Supernova Surveys

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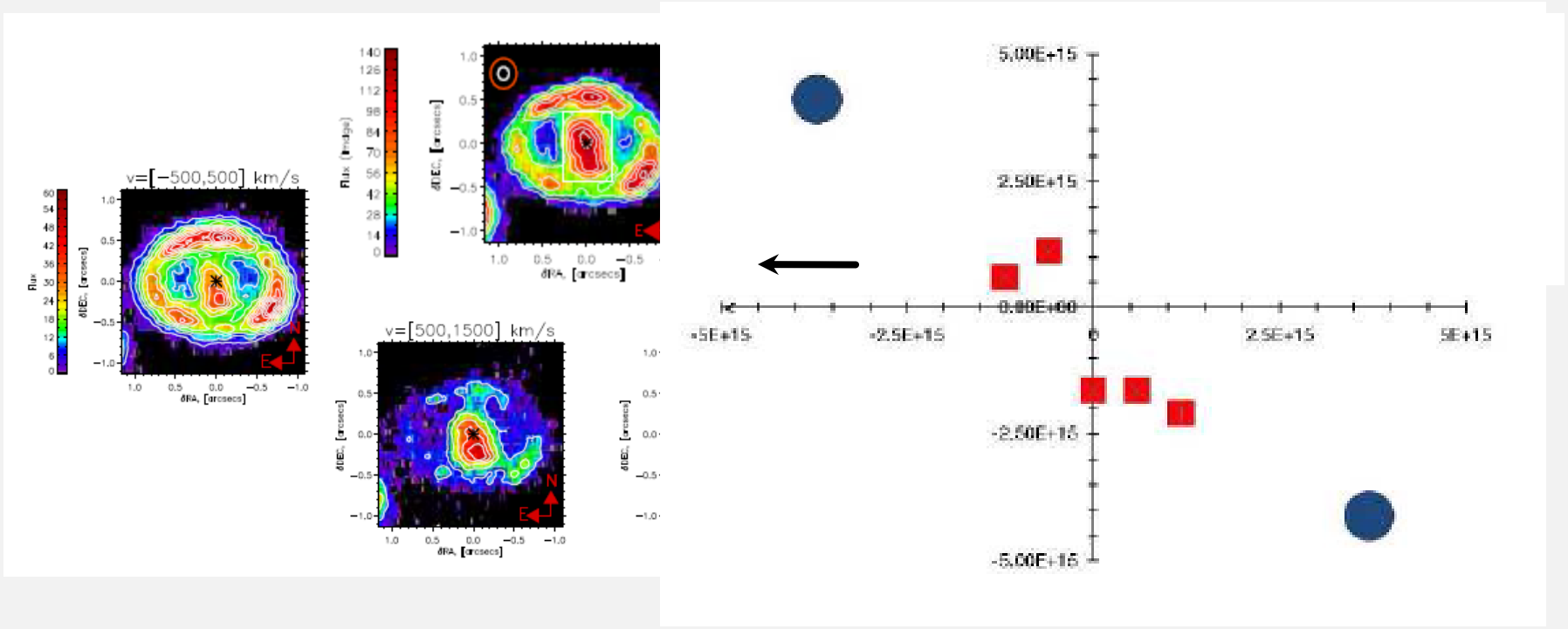
ESO

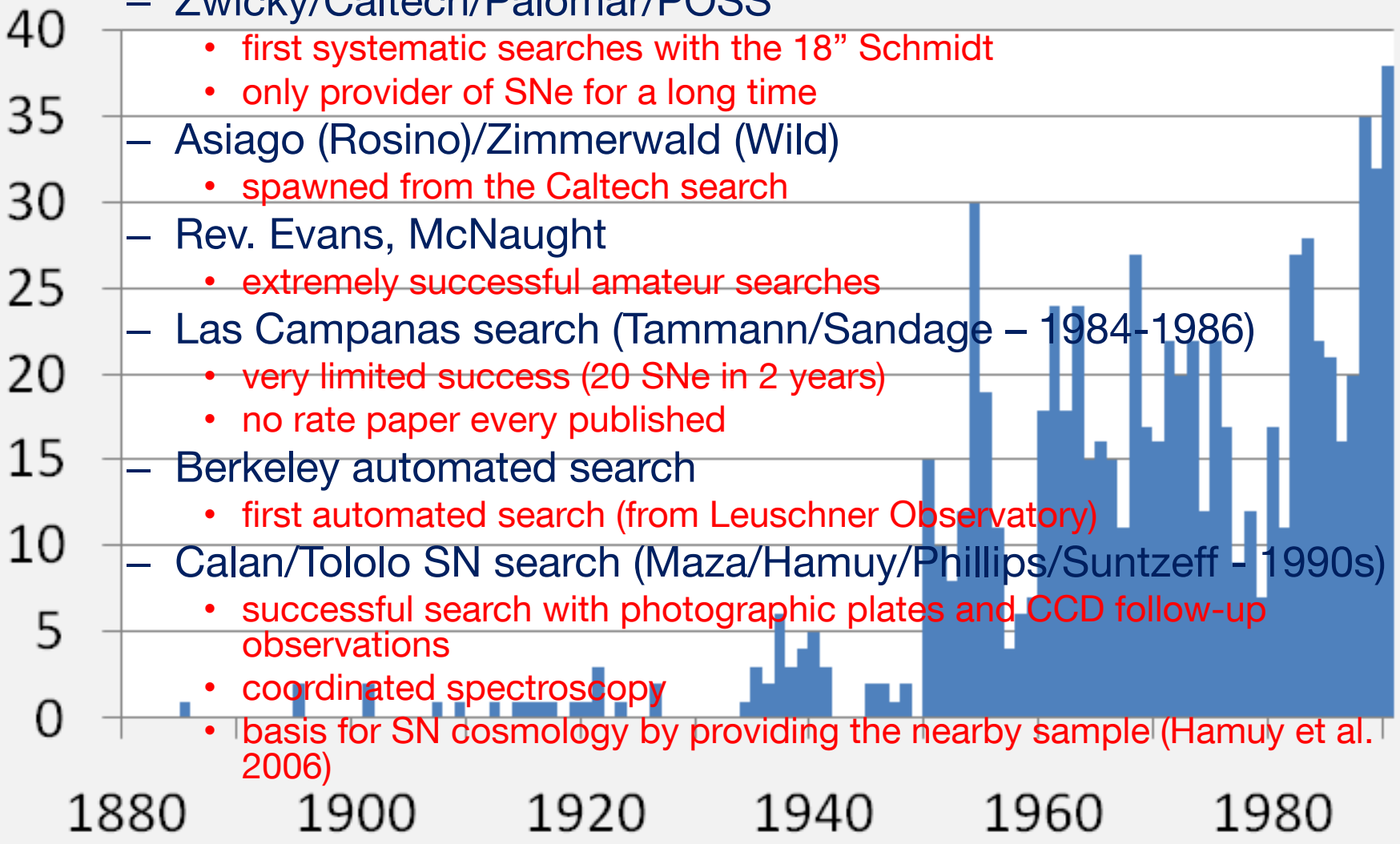
One-slide SN 1987A

- Kjær et al. (arXiv:1003.5684)
  - inner ejecta resolved and mapped in [Si I] and [Fe II] as well as He I lines



Some past supernova surveys

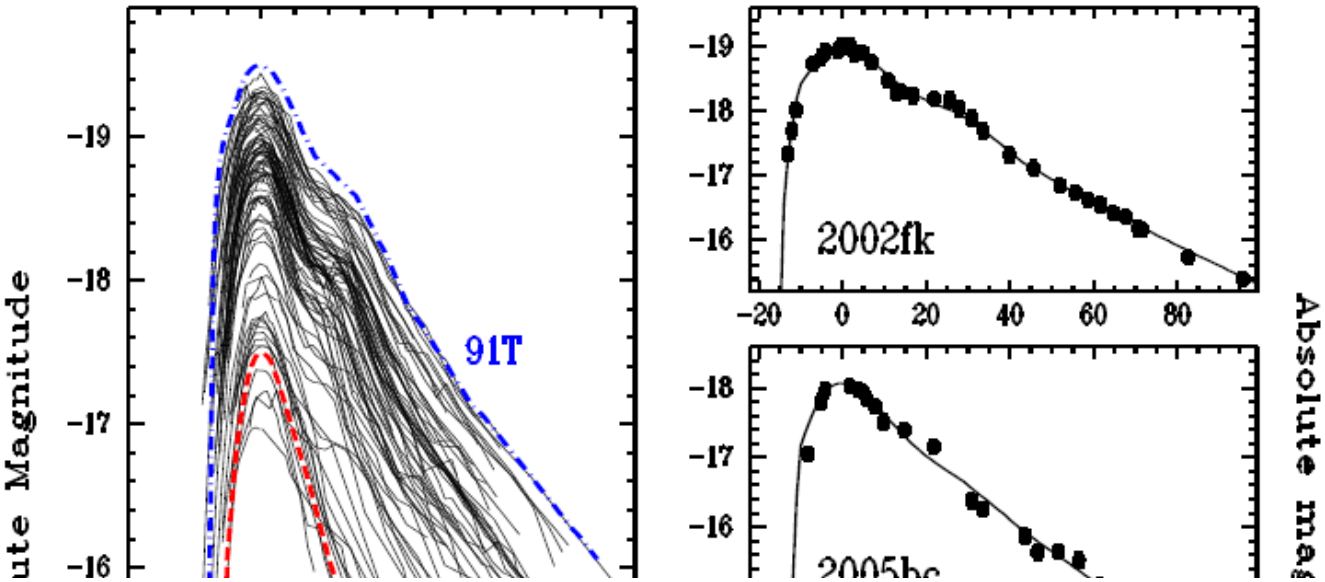
- Historical surveys
  - Zwicky/Caltech/Palomar/POSS
    - first systematic searches with the 18” Schmidt
    - only provider of SNe for a long time
  - Asiago (Rosino)/Zimmerwald (Wild)
    - spawned from the Caltech search
  - Rev. Evans, McNaught
    - extremely successful amateur searches
  - Las Campanas search (Tammann/Sandage – 1984-1986)
    - very limited success (20 SNe in 2 years)
    - no rate paper every published
  - Berkeley automated search
    - first automated search (from Leuschner Observatory)
  - Calan/Tololo SN search (Maza/Hamuy/Phillips/Suntzeff - 1990s)
    - successful search with photographic plates and CCD follow-up observations
    - coordinated spectroscopy
    - basis for SN cosmology by providing the nearby sample (Hamuy et al. 2006)



Nearby supernova surveys

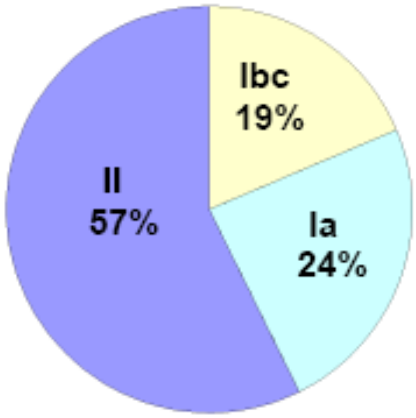
- Nearby – z<0.03
  → mostly focused on prominent, large galaxies
  → "stellar explosions → look where the stars are"
  - amateurs
    - many, over long periods
    - well organised (e.g. finding charts, networks, Web pages)
    - still find interesting objects, often find them early
  - LOSS/LOTOS
    - KAIT (first Leuschner then Lick)
    - running for over 15 years (11 years with KAIT – Weidong Li)
    - >1000 SNe discovered – all types
    - best nearby sample for SN rates
    - results are being published
      - Smith et al. 2010, Leaman et al. 2010, Li et al. 2010ab

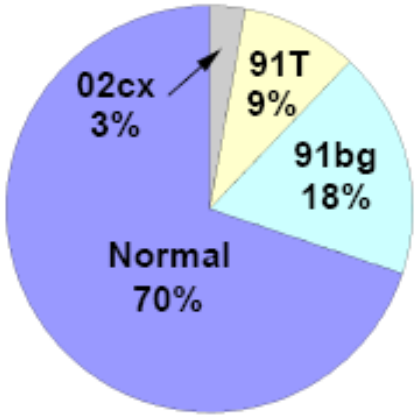
Lick Observatory Supernova Search

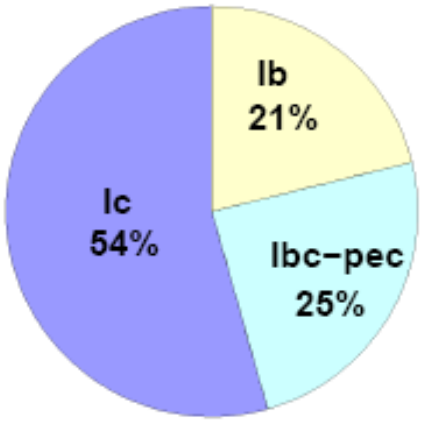


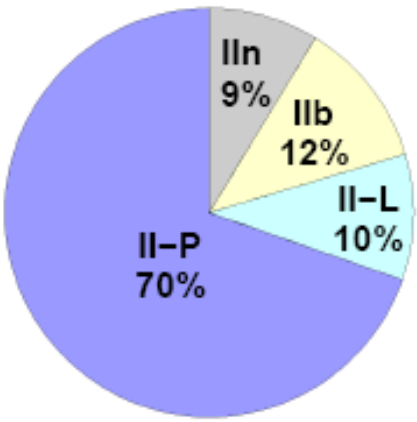
	no classification
	14
	1.6%
	12
	1.6%

All SNe Ia SNe Ibc SNe II









Nearby SN surveys

- Nearby (cont.)
  - Center for Astrophysics
    - follow-up of interesting objects – all types
    - active for the past 2 decades
    - many individual and peculiar objects
    - most extensive nearby SN Ia sample
      - critical for the cosmology (e.g. Riess et al. 1999, Jha et al. 2003, Hicken et al. 2009)
  - Carnegie Supernova Project – CSP
    - nearby and distant SN follow-up
    - all types
    - including on IR light curves
      - Hamuy et al. 2006, Phillips et al. 2007, Folatelli et al. 2010

Nearby SN surveys

- ROTSE-III
  - Akerlof et al. 2003
- SN Factory
  - see talk by Childress
  - 600 SNe in two years
  - mostly unpublished
- Quest (Palomar/La Silla)
  - continuation of SN Factory search in southern sky
- CHASE
  - new search providing mostly bright supernovae (e.g. 2010ev)
- Catalina Real-Time Transient Survey
  - covers 26000 □°
  - 62 SNe in six months
  - publish events through VOEvents
    - Drake et al. 2009

Nearby SN surveys

- Palomar Transient Factory
  - see Mark Sullivan's talk
  - >500 SNe in one year
    - most not reported to IAU
    - several peculiar objects detected
      - Avishai Gal-Yam's talk
    - 'unbiased' statistics
- PanSTARRS-1
  - started this year
  - expect 26000 core-collapse SNe year^{-1}
    - most not reported
      - Young et al. 2008

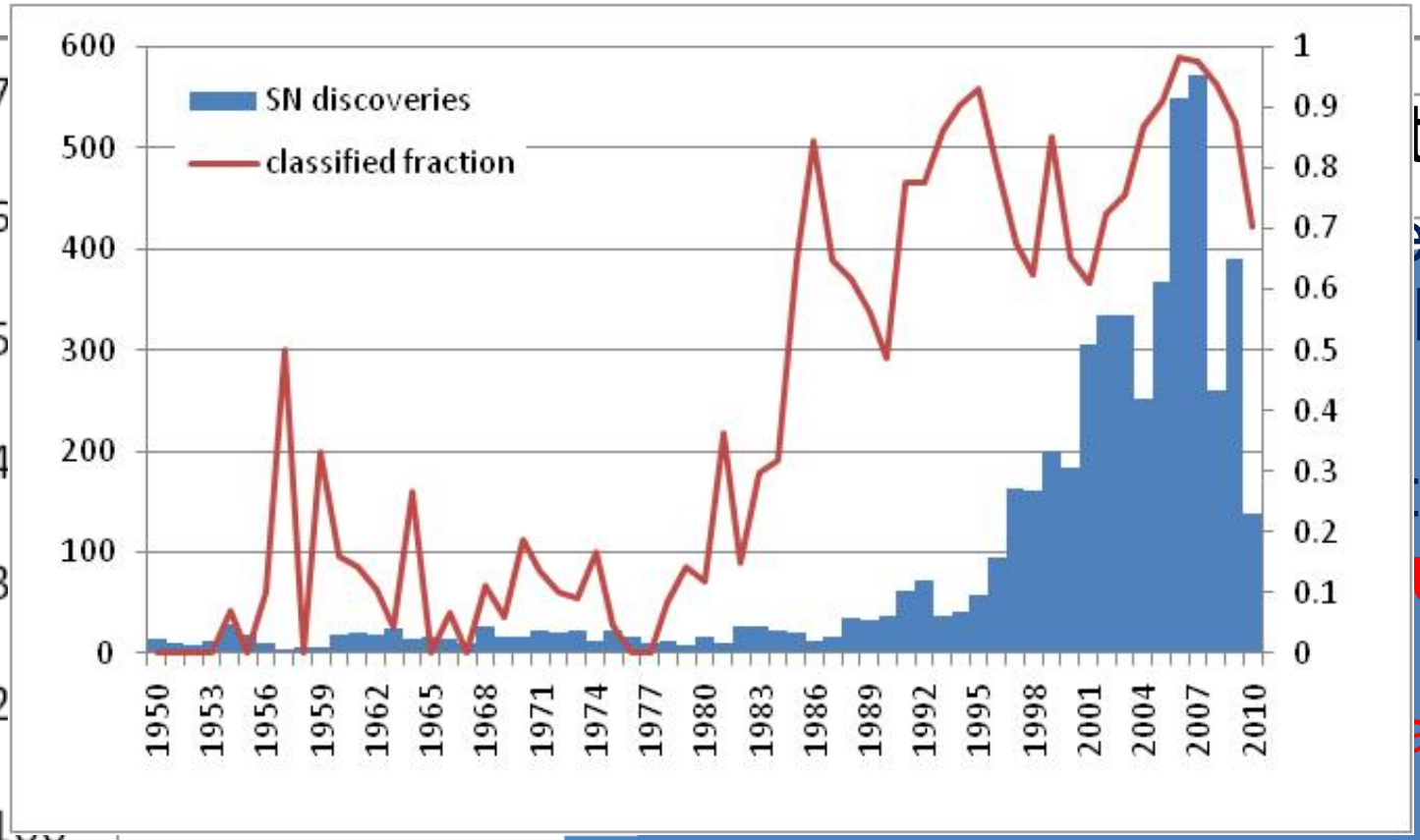
Distant SN surveys

- Intermediate 0.03<z<0.3
  - SDSS
    - see Bob Nichol's talk
      - Kessler et al. 2009
  - CSP
      - Freedman et al. 2009
- Distant z>0.3
  - Danish distant SN Search
    - Danish 1.54m telescope on La Silla
    - two year search
      - 1 Type Ia (Norgaard-Nielsen et al. 1989), 1 Type II (Hansen et al. 1989)
  - Supernova Cosmology Project
    - several projects (NOAO, AAT, CTIO 4m)
    - started 1991
      - Perlmutter et al. 1995, 1997, 1999, Knop et al. 2003
  - High-z SN Search Team
    - CTIO 4m
    - started 1995
      - Schmidt et al. 1998, Riess et al. 1998, Tonry et al. 2003

Distant SN surveys

- CFHT SN Legacy Survey
  - CFHT+MegaCam
    - 4 filters, six years, rolling search all year
      - Astier et al. 2006, Howell et al. 2006, Sullivan et al. 2006ab and many more
  - ESSENCE
    - 2 filters, six years, search during 3 months per year
      - Miknaitis et al. 2007, Wood-Vasey et al. 2007, Foley et al. 2008, 2009
  - GOODS HST SN Search/SHOES/PANTS
    - highest-z SNe Ia so far (z>1.2)
      - Riess et al. 2004, 2007, 2009, Strolger et al. 2004

Some thoughts on current status



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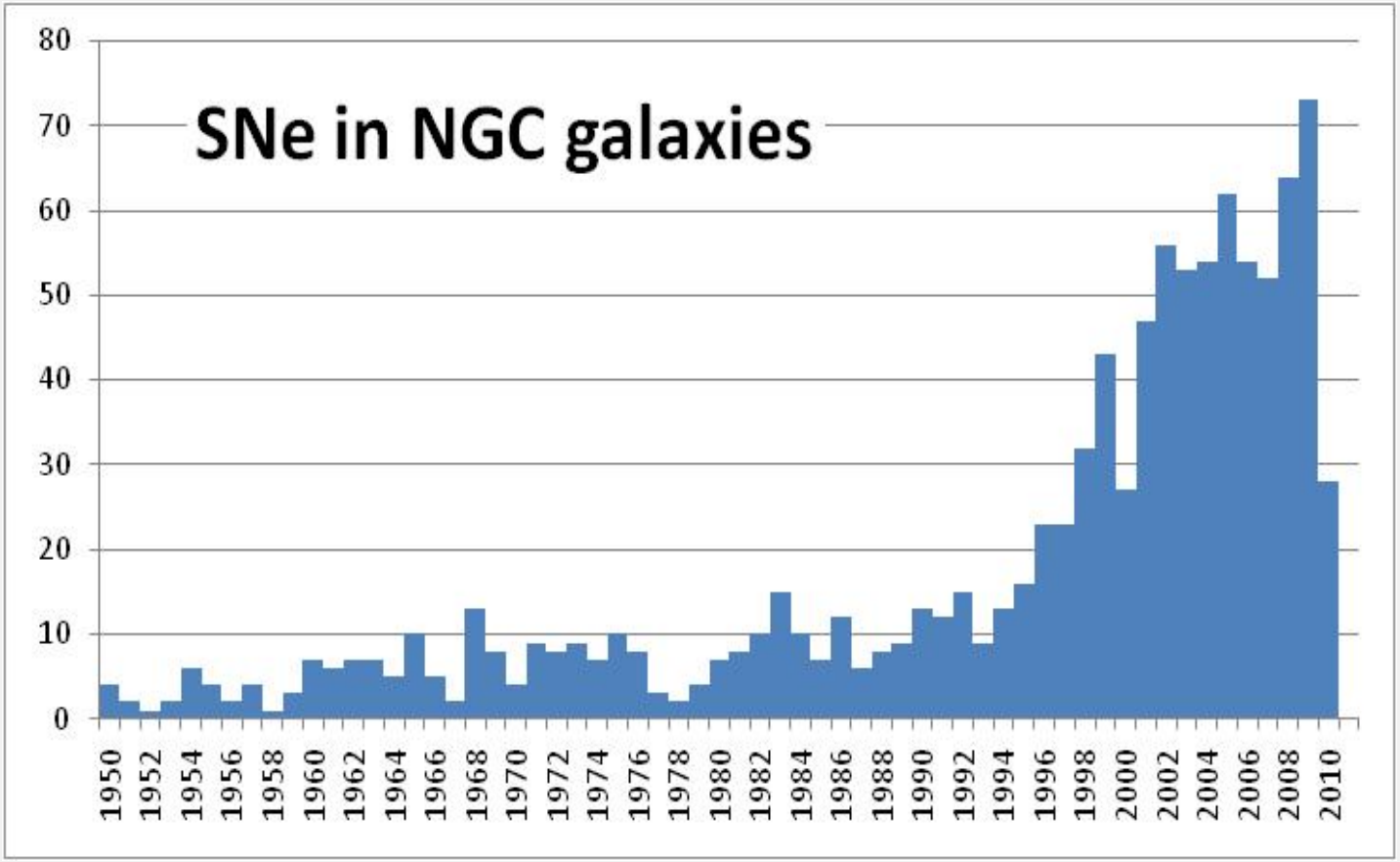
– Most reported supernovae are classified

1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

Nearby supernovae

- More bright supernovae discovered



Surveys targeting SN progenitors

- SPY
  - search for white dwarf binaries that will merge within a Hubble time
- VLT-FLAMES Survey of Massive Stars
- Smartt/VanDyk HST/Keck/VLT programs to detect massive stellar progenitors
- X-ray surveys
  - Roelofs et al. 2008 – failed in this case, but still promising
  - X-ray all sky surveys – eROSITA?

Direct observations of SN progenitors

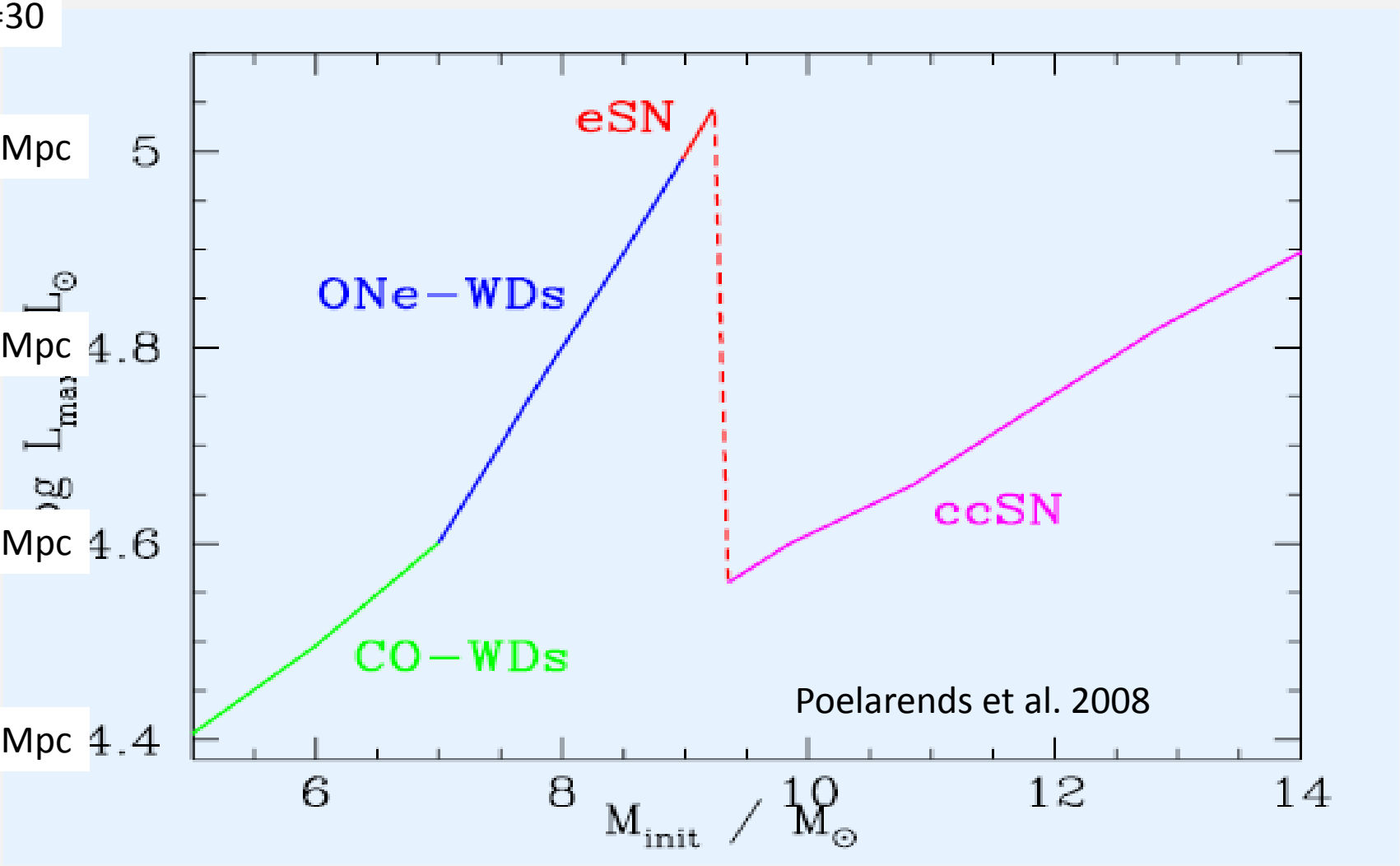
m=30

350Mpc

280Mpc

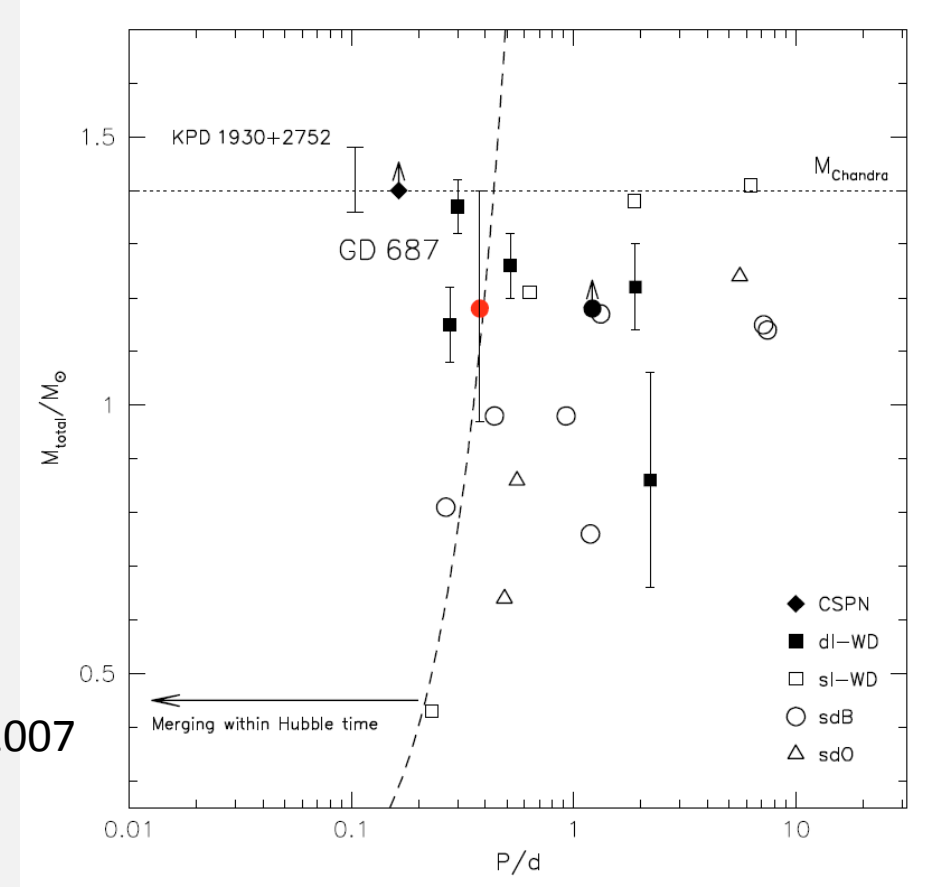
220Mpc

180Mpc



Supernova Progenitor surveY

- ~1000 white dwarfs checked for radial velocity changes → search close binaries
  - are there double degenerate white dwarfs in the solar neighbourhood?
  - discovered ~100 double degenerate systems



Napiwotzki et al. 2007
Geier et al. 2010

Other searches for SN signatures

- υ-surveys
  - heavily discussed in the υ community
  - science case for various current and future υ detectors (e.g. AMANDA or ICECube)
- IR surveys (VVV, VIDEO, UltraVista)
  - just started – too early to tell

Future surveys

- Several searches/surveys continue:
  - Amateurs, LOSS, CfA, CHASE, PTF, PanSTARRS-1
- New surveys
  - SkyMapper
    - 1.35m telescope, 4 filters, 1250 □° 'rolling'
    - expect ~400 SNe per year
    - IR follow-up organised
    - to start seriously next year
  - GAIA transient sources
    - expect ~6000 transients during mission

Future distant surveys

- CANDELS/CLASH
  - part of two HST multi-cycle treasury programs
  - z>1.5 SNe for rates
    - see Enikö Regös' talk
      - Riess et al.
- DES
  - several hundred SNe Ia
    - see Bob Nichol's talk
      - Bernstein et al. 2008
- PanSTARRS-4/LSST
  - >100000 supernovae per year
- EUCLID/JDEM
  - EUCLID: SNe not main driver (weak lensing and BAO)
    - details by Bob Nichol
  - JDEM: BAO and supernovae
  - expect several thousand SNe

Cosmology - do we need more?

- Already in hand
  - >1000 SNe Ia for cosmology
  - constant ω determined to 5%
  - accuracy dominated by systematic effects
    - reddening, correlations, local field, evolution
- Test for variable ω
  - required accuracy ~2% in *individual* distances
  - can SNe Ia provide this?
    - can the systematics be reduced to this level?
    - homogeneous photometry?
    - further parameters (e.g. host galaxy metalicity)
    - handle >100000 SNe Ia per year?

More supernovae

- Increase in interesting supernovae
  - many more general searches
    - remove paradigms
  - possible through the technological progress
    - detectors, data storage, data handling and processing
  - Need to keep the overview
- Improved understanding
  - hints on explosion physics
  - statistical samples
    - progenitor environments – ‘short fuse’ required
    - rates → clues on progenitor systems

More supernovae

- (Do we need a definition of what is a supernova?)
- Do we need a central SN database?
  - collect all SN discoveries?
  - IAU database outdated and not capable to supported most new searches
- Follow-up observations
  - classification
  - critical to explore the physics
    - explosions
    - nucleosynthesis
    - asymmetries
    - peculiarities
    - masses