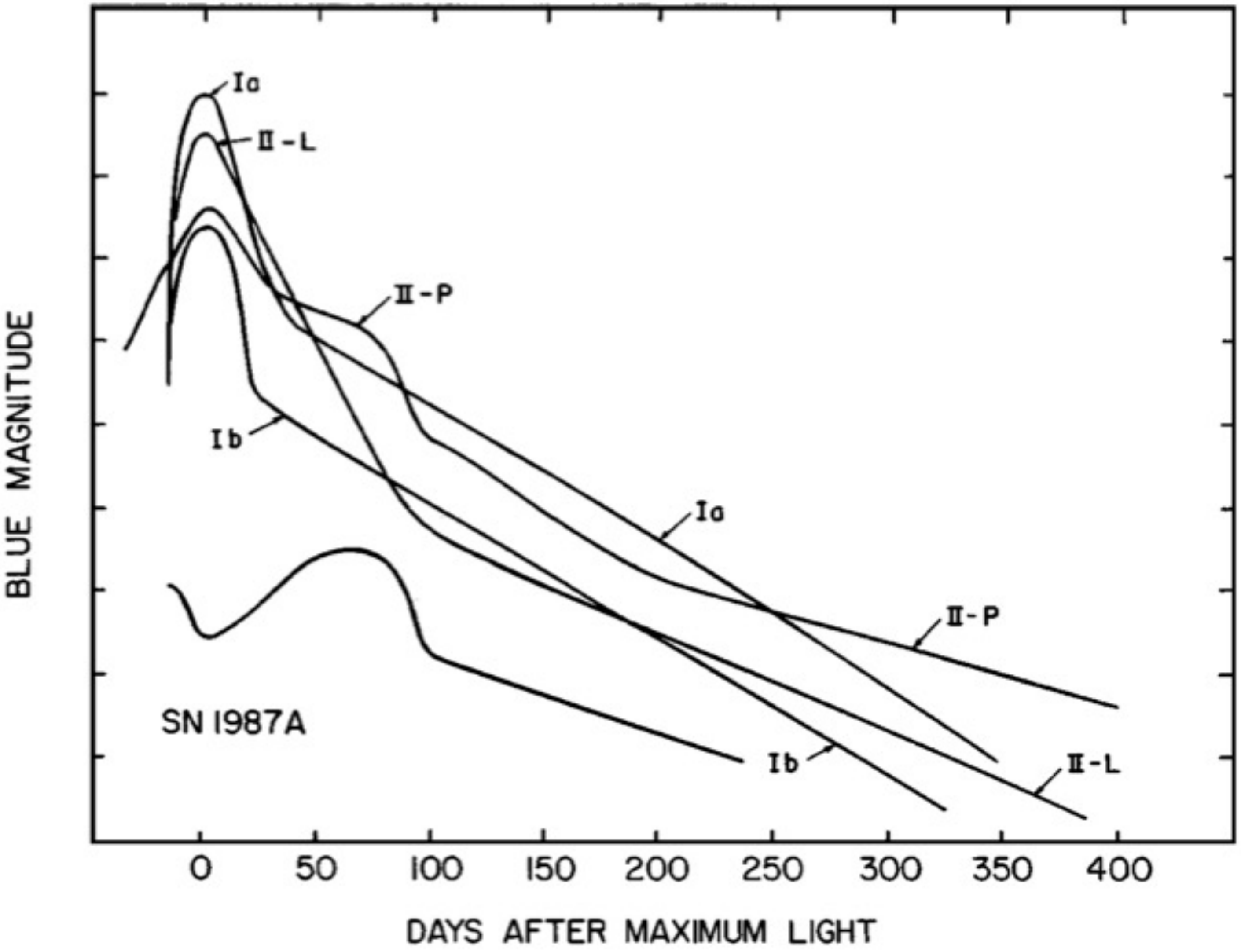
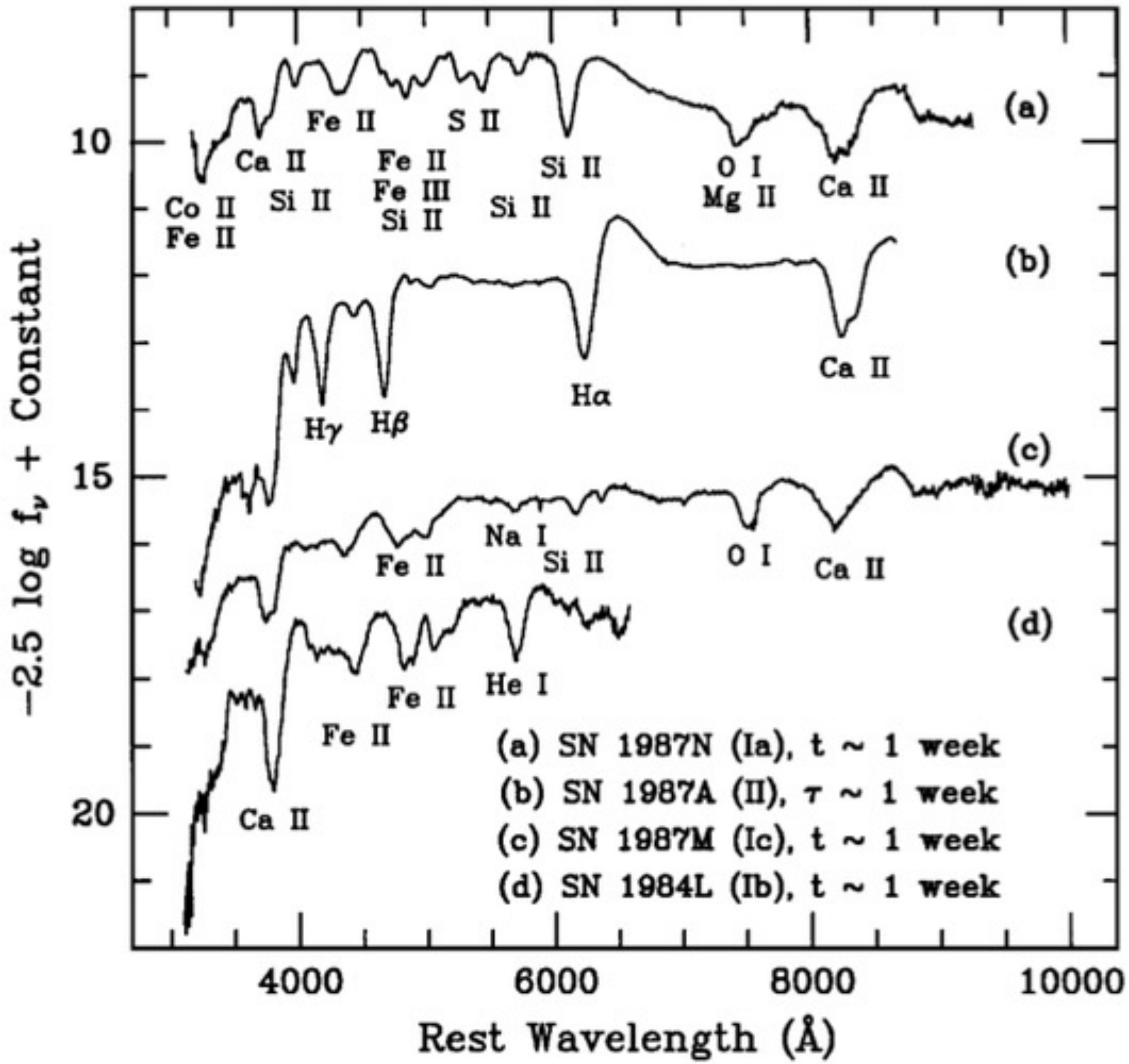
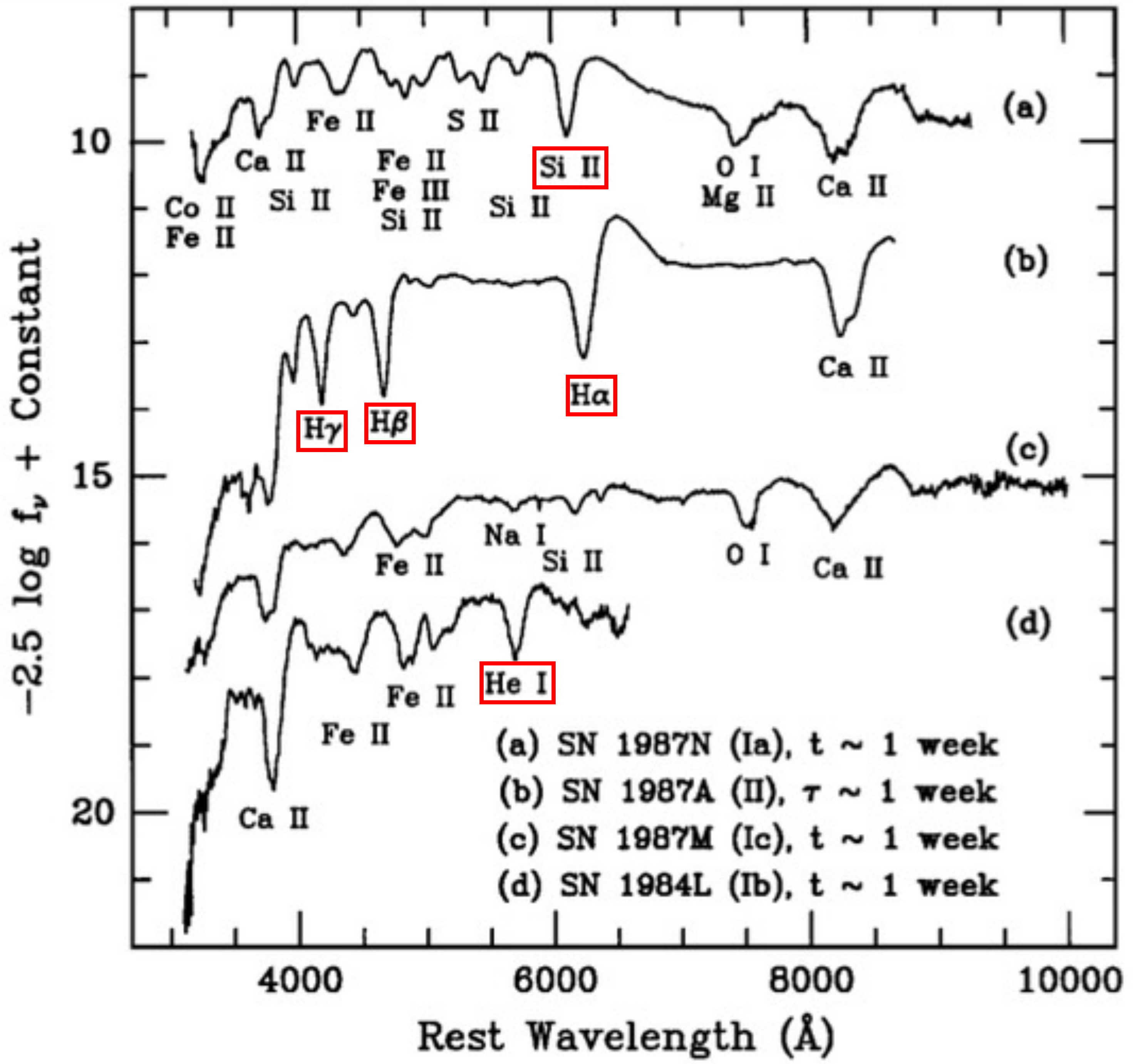


Figure 3 Schematic light curves for SNe of Types Ia, Ib, II-L, II-P, and SN 1987A. The curve for SNe Ib includes SNe Ic as well, and represents an average. For SNe II-L, SNe 1979C and 1980K are used, but these might be unusually luminous.

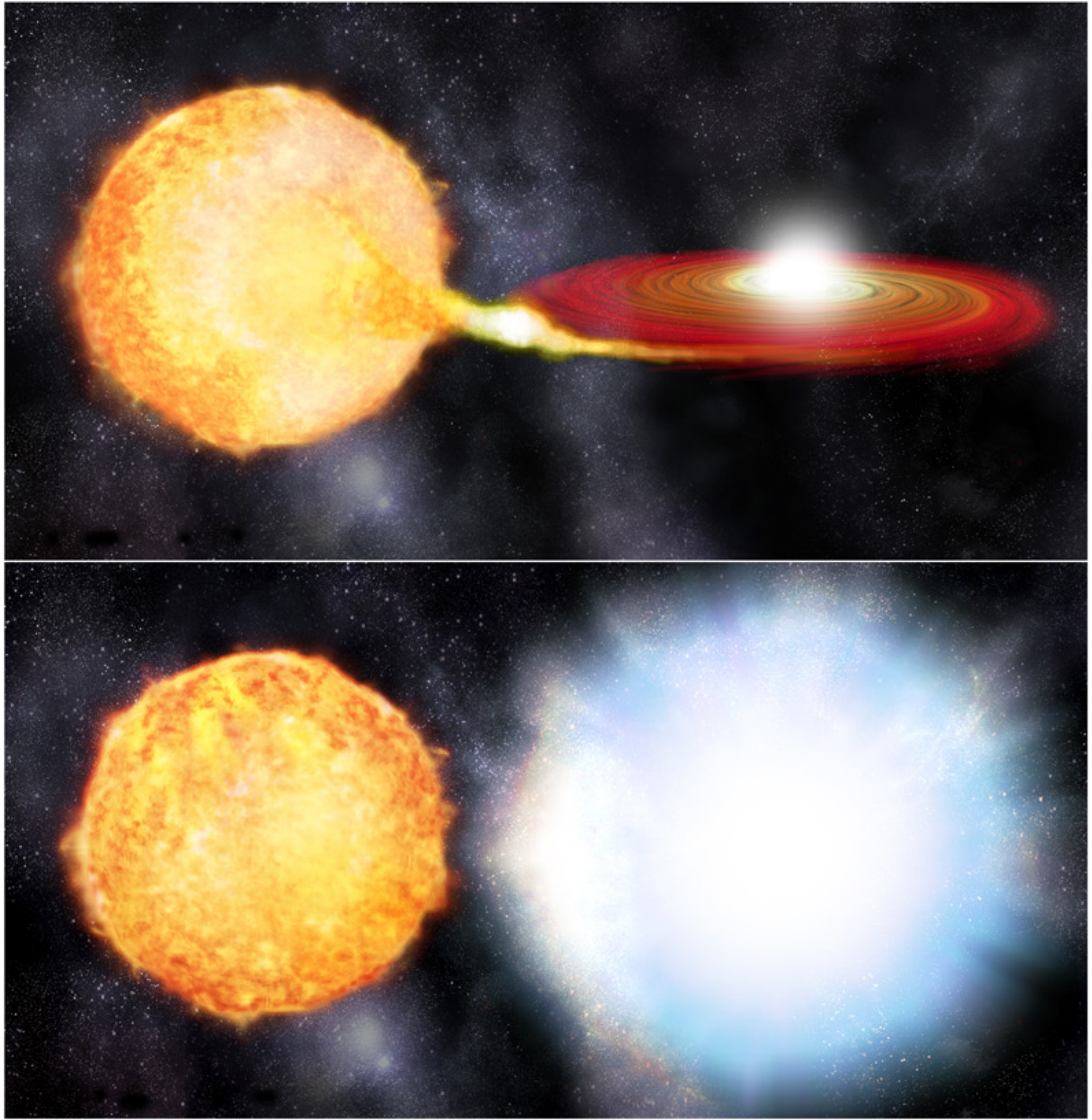
Figure Credit: Wheeler, J. C., & Harkness, R. P. 1990, RPPh, 53, 1467



−2.5 log f$_\nu$ + Constant
10
15
20
4000
6000
8000
10000
Rest Wavelength (Å)
(a)
(b)
(c)
(d)
Co II
Fe II
Ca II
Si II
Fe II
Fe II
Fe III
Si II
S II
Si II
Si II
O I
Mg II
Ca II
Hγ
Hβ
Hα
Ca II
Fe II
Na I
Si II
O I
Ca II
Fe II
Fe II
He I
Ca II
(a) SN 1987N (Ia), t ~ 1 week
(b) SN 1987A (II), τ ~ 1 week
(c) SN 1987M (Ic), t ~ 1 week
(d) SN 1984L (Ib), t ~ 1 week



(a)
(b)
(c)
(d)
Fe II
S II
Ca II
Fe II
Fe III
Si II
Si II
O I
Mg II
Ca II
Co II
Fe II
Si II
Si II
Hγ
Hβ
Hα
Ca II
Na I
Fe II
Si II
O I
Ca II
He I
Fe II
Fe II
Ca II
(a) SN 1987N (Ia), t ~ 1 week
(b) SN 1987A (II), τ ~ 1 week
(c) SN 1987M (Ic), t ~ 1 week
(d) SN 1984L (Ib), t ~ 1 week
−2.5 log f_ν + Constant
10
15
20
4000
6000
8000
10000
Rest Wavelength (Å)



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Chandrasekhar limit

From Wikipedia, the free encyclopedia

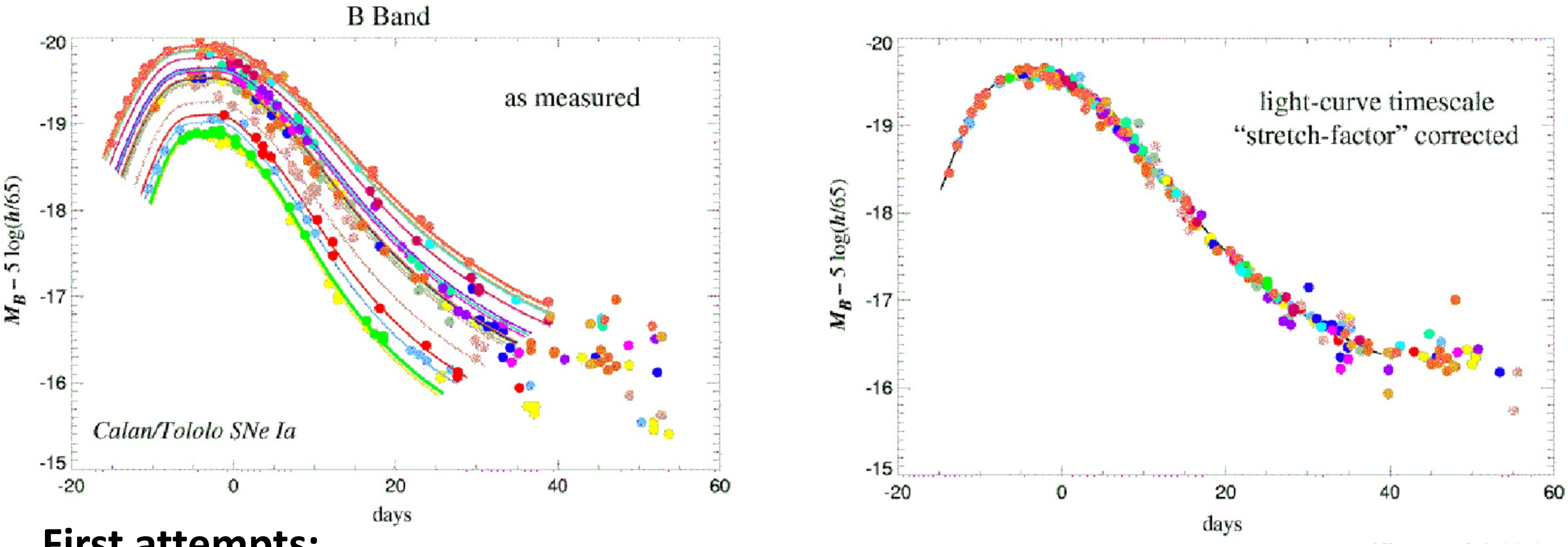
The **Chandrasekhar limit** (/tʃʌndrəˈseɪkər/) is the maximum mass of a stable white dwarf star. The currently accepted value of the Chandrasekhar limit is about 1.4 $M_\odot$ (2.765 × 10^{30} kg).[1][2][3]

White dwarfs resist gravitational collapse primarily through electron degeneracy pressure, compared to main sequence stars, which resist collapse through thermal pressure. The Chandrasekhar limit is the mass above which electron degeneracy pressure in the star's core is insufficient to balance the star's own gravitational self-attraction. Consequently, a white dwarf with a mass greater than the limit is subject to further gravitational collapse, evolving into a different type of stellar remnant, such as a neutron star or black hole. Those with masses up to the limit remain stable as white dwarfs.[4] Tolman–Oppenheimer–Volkoff limit is theoretically a next level to reach in order for a neutron star to collapse into a denser form such as a black hole.

The limit was named after Subrahmanyan Chandrasekhar. Chandrasekhar improved upon the accuracy of the calculation in 1930 by calculating the limit for a polytrope model of a star in hydrostatic equilibrium, and comparing his limit to the earlier limit found by E. C. Stoner for a uniform density star. Importantly, the existence of a limit, based on the conceptual breakthrough of combining relativity with Fermi degeneracy, was indeed first established in separate papers published by Wilhelm Anderson and E. C. Stoner in 1929. The limit was initially ignored by the community of scientists because such a limit would logically require the existence of black holes, which were considered a scientific impossibility at the time. The fact that the roles of Stoner and Anderson are often overlooked in the astronomy community has been noted.[5][6]

Contents [hide]

Physics [edit]



First attempts:

(1) Philips relation: $M_{\max} \propto \Delta m_{15}$ [Philips, M. M.; ApJ 413, L105 (1993)]

(2) $M_{\max} = a + b\,(\Delta m_{15}(B) - 1.1)$

B-band: $a = -19.256 \pm 0.053$
$b = 0.86 \pm 0.21$

[Hamuy, M., *et al.*; AJ 112, 2391 (1996)]

Distance modulus:

$$\mu \equiv m - M = 5\lg\left(d_L[10\ \mathrm{pc}]\right)$$

$$m - \overline{M} - b \cdot \Delta m_{15}(B) = 5\lg\left(\frac{c}{H_0}[10\ \mathrm{pc}]\right) + 5\lg\left((1+z)\int_0^z \frac{\mathrm{d}z'}{E(z')}\right)$$

Physics Nobel Prize 2011

Saul Perlmutter | Brian P. Schmidt | Adam G. Riess

The Nobel Prize in Physics 2011 was divided, one half awarded to Saul Perlmutter, the other half jointly to Brian P. Schmidt and Adam G. Riess "for the discovery of the accelerating expansion of the Universe through observations of distant supernovae".

Perlmutter, S., *et al.*; ApJ 517, 2, 565 (1999)

Riess, A. G., ..., Schmidt, B. P., *et al.*; AJ, 116, 3, 1009 (1998)

Distance modulus:

$$\mu \equiv m - M = 5\,\mathrm{lg}\left(d_L[10\ \mathrm{pc}]\right)$$

$$m - \overline{M} - b \cdot \Delta m_{15}(B) = 5\,\mathrm{lg}\left(\frac{c}{H_0}[10\ \mathrm{pc}]\right) + 5\,\mathrm{lg}\left((1+z)\int_0^z \frac{\mathrm{d}z'}{E(z')}\right)$$

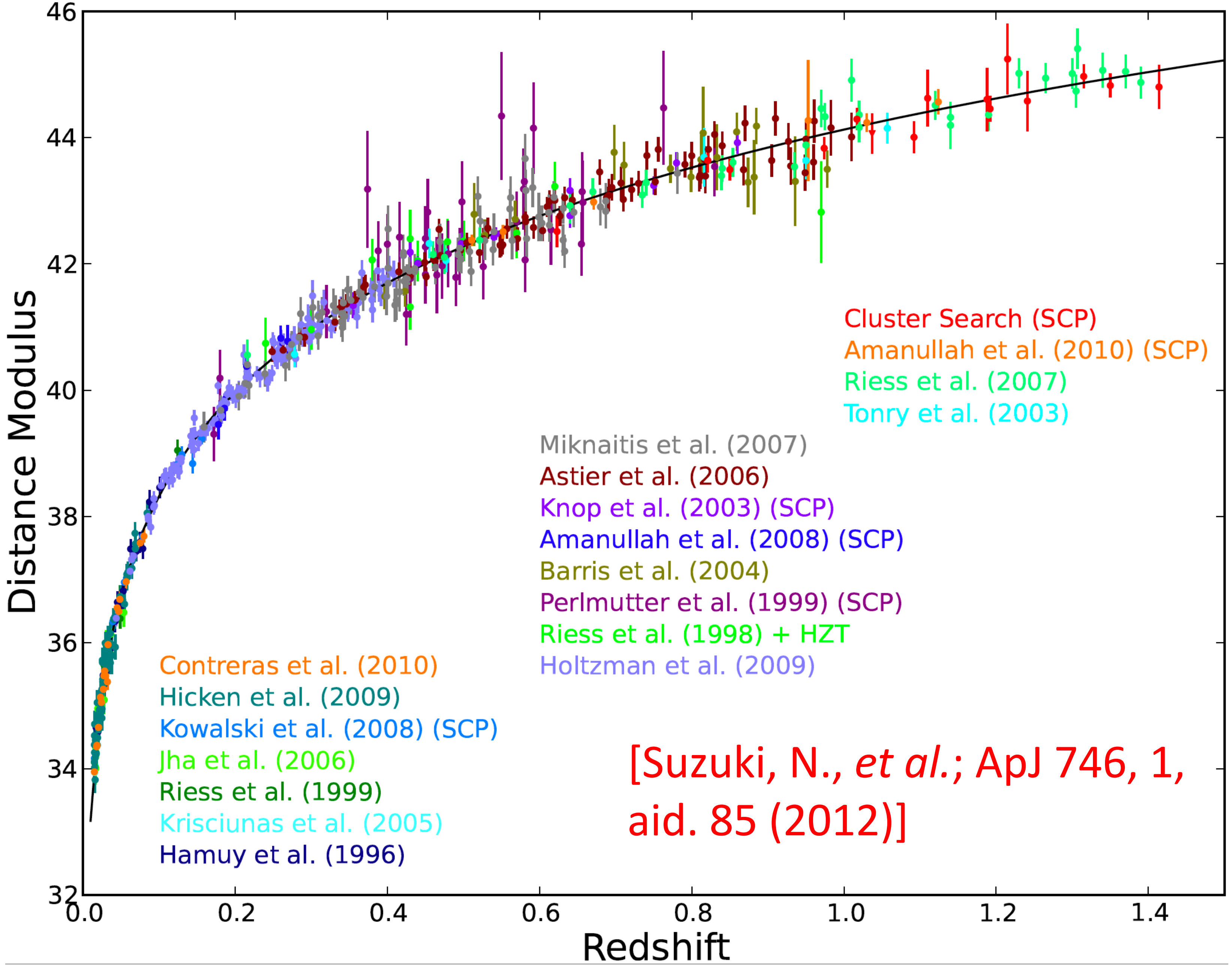
$$\mu_{\mathrm{SN}} = m_B^{\mathrm{max}} + \alpha \cdot x_1 - \beta \cdot c + \delta \cdot P - M_B$$

x_1 (stretch) – the deviation of the SN Ia lightcurve from the average lightcurve shape

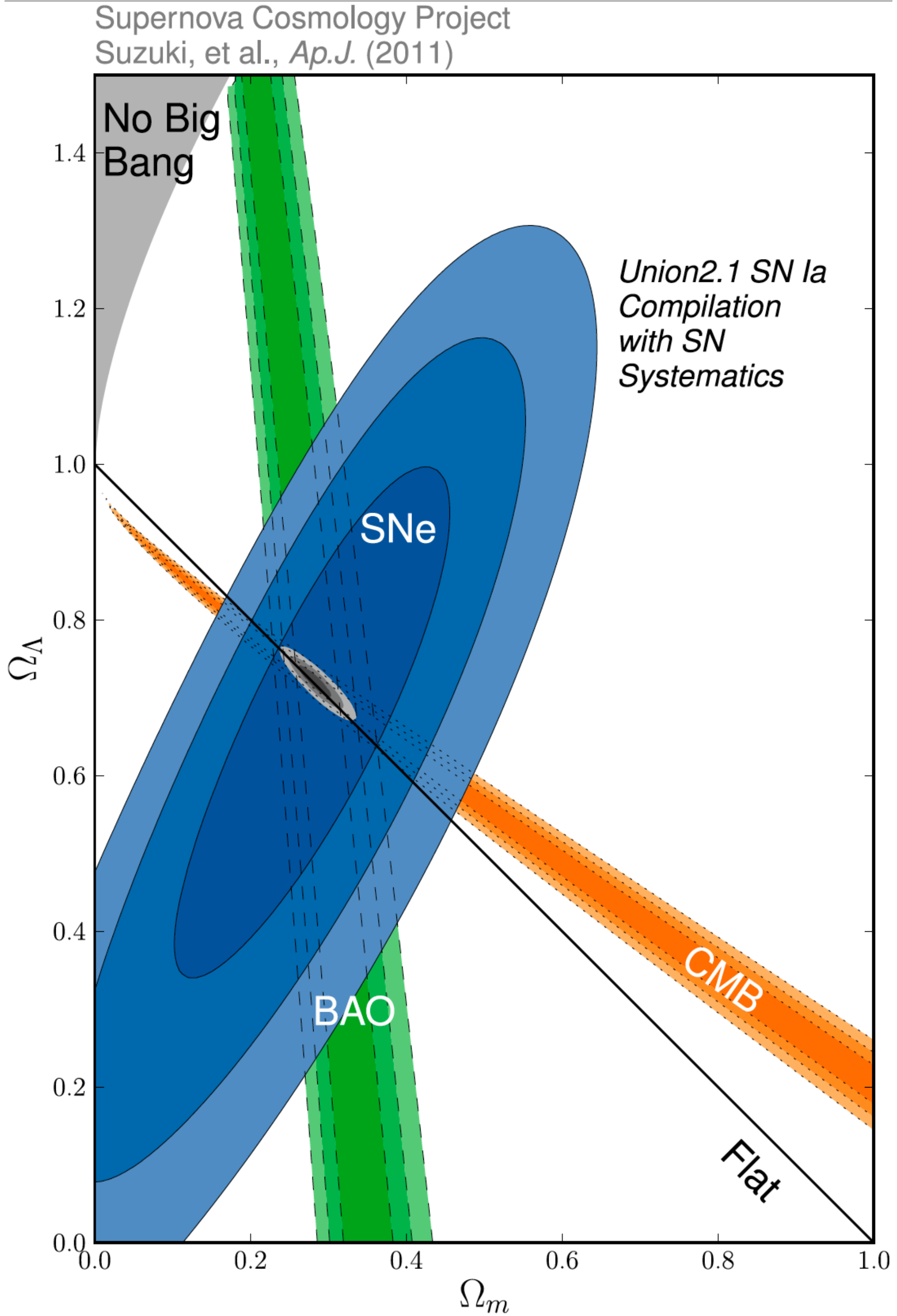
c (color) - the deviation of the SN Ia *(B-V)* color from the mean SN Ia *(B-V)* color

$P(m_*^{true} < m_*^{threshold})$ – the probability that the host galaxy belongs in a low-host-mass category

e.g. using 580 SN Ia from the *Union 2.1* data compilation of the *Supernova Cosmology Project* [Suzuki, N., *et al.*; ApJ 746, 1, aid. 85 (2012)]



Distance Modulus
Redshift
46
44
42
40
38
36
34
32
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Cluster Search (SCP)
Amanullah et al. (2010) (SCP)
Riess et al. (2007)
Tonry et al. (2003)
Miknaitis et al. (2007)
Astier et al. (2006)
Knop et al. (2003) (SCP)
Amanullah et al. (2008) (SCP)
Barris et al. (2004)
Perlmutter et al. (1999) (SCP)
Riess et al. (1998) + HZT
Holtzman et al. (2009)
Contreras et al. (2010)
Hicken et al. (2009)
Kowalski et al. (2008) (SCP)
Jha et al. (2006)
Riess et al. (1999)
Krisciunas et al. (2005)
Hamuy et al. (1996)
[Suzuki, N., *et al.*; ApJ 746, 1, aid. 85 (2012)]



[Suzuki, N., *et al.*; ApJ 746, 1, aid. 85 (2012)]

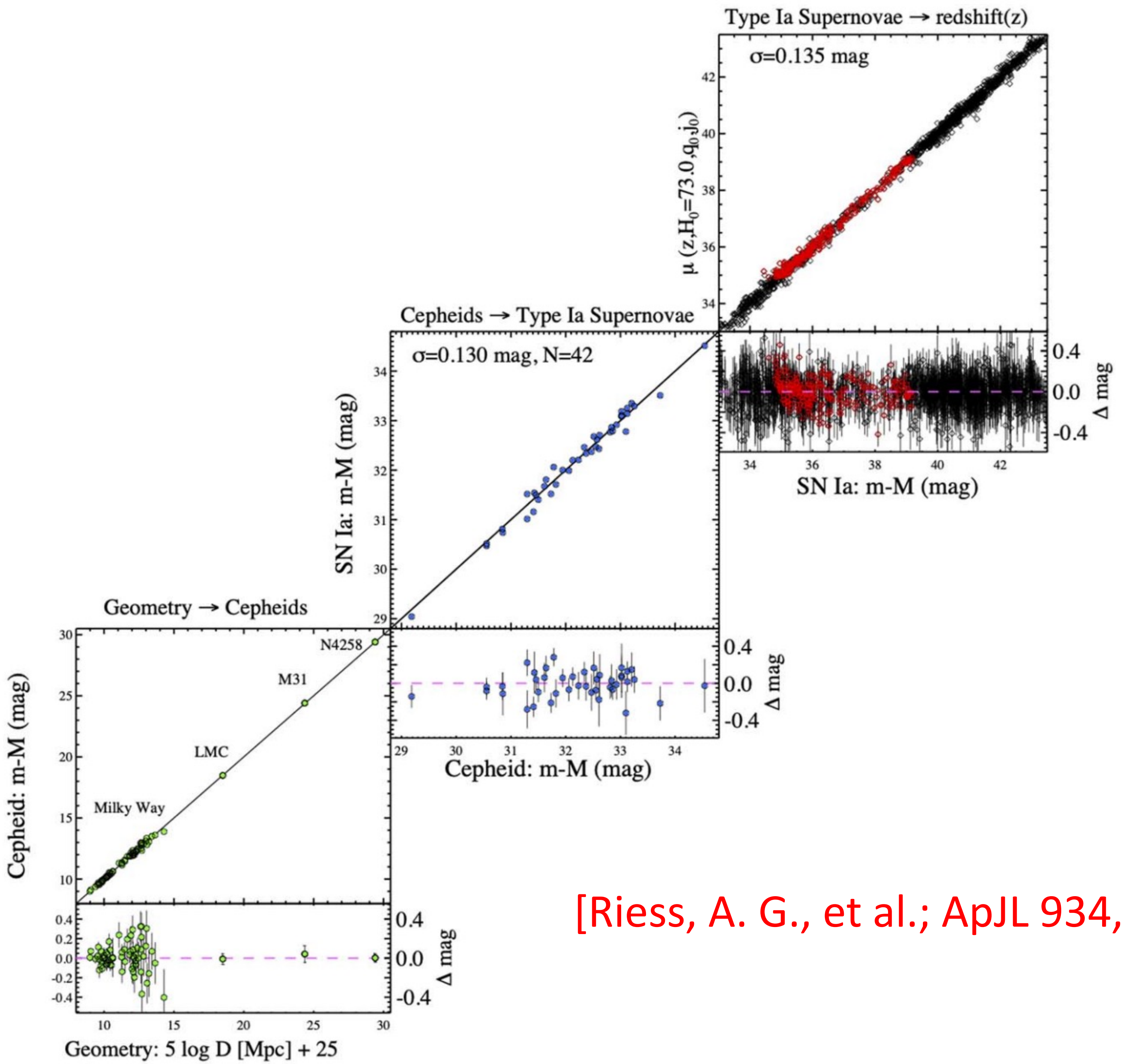
Other most recent SN Ia datasets:

SH0ES - Riess, A. G., et al.; ApJ 853, 2, 126 (2018)

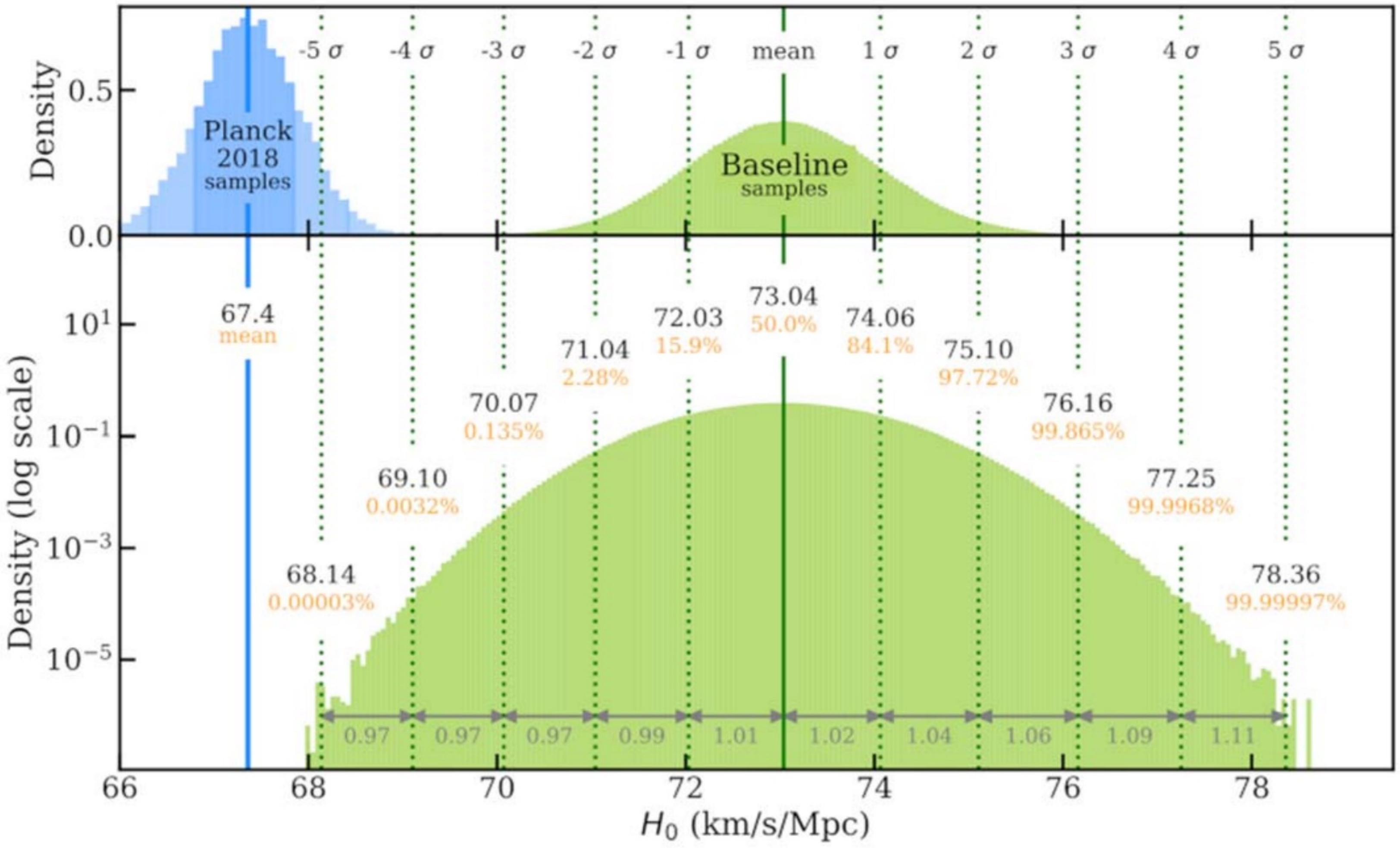
Pantheon - Scolnic, D. M., et al.; ApJ 859, 2, 101 (2018)

Pantheon+ - Scolnic, D. M., et al.; ApJ 938, 2, 113 (2022)

Jones et al. - Jones, D. O., et al.; ApJ 857, 1, 51 (2018)



[Riess, A. G., et al.; ApJL 934, 1, L7 (2022)]

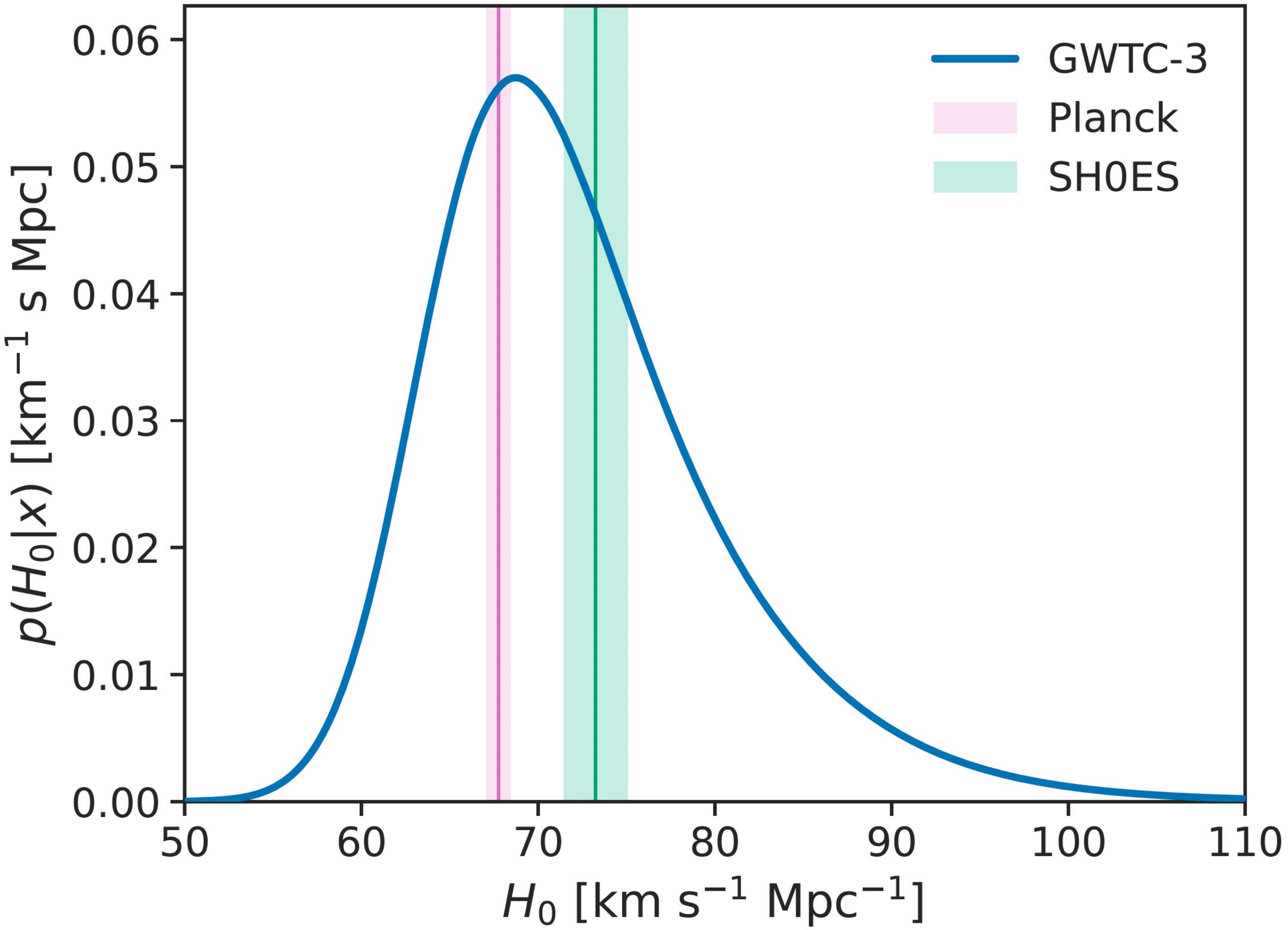


[Riess, A. G., et al.; ApJL 934, 1, L7 (2022)]

The Hubble tension (or Hubble crisis?)

[Riess, A. G.; Nature Reviews Physics 2, 1, 10 (2020)]

Measuring H_0 from gravitational-wave standard sirens



[The LVC, ApJ 949, 76 (2023)]