Сверхновые: Общие Сведения

“Nova star” in the Andromeda Nebula

31 августа 1885 г. на обсерватории в г. Тарту астроном Э. Гартвиг обнаружил новую звезду около ядра туманности Андромеды M31.

Ernst Hartwig (1851–1923)

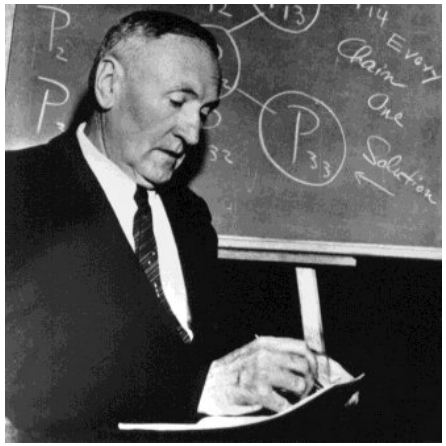
Edwin Hubble (1889–1953)

- Extragalactic nature of "nebular objects" (1920–1933).
- The expanding universe — "Hubble's law" (1929).

Robert Gendler (2002)

W. Baade and F. Zwicky

Walter Baade (1893–1960)



Fritz Zwicky (1898–1974)

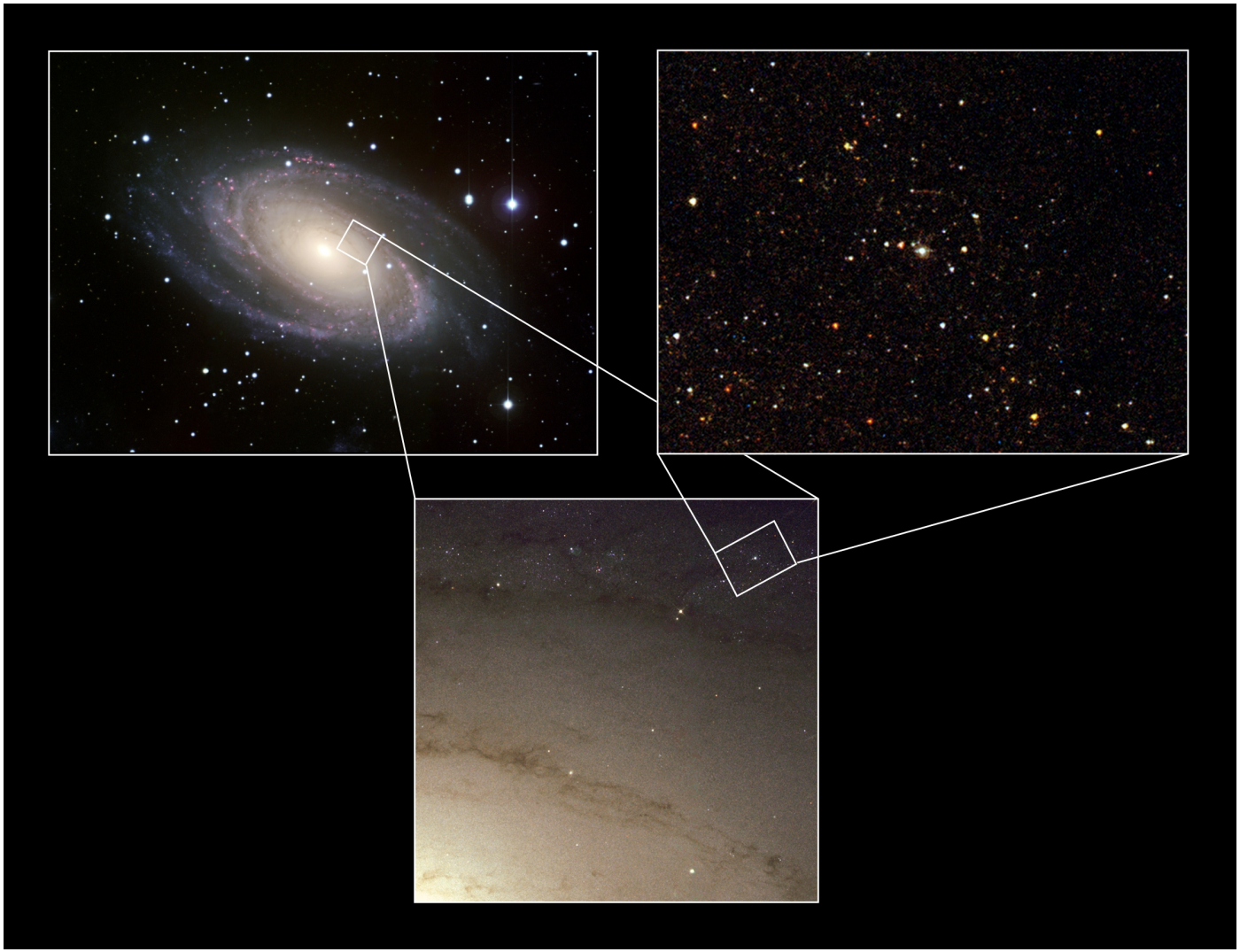
Zwicky (1940):
Baade and I first introduced the term "supernovae" in seminars and in a lecture course on astrophysics at the California Institute of Technology in 1931.

Обозначение: SN 1054, SN 1987A, SN 2000aa
Признак: $L \geq 10^{41}$ эрг/сек

Baade & Zwicky (1934):

> In addition, the new problem of developing a more detailed picture of the happenings in a super-nova now confronts us. With all reserve we advance the view that a super-nova represents the transition of an ordinary star into a *neutron star*, consisting mainly of neutrons. Such a star may

Supernova 1993J in the Galaxy M81



Maund et al. (2004)

Supernova 1994D in the Galaxy NGC 4526

High-Z Supernova Search Team, HST, NASA (1998)

Supernova 2005cs in the Galaxy M51

GaBany (2005)

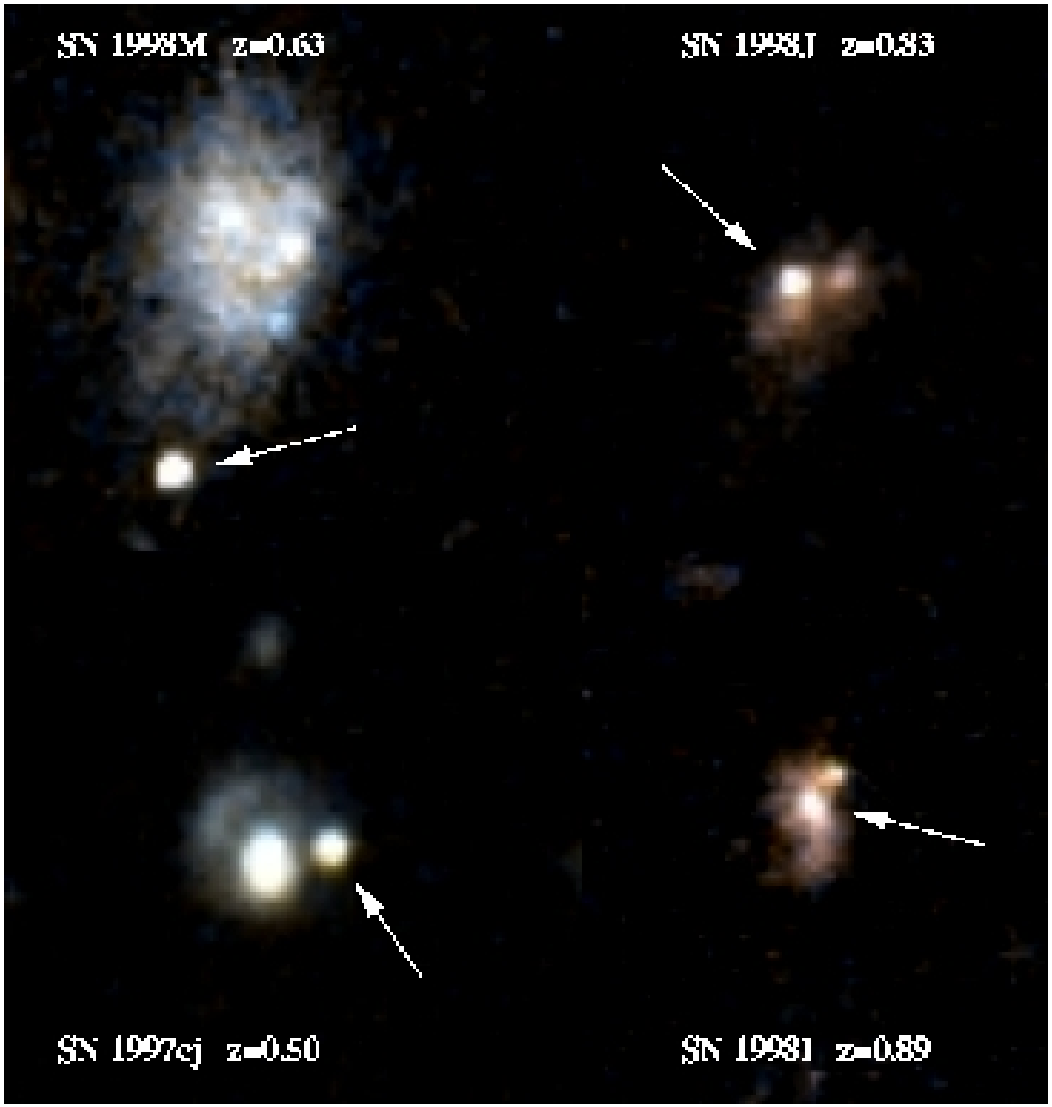
The Hubble Space Telescope (1990, 2.4 meter)

STS-103, STScI, ESA, NASA (2001)

The Hubble Deep Field

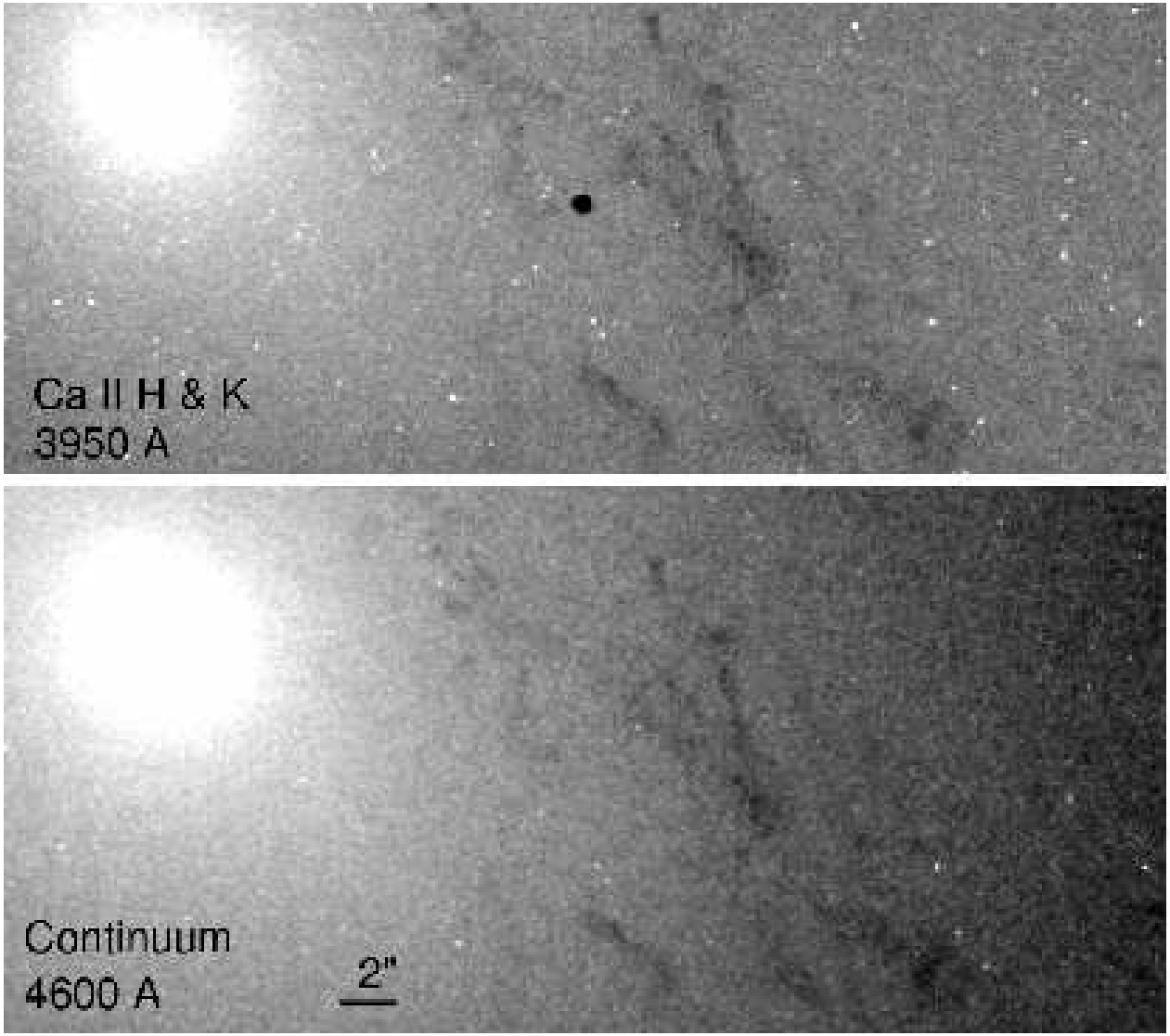
Williams, The HDF Team, NASA (2002)

The Year of Distant Supernovae



High-Z Supernova Search Team, HST, NASA (1998)

Presence of SN 1885 Remnant in galaxy M31

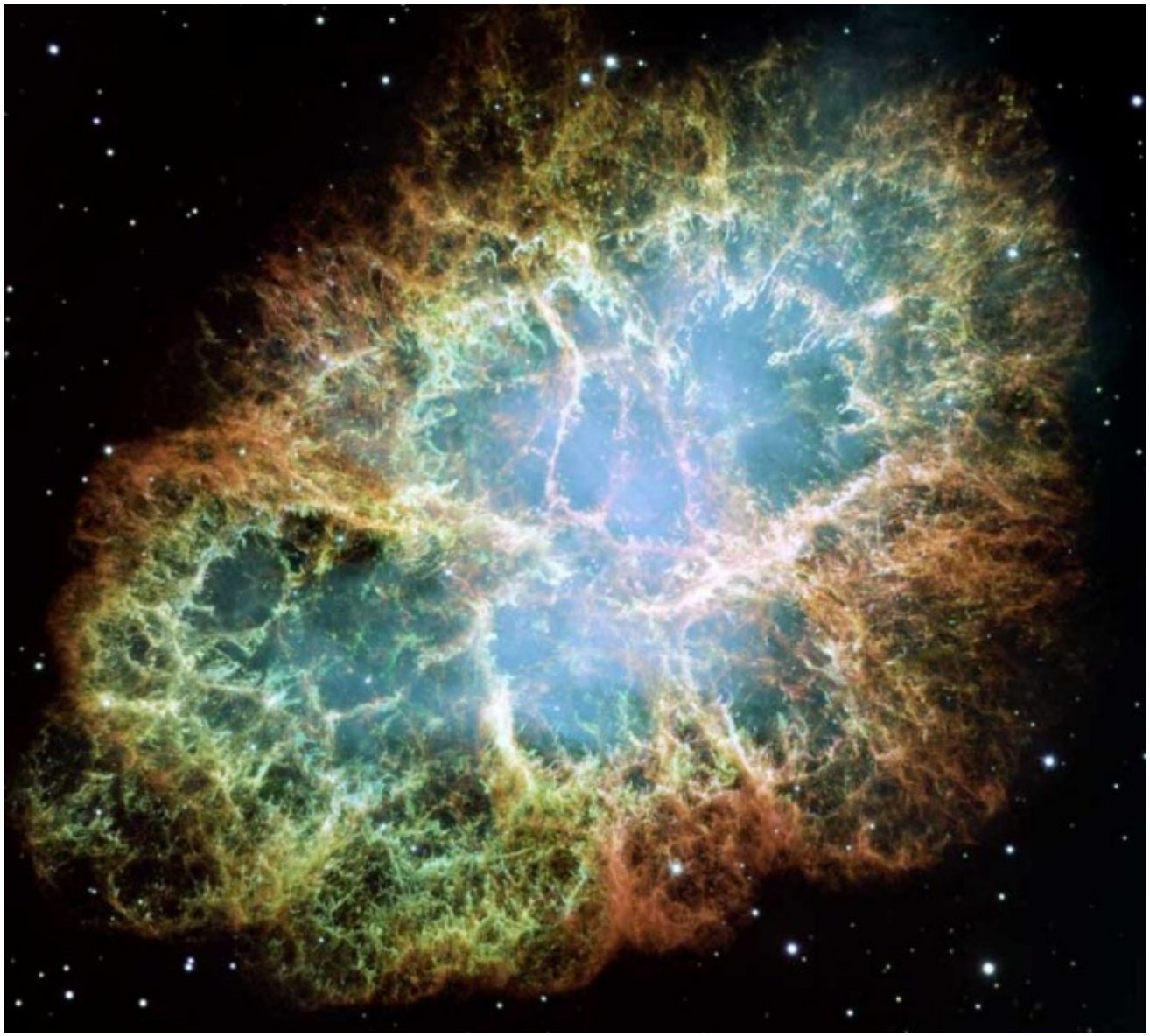


Fesen et al. (2007)

SN 1006: Supernova Remnant in X-Rays

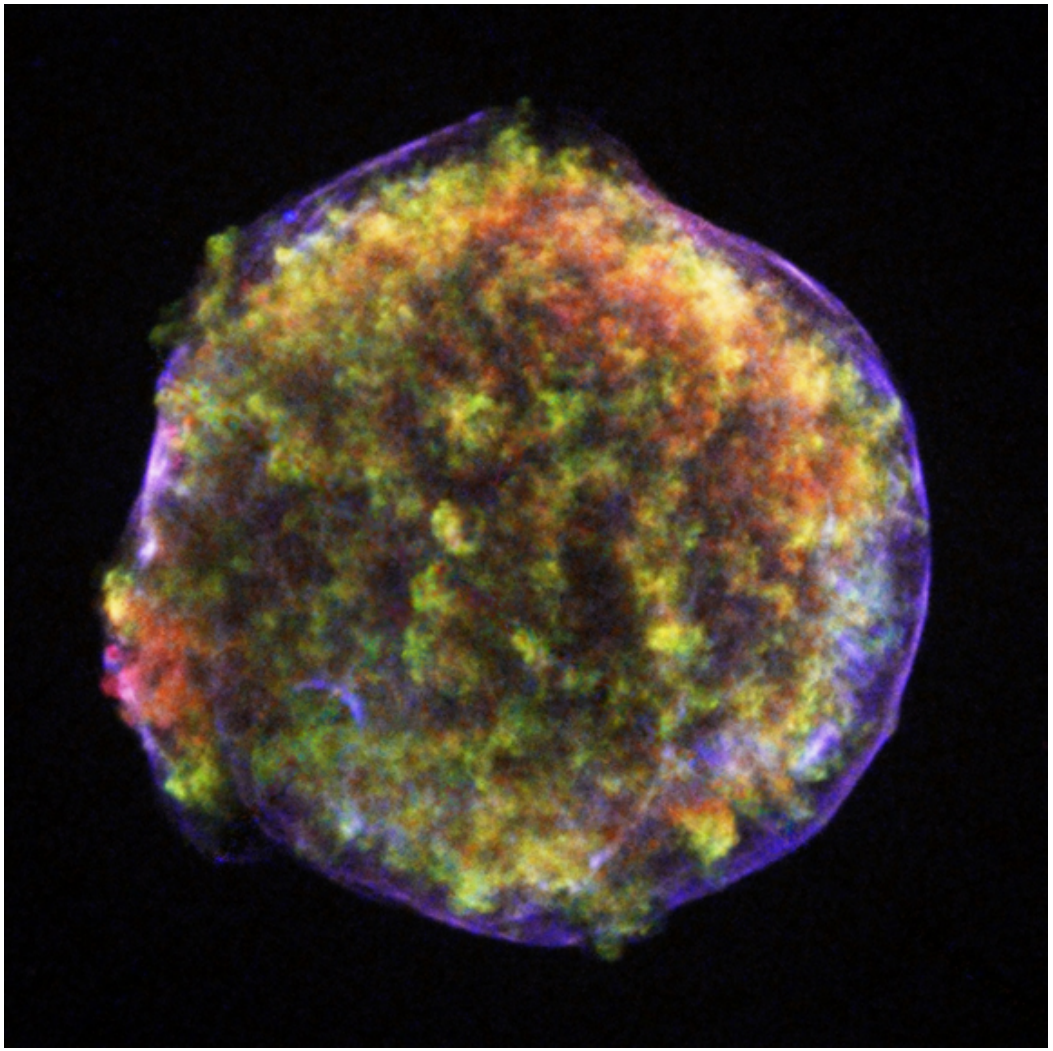
NASA/CXC, Winkler (2013)

SN 1054 – Crab Nebula (M1)

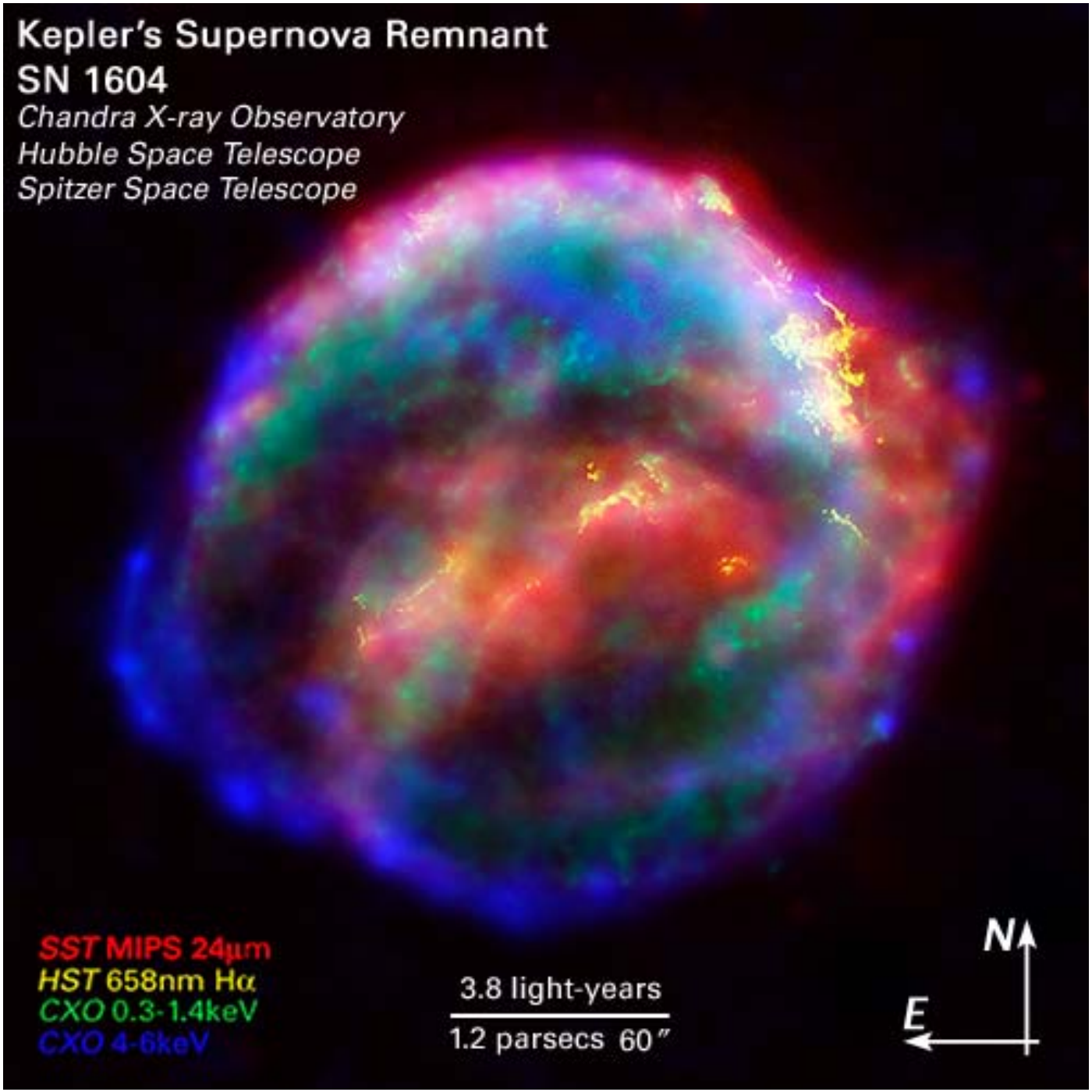


NASA, ESA, Hester, Loll (2005)

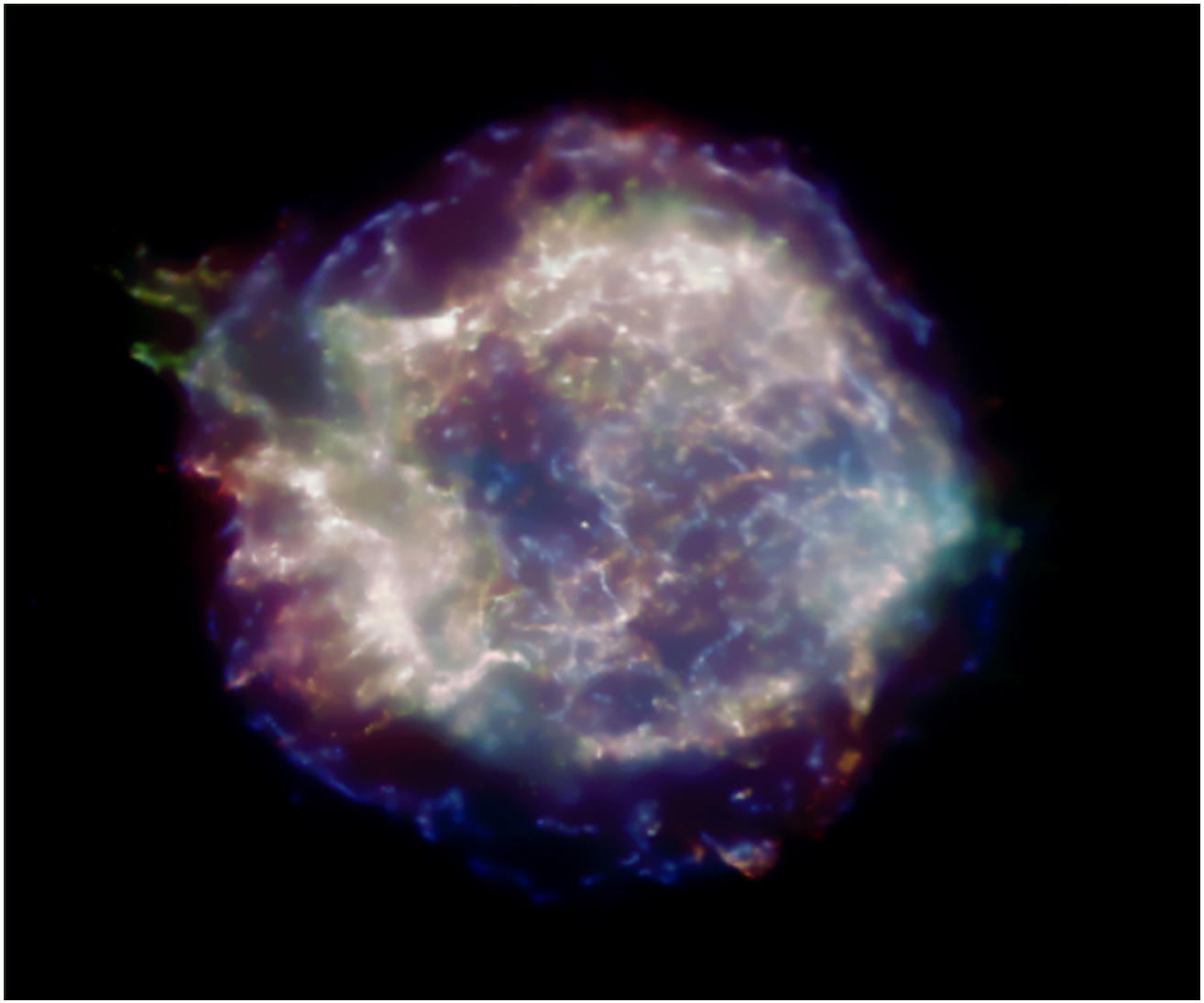
X-Rays From Tycho's Supernova Remnant



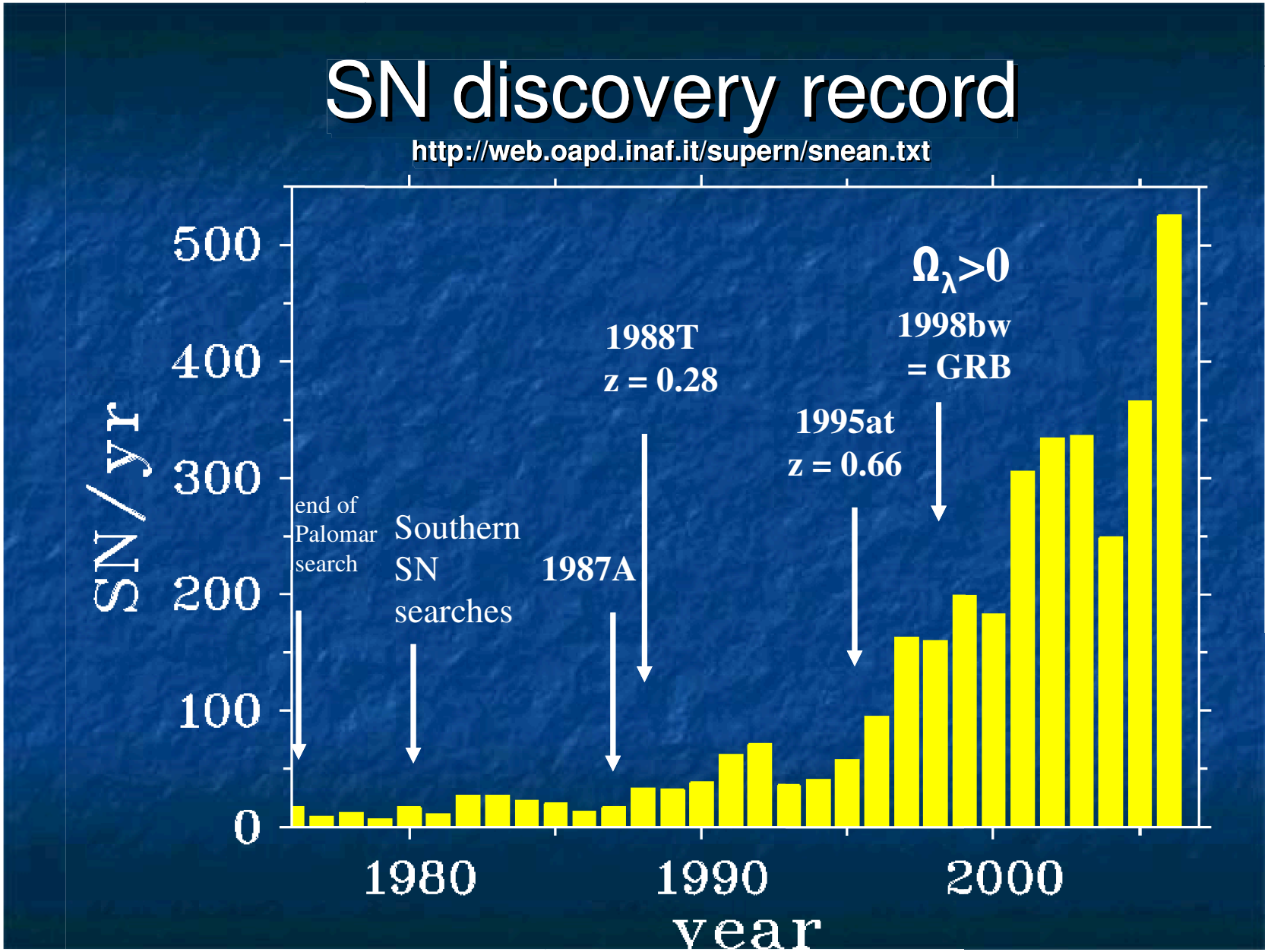
NASA/CXC, Lu (2011)


Kepler's Supernova Remnant
SN 1604
Chandra X-ray Observatory
Hubble Space Telescope
Spitzer Space Telescope
SST MIPS 24μm
HST 658nm Hα
CXO 0.3-1.4keV
CXO 4-6keV
3.8 light-years
1.2 parsecs 60″
N
E

Cassiopeia A Supernova Remnant in X-Rays

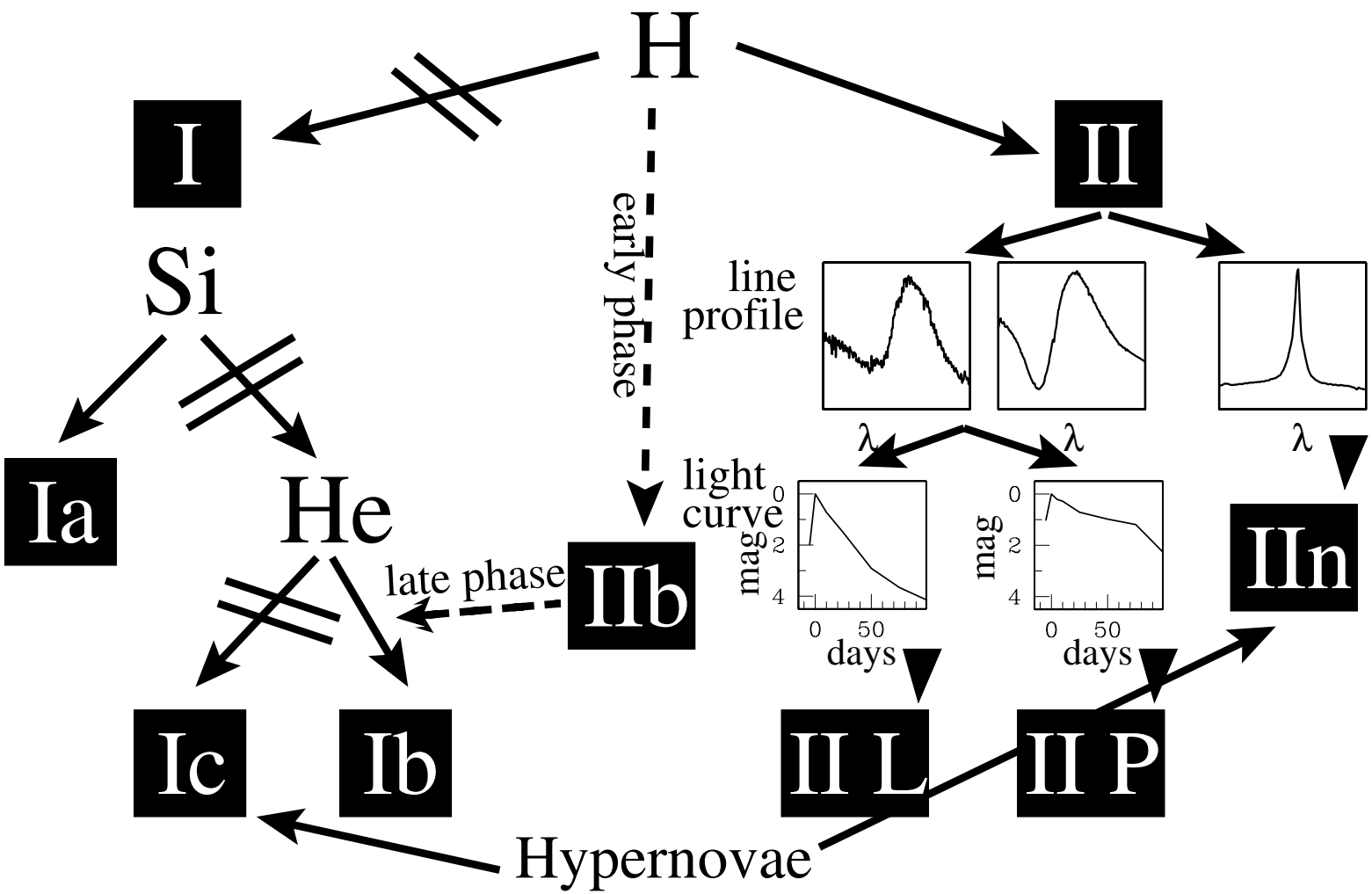


Hughes et al., NASA/CXC/SAO (2002)



Capellaro (2007)

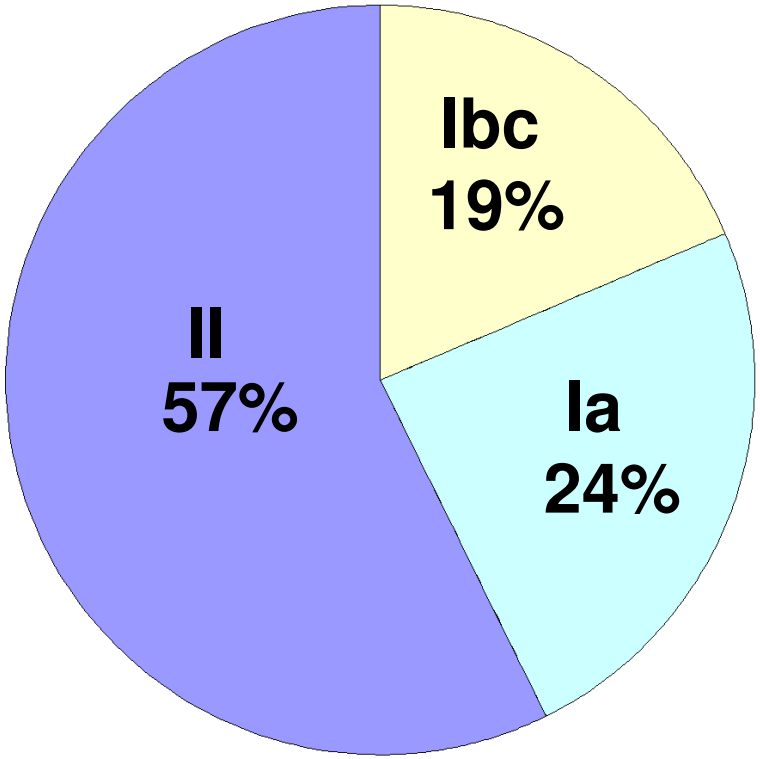
Supernova taxonomy



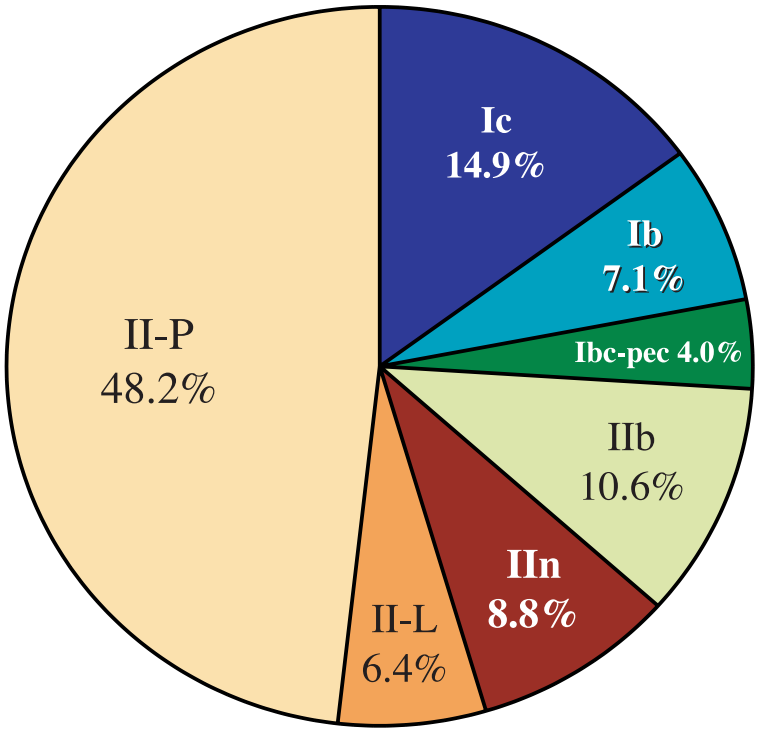
Turatto (2003)

Supernova Relative Fractions

All

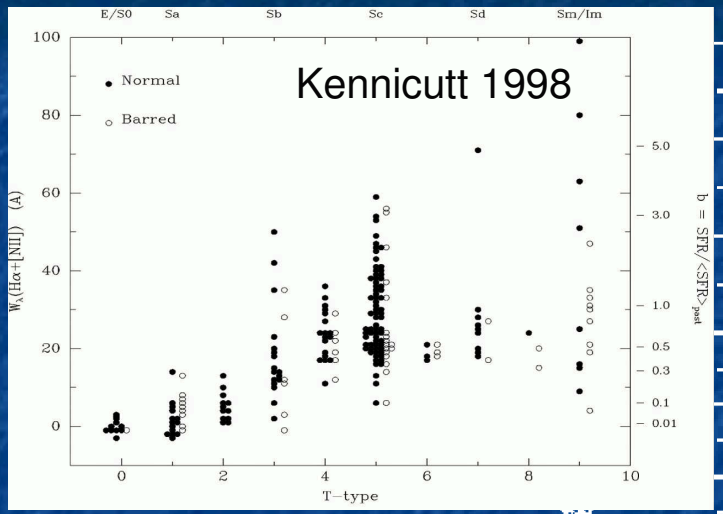


Core-Collapse Supernovae

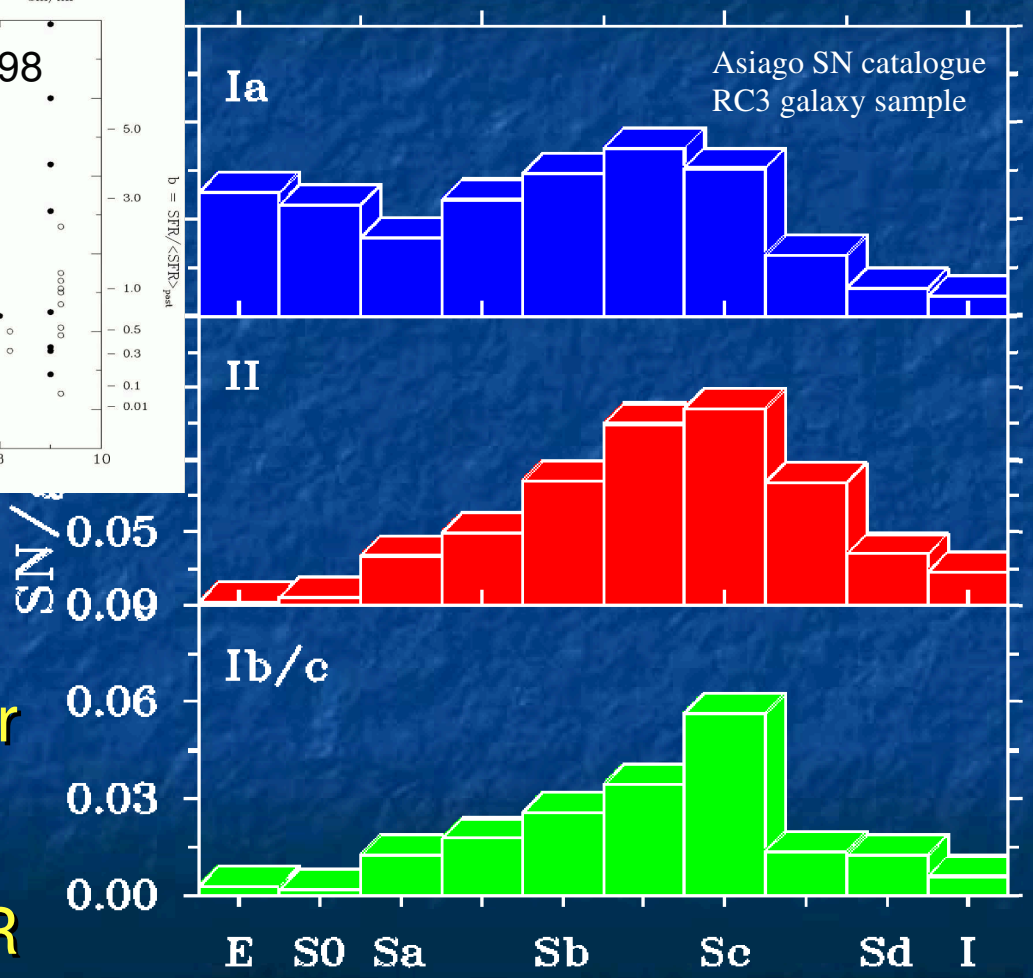


Li et al. (2011), Smith et al. (2011)

SN and galaxy types

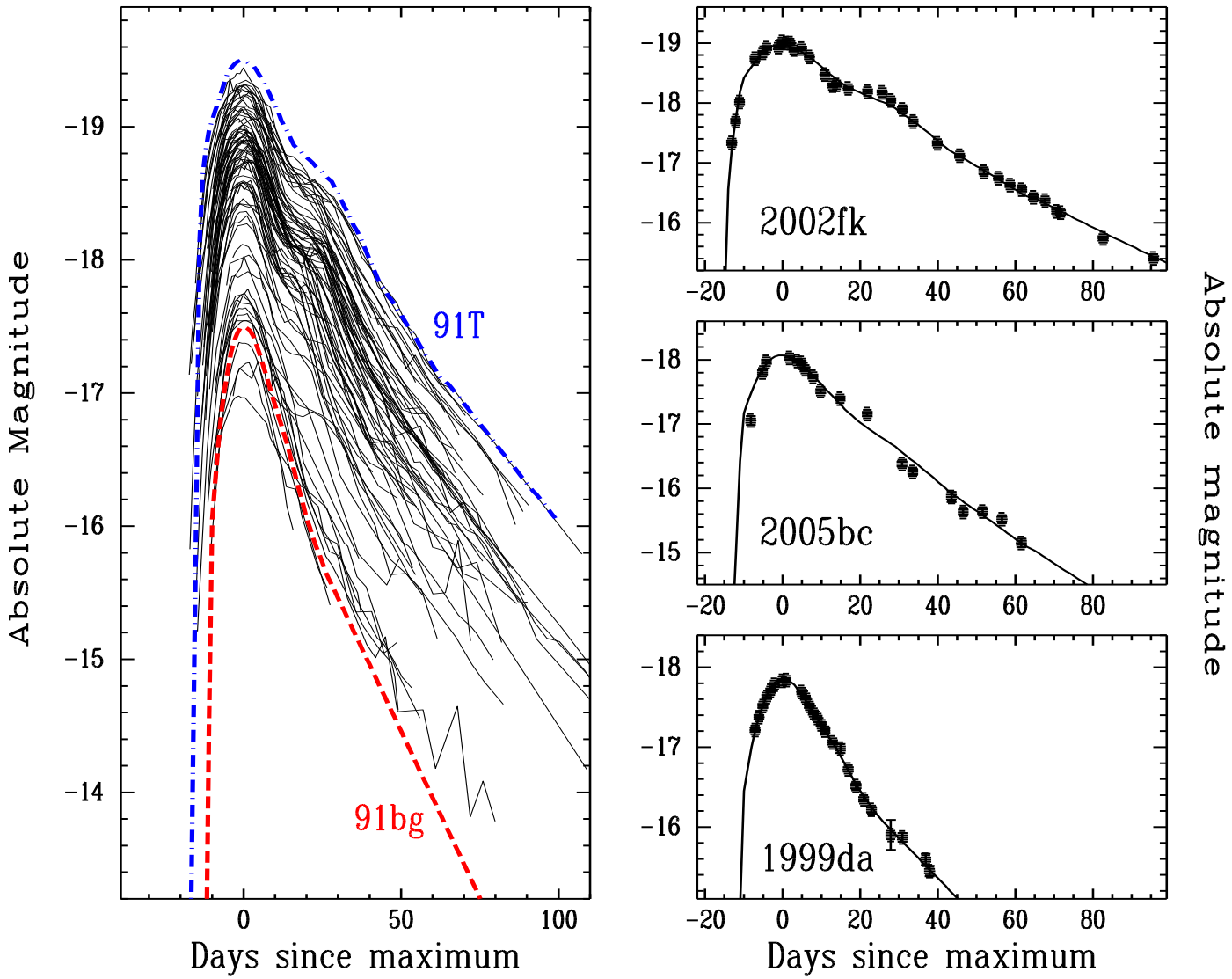


SFH → IMF & progenitor scenarios → SNR



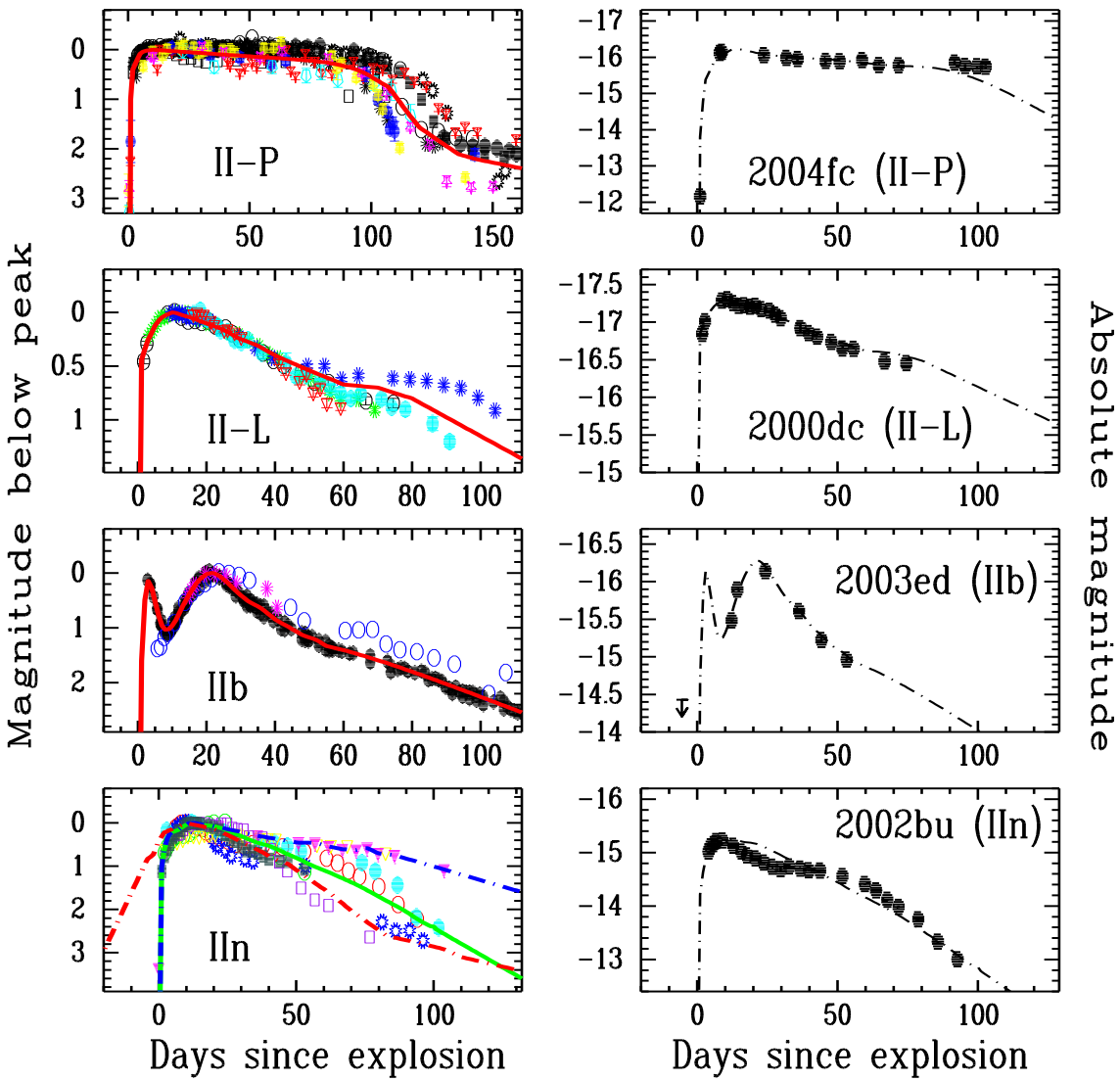
Capellaro (2007)

Light Curves of Type Ia Supernovae



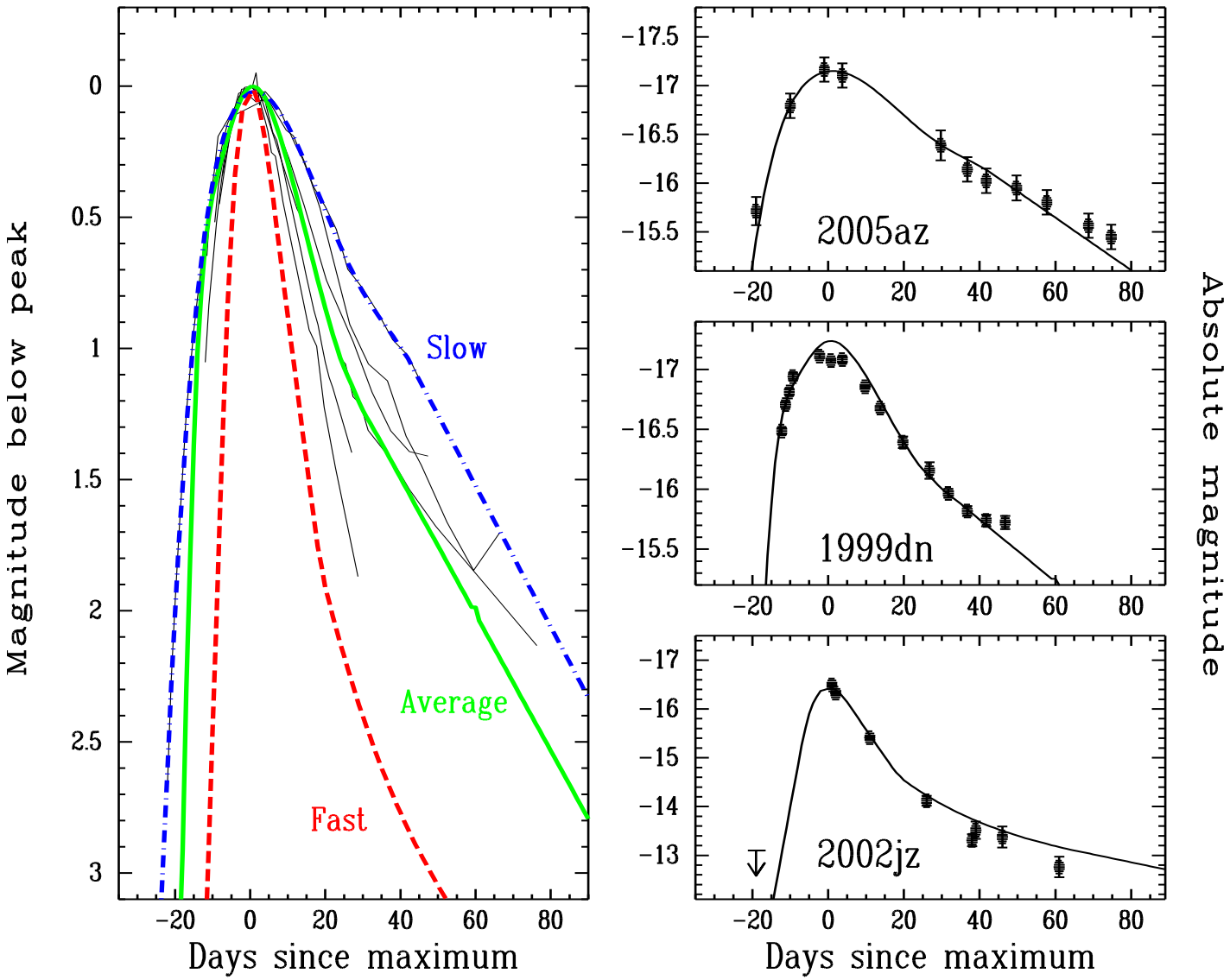
Li et al. (2011)

Light Curves of Type II Supernovae



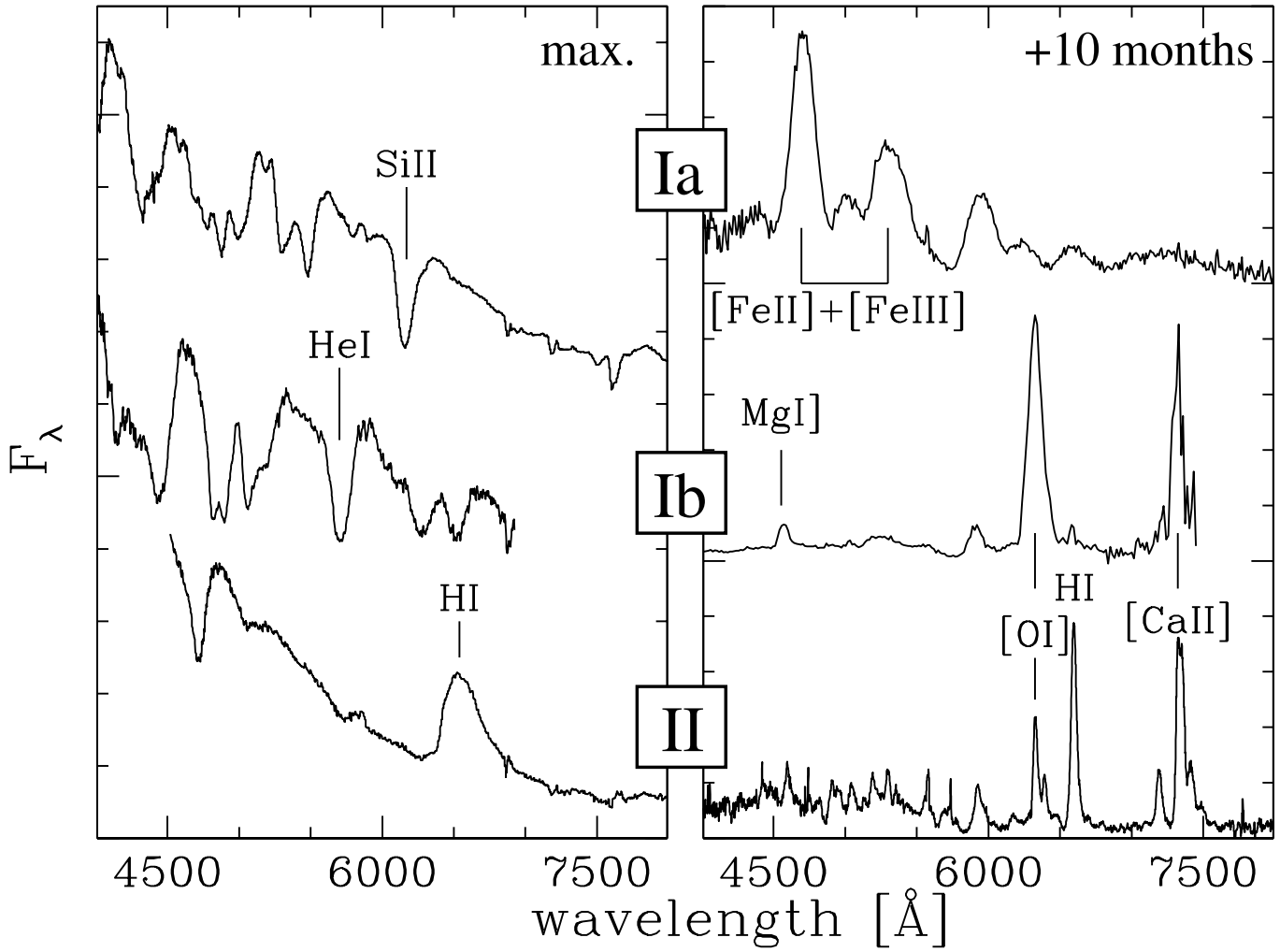
Li et al. (2011)

Light Curves of Type Ibc Supernovae



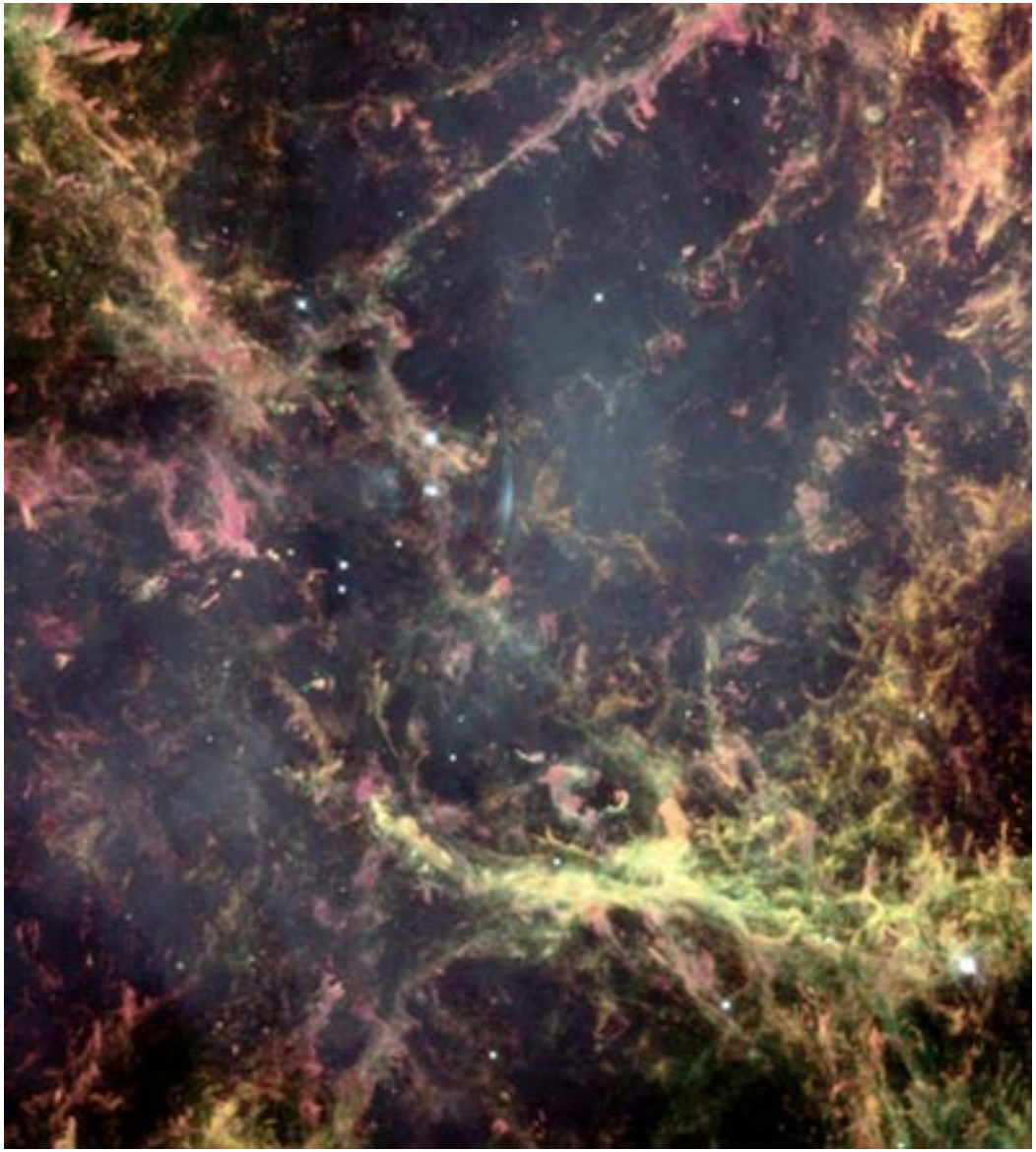
Li et al. (2011)

Spectra of Basic Supernova Types



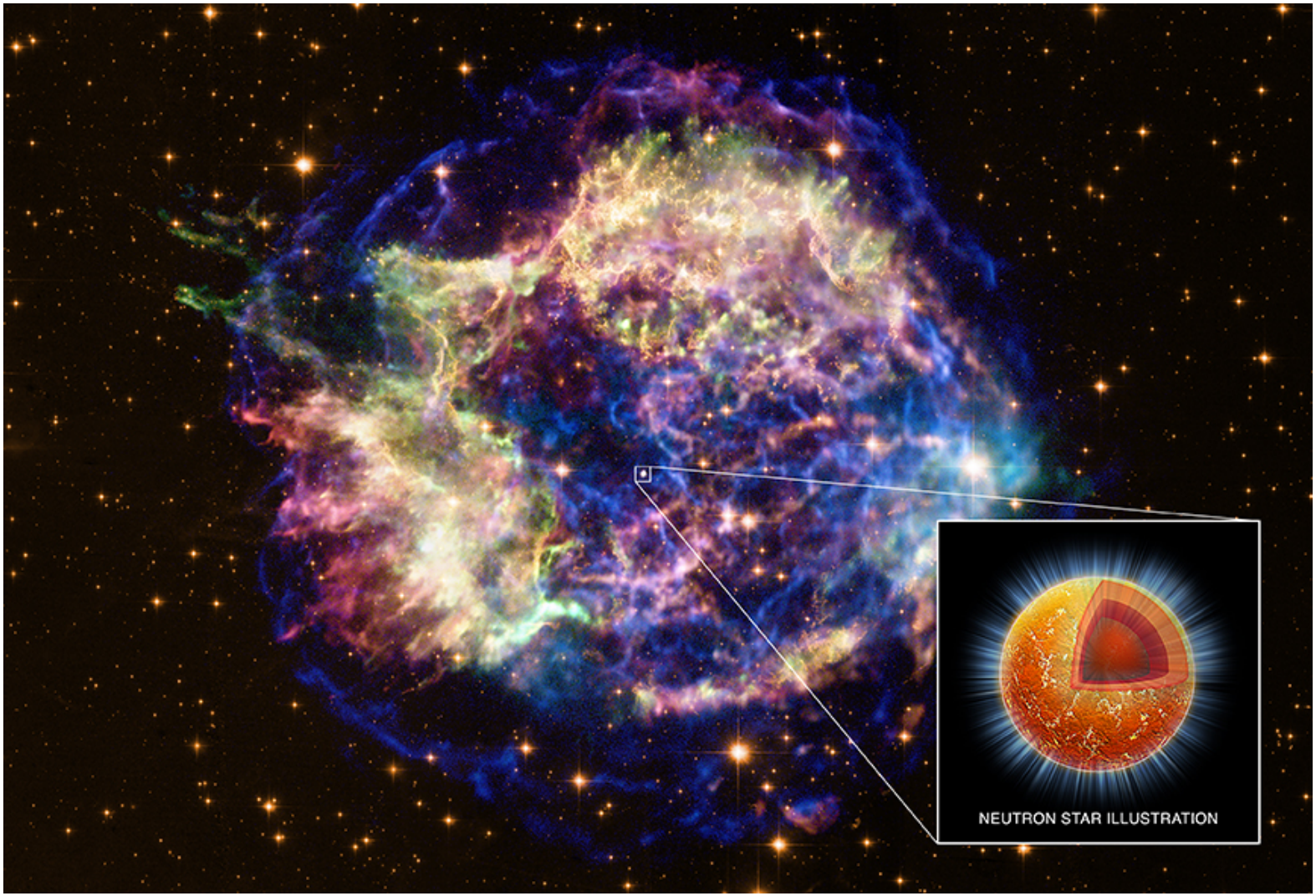
Turatto (2003)

In the Heart of the Crab



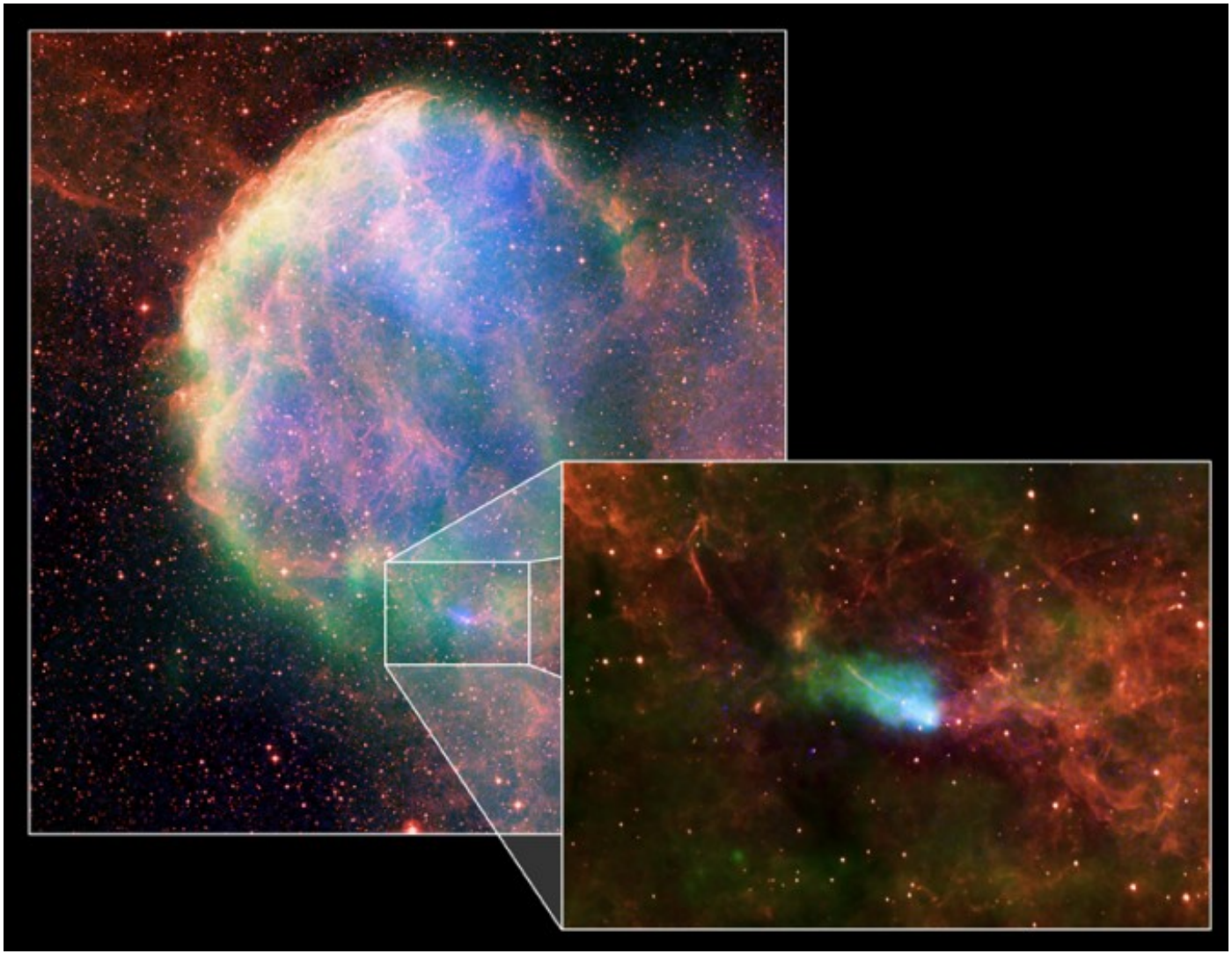
Blair et al. Hubble Heritage Team, NASA (2000)

Cooling Neutron Star in Cassiopeia A



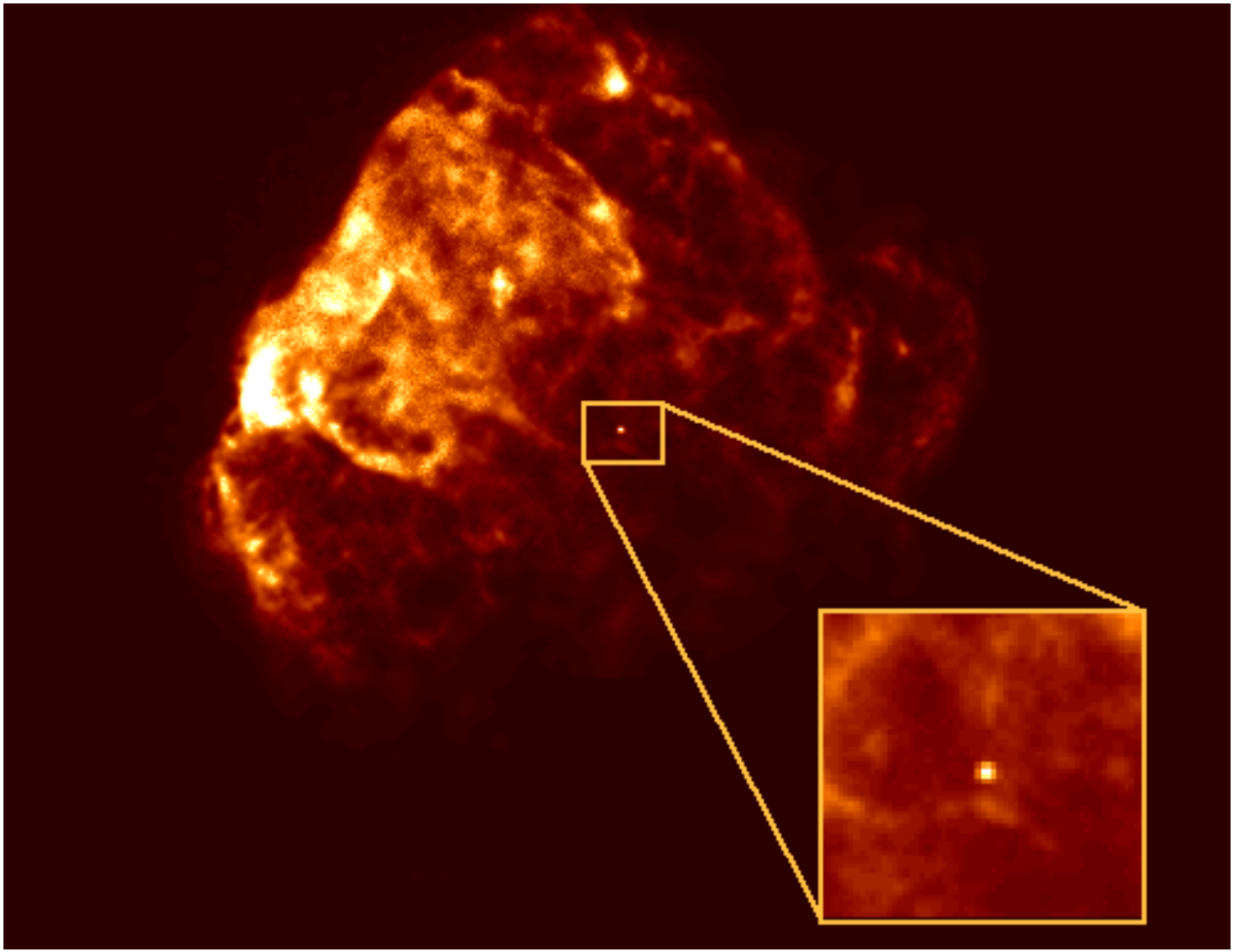
NASA/CXC/UNAM/Ioffe/Page, Shternin et al; NASA/STScI;
NASA/CXC/Weiss (2011)

IC 443: Supernova Remnant and Neutron Star



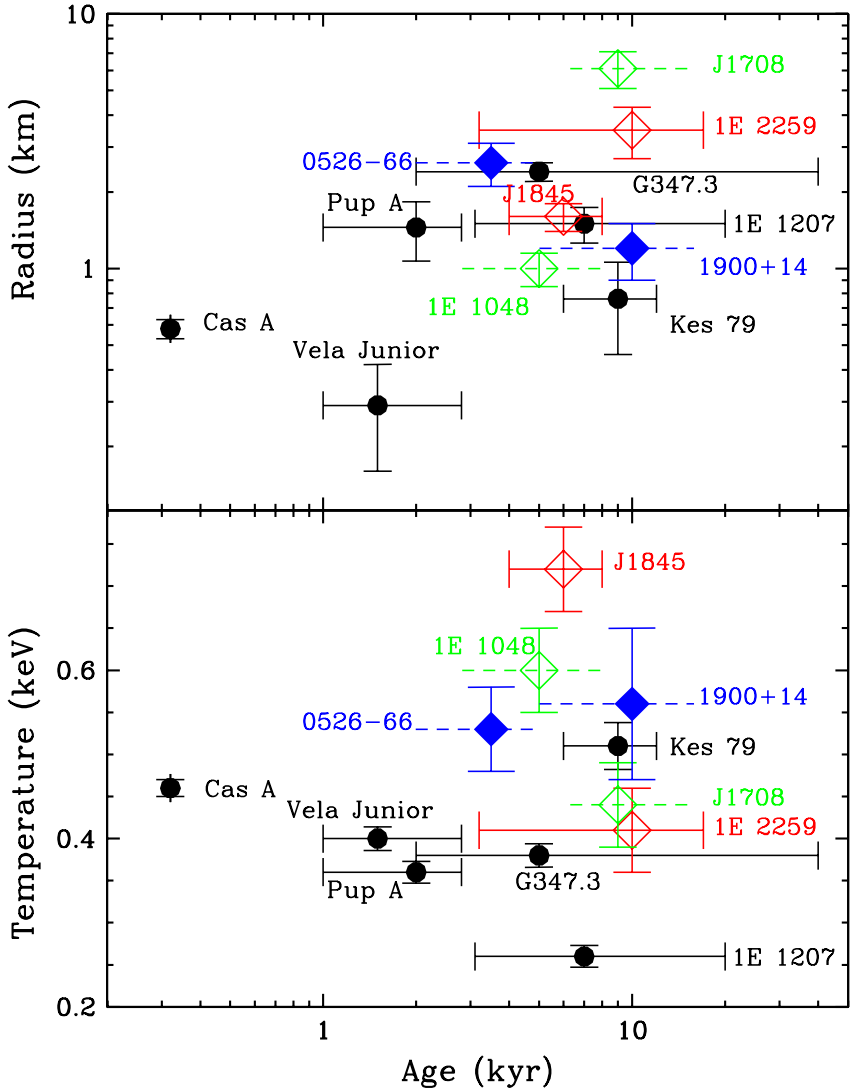
NASA/CXC/Gaensler et al., NASA/ROSAT/Asaoka & Aschenbach, NRC/DRAO/Leahy, NRAO/VLA (2006)

X-ray Emission from SNR Puppis A



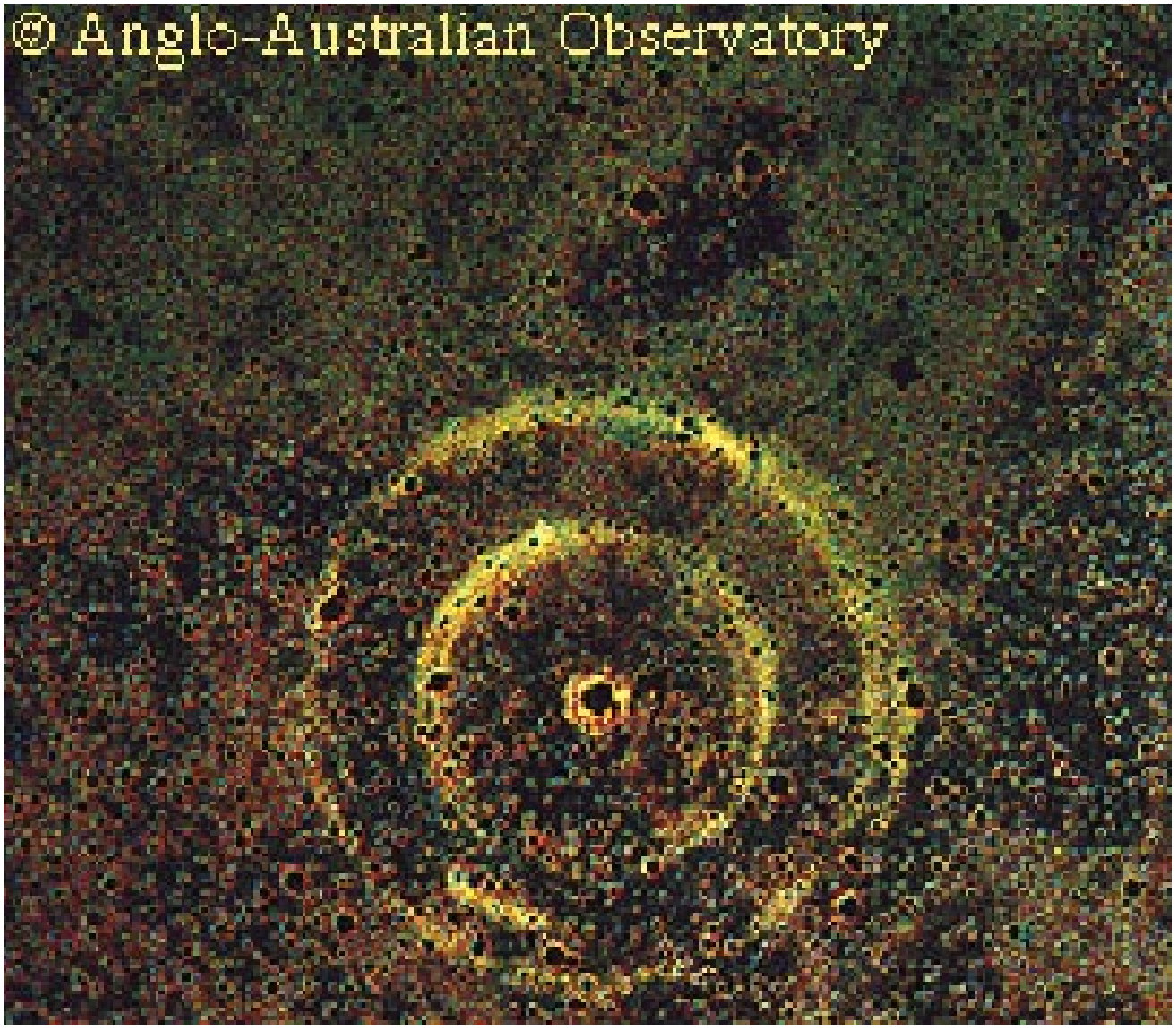
Snowden, Petre, Becker et al., ROSAT Project, NASA (1998)

Central Compact Objects in SN Remnants



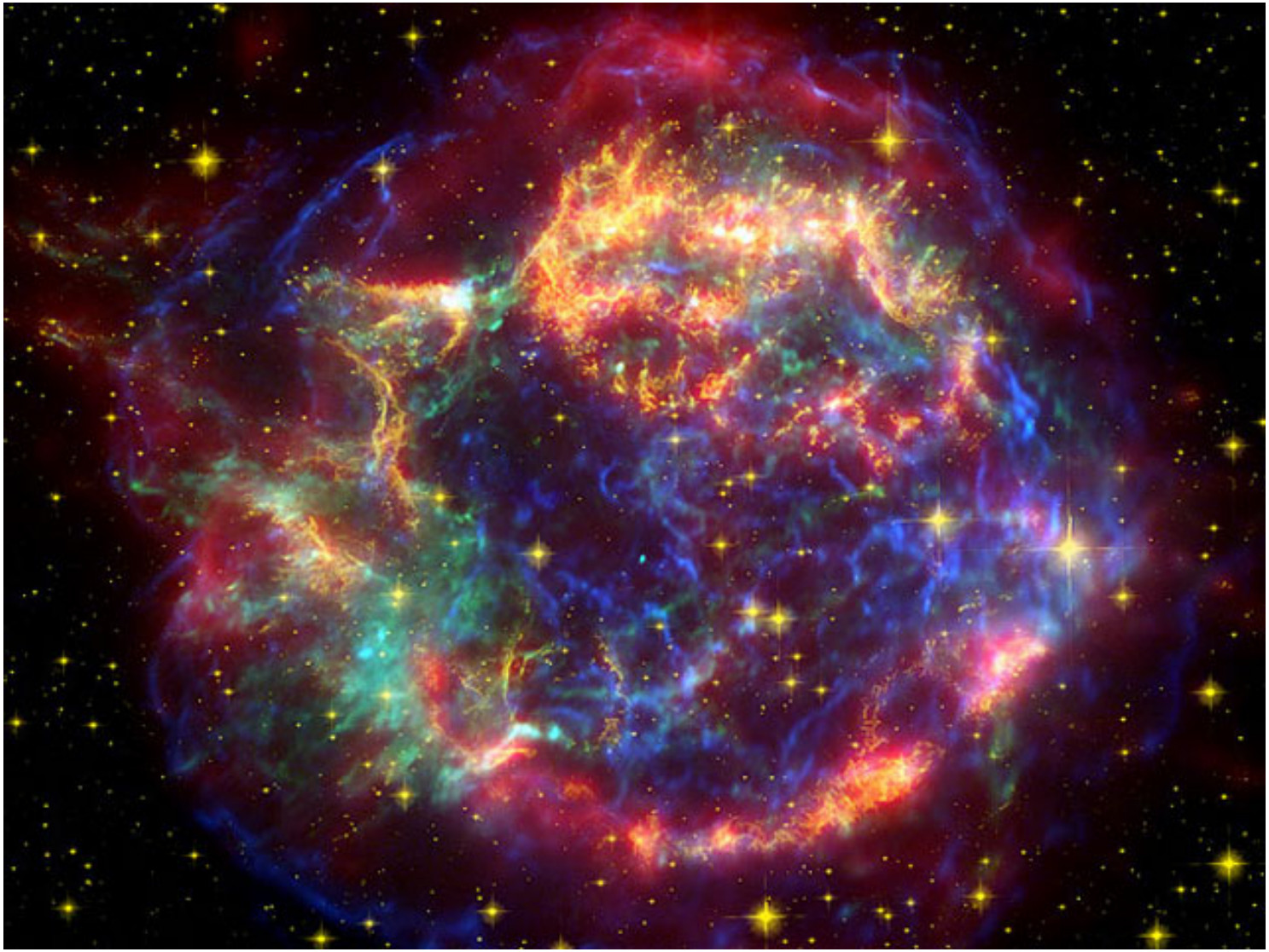
Pavlov et al. (2003)

Echos of Supernova 1987A



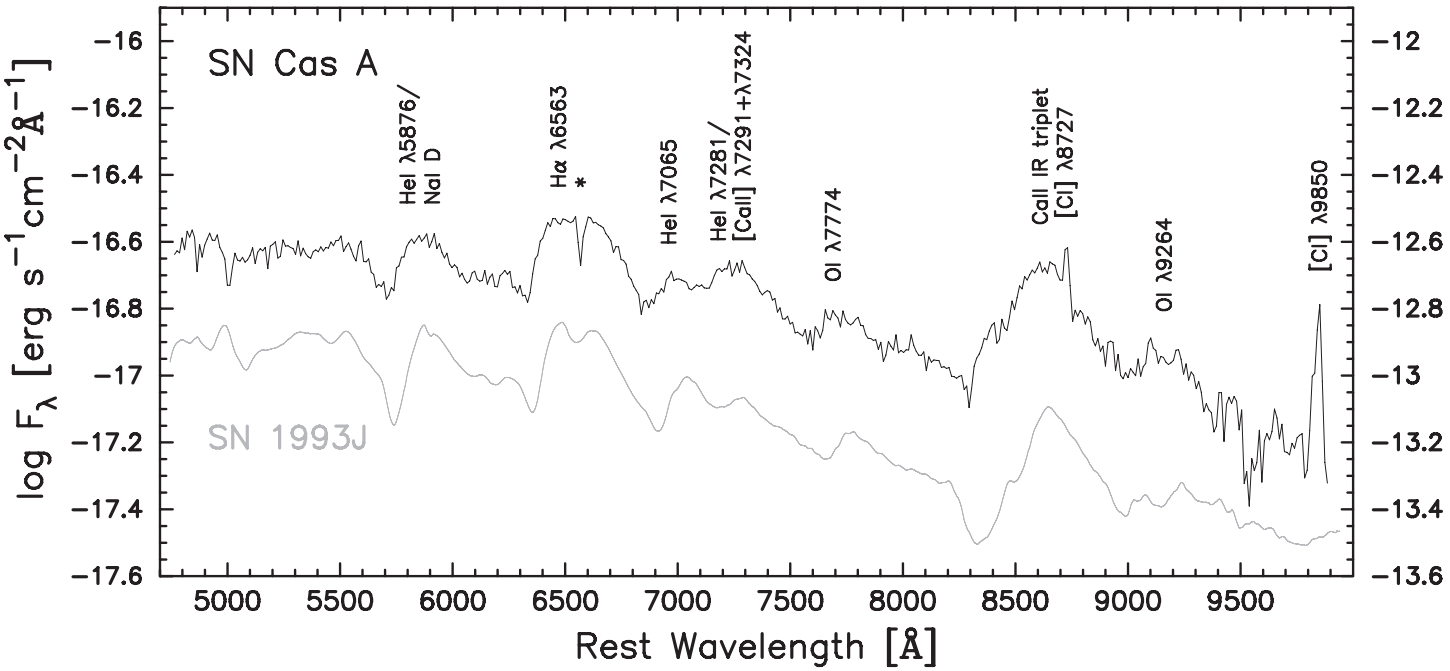
Malin (1997)

Cassiopeia A Light Echoes in Infrared



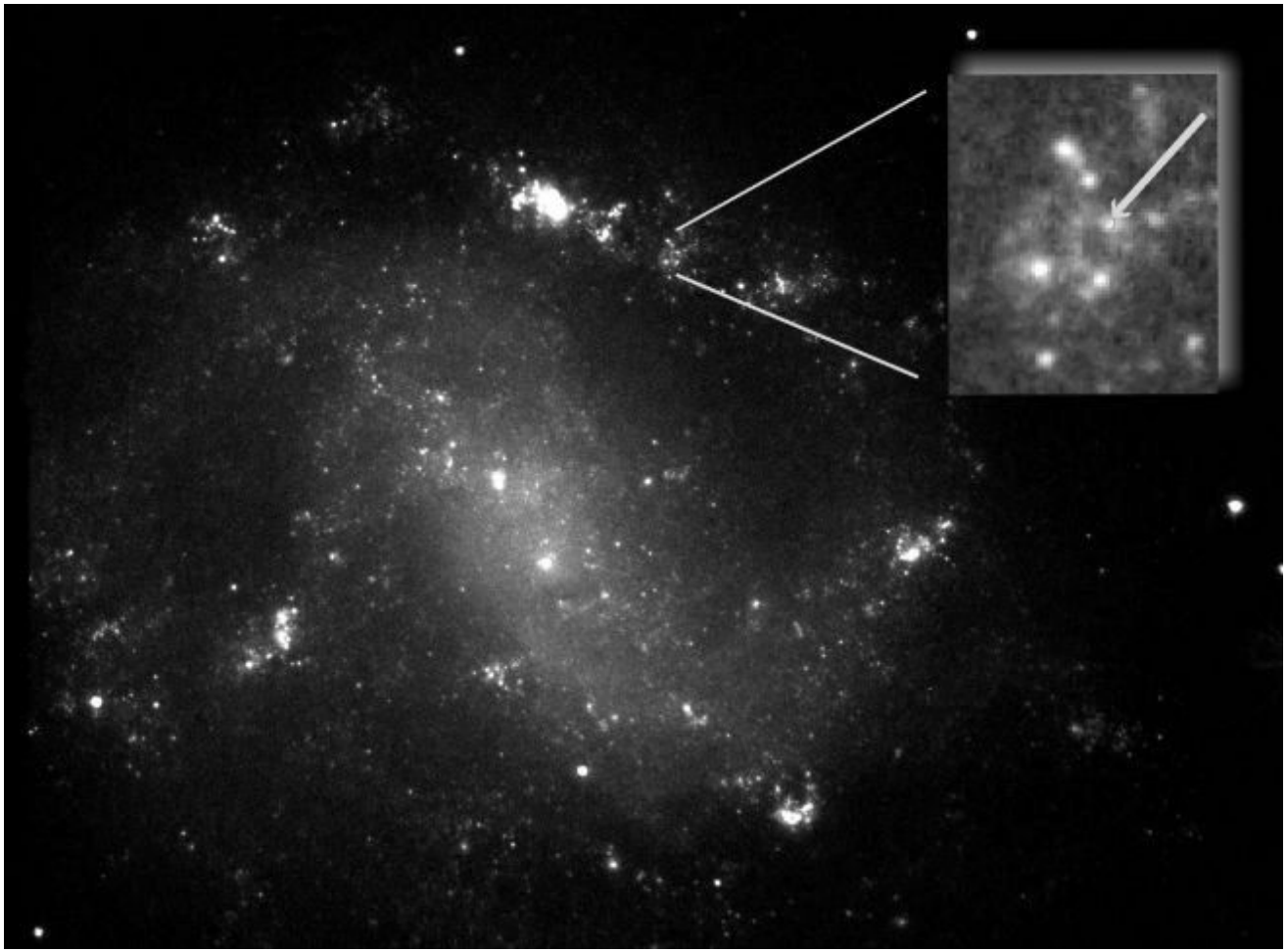
Krause et al., SSC, JPL, Caltech, NASA (2005)

The Cassiopeia A Supernova Was of Type IIb



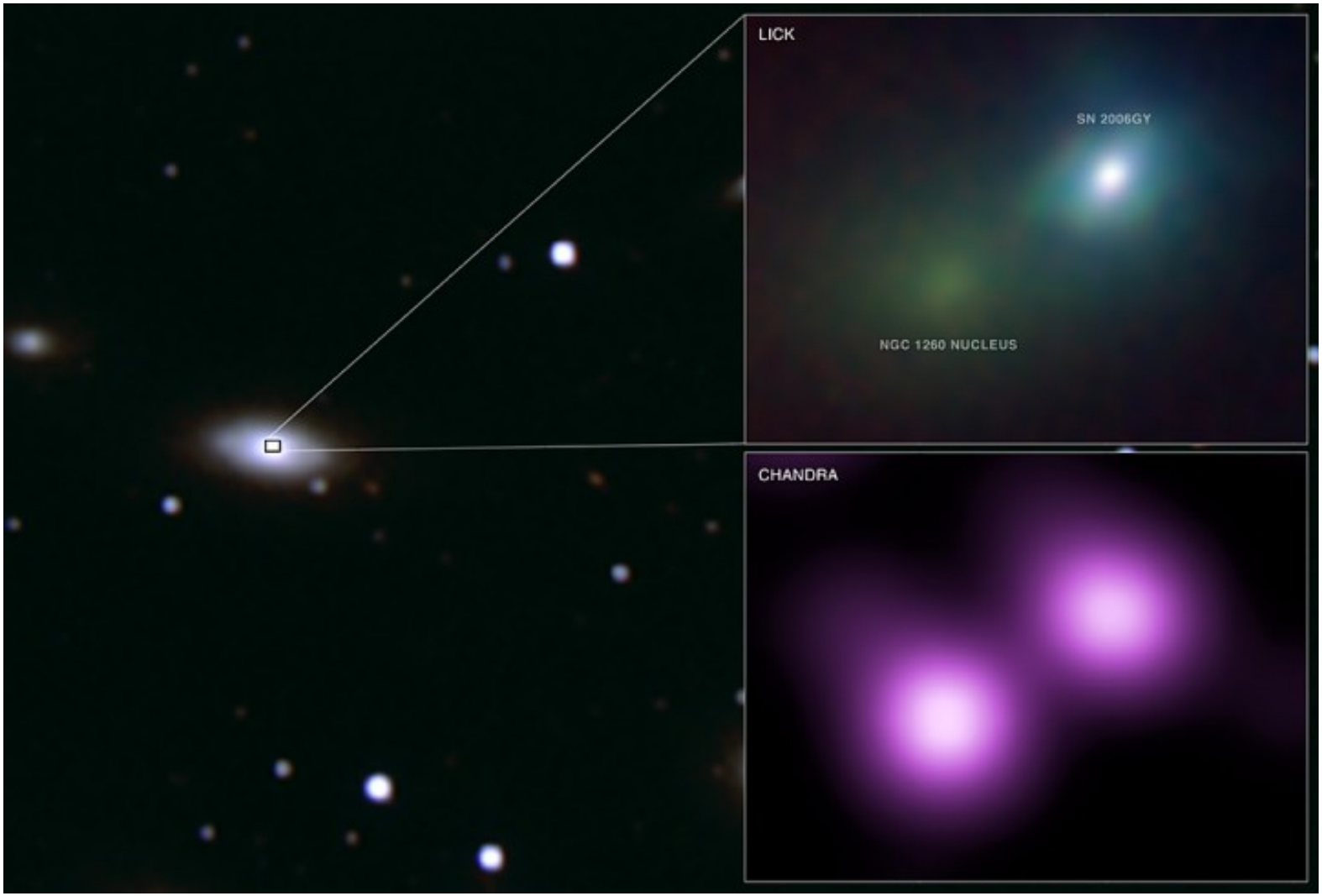
Krause et al. (2008)

SN 1998bw and GRB 980425: Supernova – Gamma Ray Burst Connection



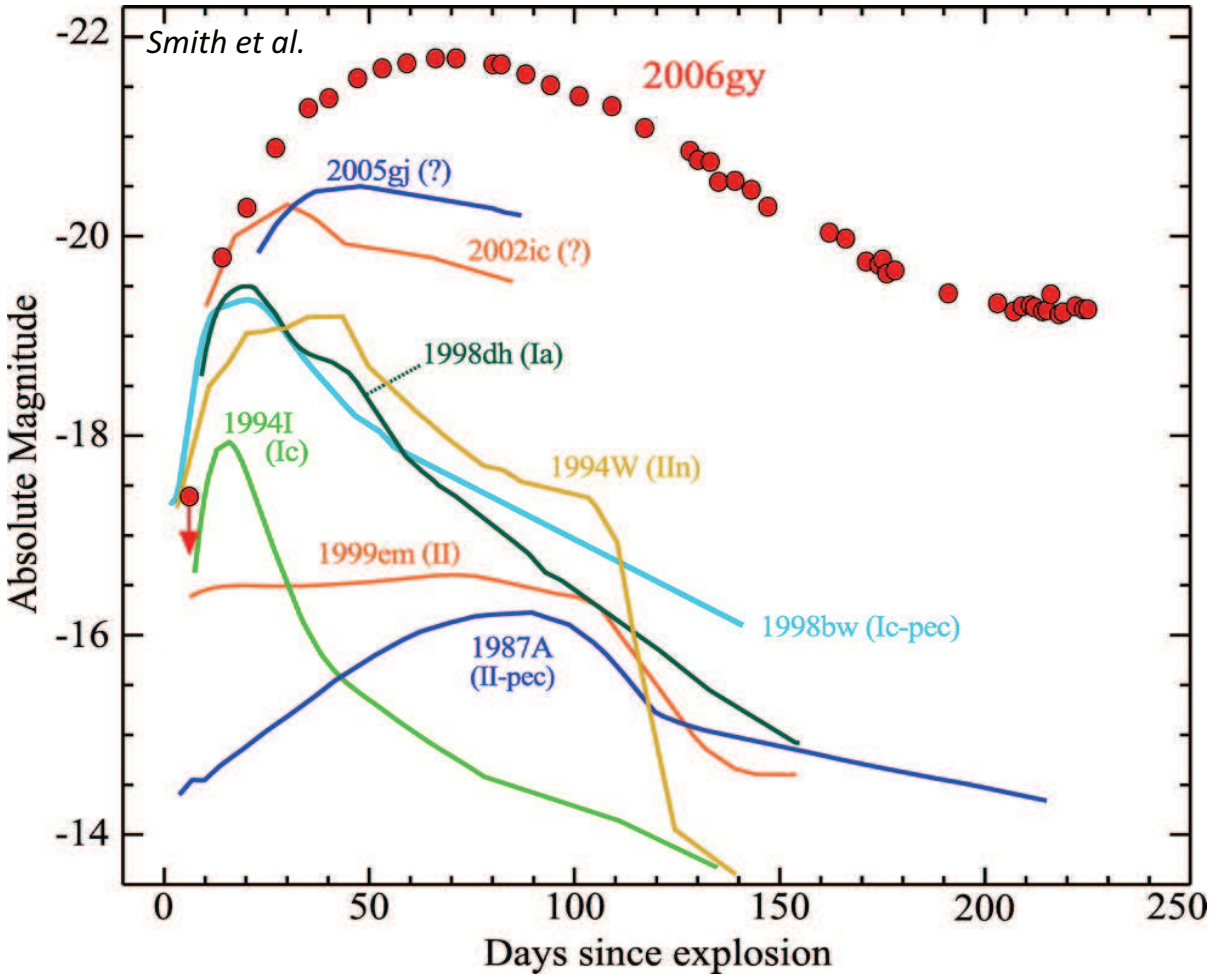
Holland, Hjorth, Fynbo, ESA, NASA (2002)

SN 2006GY: Brightest Supernova



Smith, Li, Bloom, Hansen et al. (2007)

Diversity of Supernova Light Curves



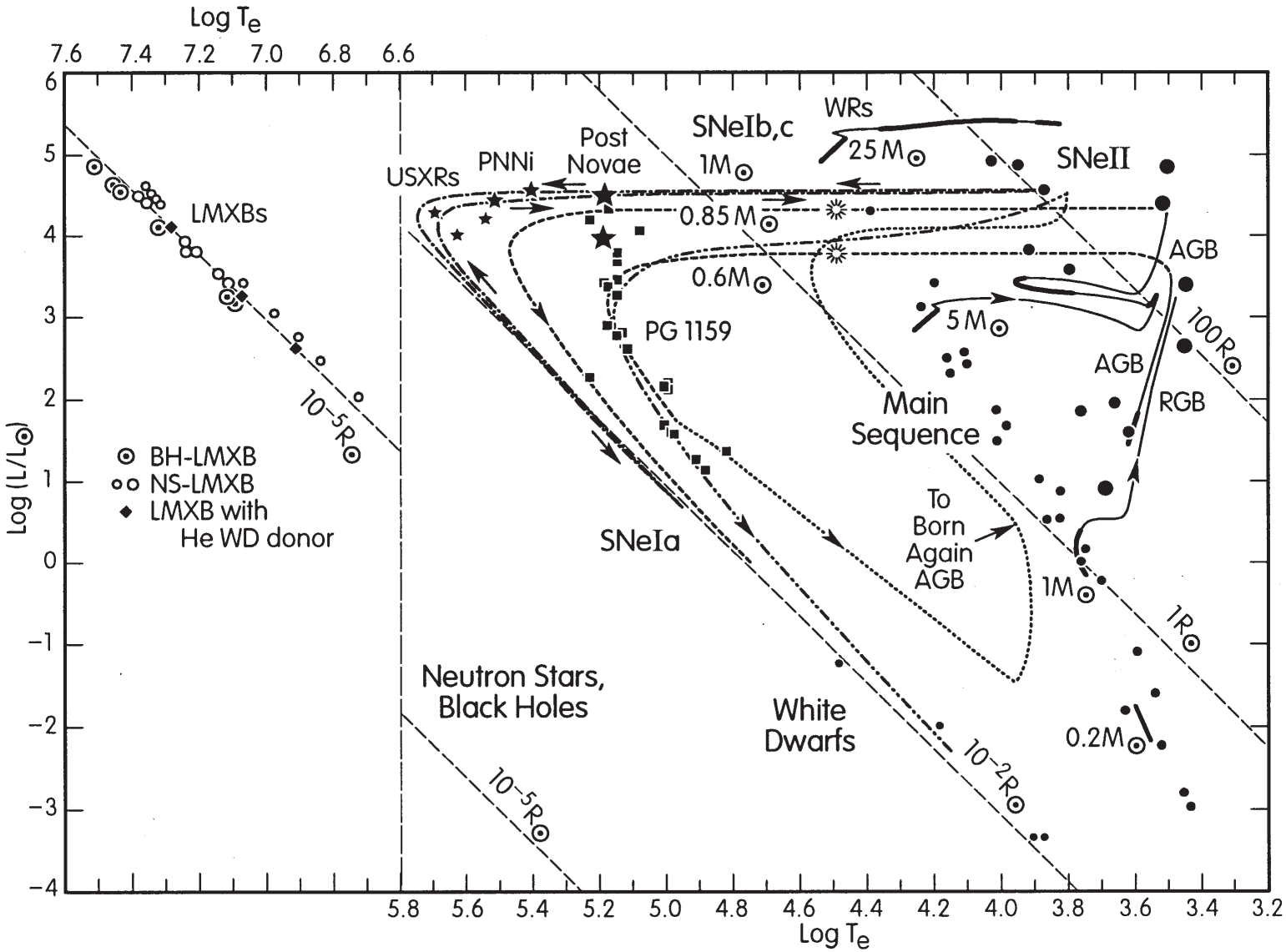
Smith et al. (2007)

Физическая Картина Взрывов Сверхновых

Тип	M ($M_\odot$)	E (10^{51} erg)	$M_{\rm Ni}$ ($M_\odot$)	Stellar remnant	Explosion mechanism
Ia	∼1	∼1	∼0.1-1.1	none	thermonuclear
Ibc	∼20+25	∼1	∼0.2	NS/BH	grav. collapse
Ic-pec hypernovae	∼30	∼20–50	∼0.5–07	NS/BH	grav. collapse
IIL, IIP IIb, IIn	∼9–30	∼0.2–4	∼0.01–0.1	NS/BH	grav. collapse
very bright IIn	∼30–100	∼10	?	NS/BH none	grav. collapse pair instability

- Basic values for core-collapse supernovae:
  The gravitational binding energy of a neutron star is about 10^{53} erg.
  The kinetic energy of a supernova is about 10^{51} erg.
  The radiated energy of a supernova is about 10^{49} erg.
- The radioactive decay ^{56}Ni $\rightarrow ^{56}$Co $\rightarrow ^{56}$Fe.

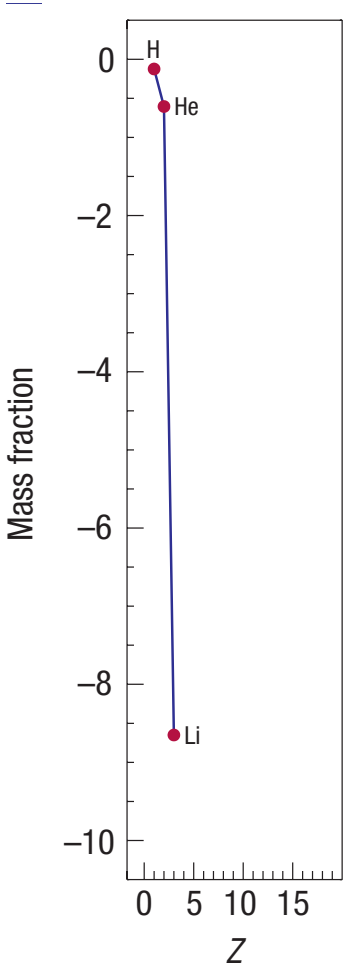
Theory and observation in the H-R diagram



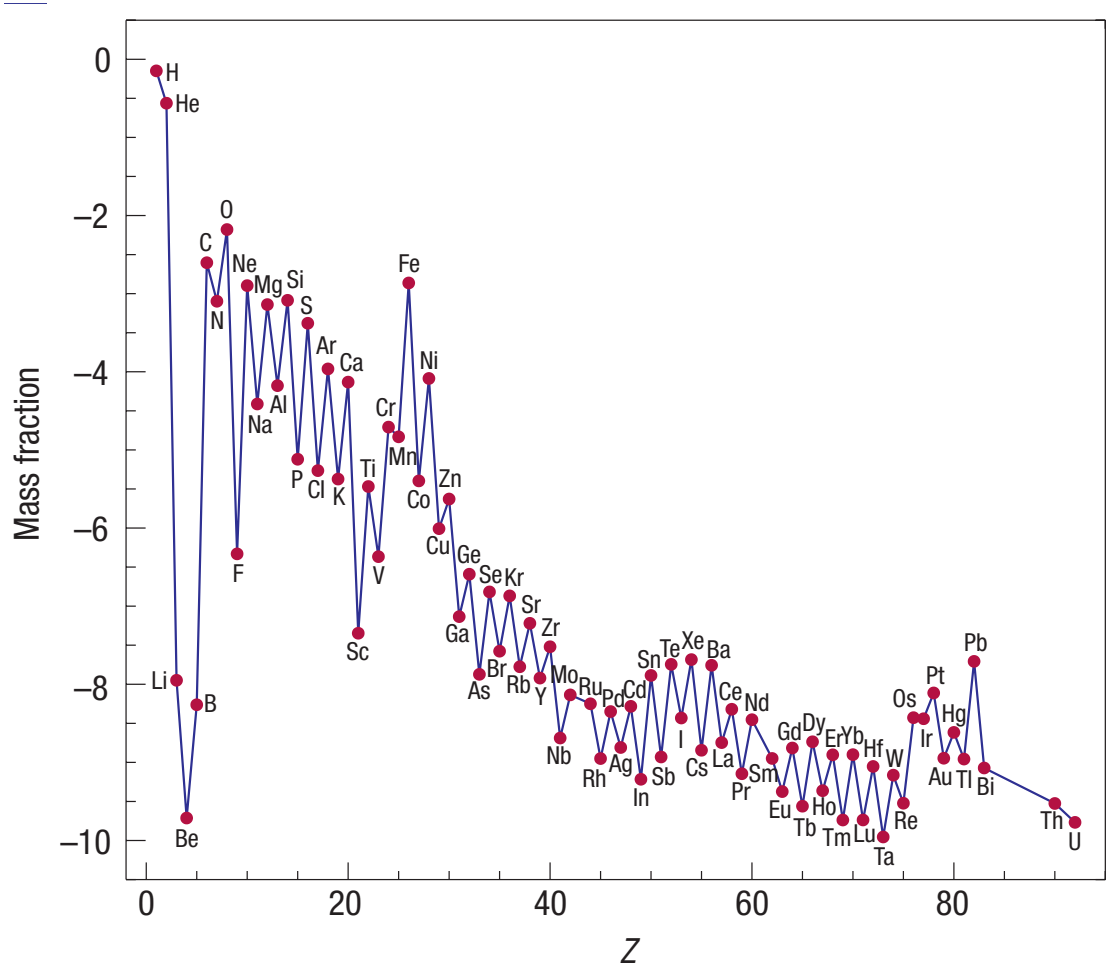
Wallerstein et al. (1997)

Composition of the Universe

After Big Bang



After nucleosynthesis in stars



Woosley (2008)