Dynamical formation of LMXBs in the bulge of M31.

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MPA, Garching

Summary

- Nearby galaxies in general:

  LMXB population ∝ stellar mass

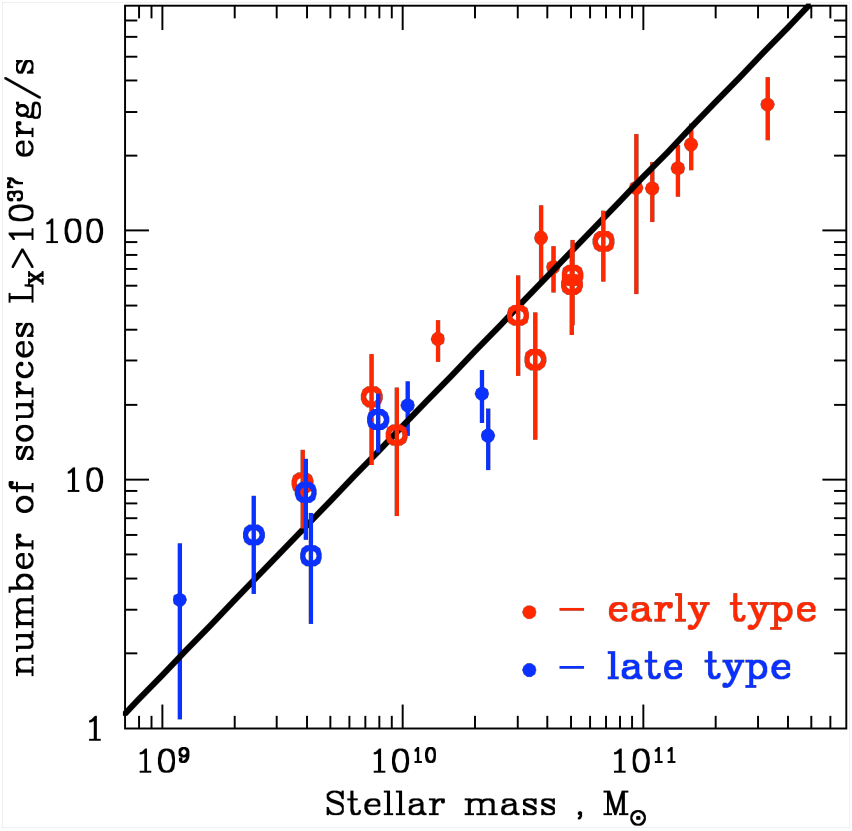
- Inner bulge of M31: **excess of bright LMXBs**

  ⌫ 2 expected, 12 observed (inside r<23″)

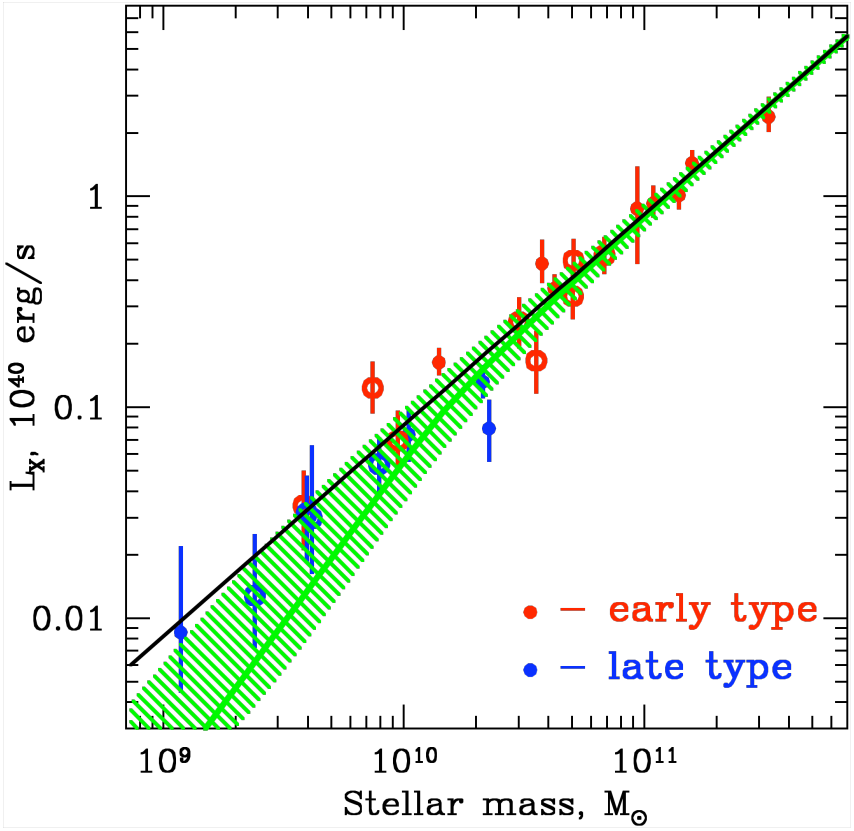
Formation of LMXBs via **dynamical interaction** (e.g. **tidal capture**) - cf. **globular clusters**

LMXBs and stellar mass

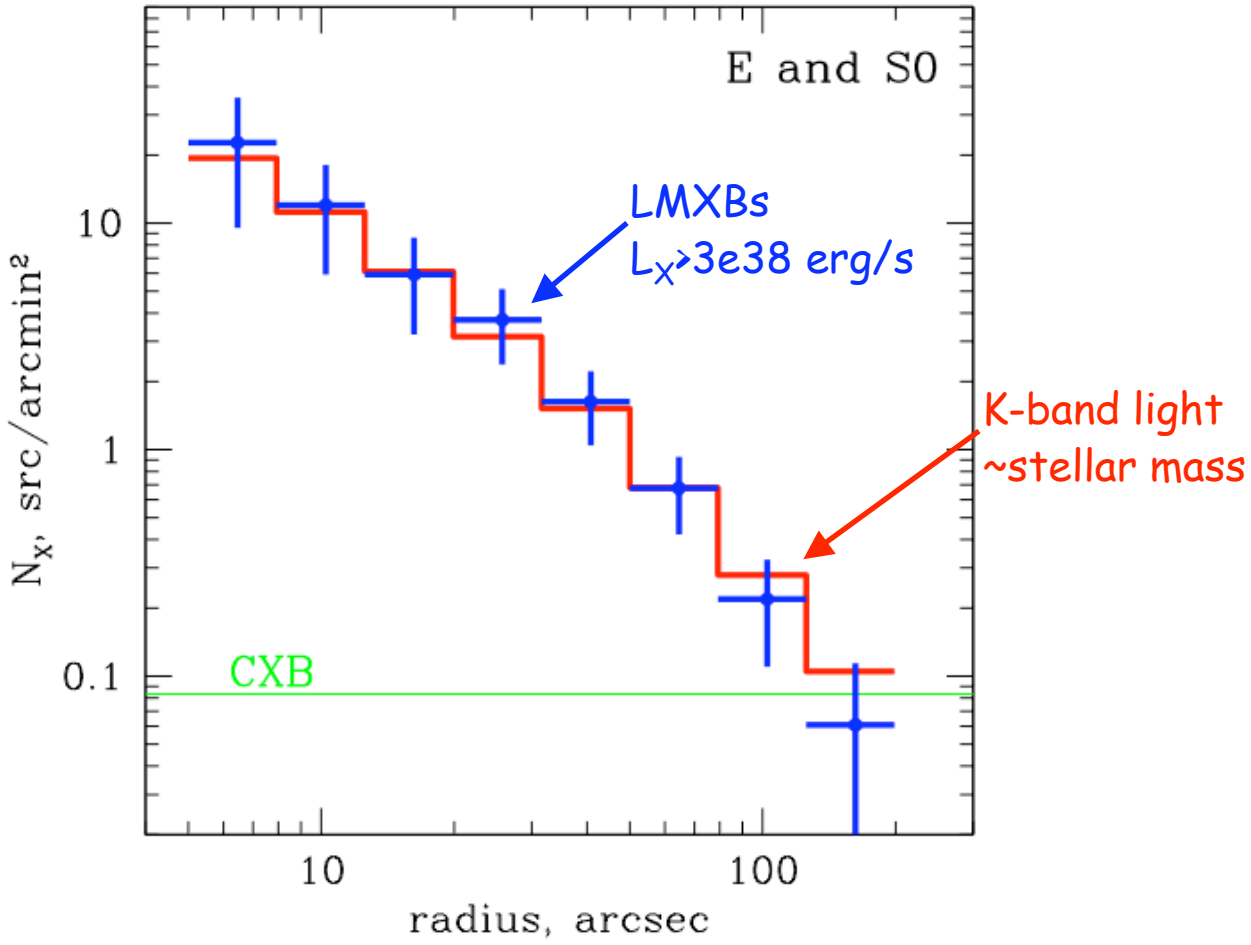
number of sources



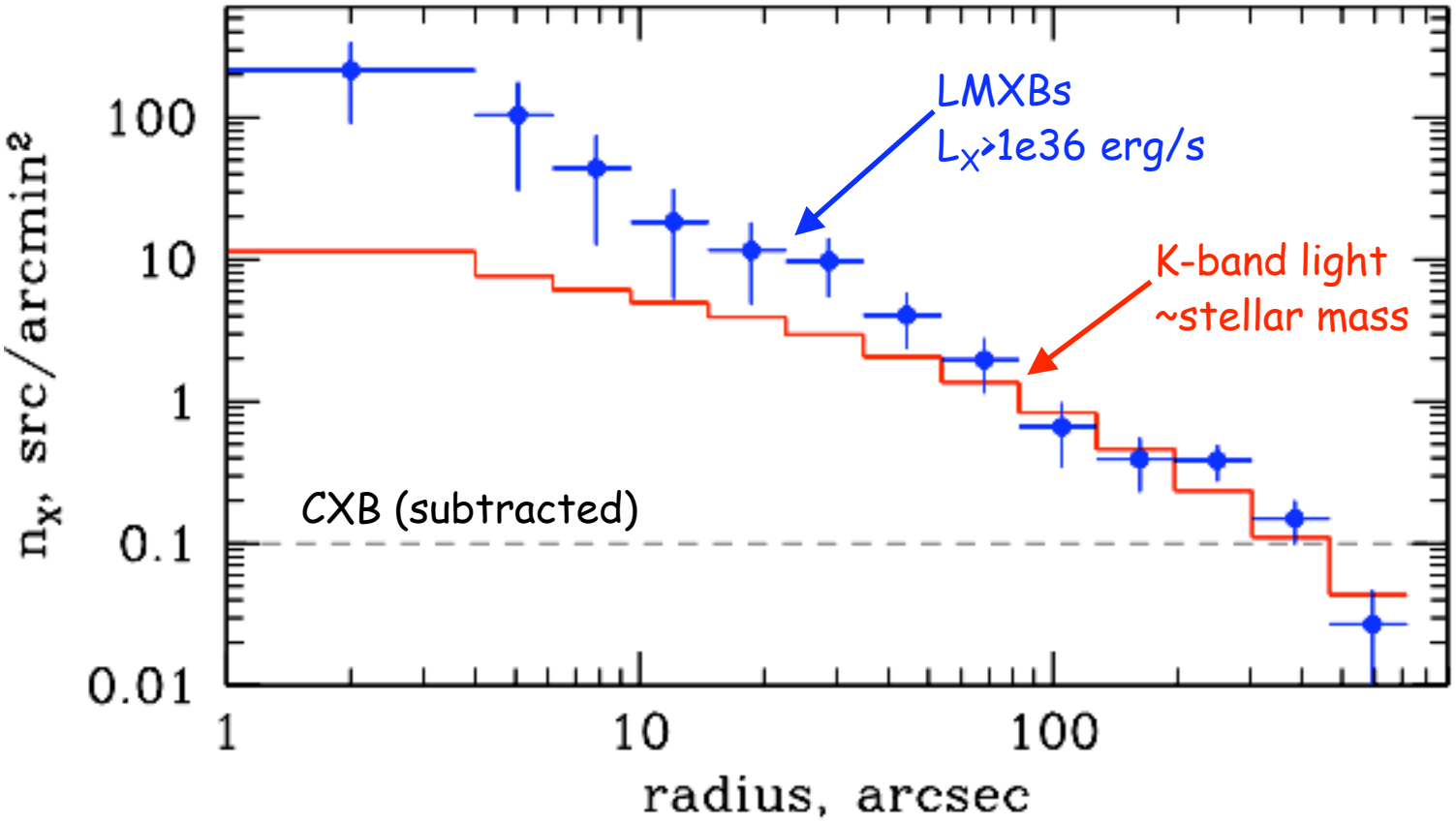
total X-ray luminosity



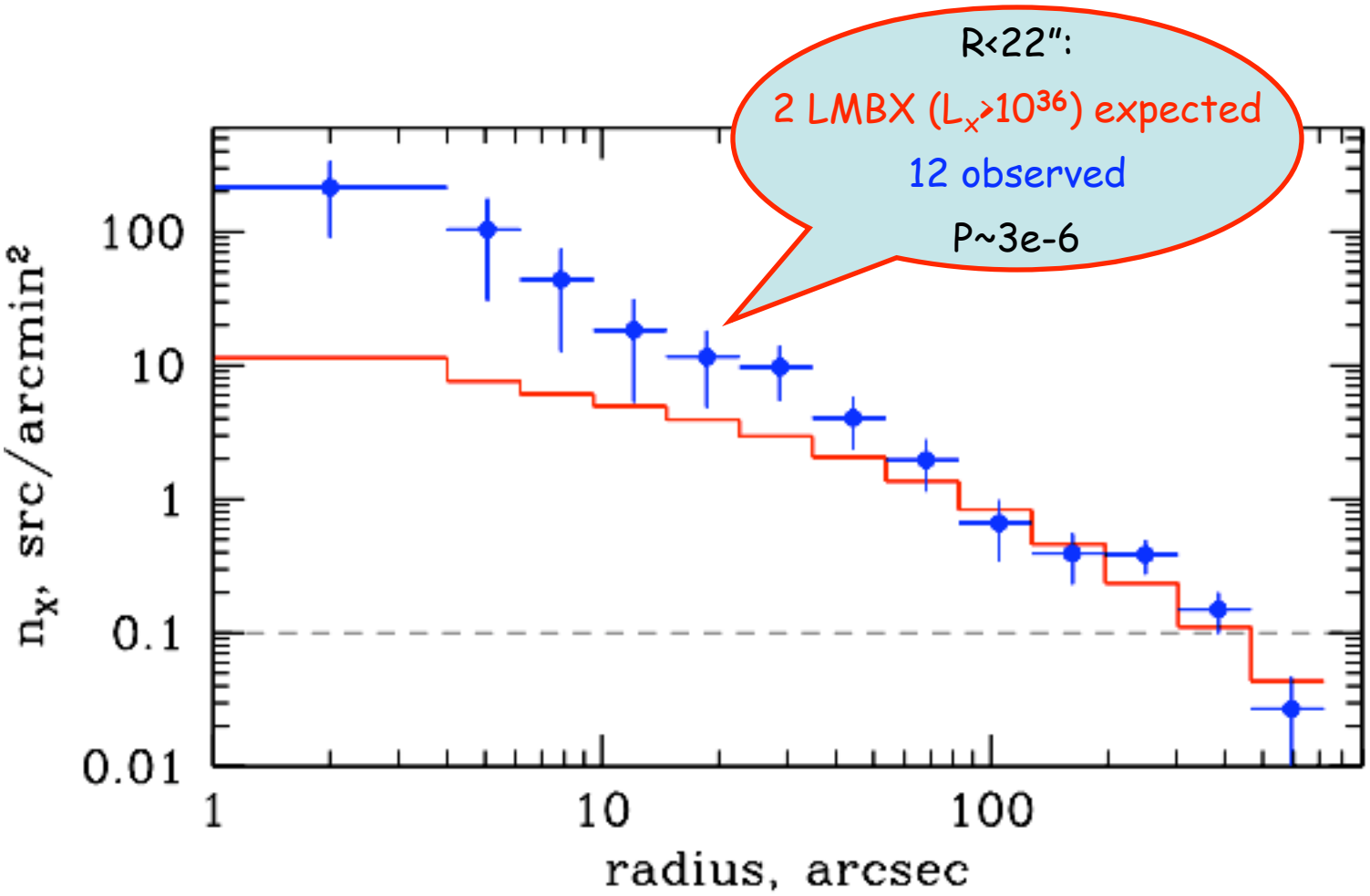
Radial profile



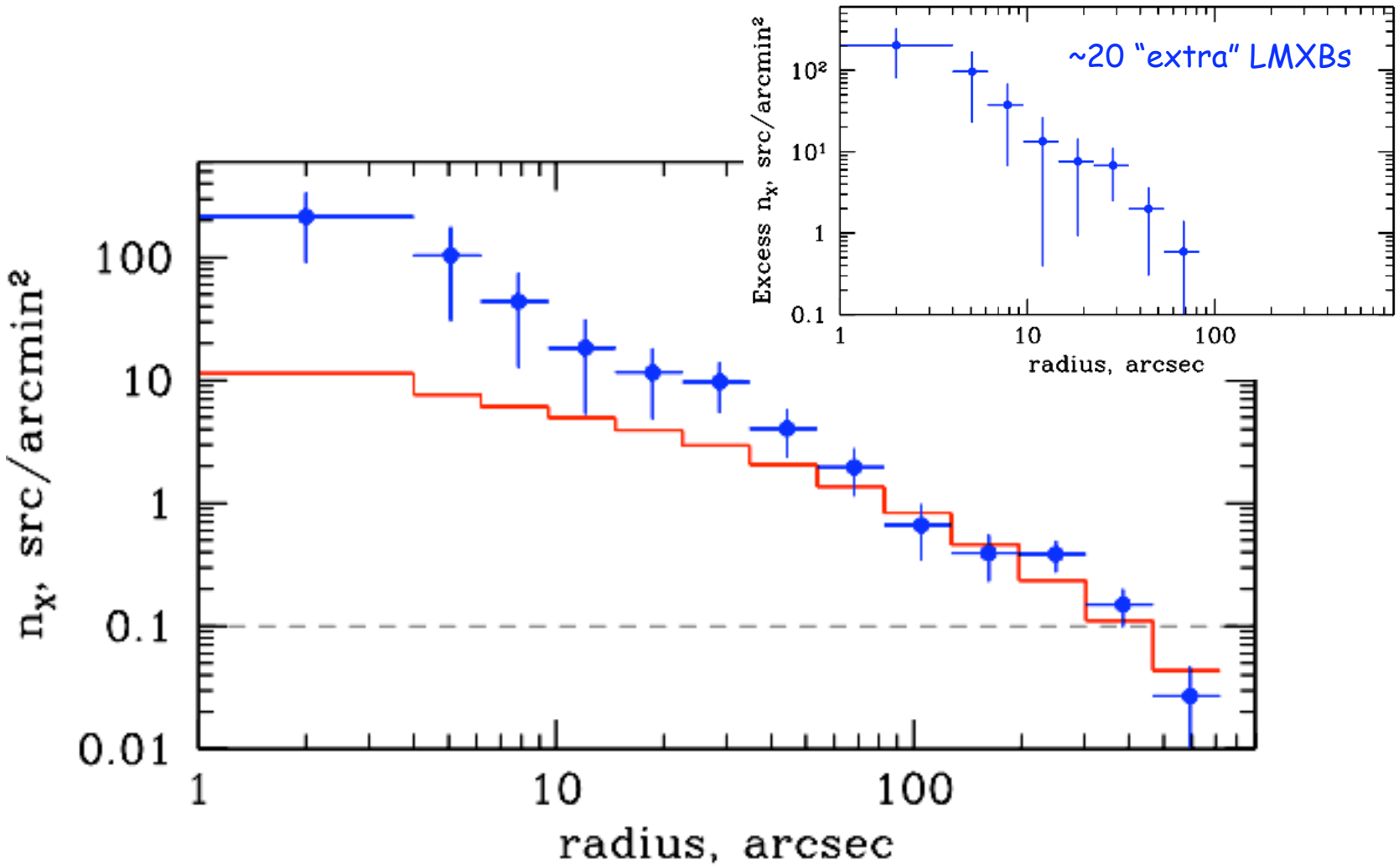
M31, radial profile



M31, radial profile



M31, radial profile



Possibilities:

- mass segregation
- destruction of globular clusters in the inner bulge
- formation of LMXBs via dynamical processes (tidal capture, exchange etc), cf. globular clusters

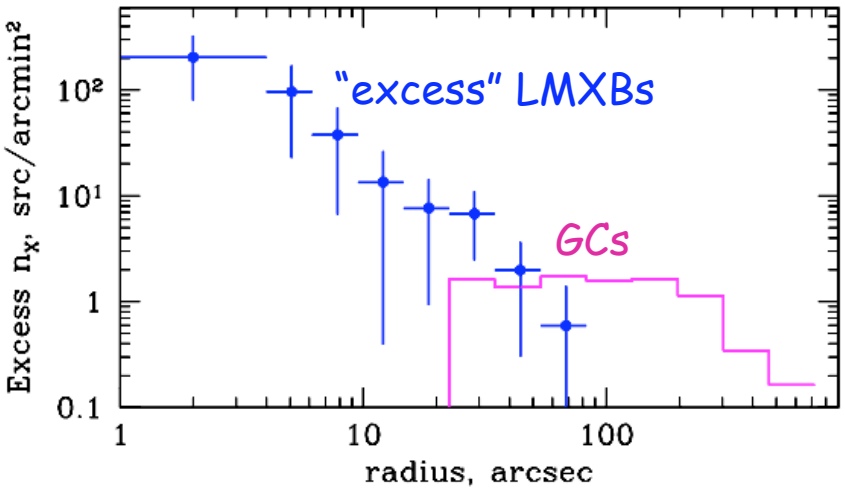
Mass segregation

time scale: $$t_{ms} \propto \frac{\left\langle v^2 \right\rangle^{3/2}}{M_1 M_2 N \ln \Lambda} \geq 10^{18} - 10^{19} \text{ sec}$$

(Spitzer, 1987)

Too long time scale

Destruction of globular cluster



- numbers:
  19 "extra" LMXBs
  19 LMXB-*GCs* (r<720"~2.7 kpc)

- LMXB life time

  $L_x > 10^{36}$ erg/s --> $\tau < 5 \cdot 10^9$ yrs

♣ ~all *GCs* in the bulge are destroyed in <5 bln yrs.

Too (?) high GC destruction rate is required

Dynamical formation

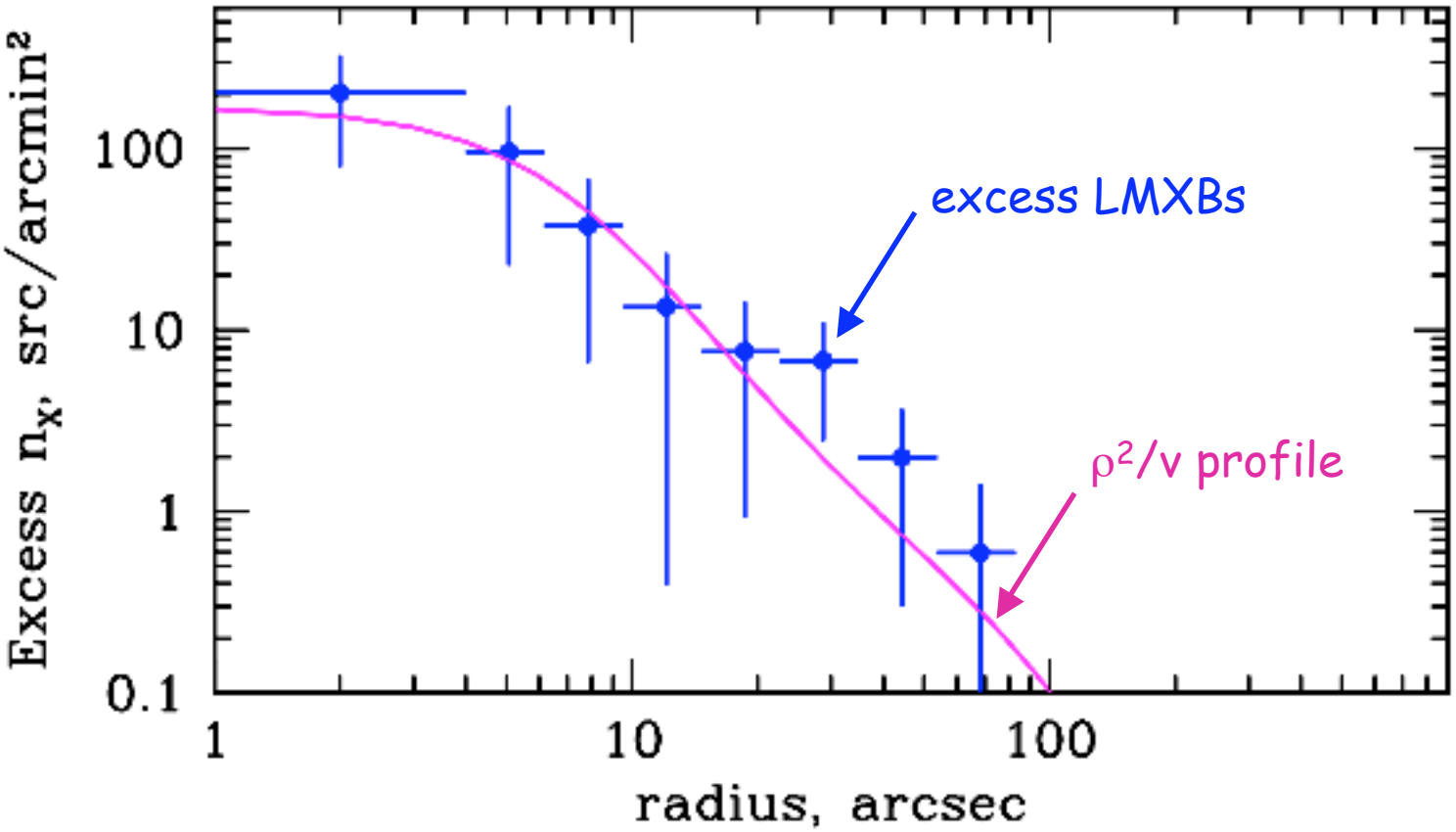
- tidal capture, binary - NS encounters, etc.
  Clark 1975; Katz 1975; Fabian et al. 1975
- high stellar density - e.g. globular clusters

- $N_{LMXB} \propto$ **encounter rate**
  Verbunt & Hut 1987;
  Pooley et al. 2003; Heinke et al. 2003

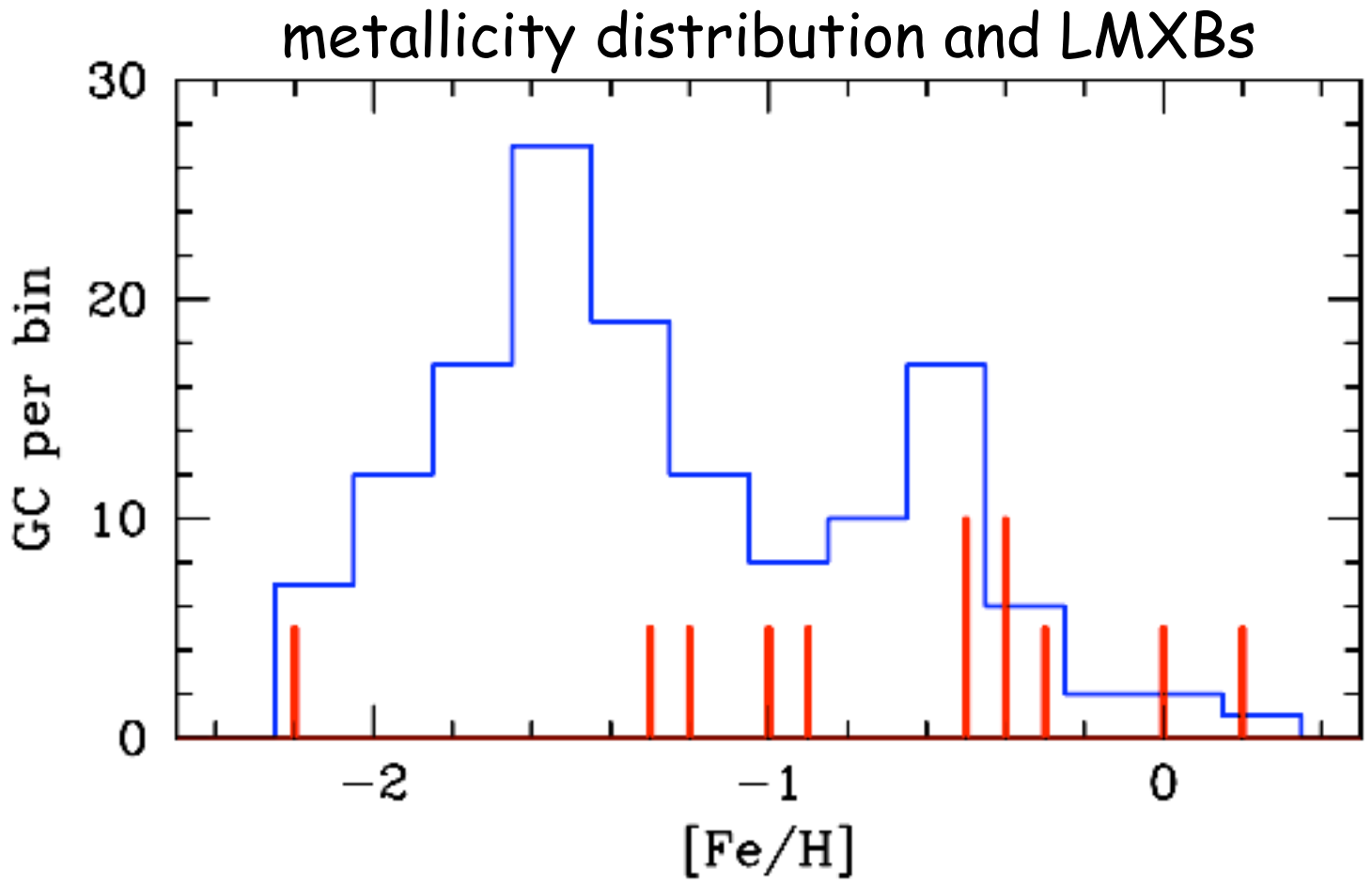
$$\Gamma \propto \frac{\rho^2}{v}$$

- Predict/explain:
  - radial profile
  - number of sources - cf globular clusters

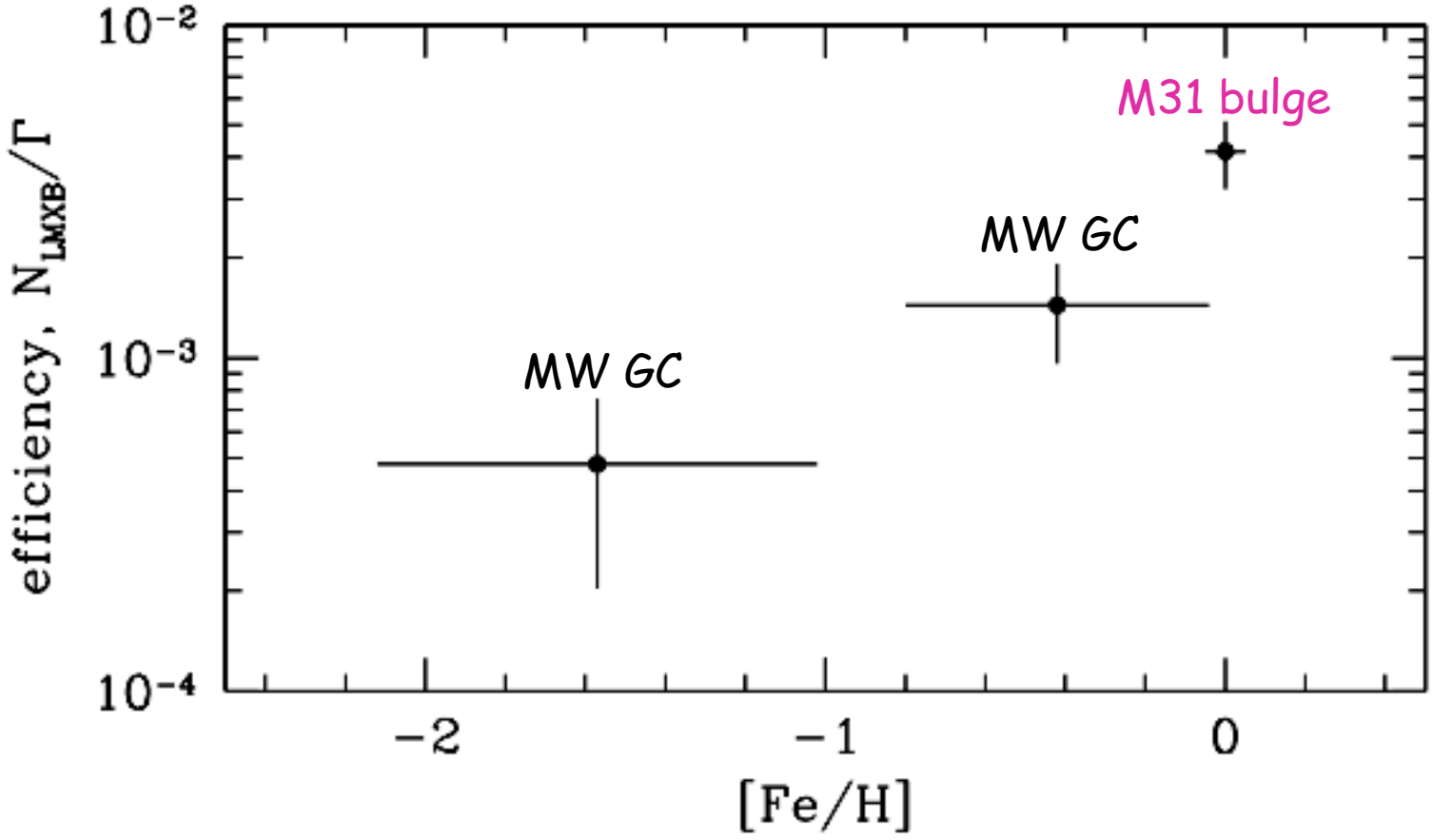
Radial distribution



Globular clusters in the MW



LMXB formation efficiency



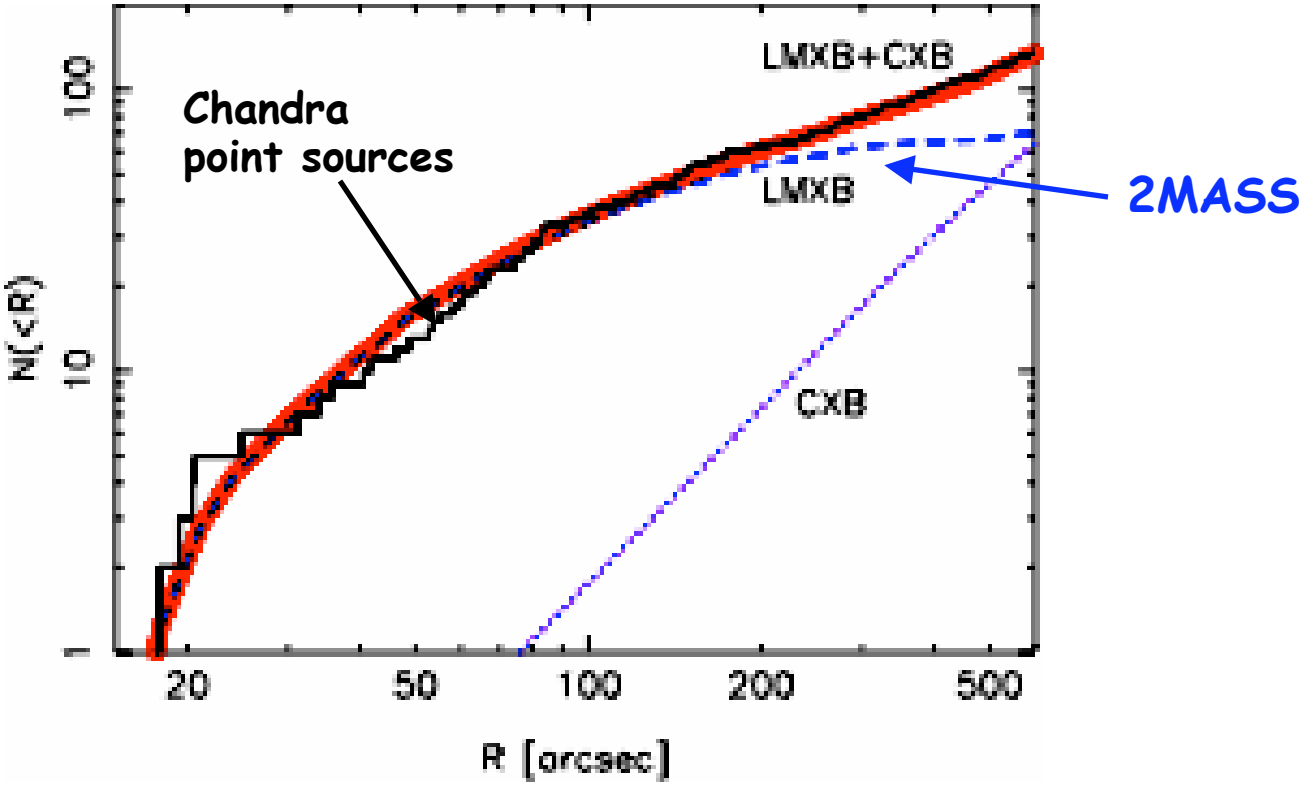
Conclusions

- **too many LMXBs** in the inner bulge of M31
- **dynamical interaction** scenario
- numbers of LMXBs (r<2.7 kpc):

primordial (?)	**dynamical interaction**	
	globular clusters	inner bulge
~60	~20	~20

The End

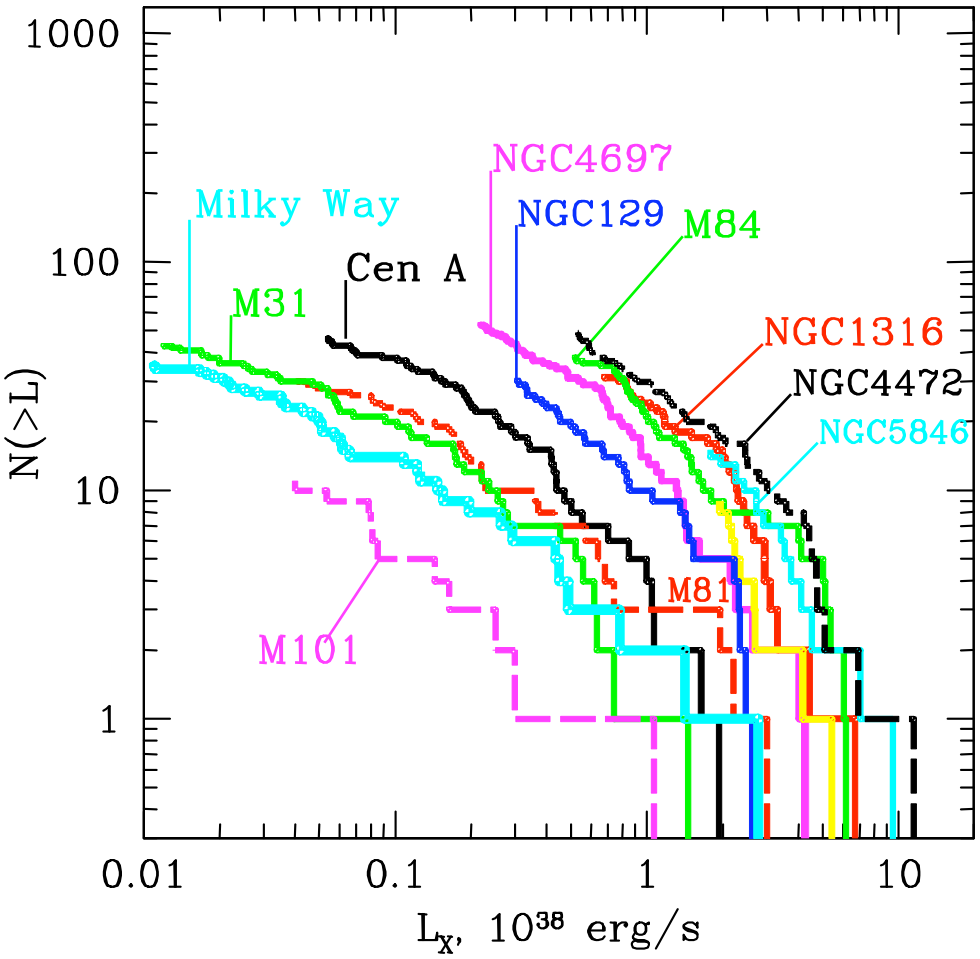
Cen A
Radial profile



LMXBs

X-ray luminosity functions:

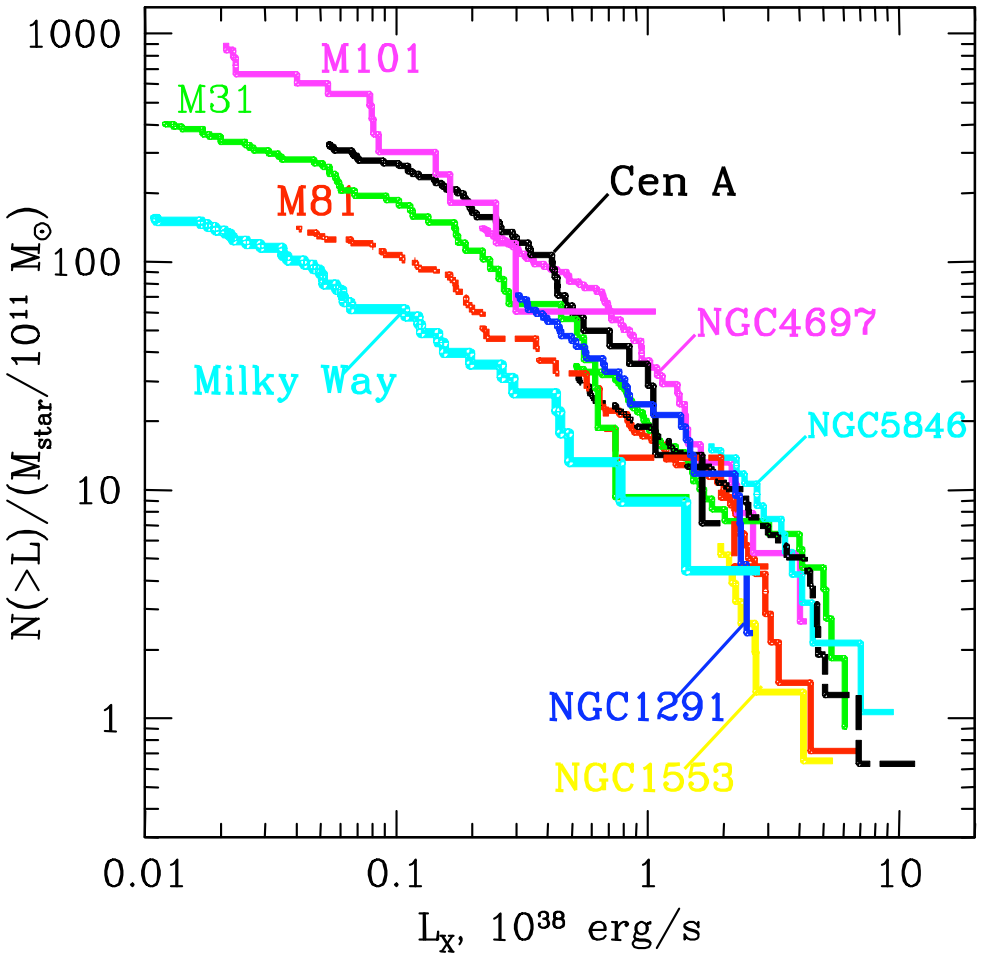
Stellar mass range:
10^9-3x10^{11} Msun



LMXBs

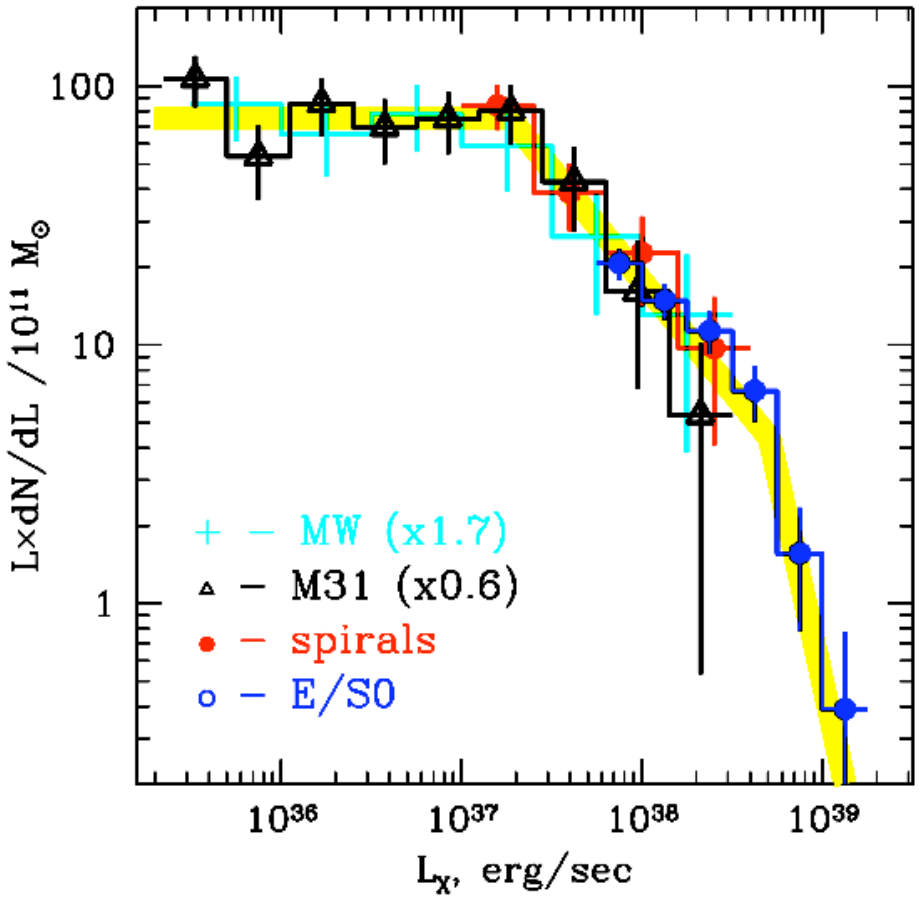
X-ray luminosity functions: **scaled to the same mass**

Stellar mass range: 10^9-3×10^{11} Msun

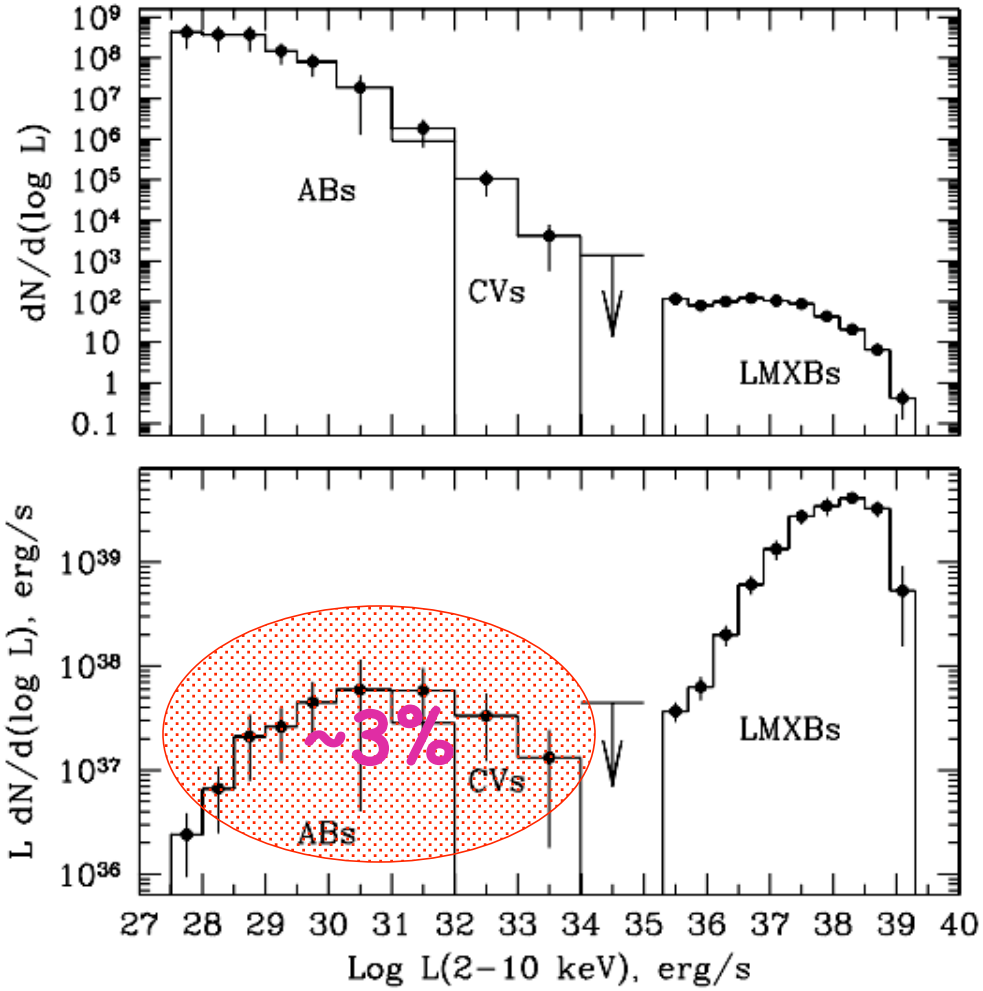


Universal XLF of LMXBs

- complex but ~constant shape
- normalization ~ mass
- cut-off @ ~few x10^{39} erg/s
- faint limit: dN/dL~1/L



Overall XLF of old populations



number of sources

contribution to total luminosity

Sazonov et al., 2005

Excess of LMXBs