Perspectives for studies of star forming galaxies near and far

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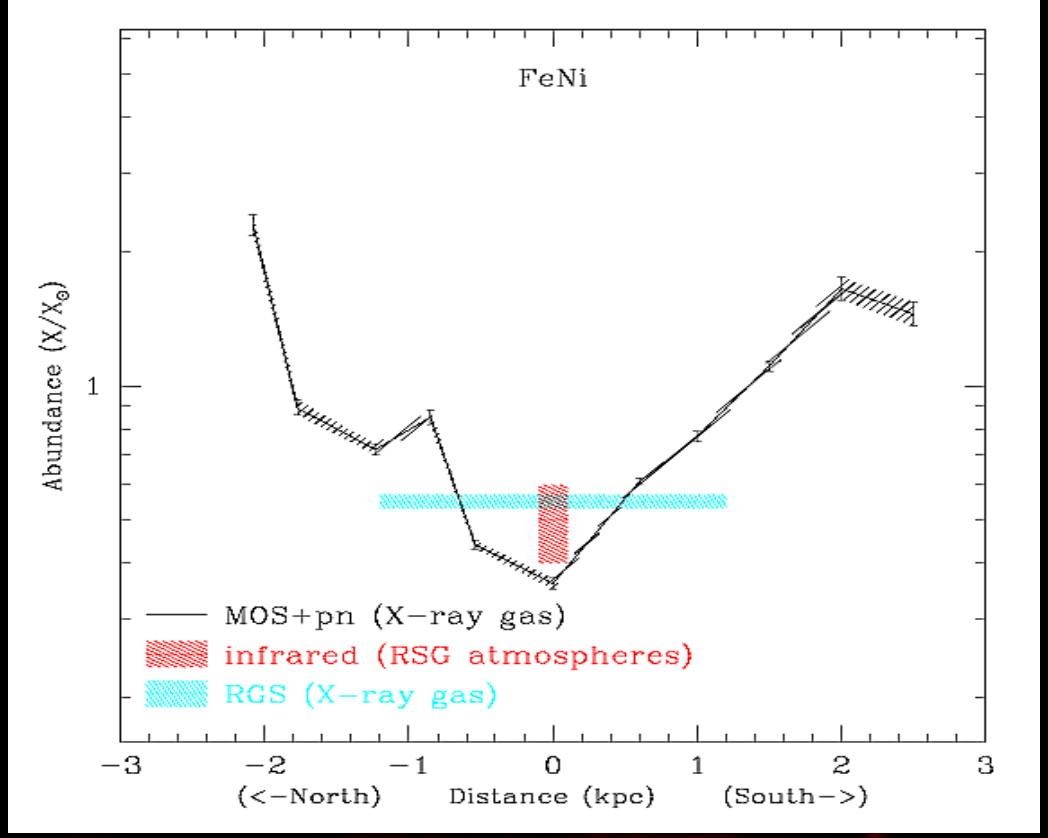
Outline:
- high-resolution, spatially resolved spectroscopy

- spectroscopy of high-z galaxies

- detection of faint galaxies, luminosity functions

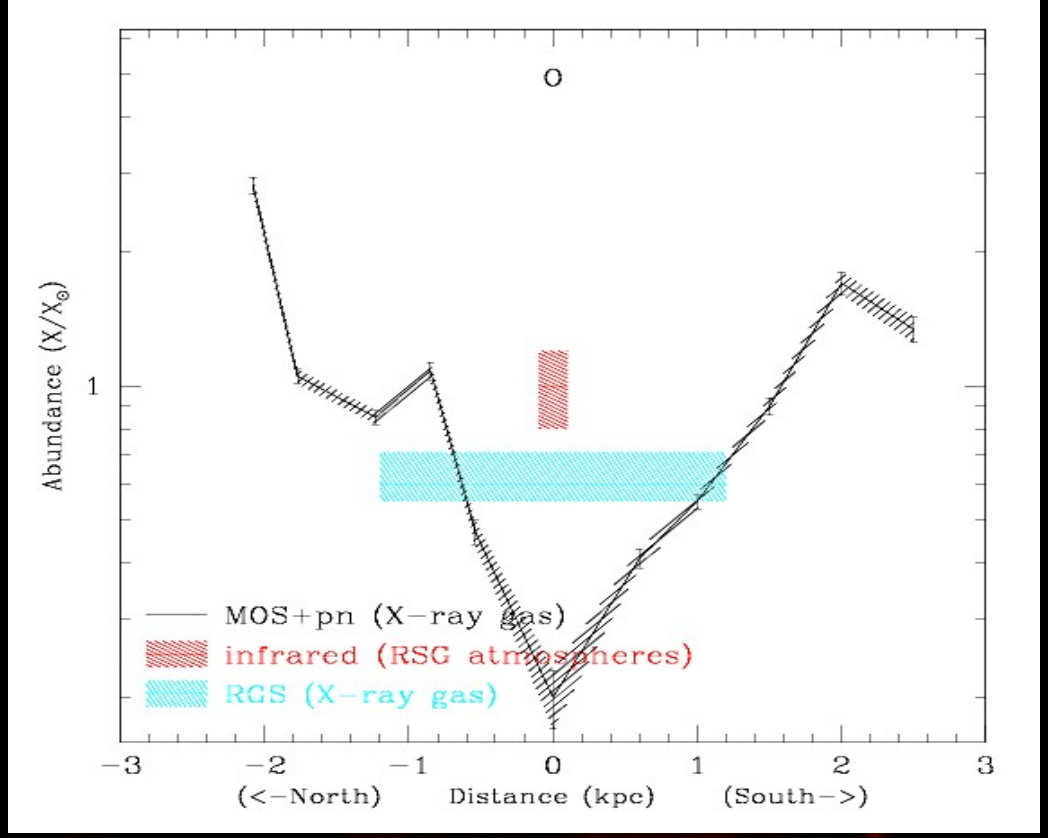


Understanding chemical evolution and enrichment

The spectral parameters of the outflow plasma in M82 are spatially dependent (Ranalli et al. 2008).

They are probably connected to the supernova yields and/or to mass loading, but how?

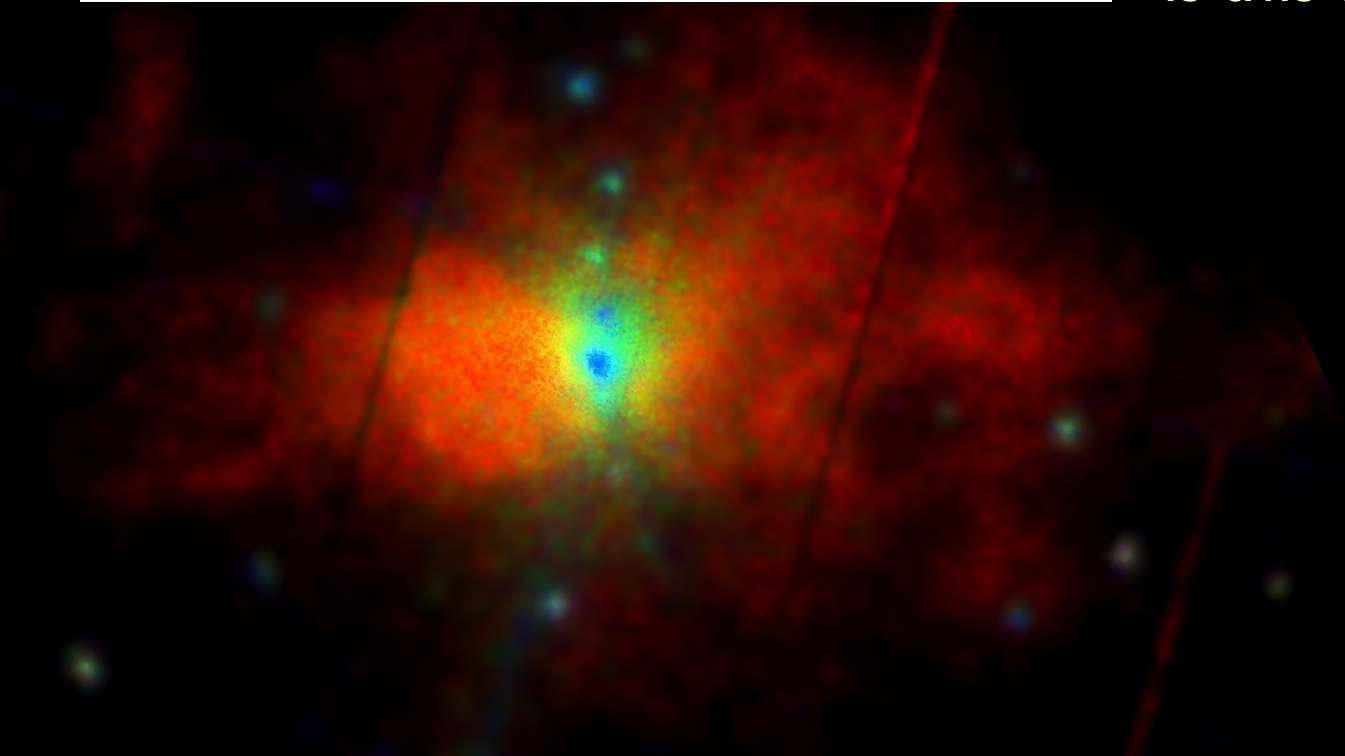
Ranalli et al. 2008 MNRAS 386, 1464



Understanding chemical evolution and enrichment

In the central areas, there is less oxygen in hot gas than in stars. Where did it go?

It has probably cooled. We detect charge-exchange lines, is this the cooling mechanism?

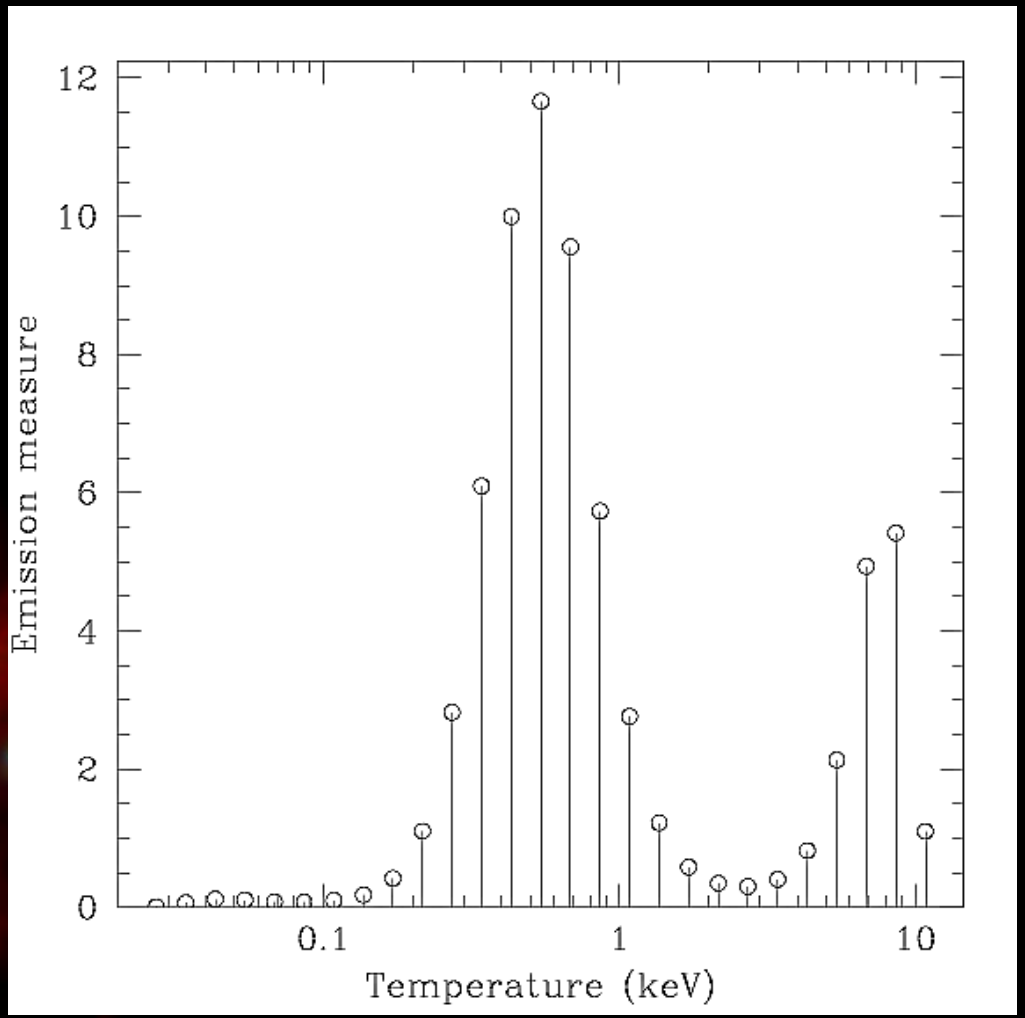


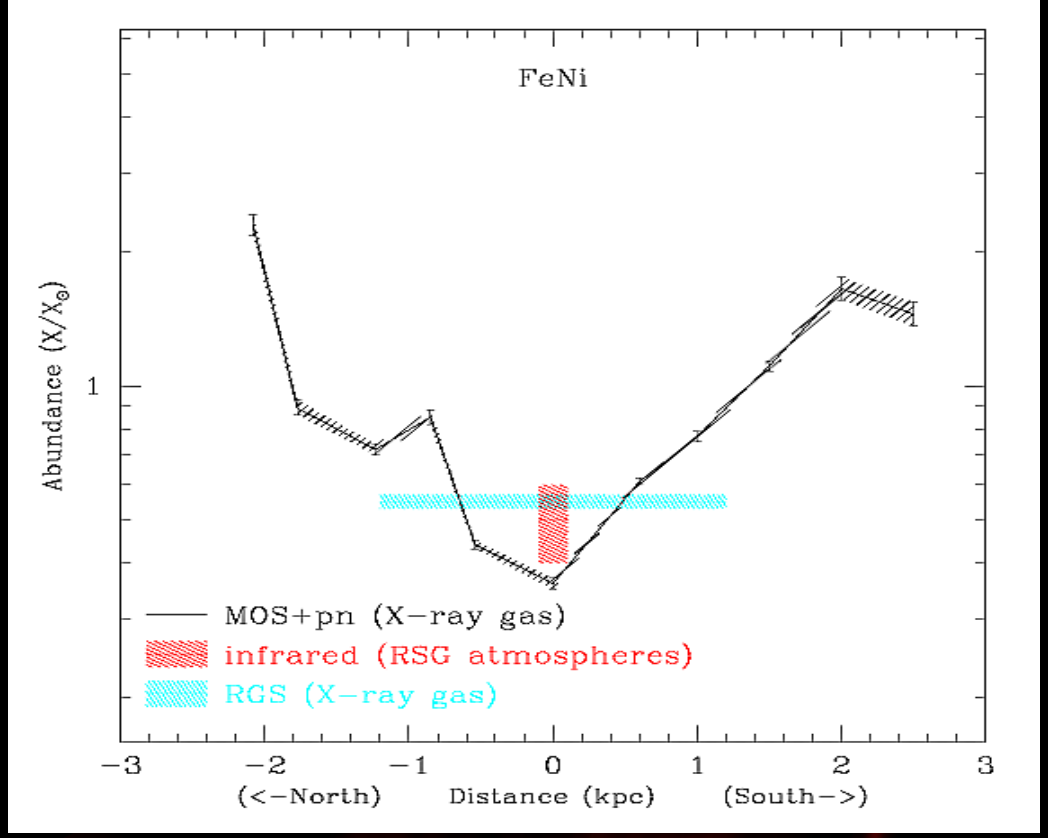
Understanding chemical evolution and enrichment

The temperature structure (DEM) is bimodal!
What is the 7 kev peak?

Point sources not likely

Maybe there are nonthermal tails in the electron spectrum (Masai's plasma model), this means particle acceleration in the outflow

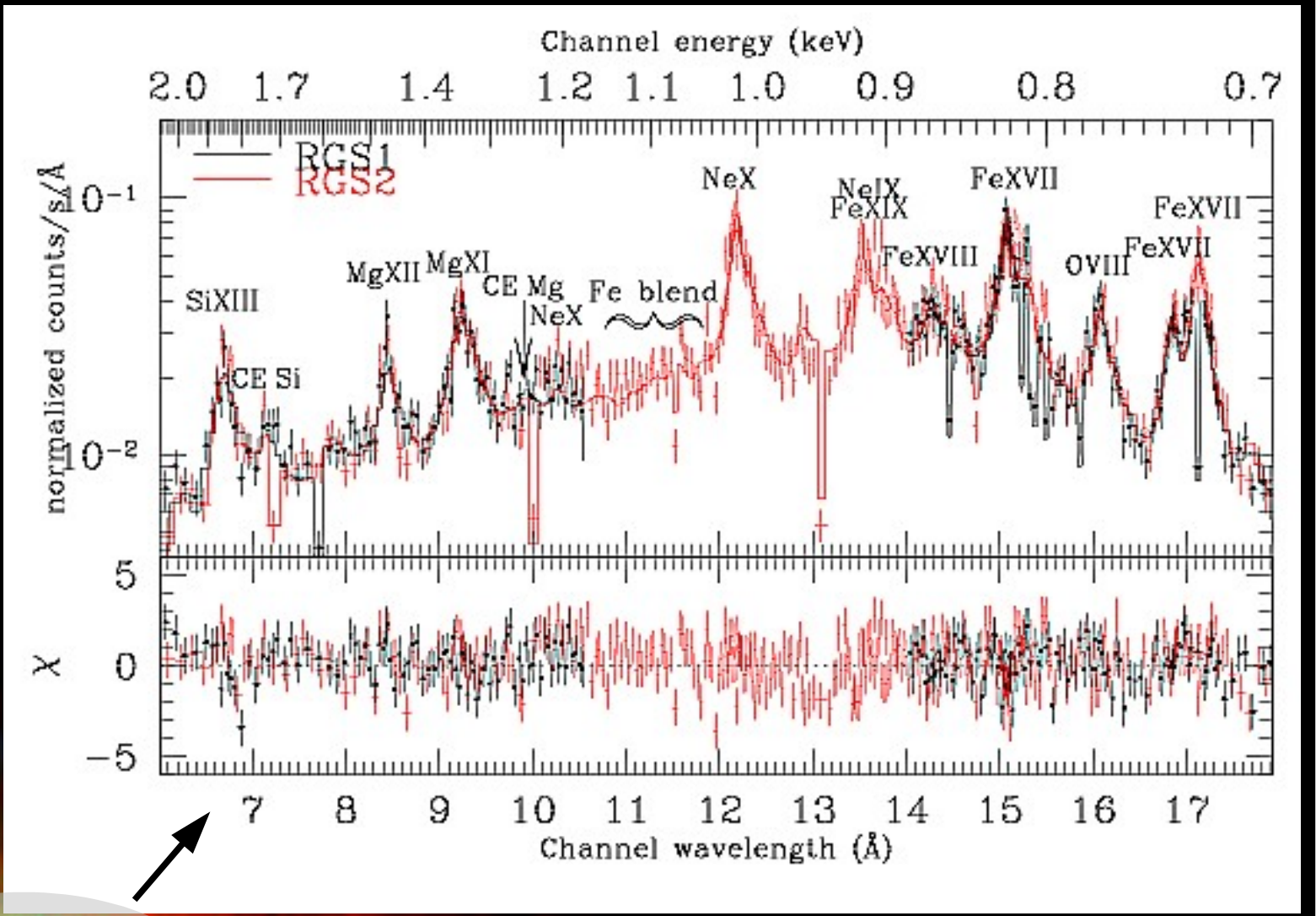




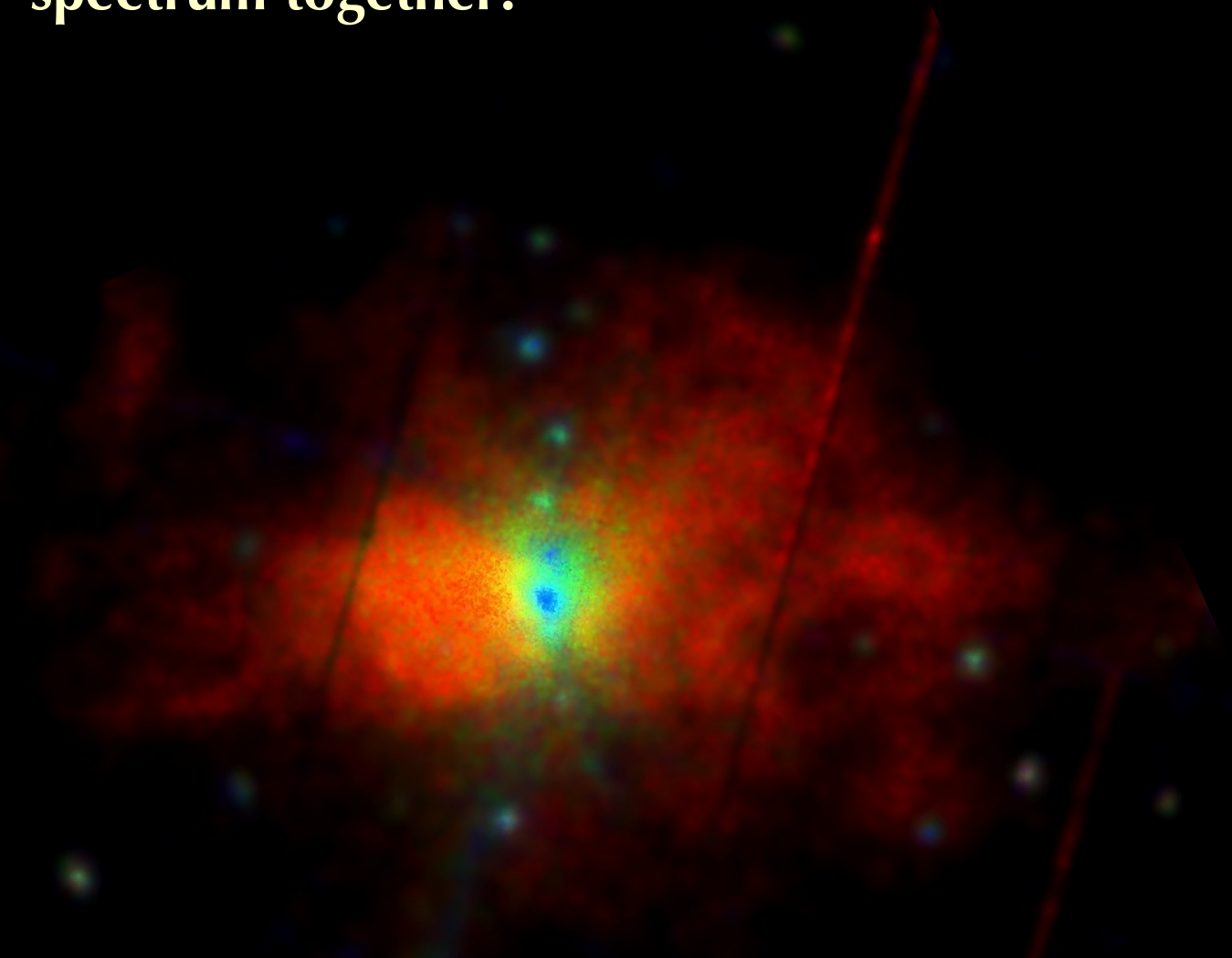
Current studies have been made mostly with XMM EPIC.

Improvements are possible only with high resolution spectrometers which can separate different regions of the sky, and which are not sensitive to the source extent.

The XMM/RGS has produced a beatiful **average** spectrum which is extremely difficult to analyse

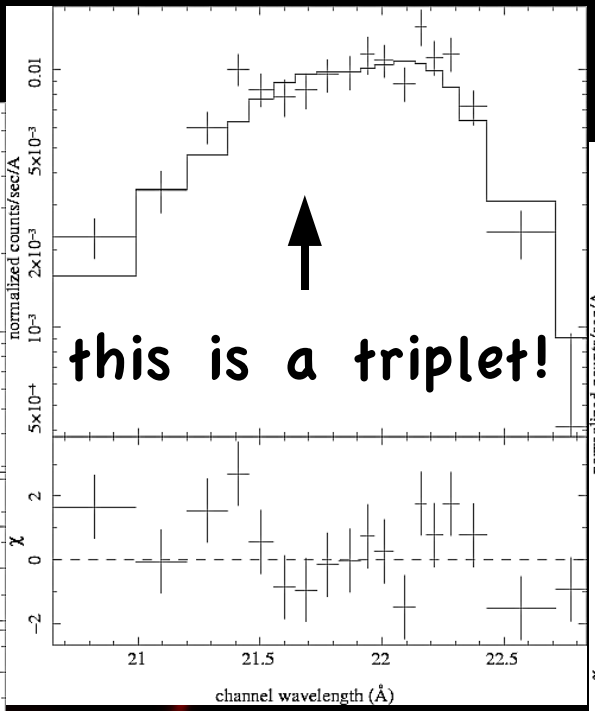


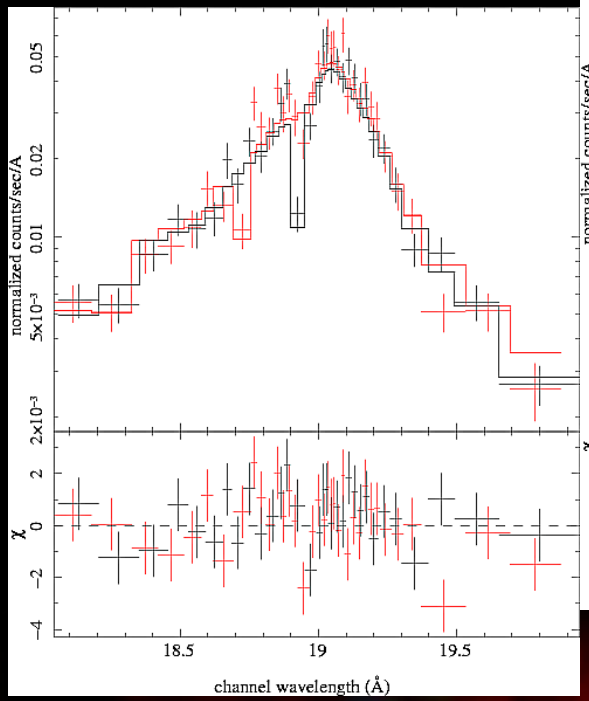
Need to consider the line broadening due to the source extent.
And this is **energy-dependent**!
Cannot fit all 0.4-2 keV spectrum together!



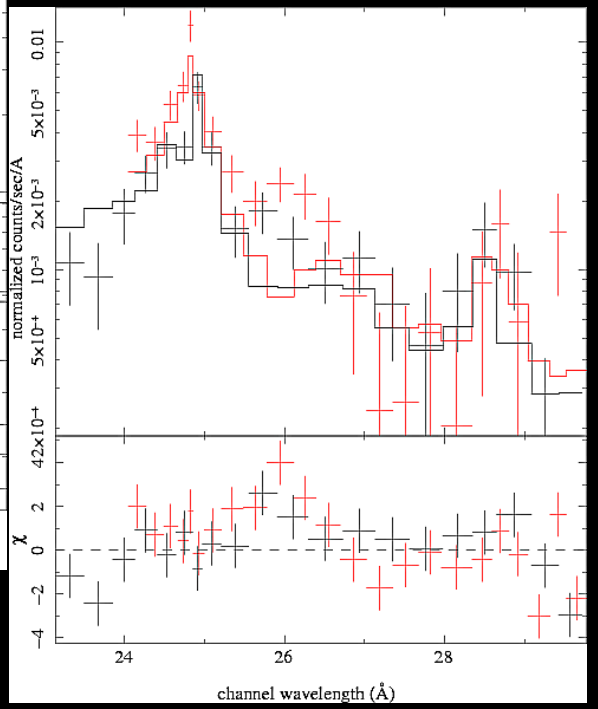
O VII

O VIII





N VII & C VI

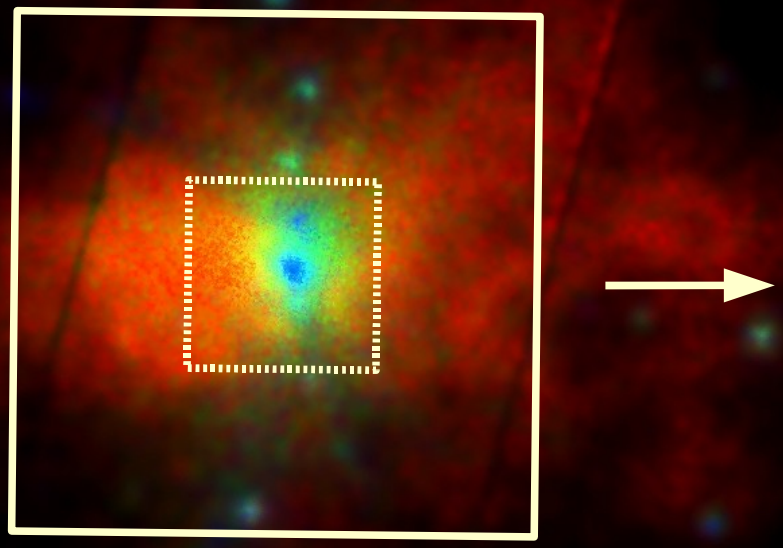


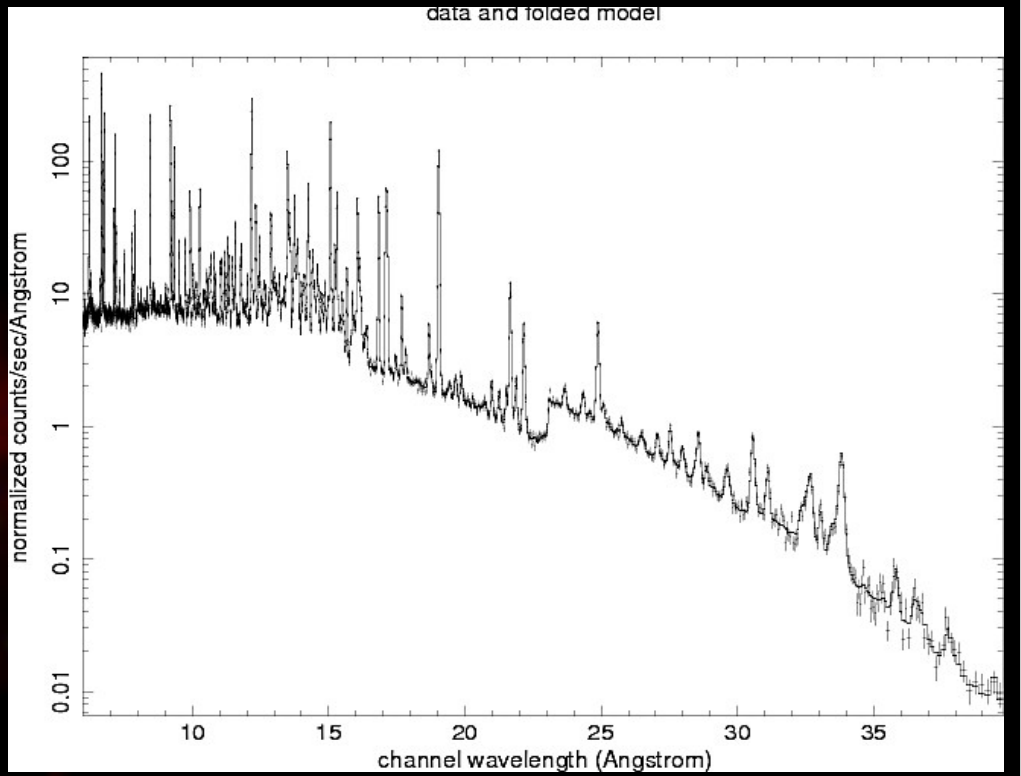
The low-energy regime is the most critical one (oxygen abundances, charge exchange emission) and also the most severely affected by line broadening.

A calorimeter as proposed for IXO (~5' FOV, ΔE~1.5--2.5 eV) performs more or less like the XMM RGS does for point sources and allows the separation of different patches of the sky

E/ΔE @ 1 keV: EPIC/PN~7 RGS~300 (point sources) IXO~400--700

=> **the more resolution and coverage at low energies, the better**

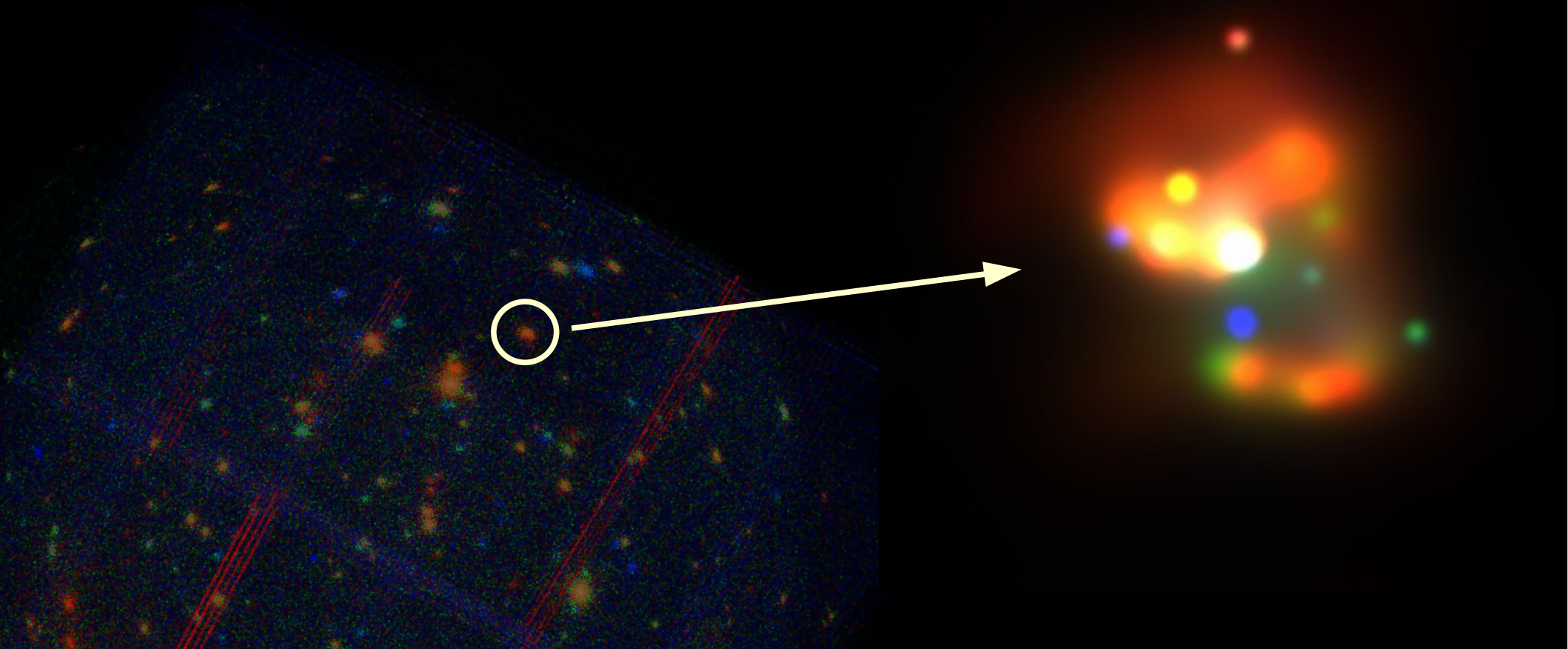




Spectrum of a galaxy at z=1

currently unknown
there is luminosity evolution => higher SFR => probably lots of outflows

connection with AGN phenomena?

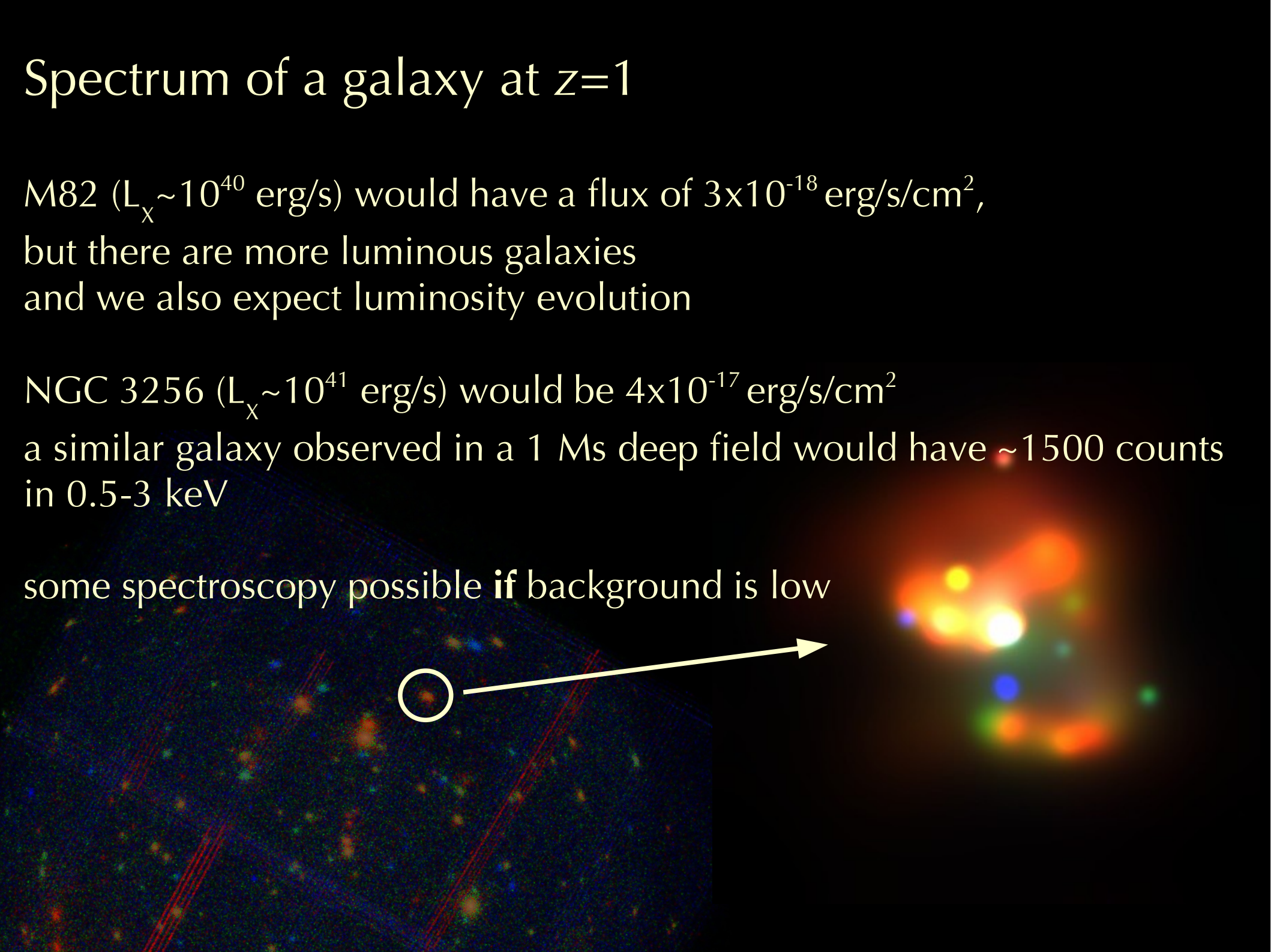


Spectrum of a galaxy at z=1

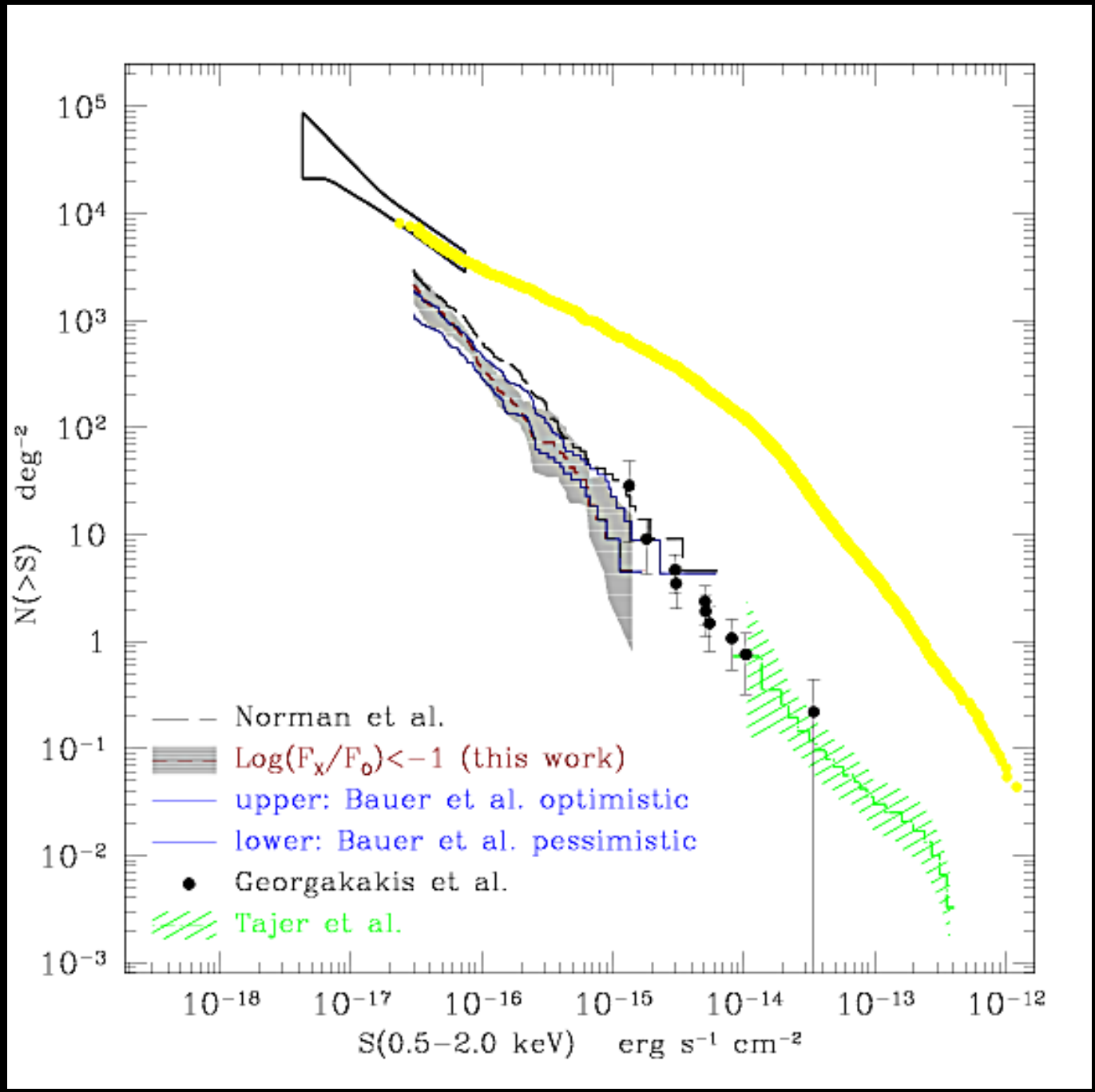
M82 (L_X~10^{40} erg/s) would have a flux of 3×10^{-18} erg/s/cm^2,
but there are more luminous galaxies
and we also expect luminosity evolution

NGC 3256 (L_X~10^{41} erg/s) would be 4×10^{-17} erg/s/cm^2
a similar galaxy observed in a 1 Ms deep field would have ~1500 counts in 0.5-3 keV

some spectroscopy possible **if** background is low

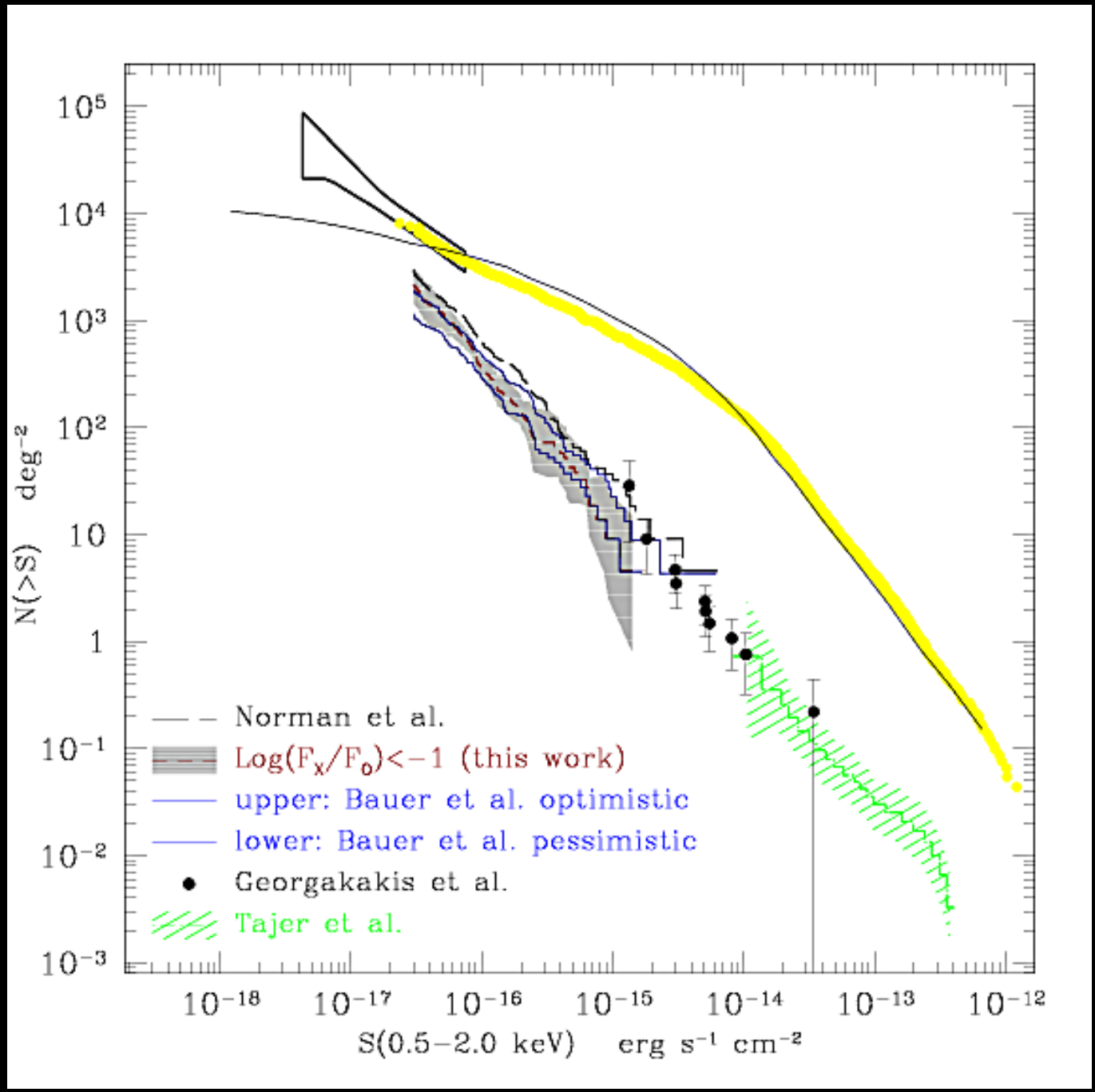


X-ray number counts of star forming galaxies



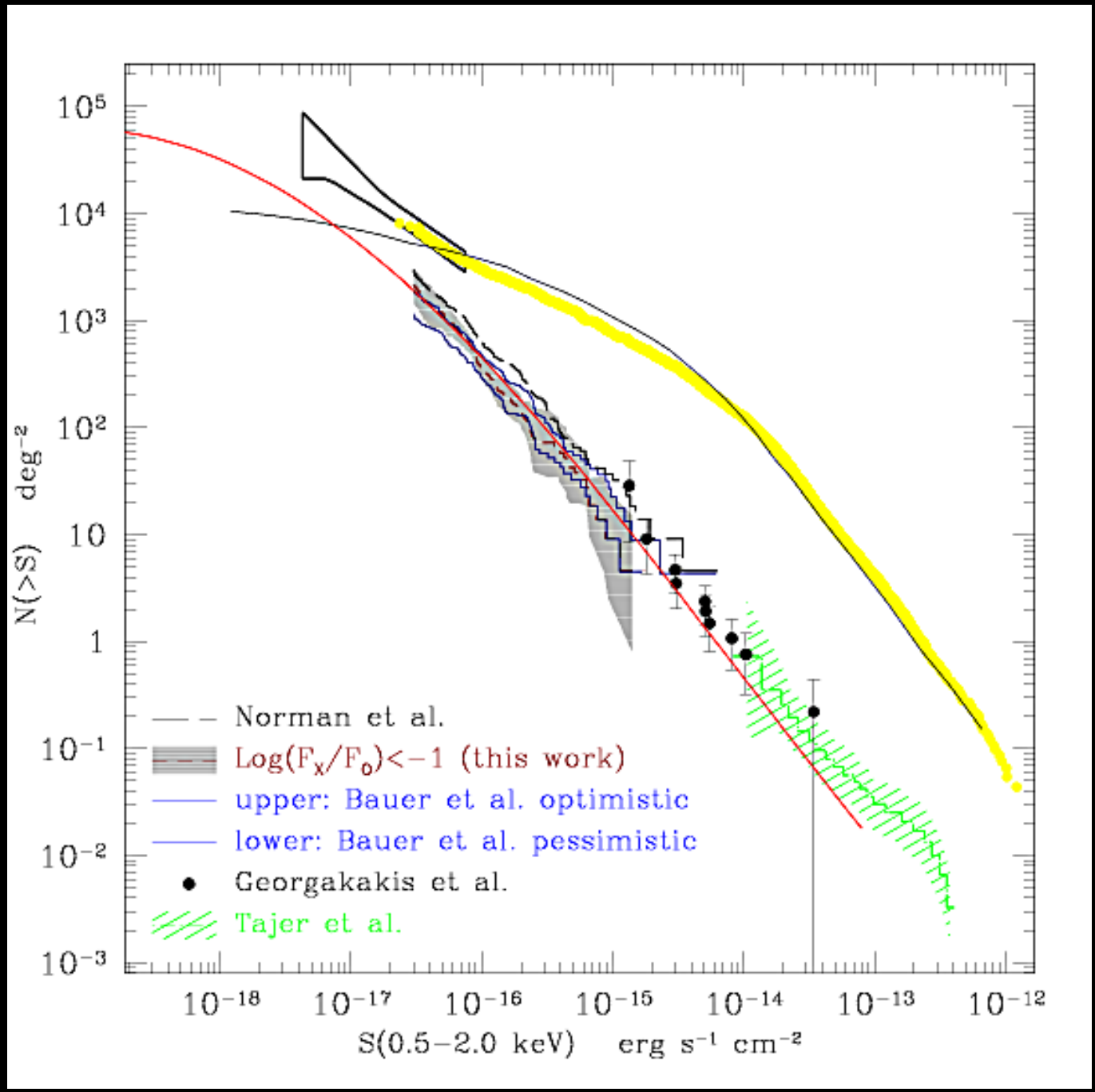
Ranalli et al. 2005
A&A 440, 23

X-ray number counts of star forming galaxies +AGN model



X-ray number counts of star forming galaxies
+ theoretical model

integration of
IRAS LF,
$L \propto L_0(1+z)^{2.7}$



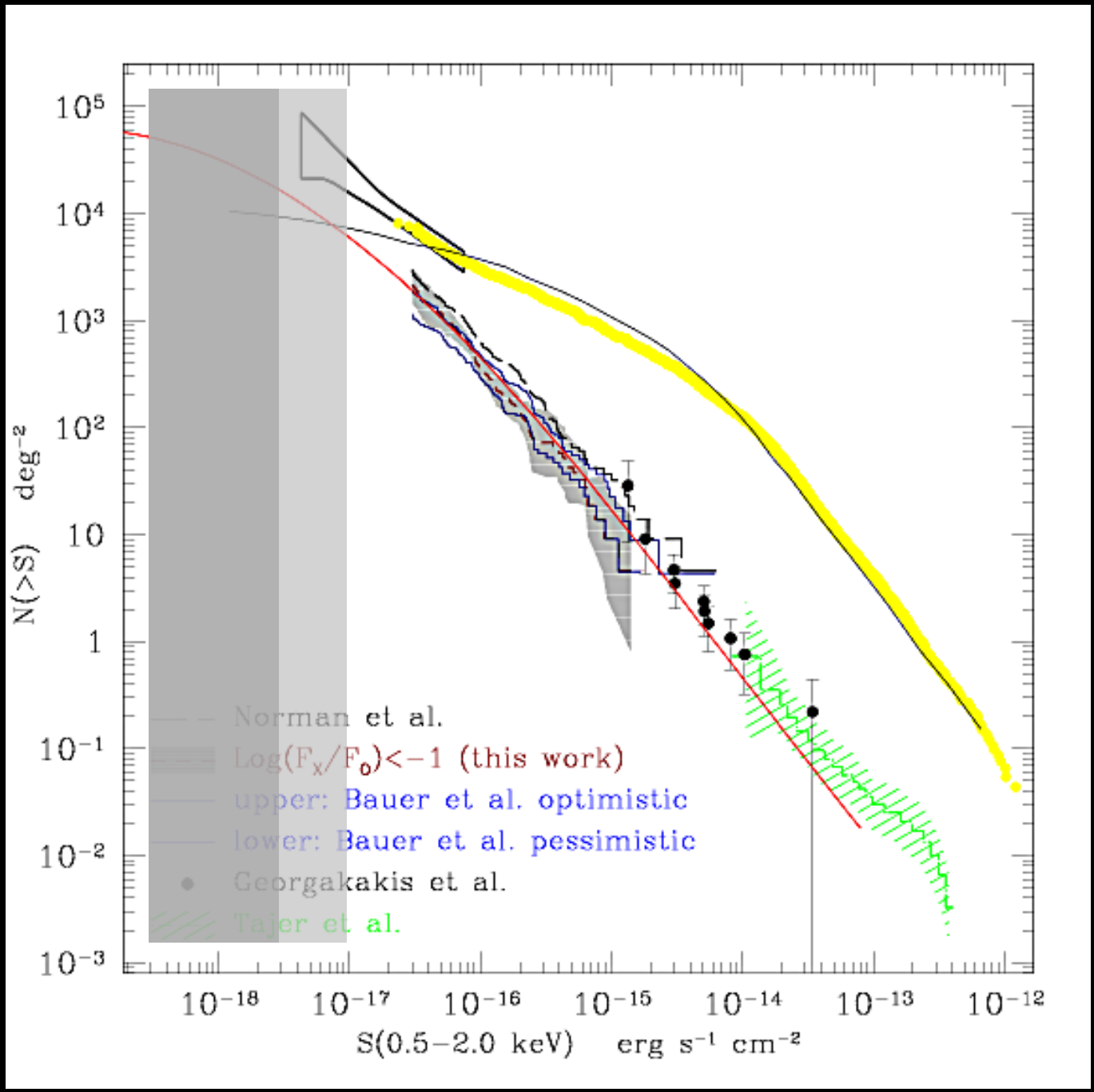
Limiting flux: 3×10^{-18} ~ 10^{-17} erg/s/cm^2

WFI FOV=14'x14'=
0.054 deg^2

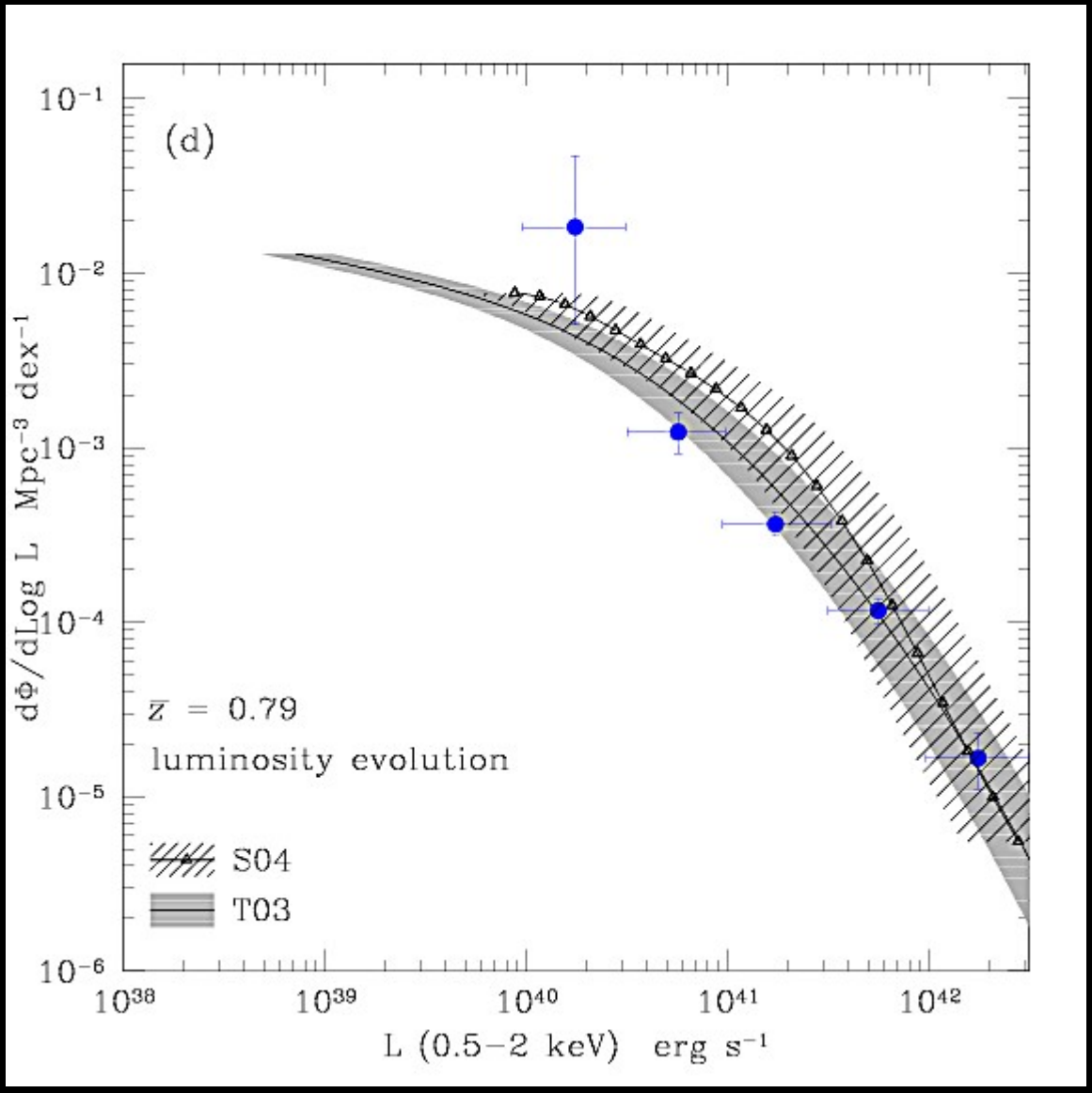
N(>S)=
6000 deg^-2
20000 deg^-2

N per field=
300
1000

risk of source confusion with 5" HEW



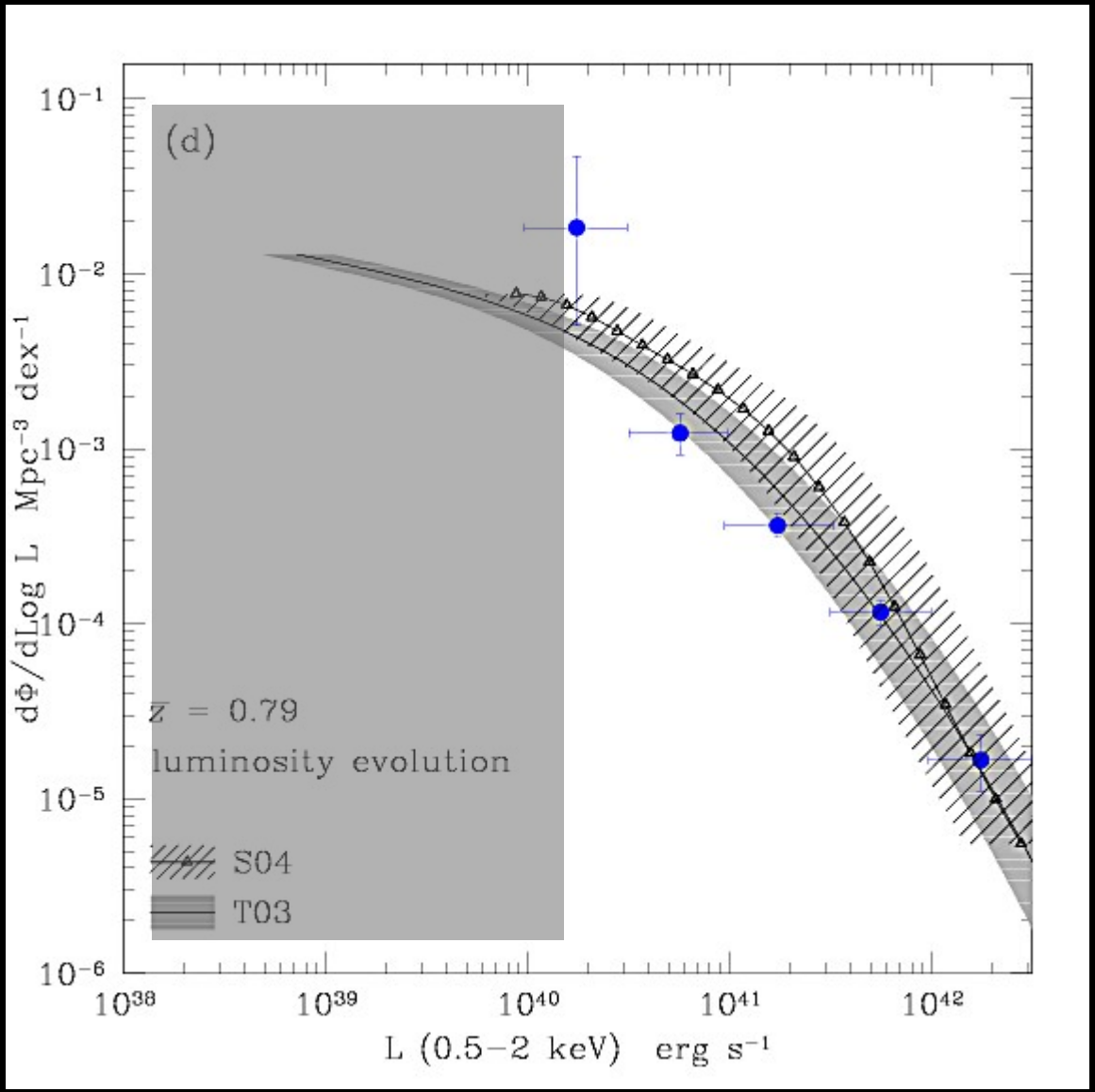
galaxy LF at 0.5<z<1 : best estimate from observations



Norman et al. 2004
Ranalli et al. 2005
see also
Tzanavaris & Georgantopoulos 2008

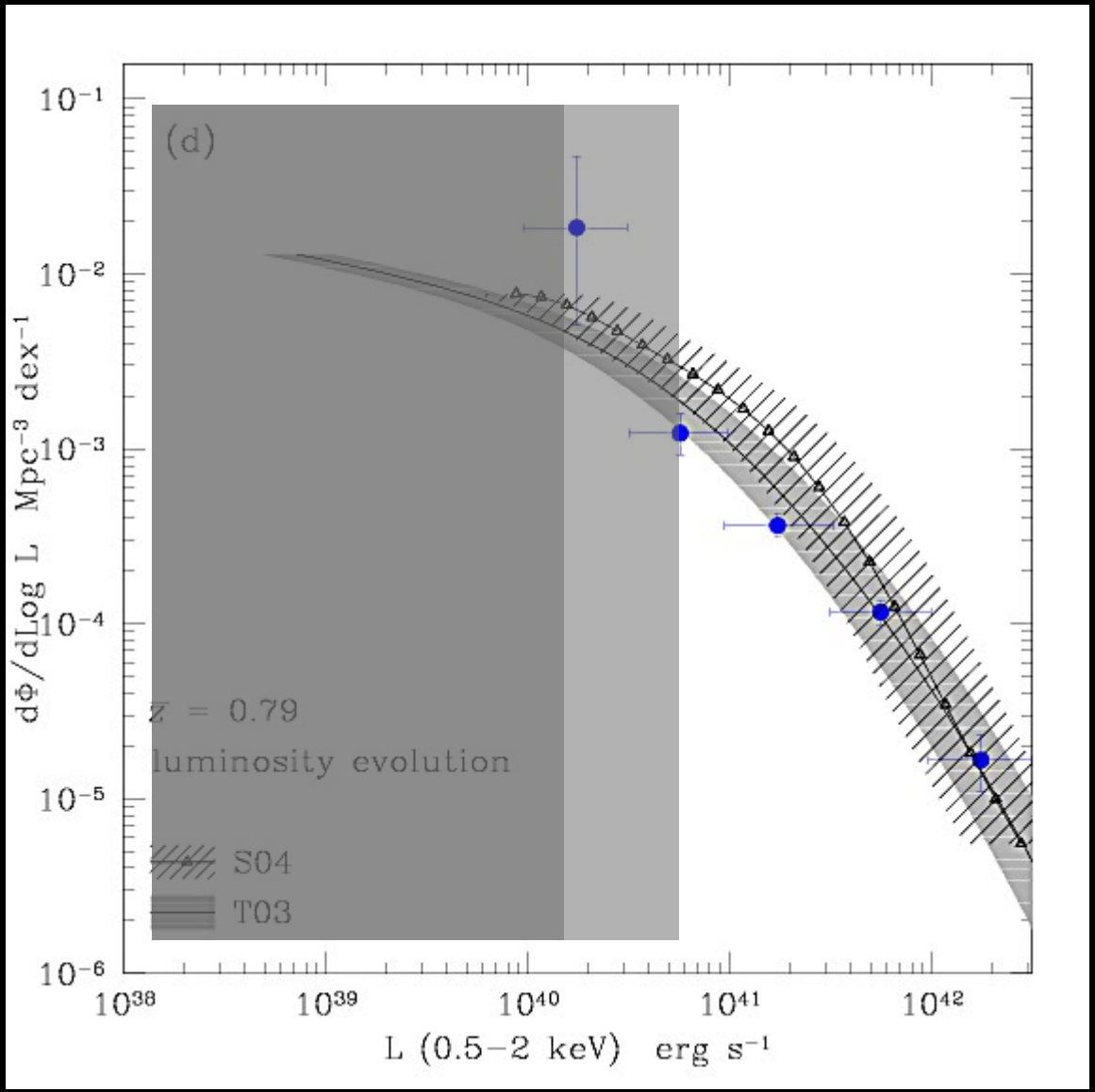
galaxy LF at z=1 : minimum observable luminosity

with flux limit at 3×10^{-18}

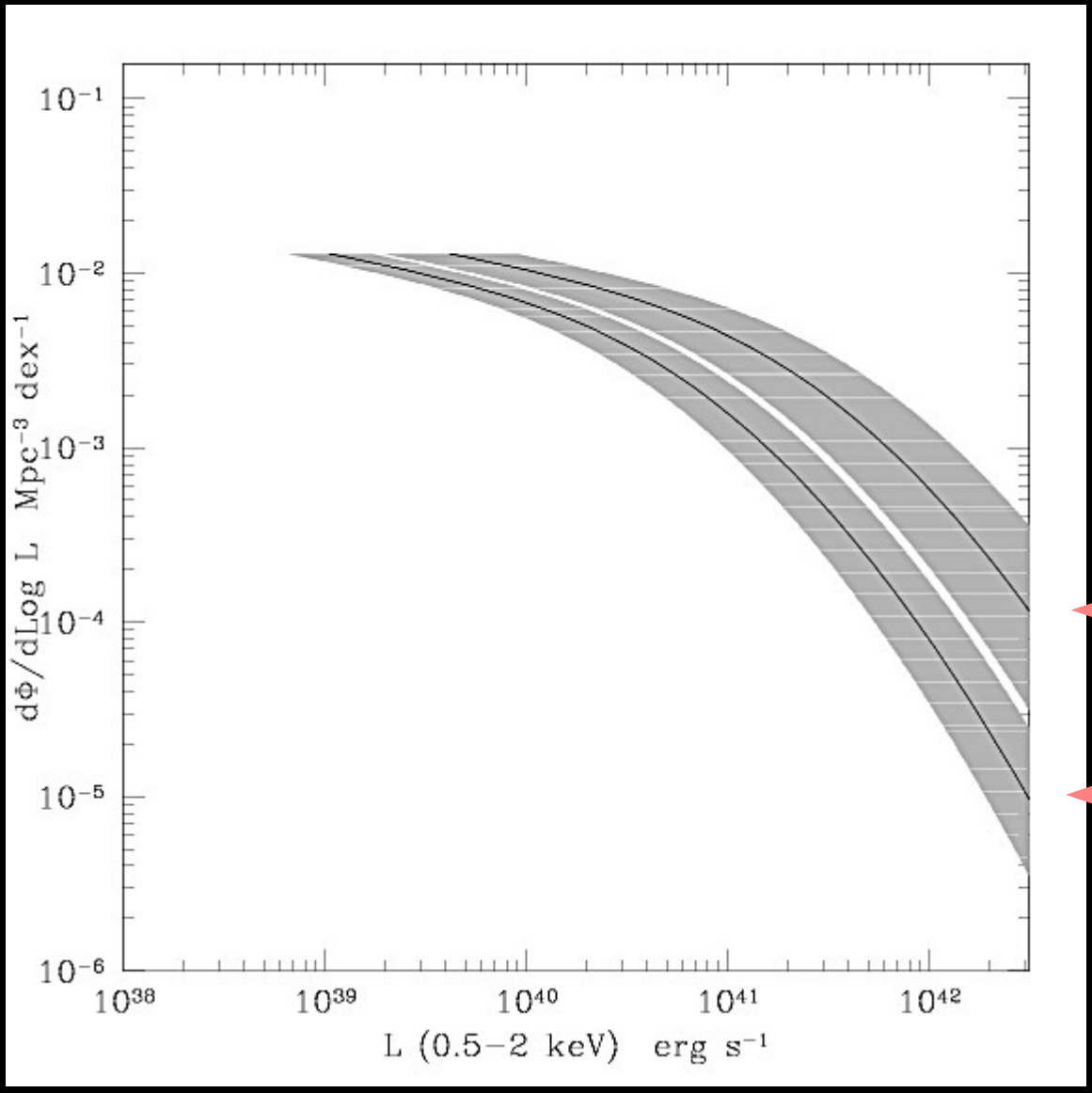


galaxy LF at z=1 : minimum observable luminosity

with flux limit at 1×10^{-17}



galaxy LF at z=3

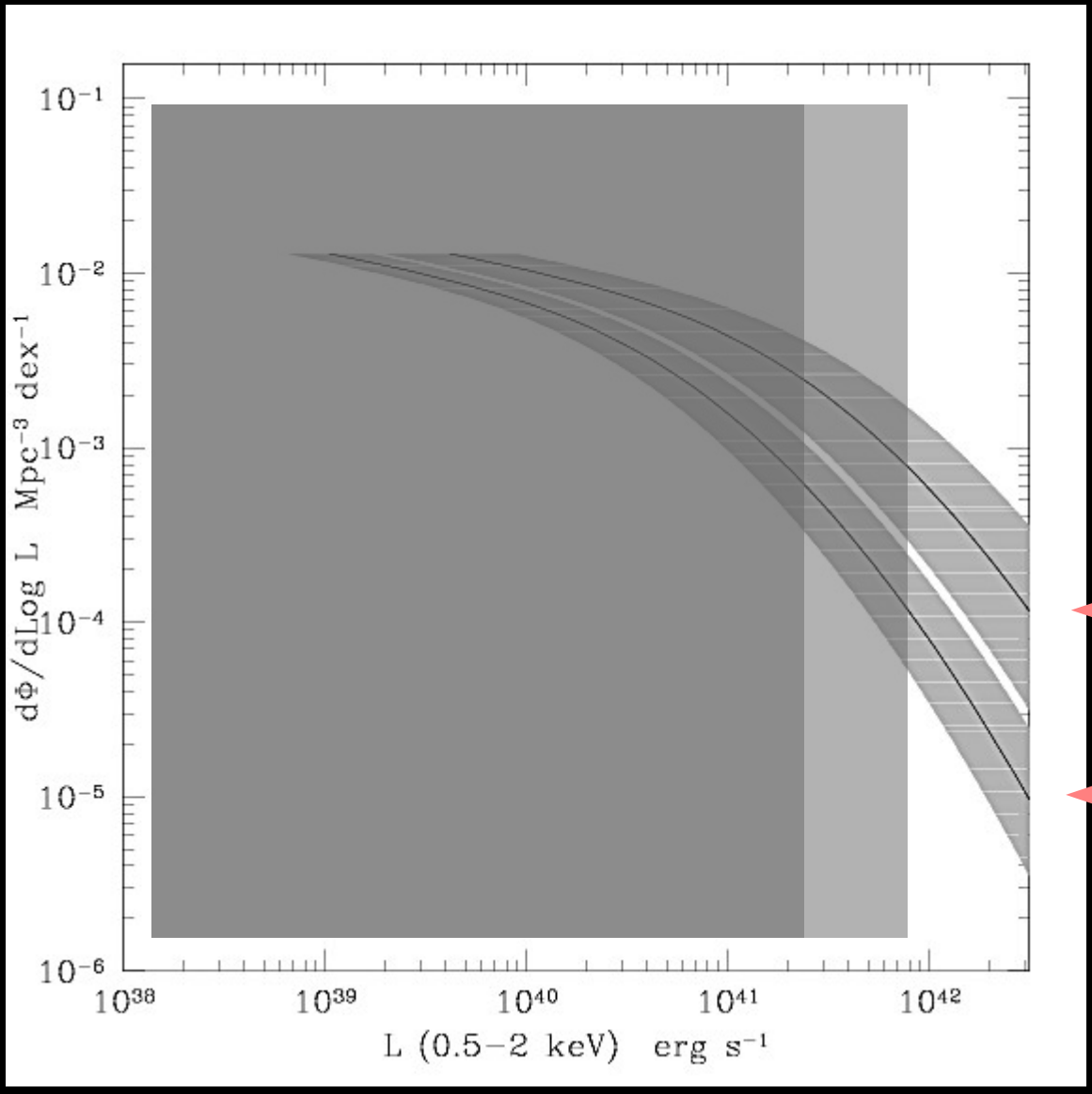


two possibilities:

evolution stopped at z=2

at z=1

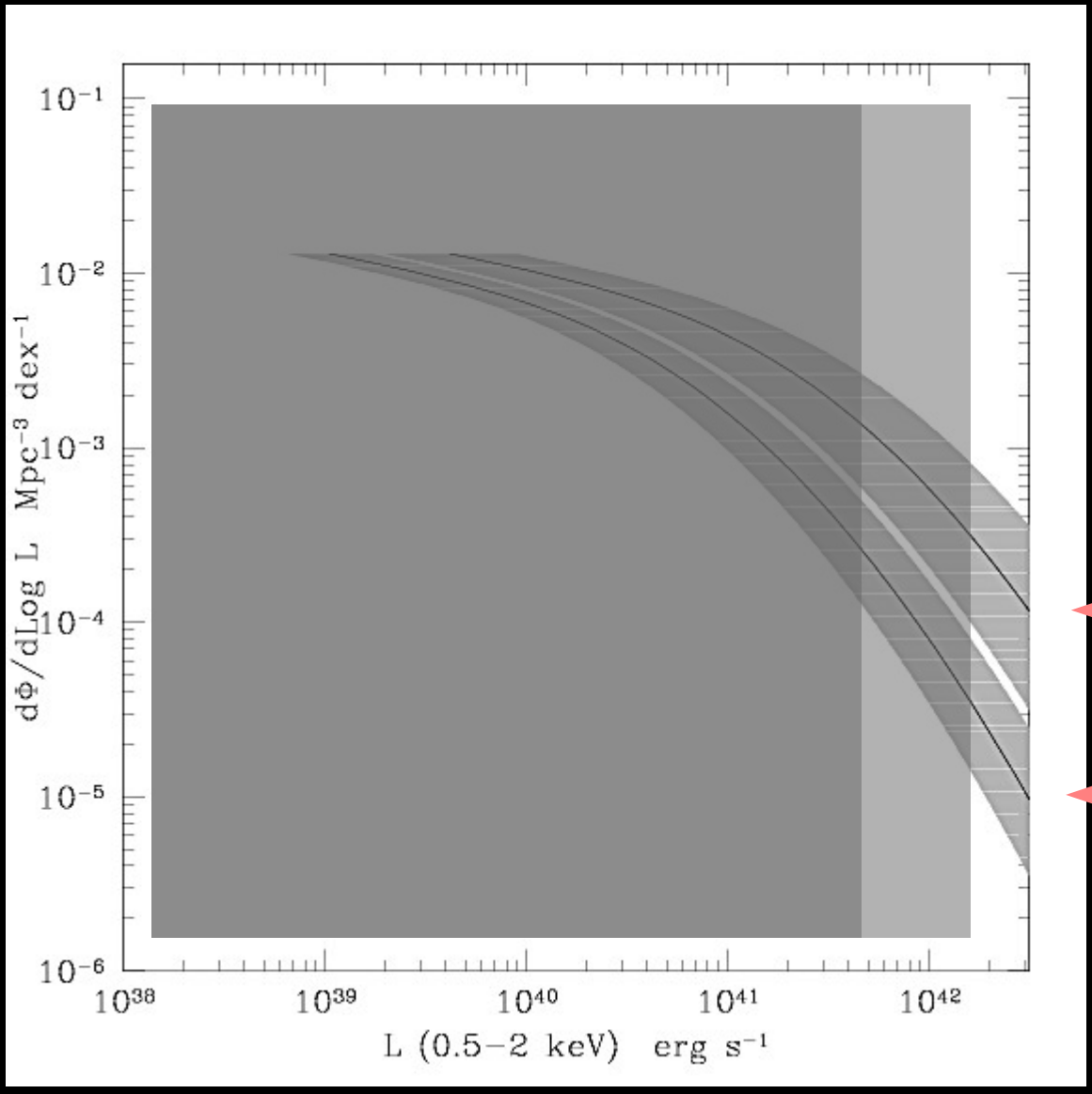
galaxy LF at z=3



evolution stopped at z=2

at z=1

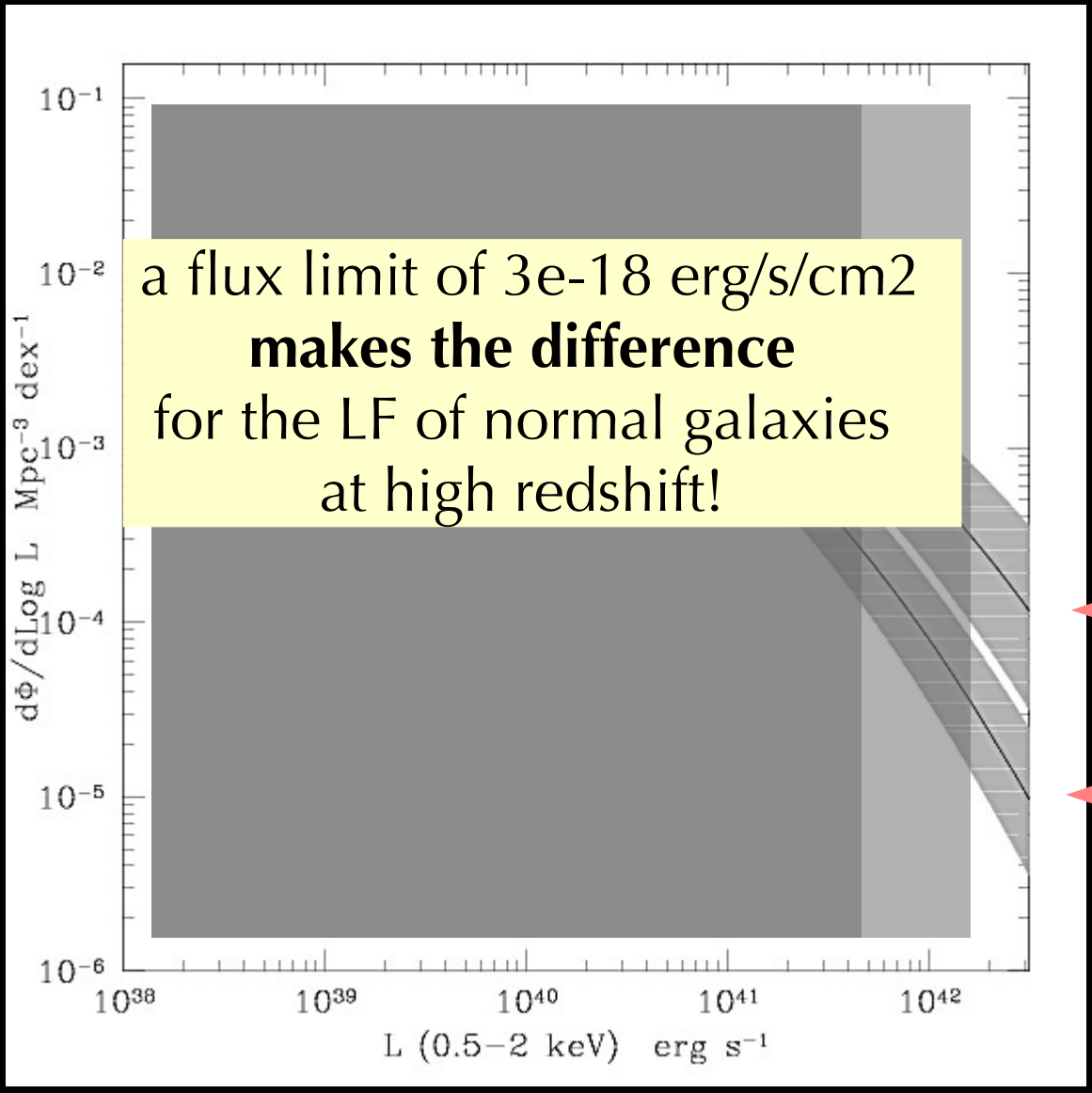
galaxy LF at z=4



evolution stopped at z=2

at z=1

galaxy LF at z=4



evolution stopped at z=2

at z=1

Conclusions:

- chemical abundances depend on distance from the galaxy centre
- bimodal temperature distribution
- detection of charge-exchange

all these require calorimeters with good resolution at low energies

- spectra of normal galaxies at z=1

require low background in WFI, large area

- evolution of luminosity function
- cosmic star formation history

require good PSF, low bkg in WFI, large area, large FOV