Type Ia Supernovae in Globular Clusters

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with

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What We Don't Know Might Hurt Us

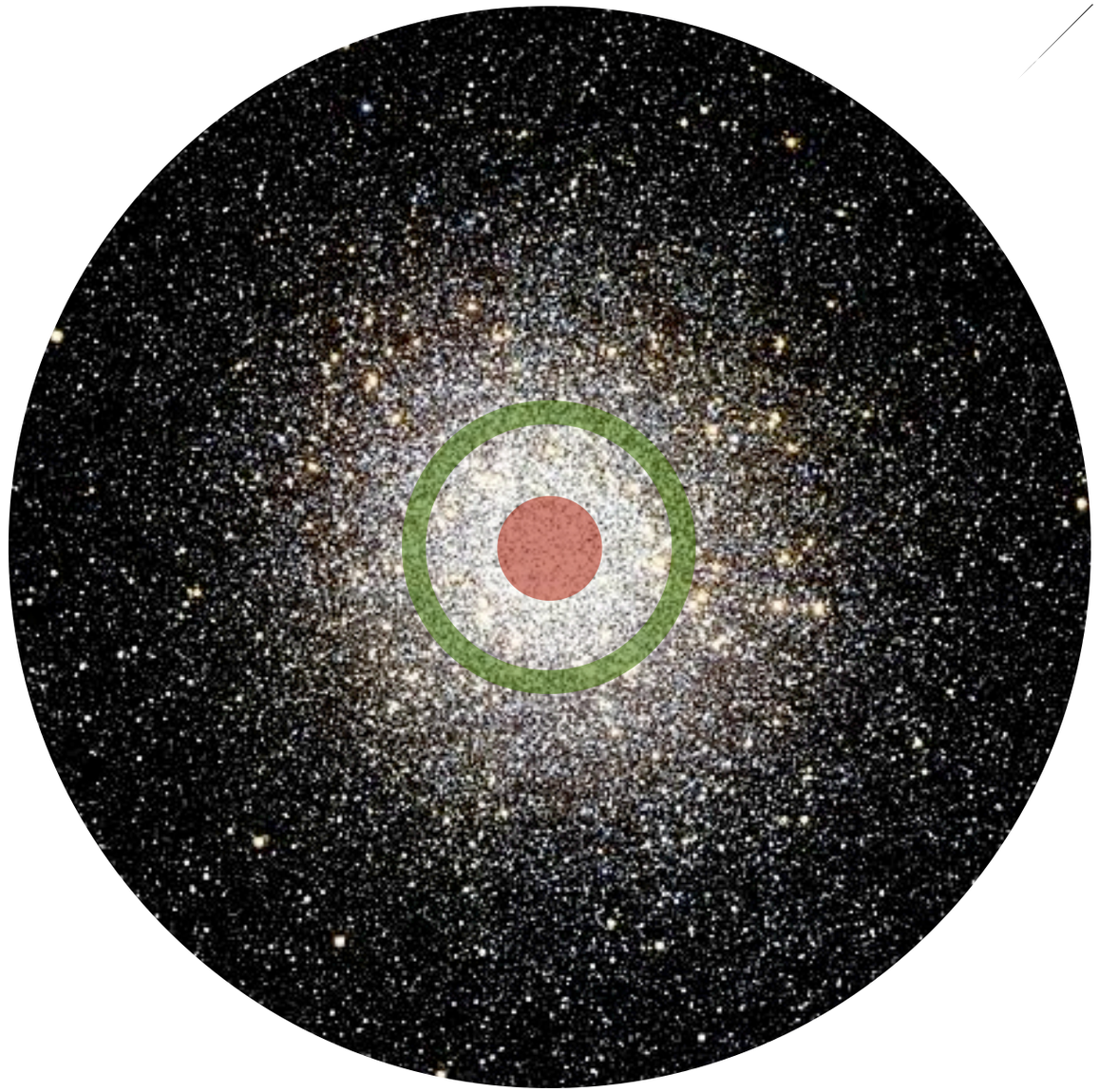
- Yes, Ias are exploding WDs.
- Yes, they're in binaries.
- But what channels lead to Ias?
- Do Ia characteristics depend on Z? On age?
- There is diversity. What causes this?
- Does any of this affect the cosmological results?

We need better constraints on Ia environments.

What is a Globular?

- Bound collection of $>10^5$ stars.
- Relics of galaxy formation.
- Typically old (10 Gyr).
- Typically subsolar Z.
- Internal ages and Zs constant.
- 10^4 - 10^6 stars pc^{-3} in center.

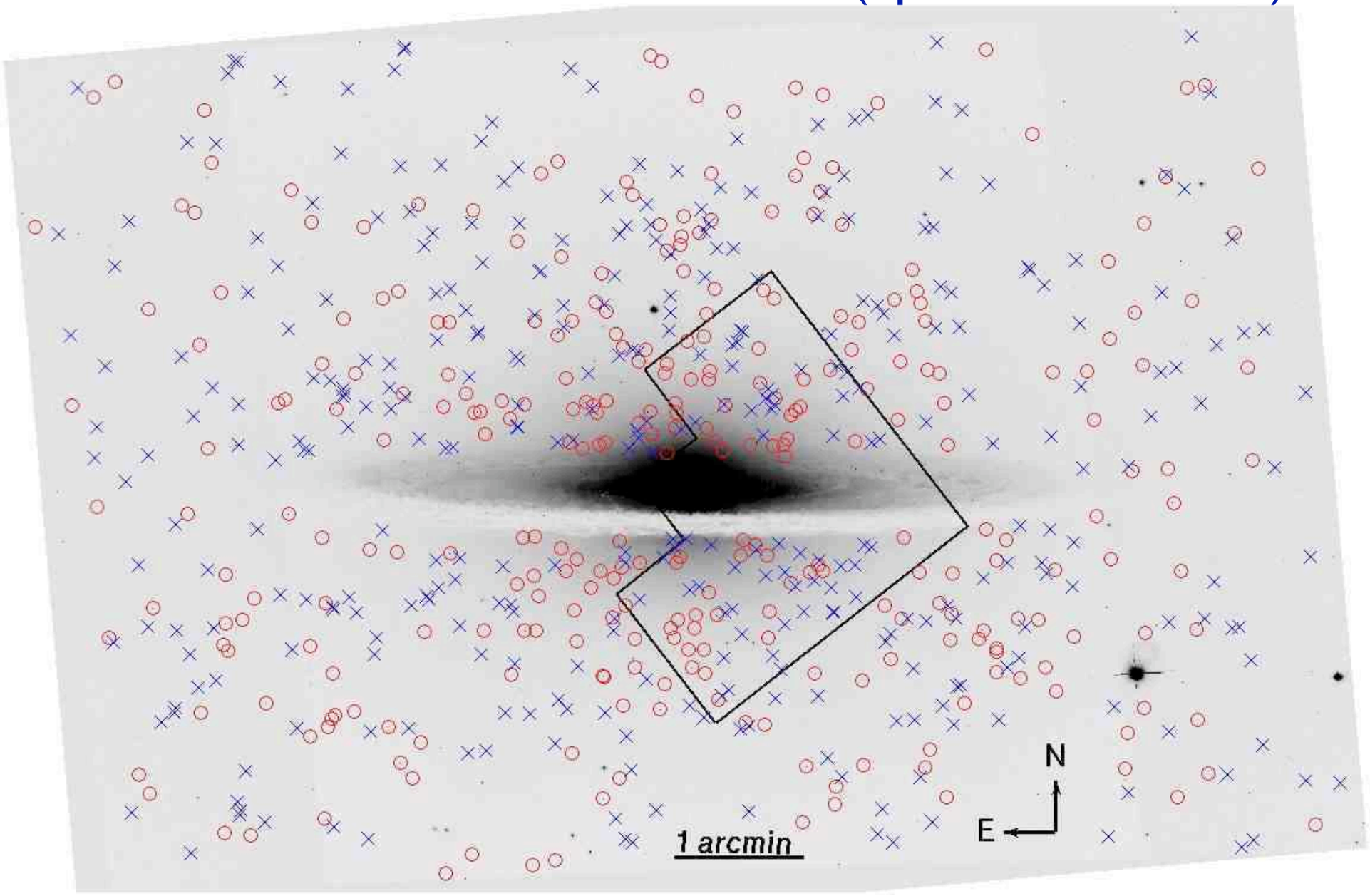
L, Age, and Z measurable!



~3 pc

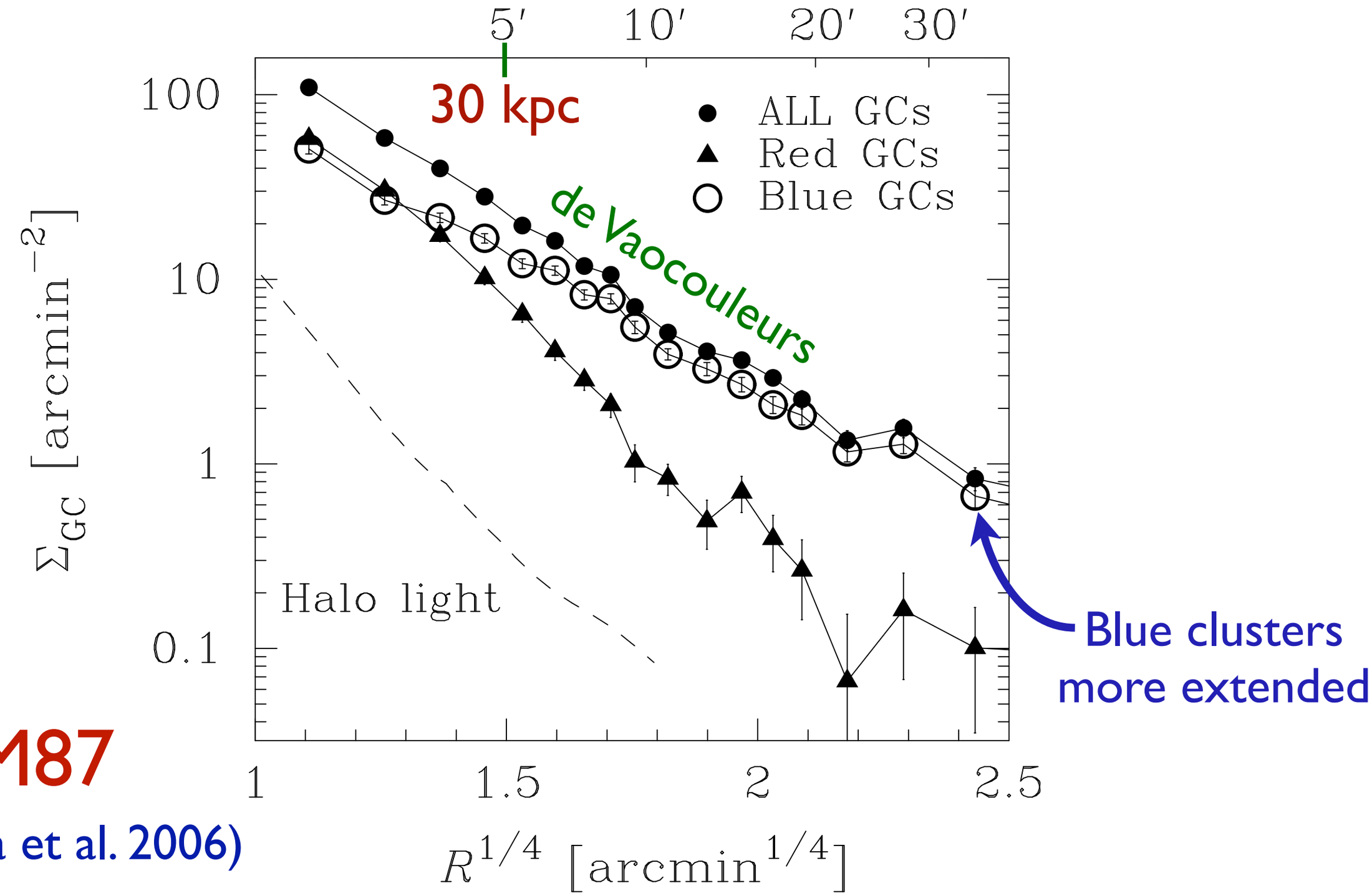
Globulars in Spirals

(Spitler et al. 2006)



M104 (Sombrero)

Globulars in Ellipticals

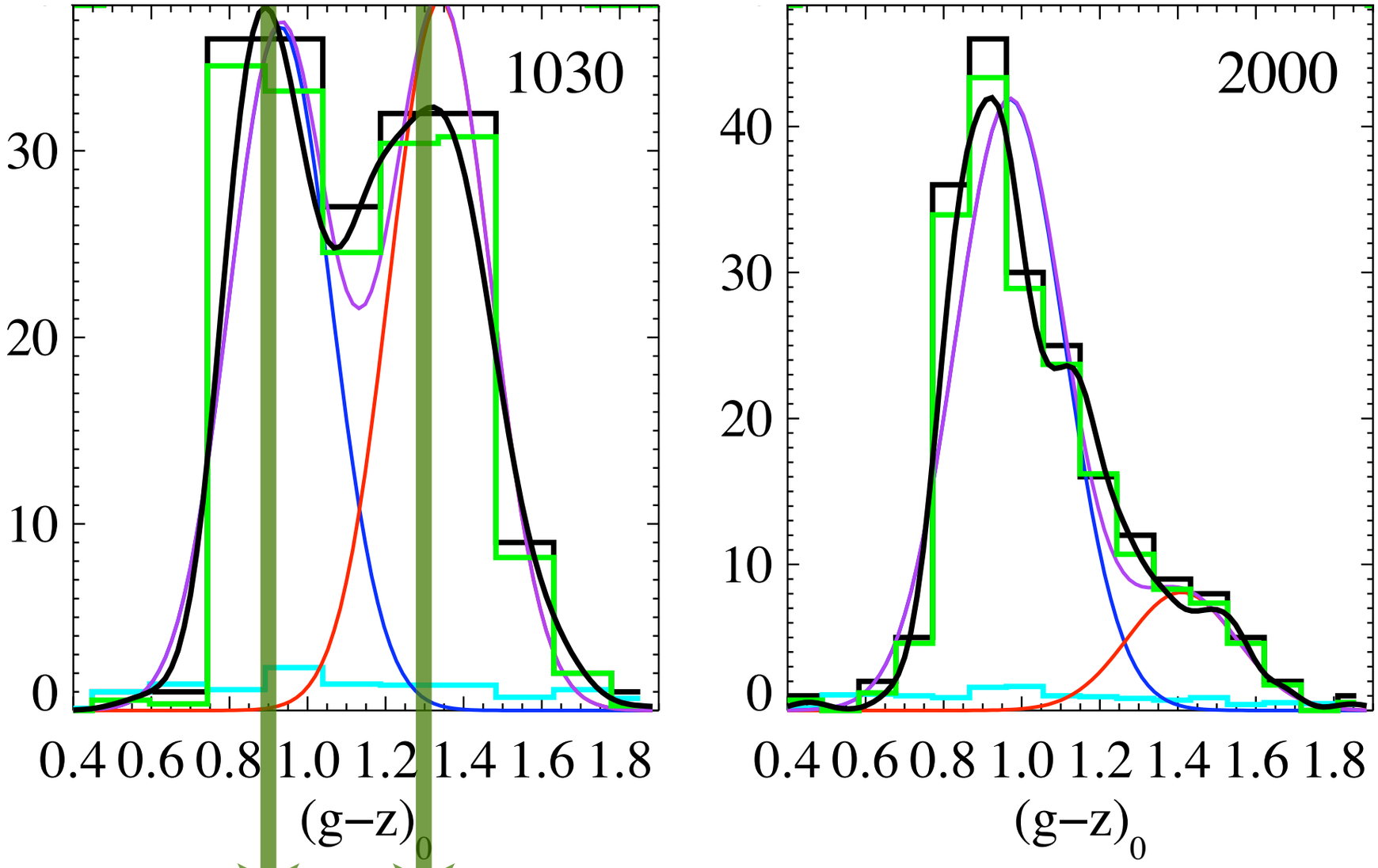


Blue clusters more extended

M87

(Tamura et al. 2006)

Metallicities

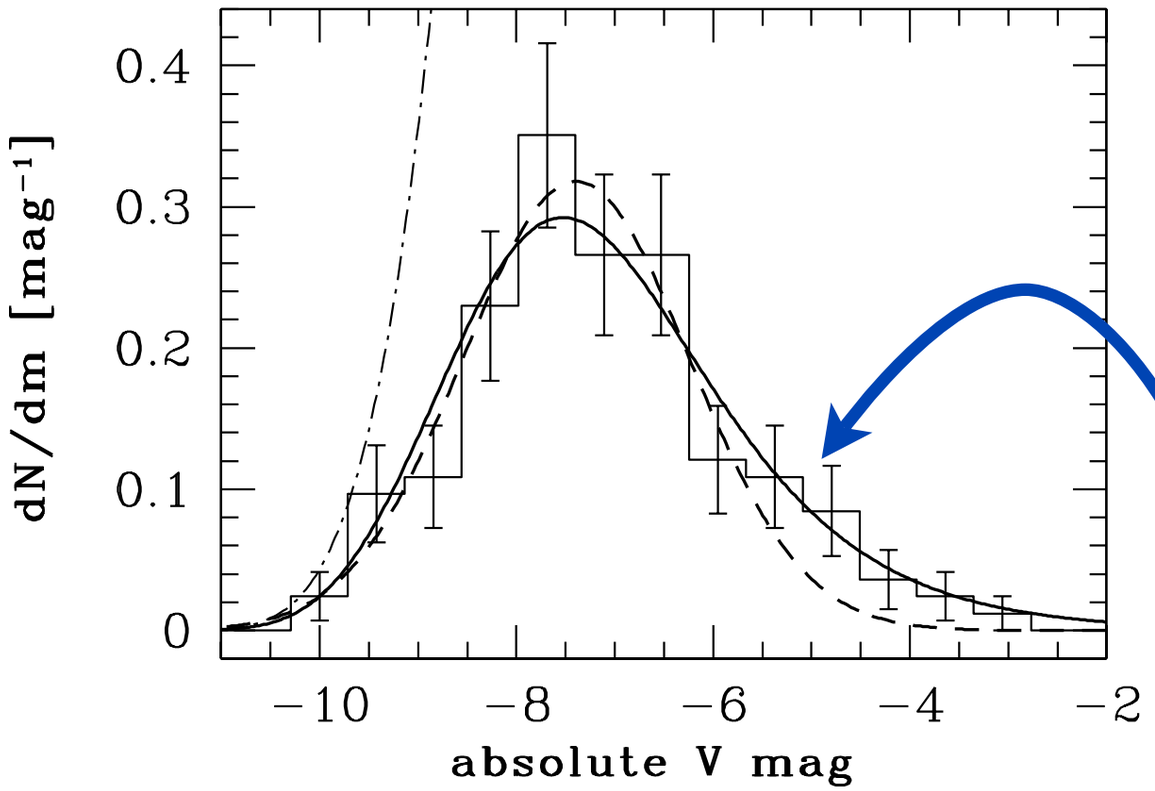


[Fe/H] = -1.5 -0.5

(Peng et al. 2006)

Luminosity Function

Milky Way

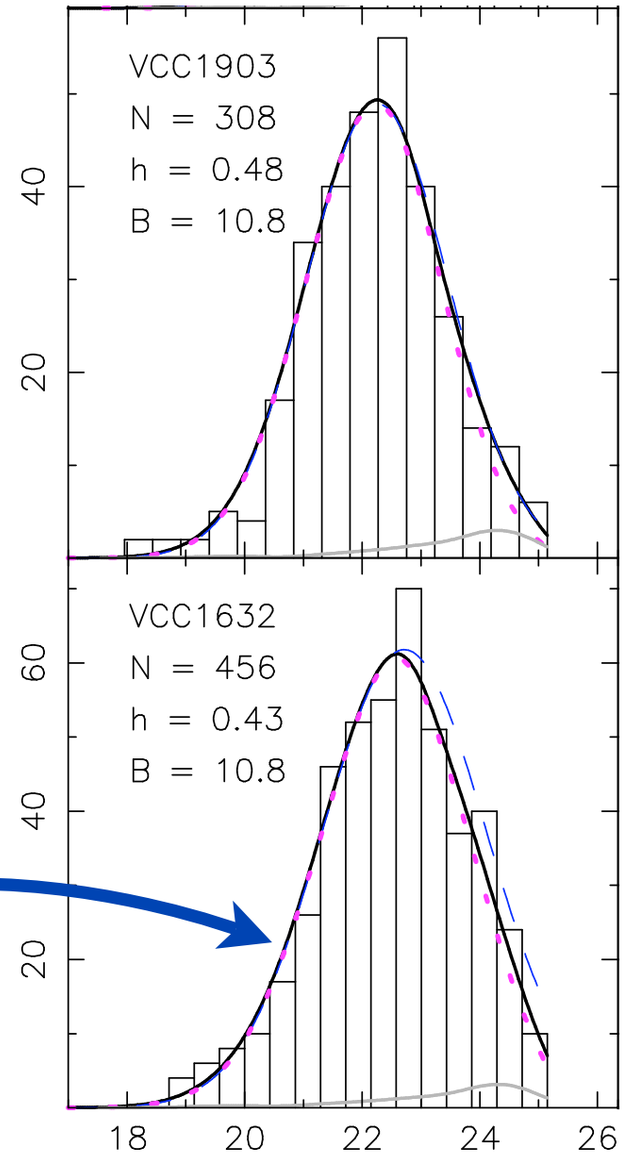


$$\langle \mathcal{M}_V \rangle = -7.5$$

$$\sigma = 1\text{–}1.5$$

Roughly Gaussian

Virgo



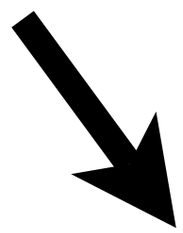
(Jordan et al. 2007)

Numbers

Specific Frequency: $S_N = N_{GC} 10^{0.4(\mathcal{M}_V + 15)}$

Spirals

$S_N \sim 1\text{-}2$



~200 GCs in the MW

Ellipticals

$S_N \sim 2\text{-}5$

~10^4 GCs in M87!

Mass Fraction

GC Mass Fraction: $F_{GC} = M_{GC}/M_{gal}$

$$F_{GC} \sim 10^{-3} S_N \frac{m_5}{\Upsilon_{V,gal}}$$

$$\left(\Upsilon_V = \frac{\text{Stellar Mass } [M_\odot]}{\text{Stellar Light } [L_{\odot,V}]} \right)$$

$$\left(m_5 = \frac{M_{GC}}{N_{GC} 10^5 \, M_\odot} \right)$$

A small fraction of las...

Rate

Low-z Ia rate: ~$10^{-4.5}$ yr^{-1} Mpc^{-3}

$$\sim 100 \left(\frac{D}{100\,\mathrm{Mpc}} \right)^3 \mathrm{yr}^{-1}$$

Reach of GC studies

~3-10% associated with mass component?

(Scannapieco & Bildsten 2005)

GCIa rate $\lesssim$ few $\times 10^{-2}\,\mathrm{yr}^{-1}$ within 100 Mpc?

Dynamical enhancement?

- Dynamical interactions may enhance the rate.
- NS binaries, blue stragglers, etc., are overabundant/mass in GCs by factor of 100.
- Why not las? (Shara & Hurley 2002; Ivanova et al. 2006)
- Enhancement of x10 may not be asking much.

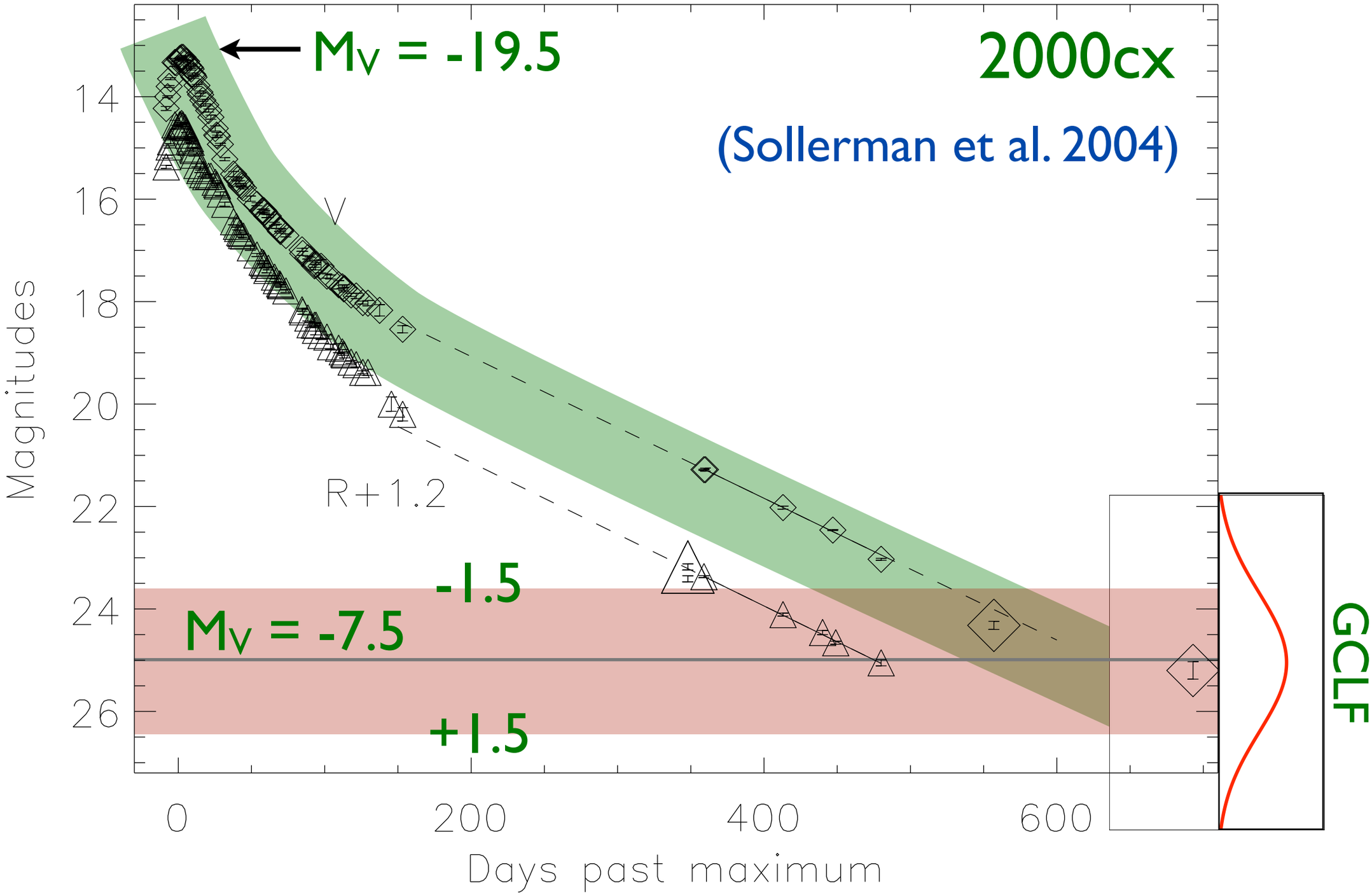
A few GClas per decade within 100 Mpc?

How do we find them?

- First, check the archive (some interesting cases).
- Use archival images (if they exist).
- Late-time followup (>1 yr).
- Especially target las with large offsets.

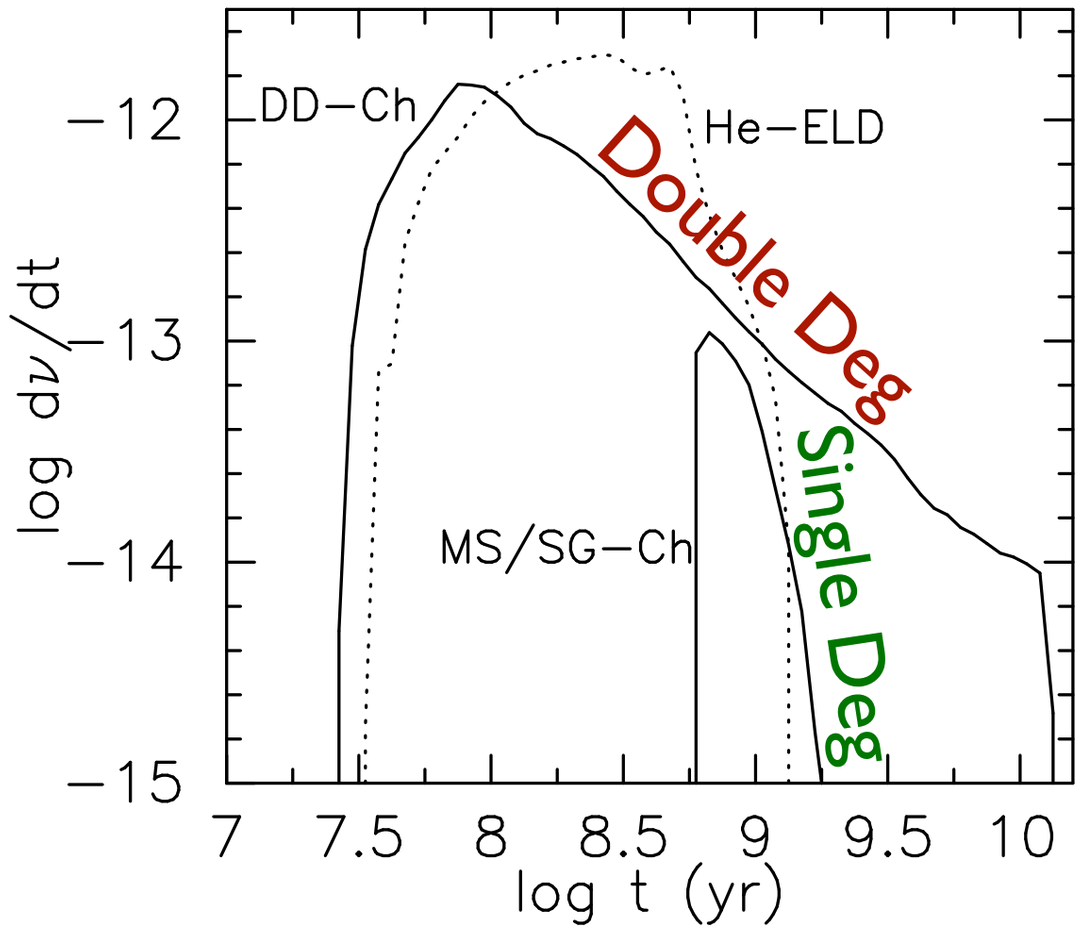
We should (and probably can) do this for every la within 100 Mpc.

Late-Time Light Curve



What do we learn?

- Are GCIas different? Peak L? Lightcurve?
- Constrain Ia progenitors?
- Affected by low Z?
- Do Ias really occur in old stellar systems? (addresses `frosting' issue)
- GCIa rate interesting for Ia progenitor models and cluster dynamics.



(Yungelson 2005)