, slow rising LCs (e.g. SN 1990n) require models which have formed a compact envelope of typically 0.2 to 0.4 $M_\odot$. Such envelopes can be produced by a pulsation phase during the explosion or by merging white dwarfs. Our interpretation is favored also from the expansion velocities observed in the spectra of the slow rising SN (Müller and Höflich, 1993). LCs from low-mass white dwarfs do not allow for a reasonable reproduction of any LC in our sample. The very peculiar SN 1991bg can be understood by a standard scenario for SN Ia but may be surrounded by a dusty region, or by pulsating delayed detonation models with little Ni (see in a forthcoming paper).

SN Ia should not be used as standard candles but the distances must be determined using the individual LC fits. From our fits, we find a value of 66 ± 10 km (s Mpc)$^{-1}$ for the Hubble constant within a 2σ error.

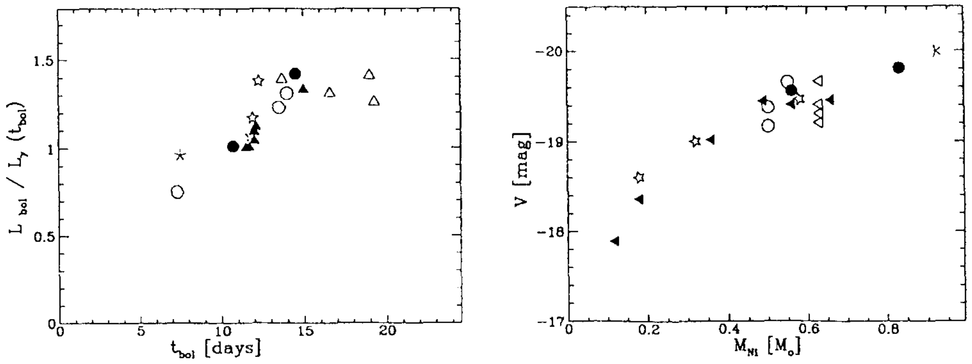

Figure 1. Maximum visual brightness V as a function of the Ni-mass (right) and ratio between bolometric luminosity and the γ-energy input at t_{max} (left). Note the small variation in V for Ni-masses less than $\approx 0.4 M_\odot$.

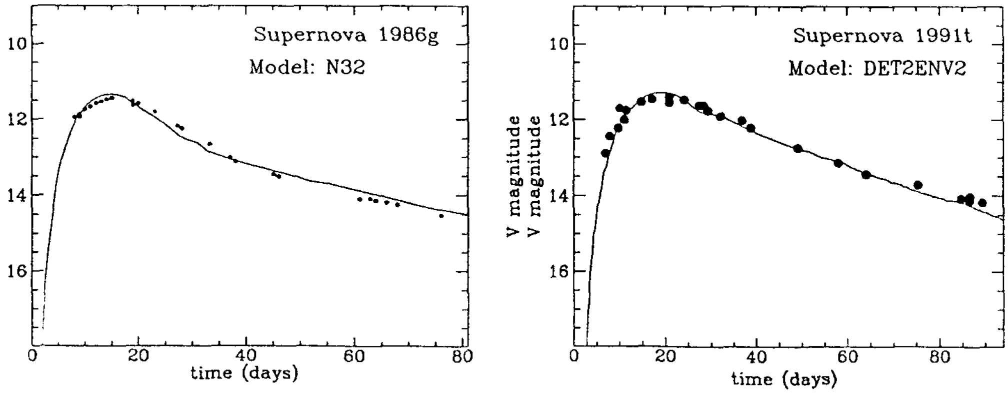

Figure 2. V light curves of SN 1986G (left) and SN 1991T (right) compared with the calculated light curve of the delayed detonation model N32 and the envelope model DET2ENV4, respectively.

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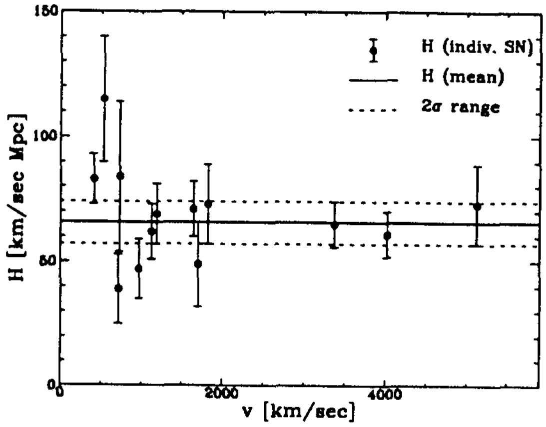

FIGURE 3. Hubble constants inferred by the distances derived for individual SNe. Note that the individual values for H_0 are inconsistent for $v_0 \leq 1000\text{km s}^{-1}$ because these SN Ia are not yet in the Hubble flow.

TABLE 1. Observed SN Ia for which sufficient monochromatic light curve data are available to allow for a discrimination of theoretical models. Columns 2 to 5 give the parent galaxy, the distance, the color excess according to our models, and the names of the models (see text) which can reproduce the observations within the error bars.

Supernovae	Galaxy	D[Mpc]	E_{B-V}	acceptable models
SN 1937C	IC 4182	4.8 ± 1	0.10	N32,W7, DET2
SN 1970J	NGC 7619	66 ± 8	0.01	DET2ENV4/2, (PDD3)
SN 1971G	NGC 4165	35 ± 9	0.0	N32, DET2, W7
SN 1972E	NGC 5253	4.8 ± 0.4	0.03	N21
SN 1972J	NGC 7634	52 ± 8	0.01	N32, W7, DET2, DF1
SN 1973N	NGC 7495	70 ± 20	0.10	N32, W7
SN 1974G	NGC 4414	18.5 ± 5	0.0	N32, W7, DET2
SN 1975N	NGC 7723	25 ± 7	0.32	PDD3/5,DET2ENV2
SN 1981B	NGC 4536	23 ± 4	0.05	N21
SN 1983G	NGC 4753	18 ± 4	0.30	N32, W7
SN 1984A	NGC 4419	17 ± 4	0.24	DET2ENV2, PDD3/5
SN 1986G	NGC 5128	4.6 ± 1.2	0.90	N32, W7
SN 1989B	NGC 3627	8.3 ± 3	0.60	N32, W7
SN 1990N	NGC 4639	21 ± 5	0.01	DET2ENV2/4, PDD3
SN 1991T	NGC 4527	12 ± 2	0.01	PDD3/5, DET2ENV2
SN 1991BG	NGC 4374	23 ± 6	(0.68)[1]	N32, DET2, W7

[1] see text