Search for star forming sub-mJy radio sources in the Chandra-COSMOS field

Piero Ranalli (Università di Bologna)

Collaborators: A. Comastri, G. Zamorani, V. Smolčić, S. Puccetti, E. Schinnerer

Method:

Search for X-ray counterparts of radio sources from the sub-mJy population

Results:

- composite SF/AGN, and interlopers are present among X-ray bright sources
- review of X-ray based selection criteria

Selection:

* Field: COSMOS
* Radio selection;
* Two synthetic rest-frame colours; diagnostic diagrams tuned for these

Object classes:

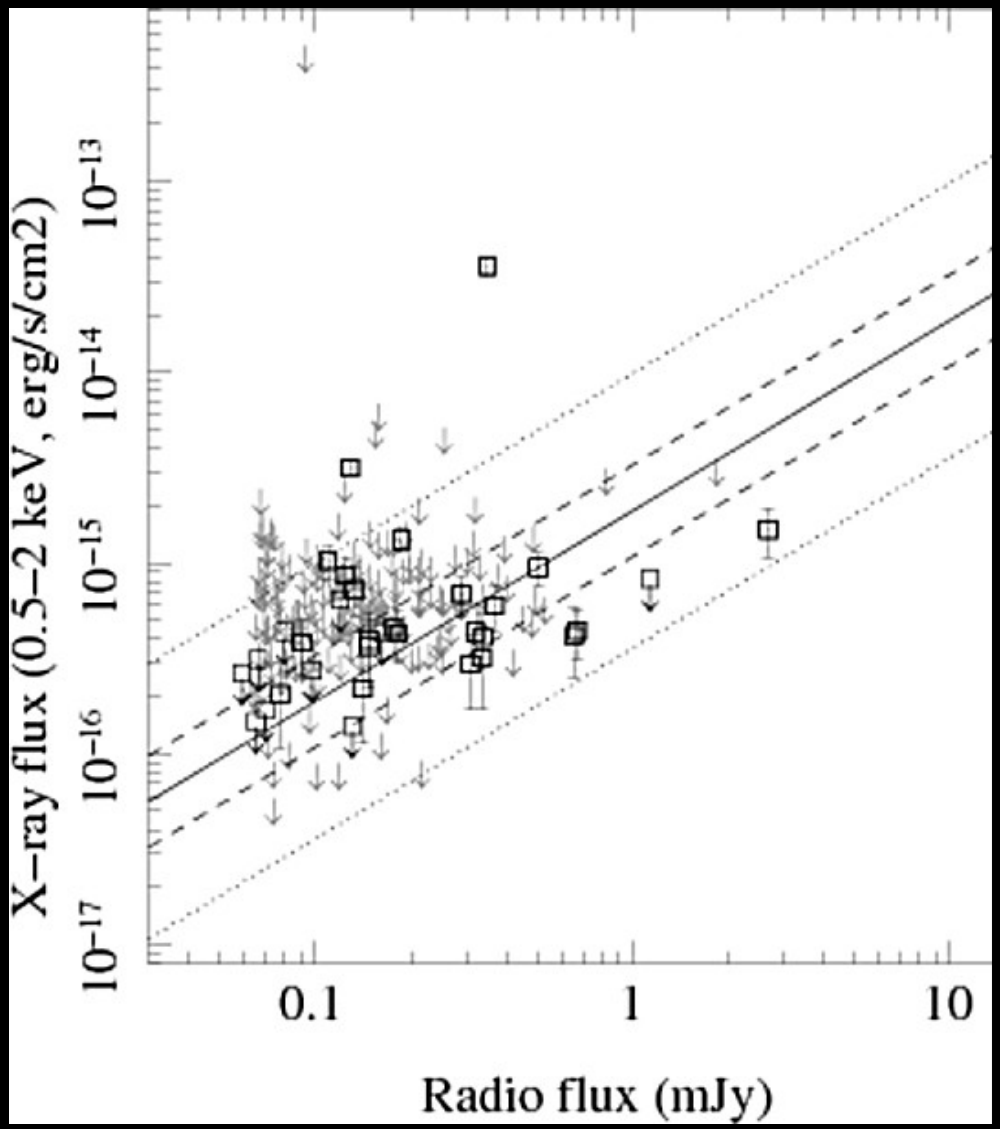
* type 1 (broad line AGN, QSO)
* galaxies
* type 2/dusty/low luminosity AGN (hereafter just "AGN")
* stars
* z>1.3 (Smolcic et al. 2008)

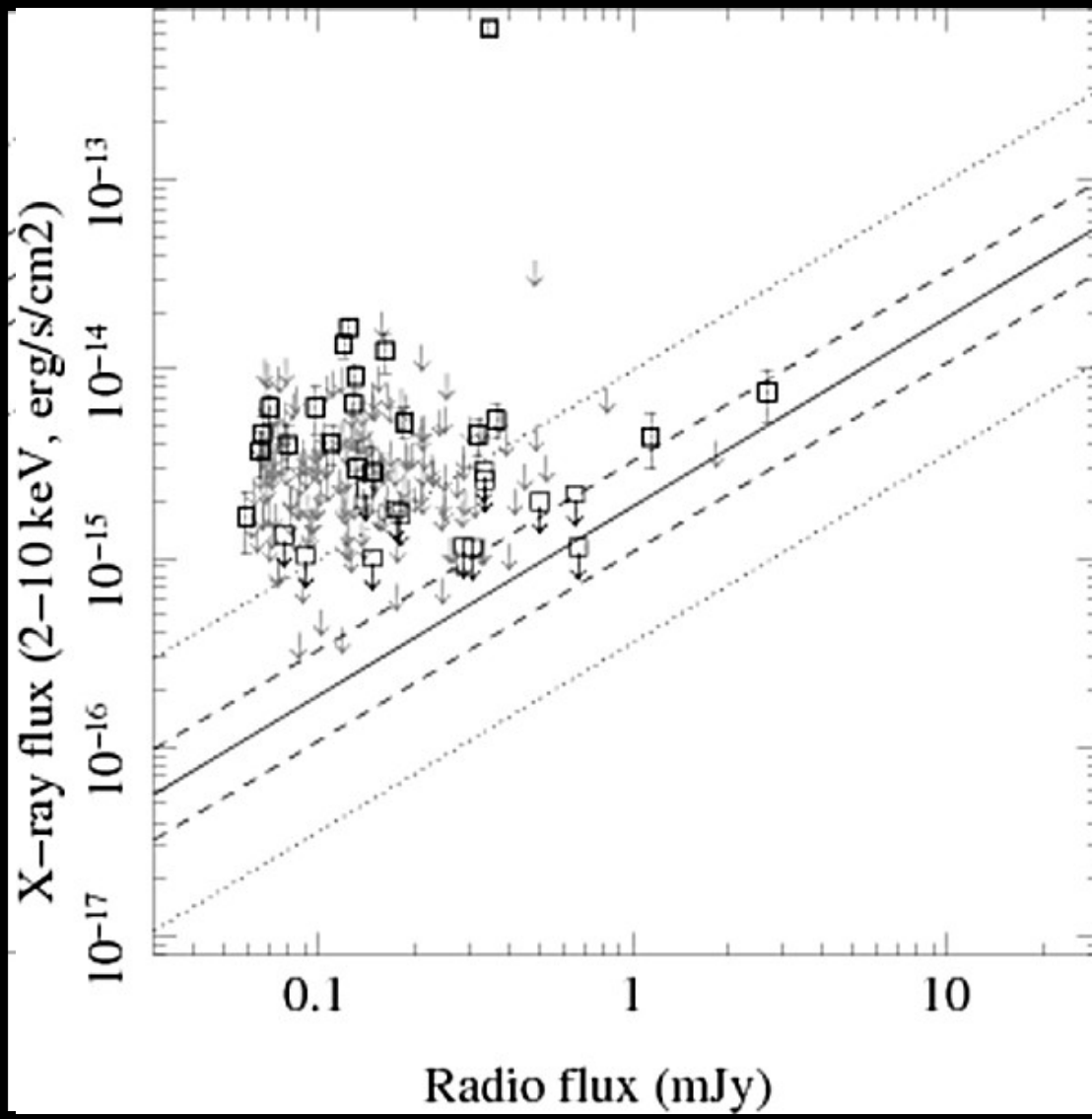
X-ray detections:

- 33 SF, 82 AGN detected; many upper limits

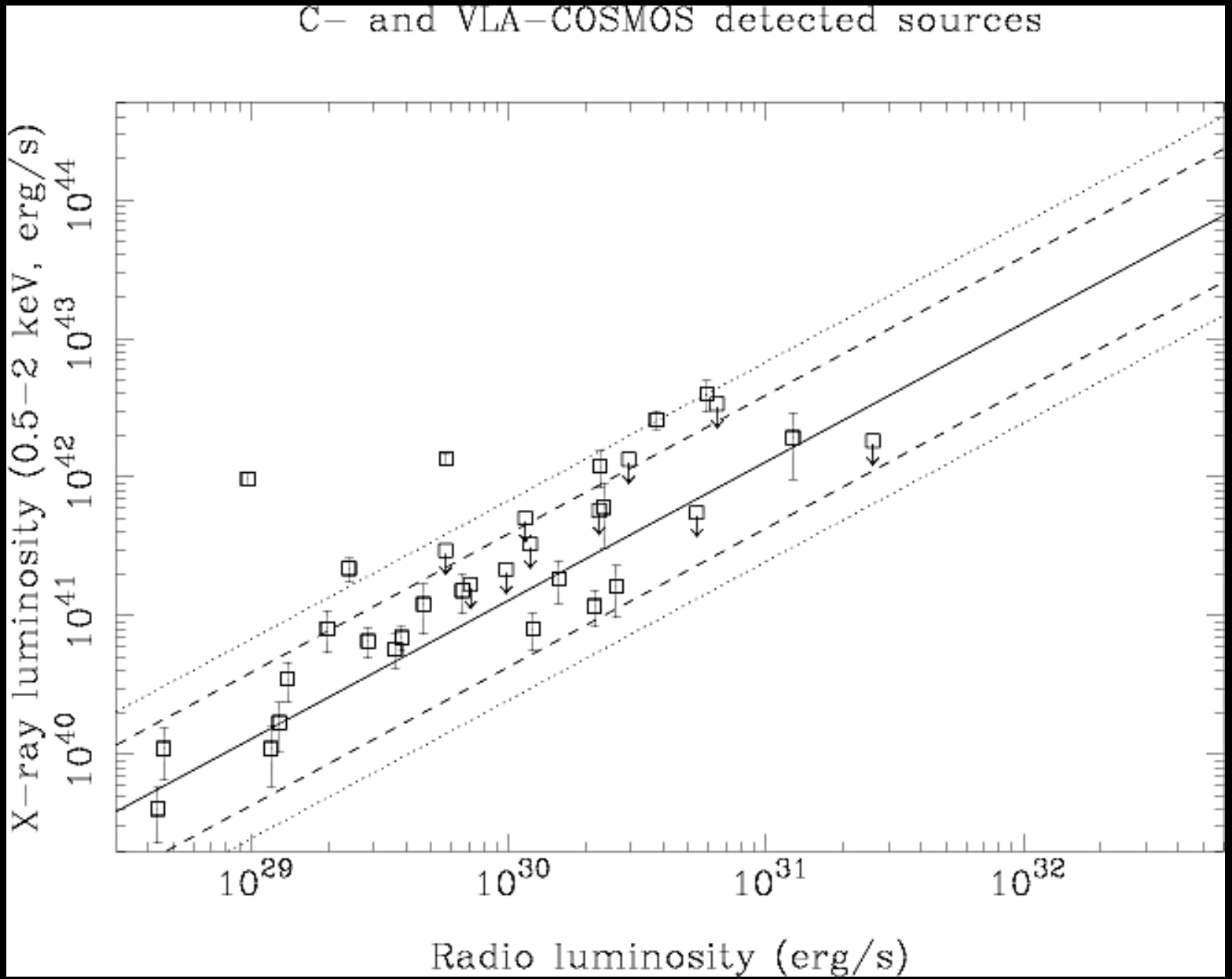
Radio vs. X-ray fluxes of SF sample (close to flux limits)

lines:
radio/X-ray
correlation
±1σ, ±3σ
(Ranalli+03)



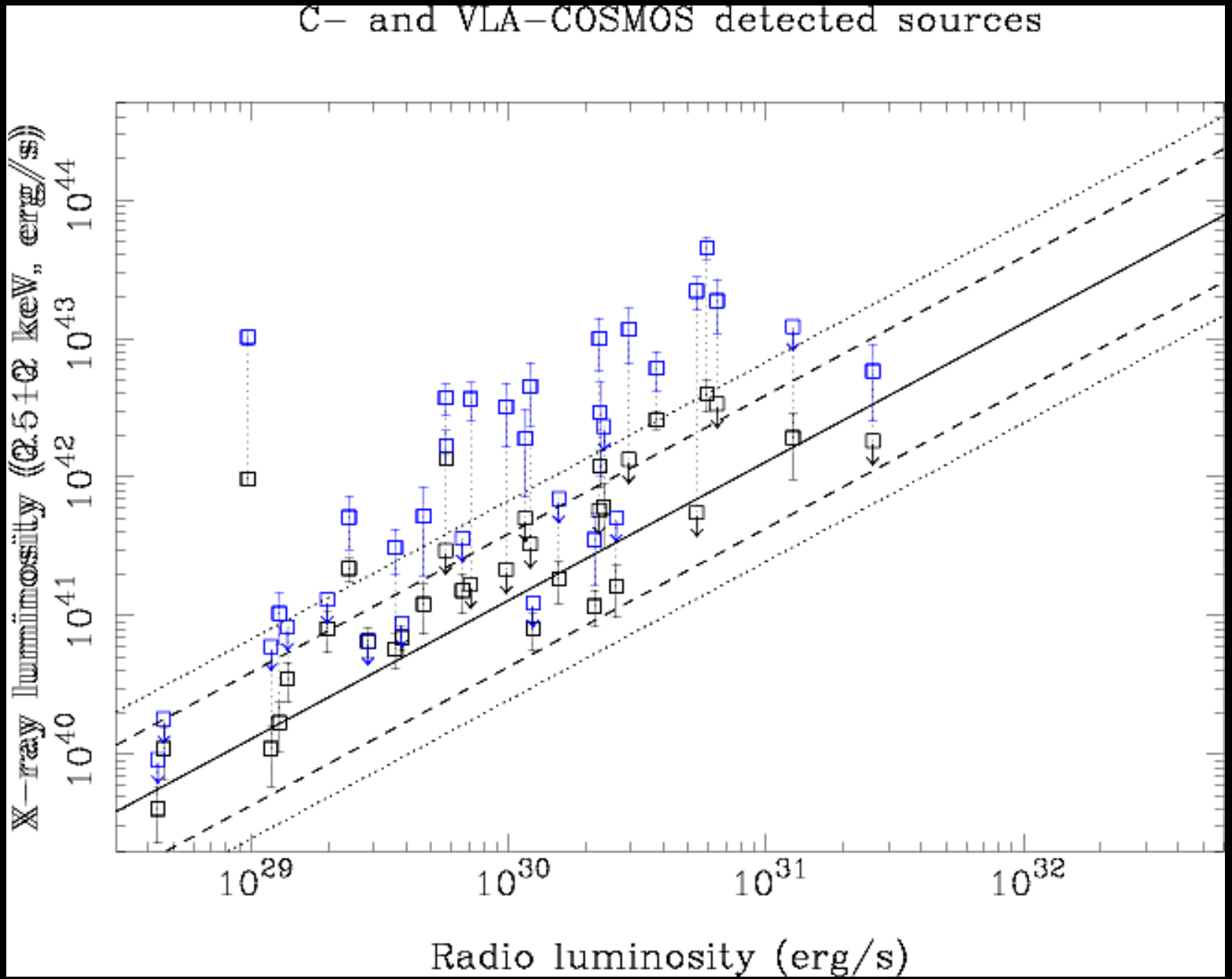


Radio vs. X-ray luminosities, SF 0.5-2 keV



lines:
radio/X-ray
correlation
±2σ, ±3σ
(Ranalli+03)

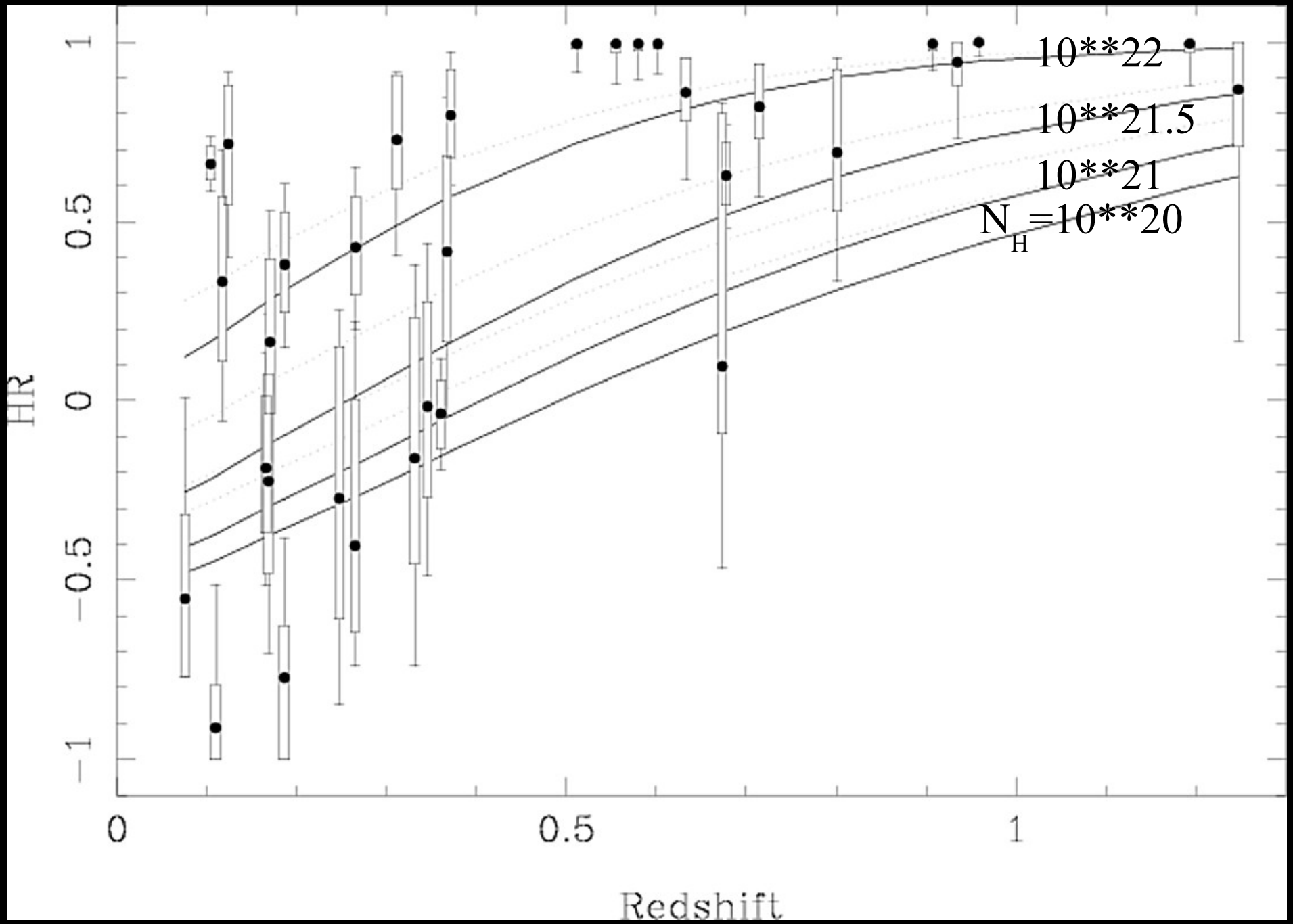
Radio vs. X-ray luminosities, SF 0.5-2 keV & 2-10 keV



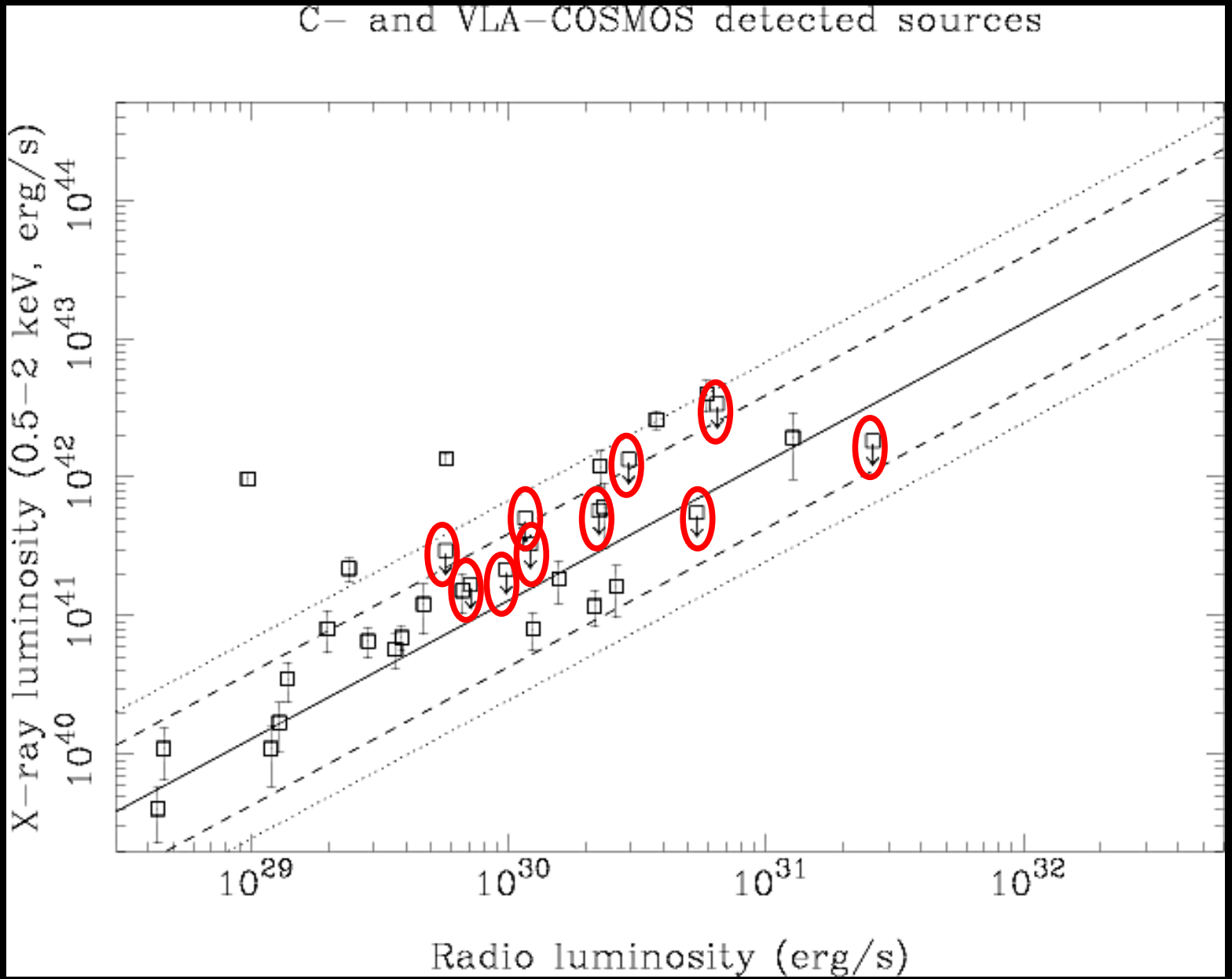
lines:
radio/X-ray
correlation
±2σ, ±3σ
(Ranalli+03)

the dotted lines
connect the 0.5-2
keV point to the
2-10 keV point
of the same source

Hardness ratios (posterior probability distributions for rest-frame H-S/H+S)



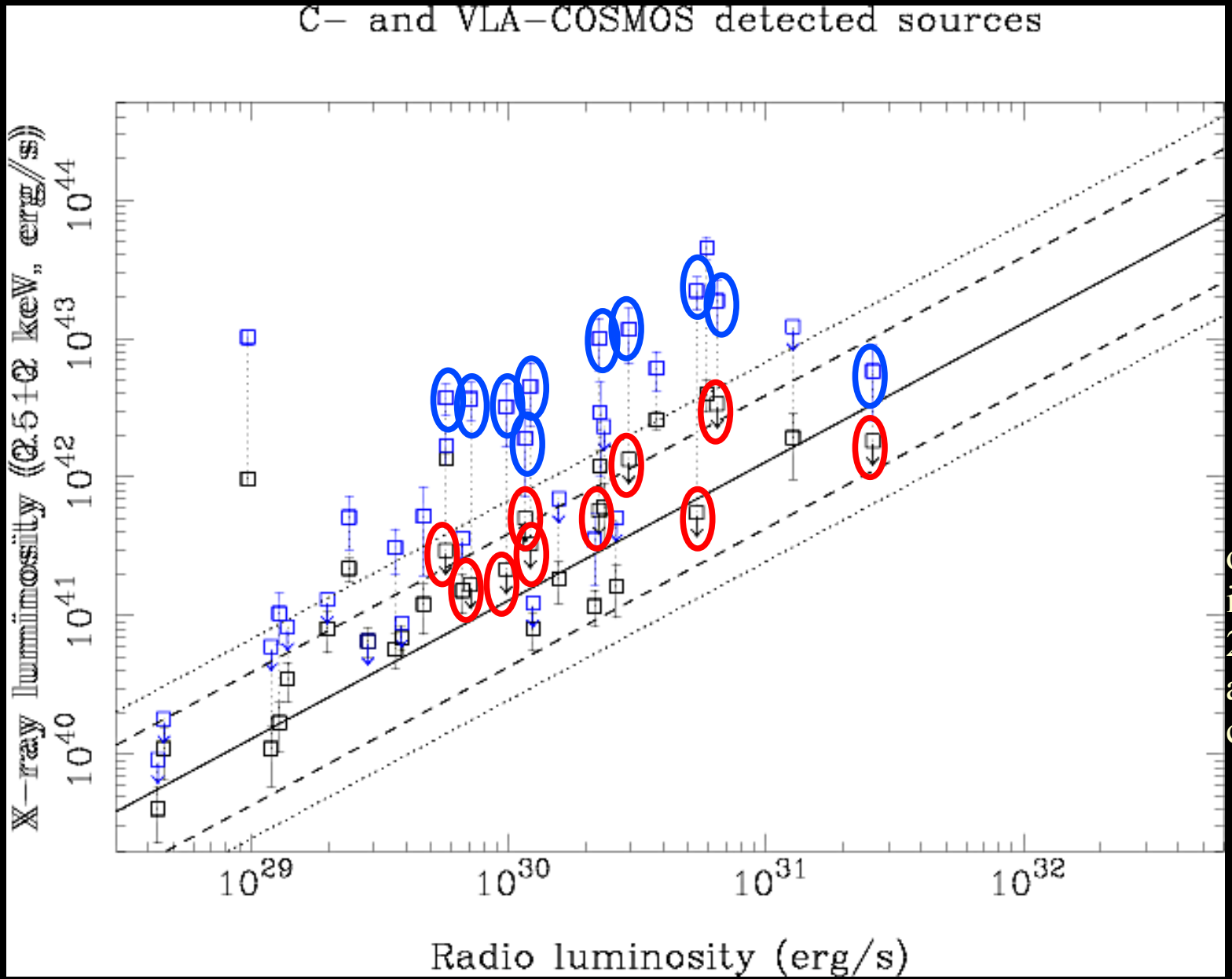
Radio vs. X-ray fluxes, SF 0.5-2 keV



lines:
radio/X-ray
correlation
±2σ, ±3σ
(Ranalli+03)

objects not
detected in 0.5-2
keV (but they ar
detected in 0.5-7
or 2-7 keV)

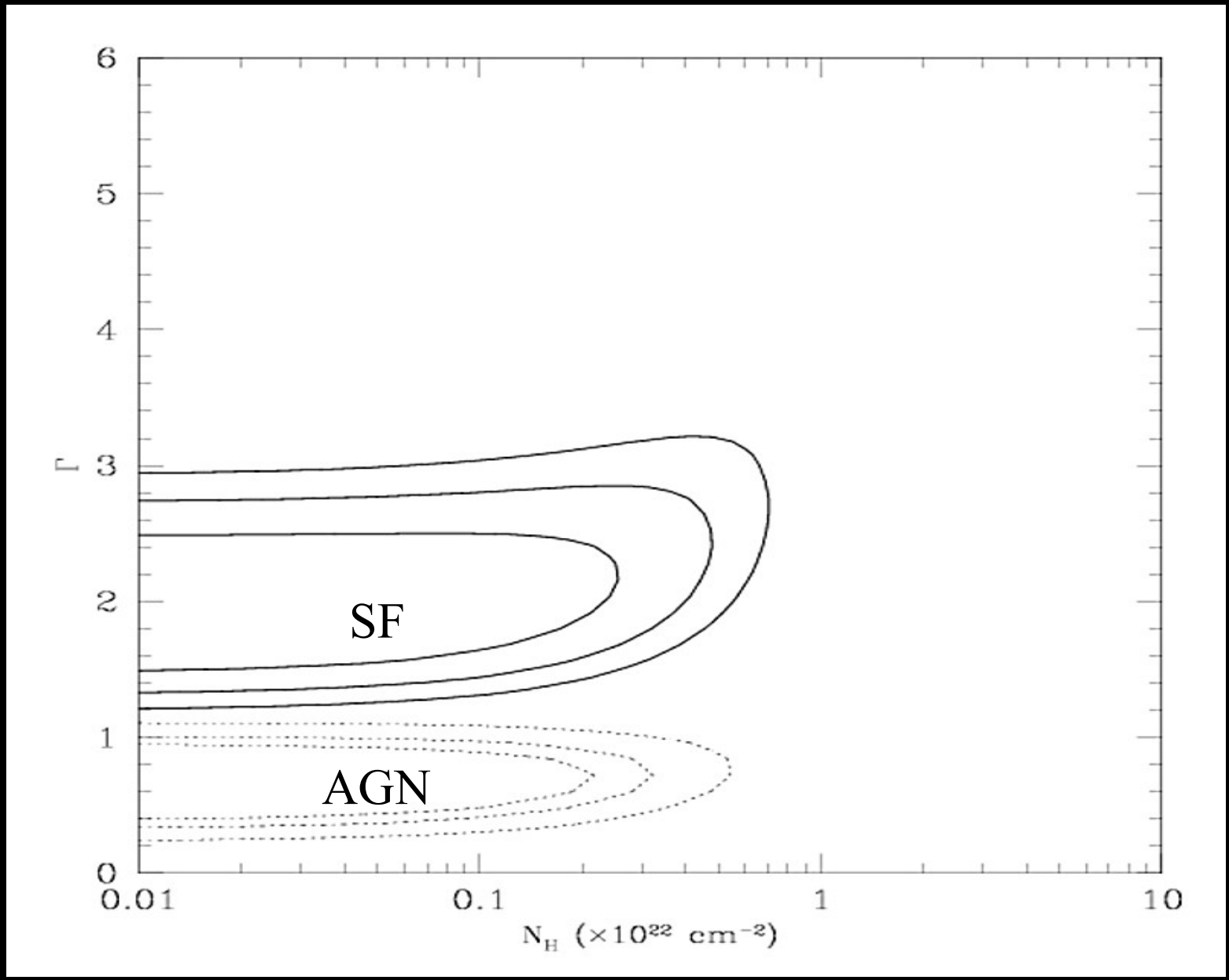
Radio vs. X-ray fluxes, SF 0.5-2 keV



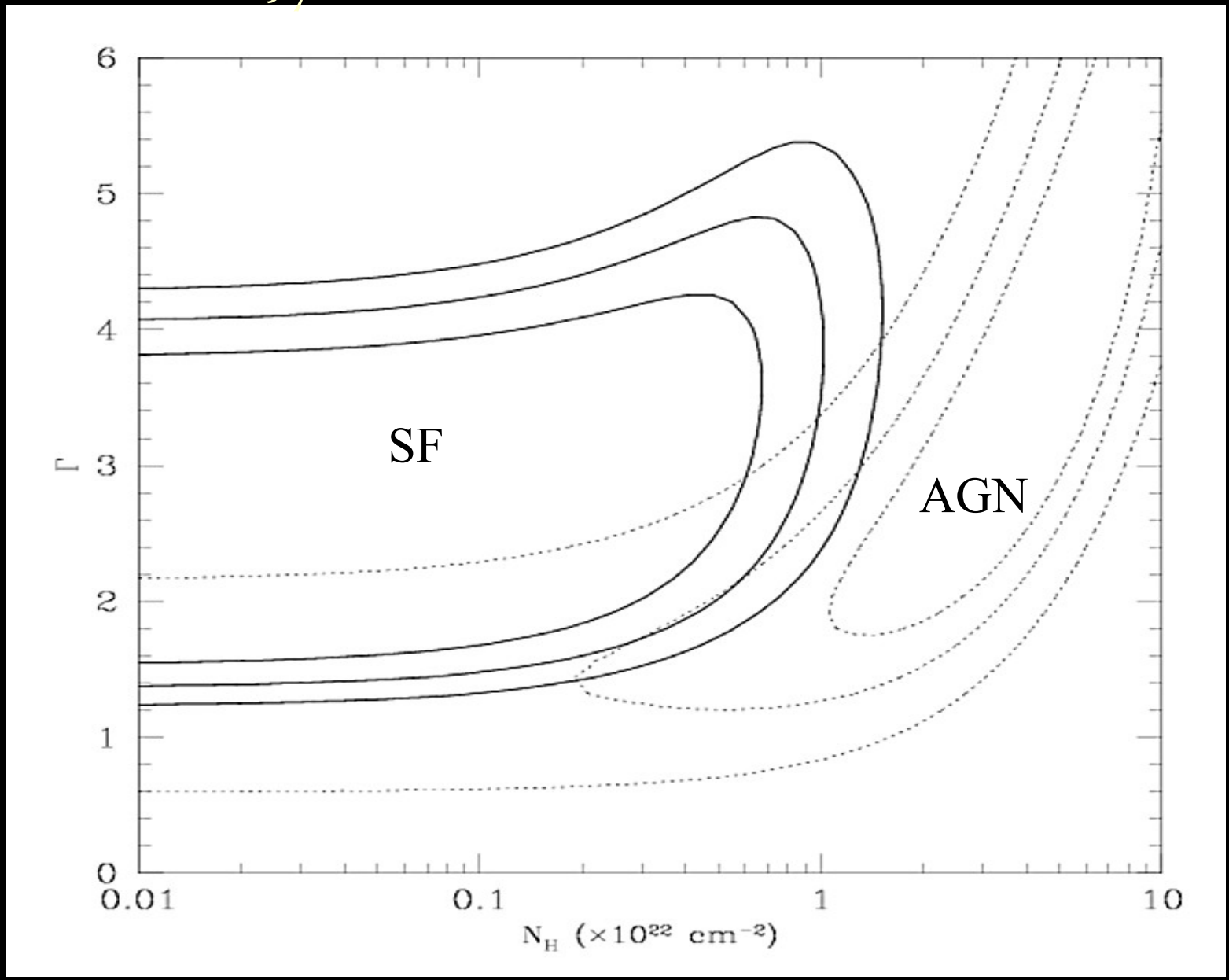
lines:
radio/X-ray
correlation
±2σ, ±3σ
(Ranalli+03)

objects not detected
in 0.5-2 keV have
2-10 keV fluxes well
above the radio/X-ray
correlation

Spectrum of undetected SF & AGN with S<0.2mJy



Spectrum of undetected SF & AGN with 0.2<S<0.63 mJy



Star forming galaxies vs. AGN

selection criteria: possibilities

"Quick and dirty" and X-ray based:

- F_X/F_{opt}
- $L<10^{42}$ (but beware of evolution)
- radio/FIR/X-ray correlation
- HR (NH)
- soft X-ray detection

Slower and complex and require multiwavelength info:

- synthetic colours and diagnostic diagrams
- narrow band, many-wavelength photometry
- optical spectral analysis

Combining them:

- count number of criteria that match/fail
- assigning probabilities to all of the above, and return a verdict according to maximum likelihood or Bayesian methods
- advanced methods from statistical literature

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=> good job of removing suspect AGN from the SF
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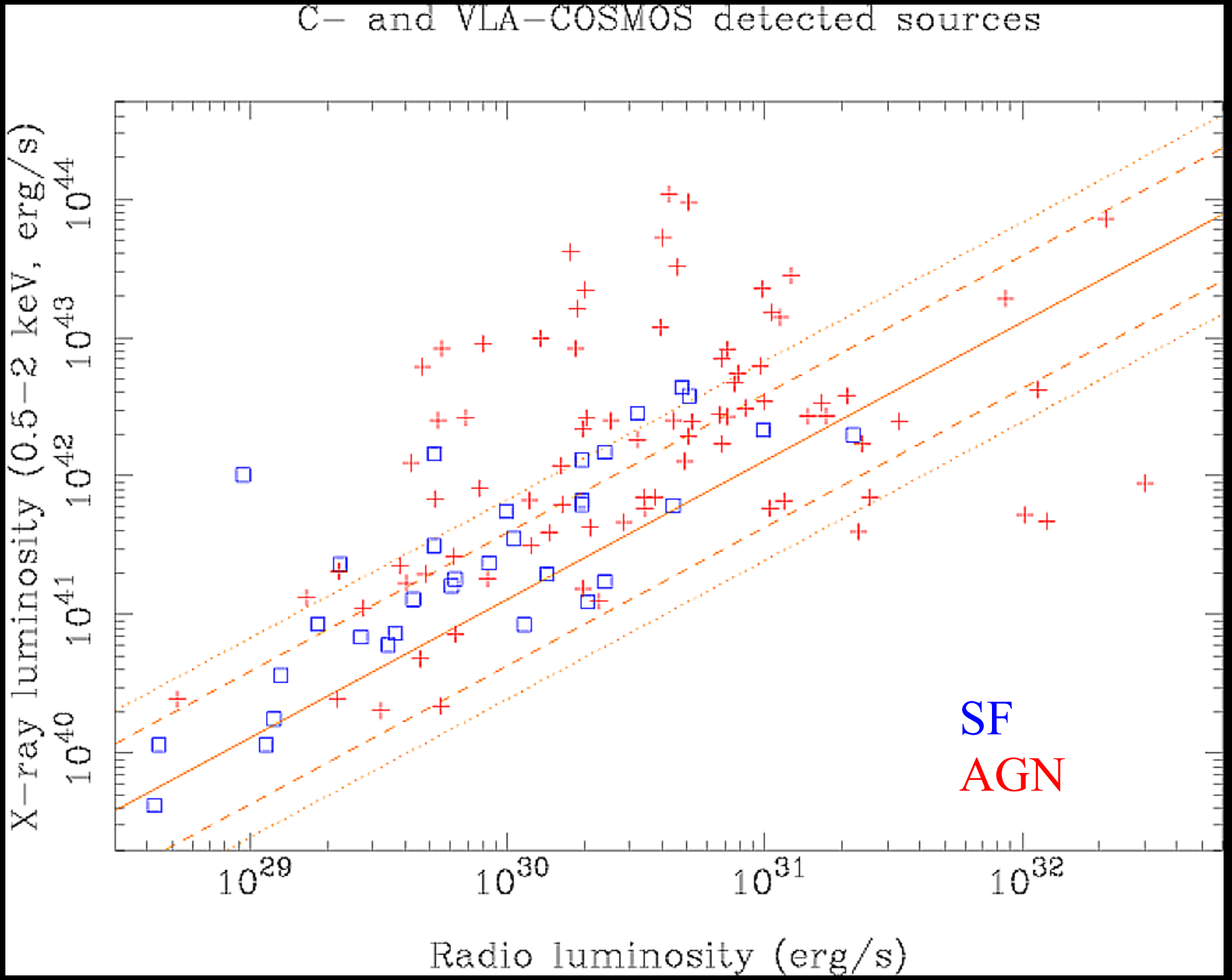
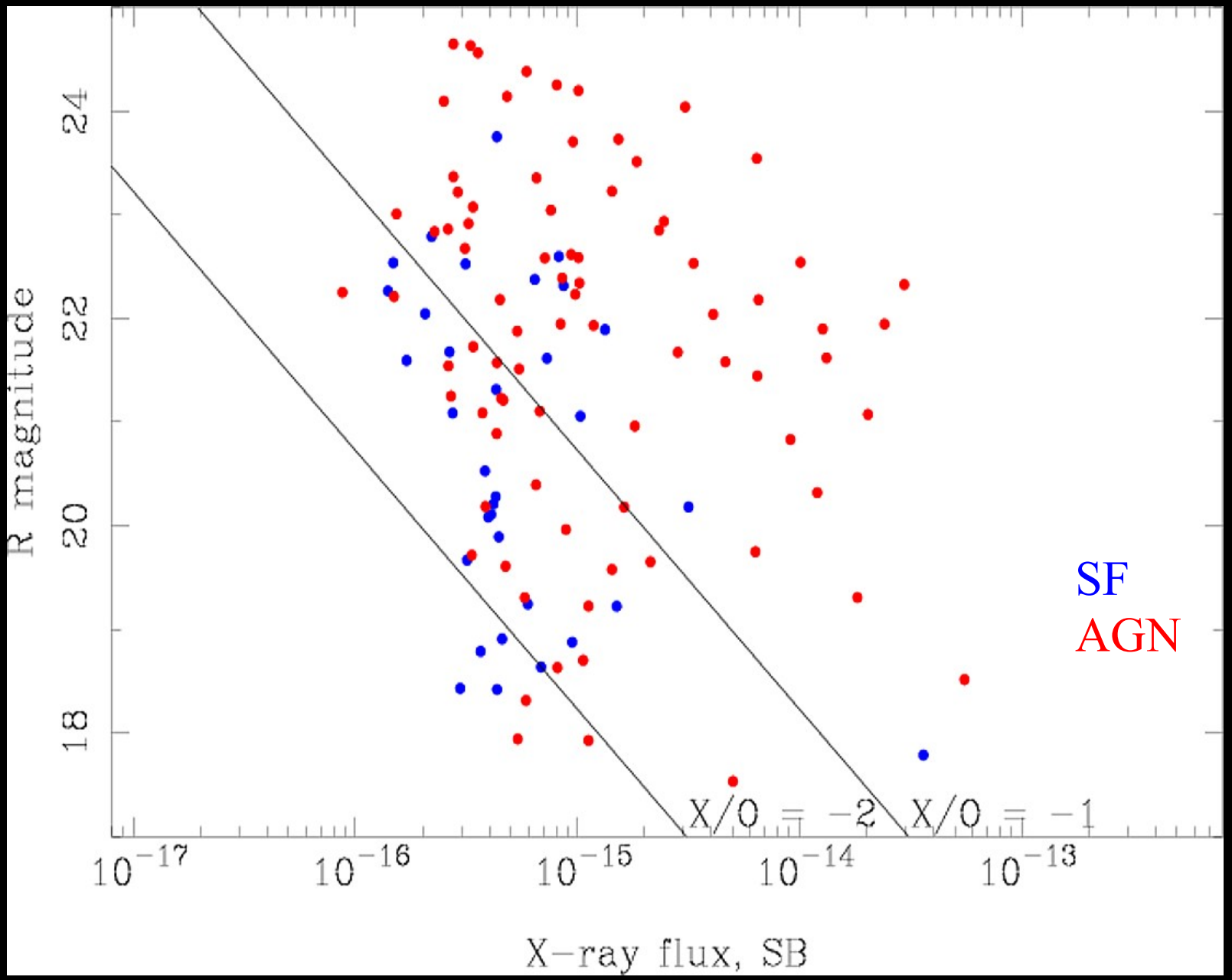
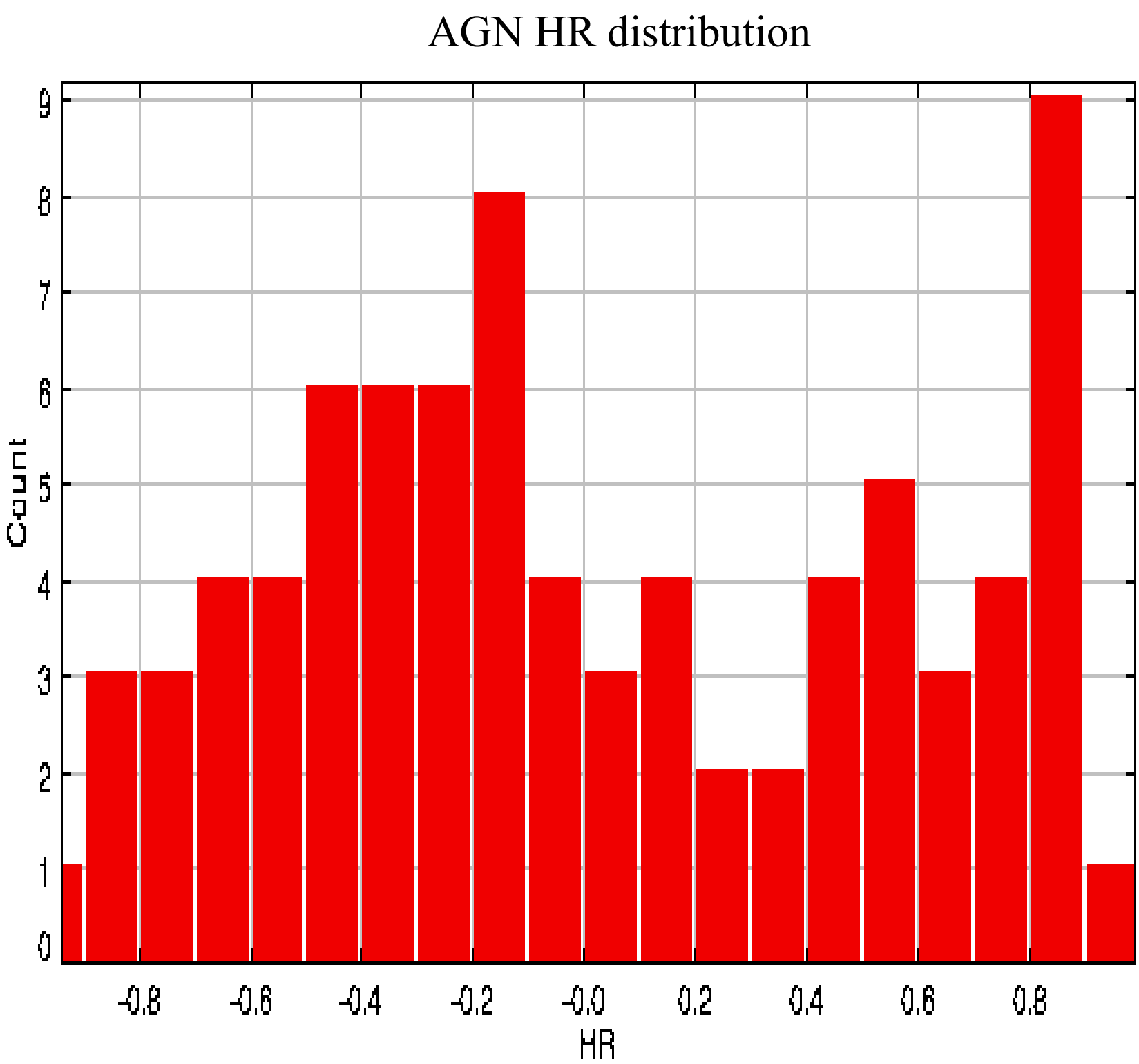

C- and VLA-COSMOS detected sources
X-ray luminosity (0.5-2 keV, erg/s)
10^{40}
10^{41}
10^{42}
10^{43}
10^{44}
10^{29}
10^{30}
10^{31}
10^{32}
Radio luminosity (erg/s)
SF
AGN


R magnitude
24
22
20
18
10^{-17}
10^{-16}
10^{-15}
10^{-14}
10^{-13}
X-ray flux, SB
X/O = −2
X/O = −1
SF
AGN


AGN HR distribution
Count
0
1
2
3
4
5
6
7
8
9
-0.8
-0.6
-0.4
-0.2
-0.0
0.2
0.4
0.6
0.8
HR

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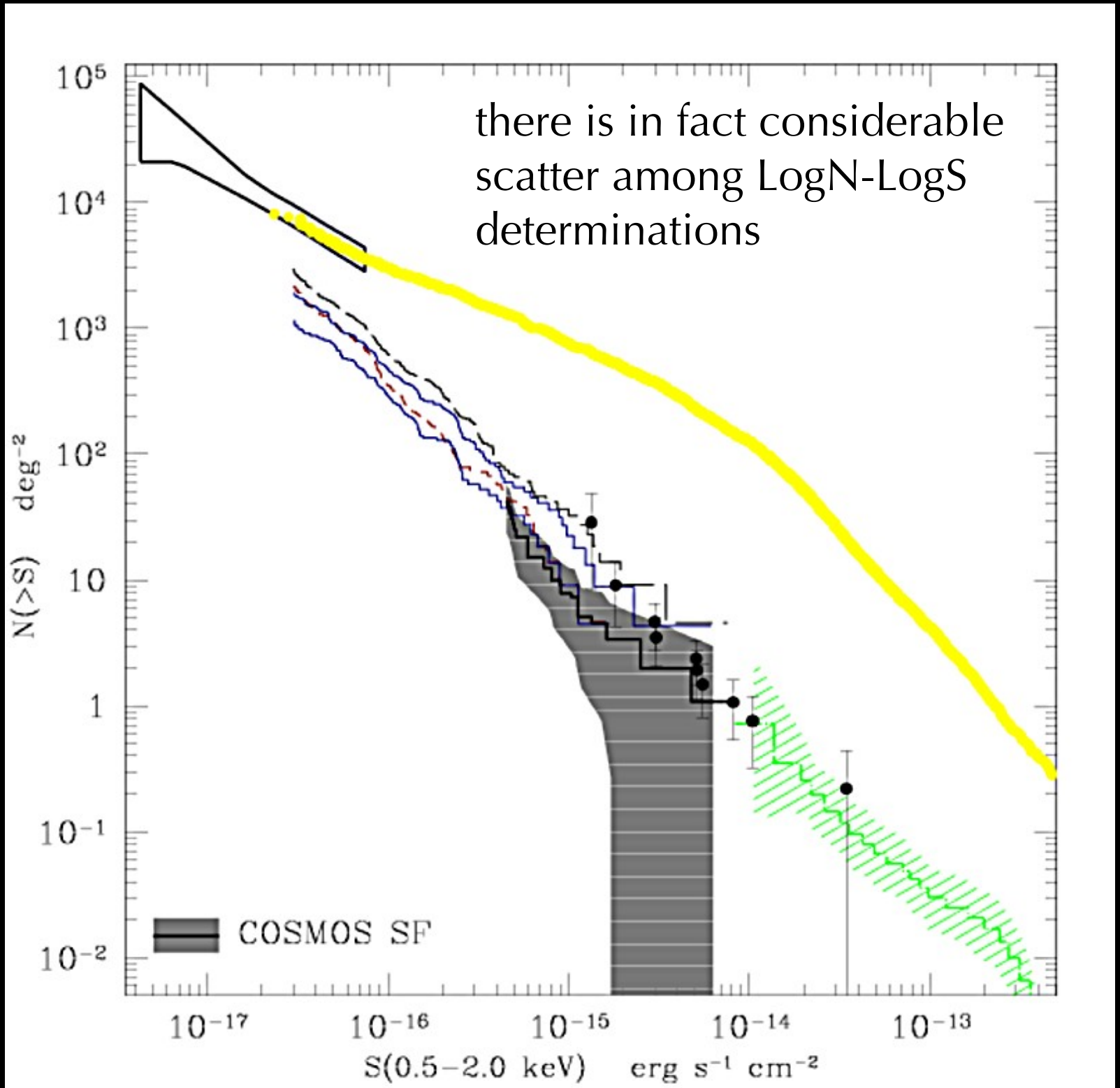
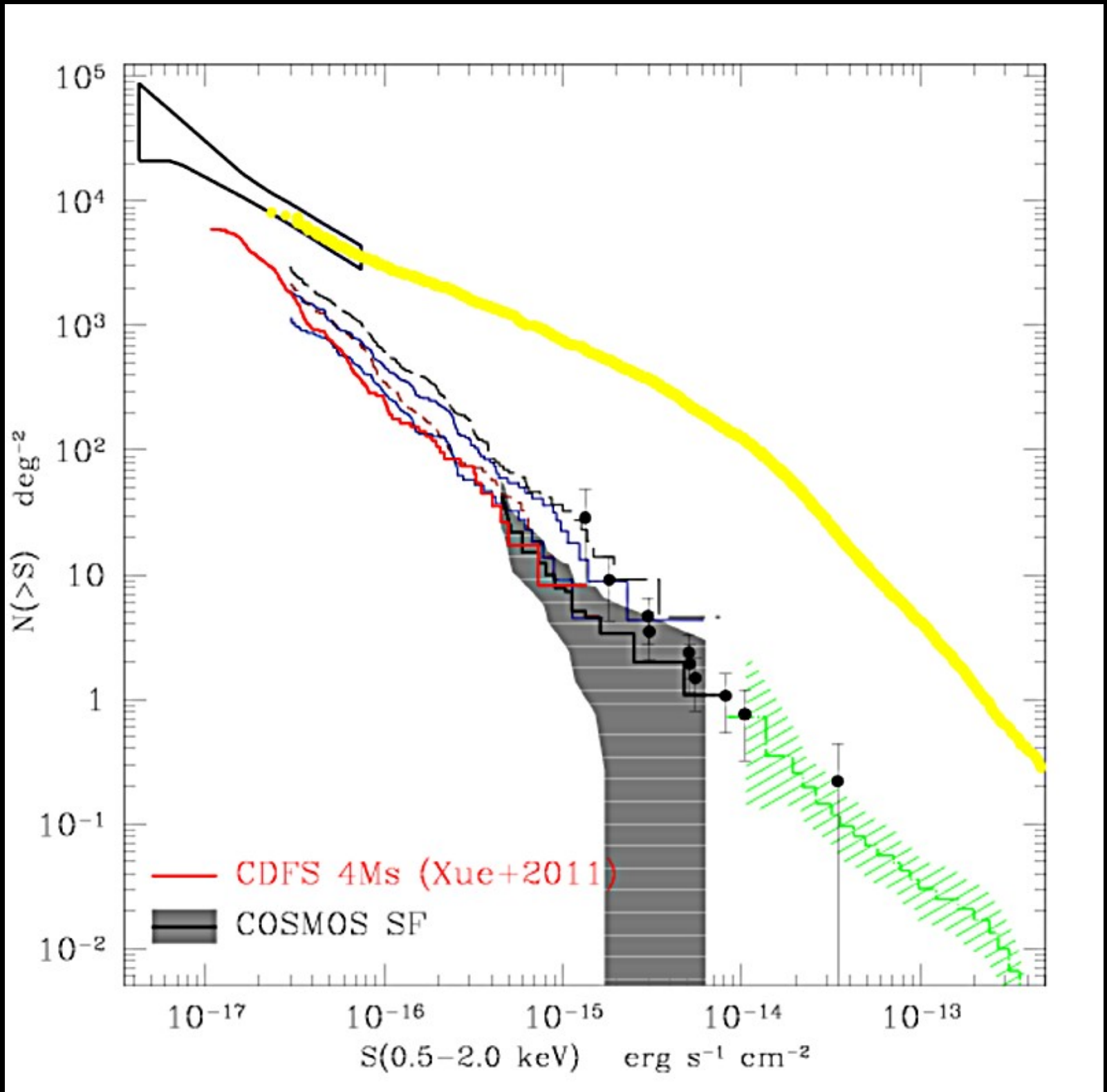
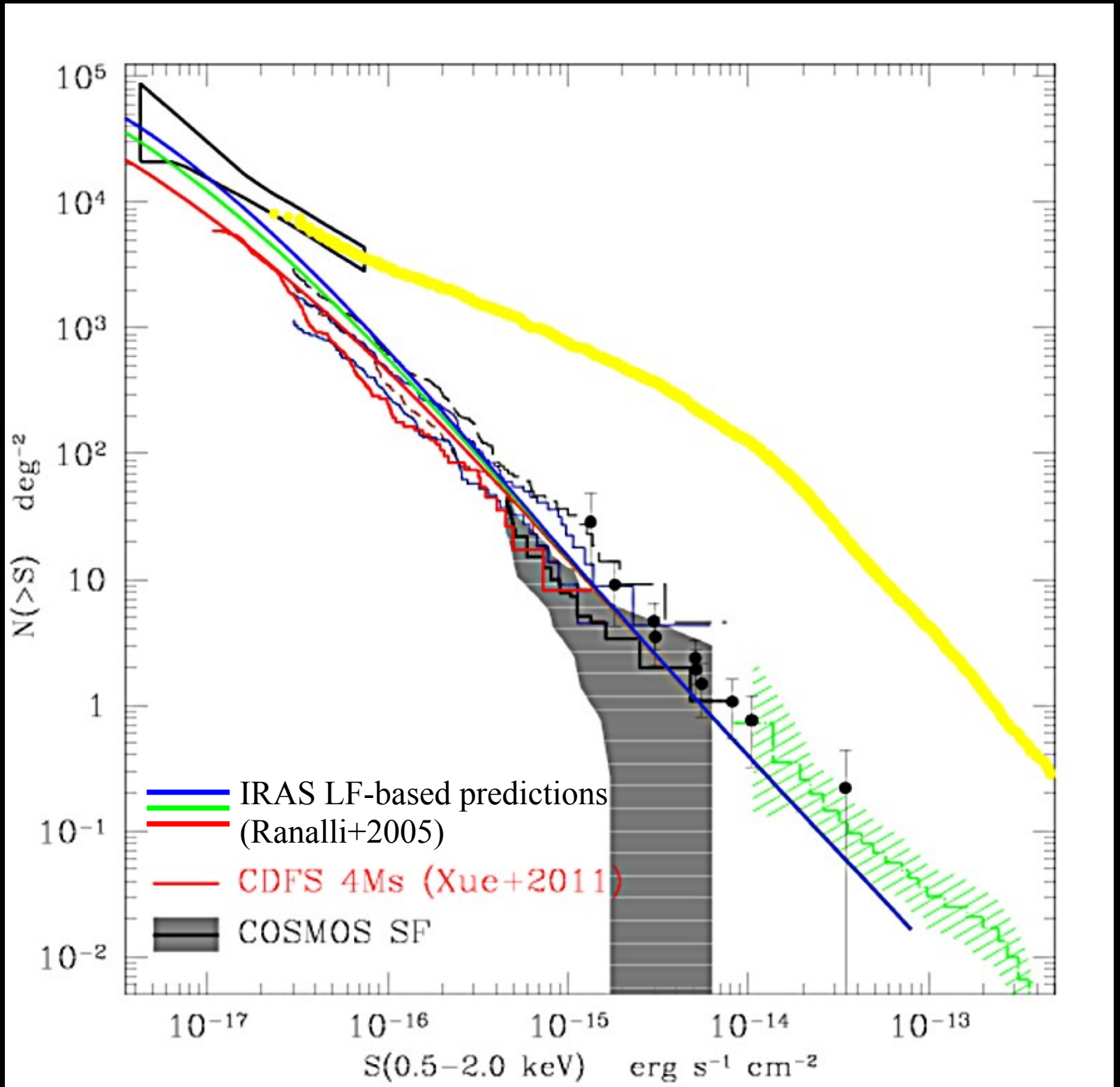

there is in fact considerable scatter among LogN-LogS determinations
COSMOS SF
N(>S) deg^{-2}
S(0.5–2.0 keV) erg s^{-1} cm^{-2}
10^{5}
10^{4}
10^{3}
10^{2}
10
1
10^{-1}
10^{-2}
10^{-17}
10^{-16}
10^{-15}
10^{-14}
10^{-13}


10^5
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
N(>S) deg^{-2}
CDFS 4Ms (Xue+2011)
COSMOS SF
10^{-17}
10^{-16}
10^{-15}
10^{-14}
10^{-13}
S(0.5−2.0 keV) erg s^{-1} cm^{-2}


10^5
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
N(>S) deg^{-2}
IRAS LF-based predictions
(Ranalli+2005)
CDFS 4Ms (Xue+2011)
COSMOS SF
10^{-17}
10^{-16}
10^{-15}
10^{-14}
10^{-13}
S(0.5–2.0 keV) erg s^{-1} cm^{-2}

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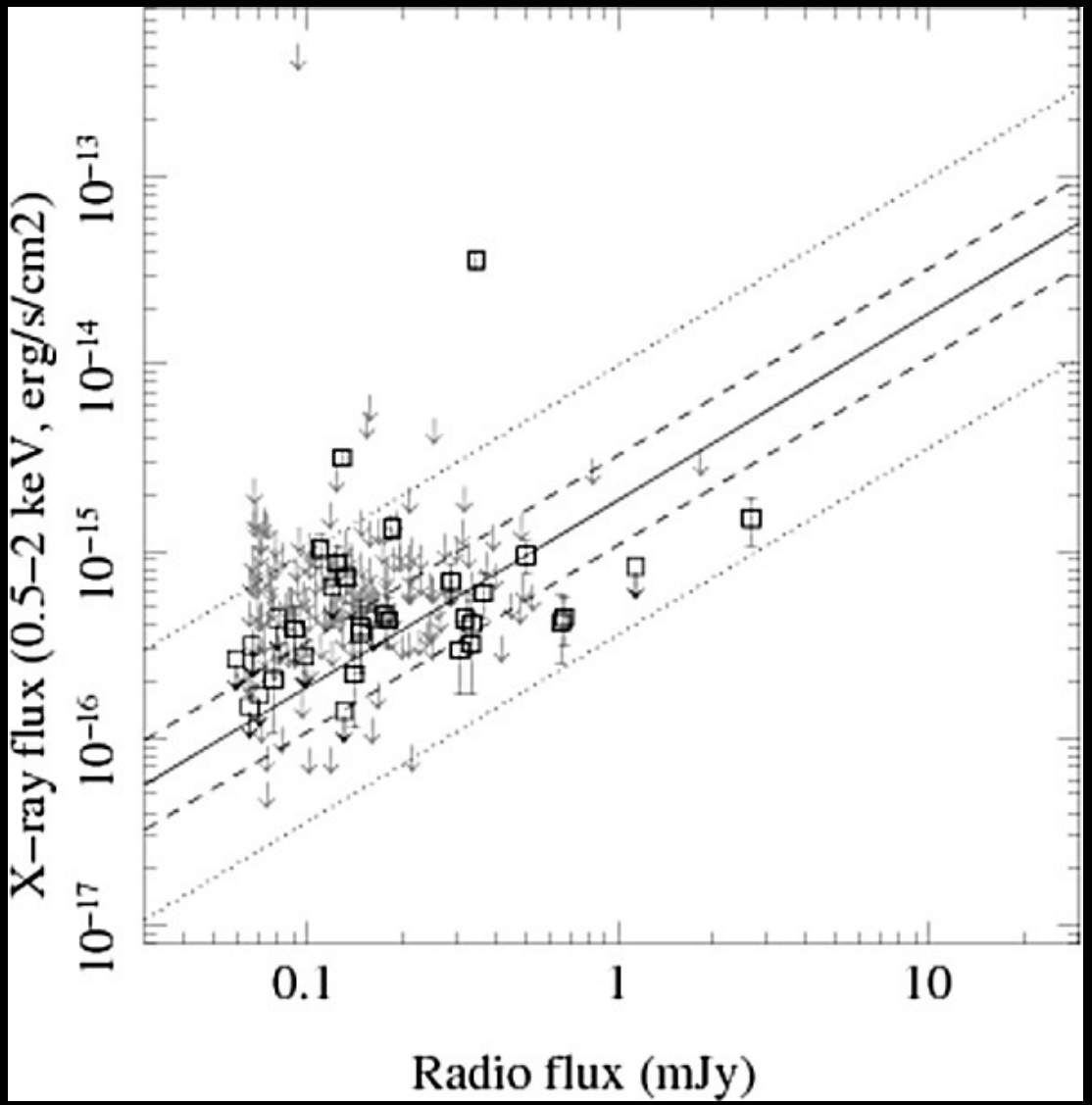
=> do the criteria evolve with redshift?

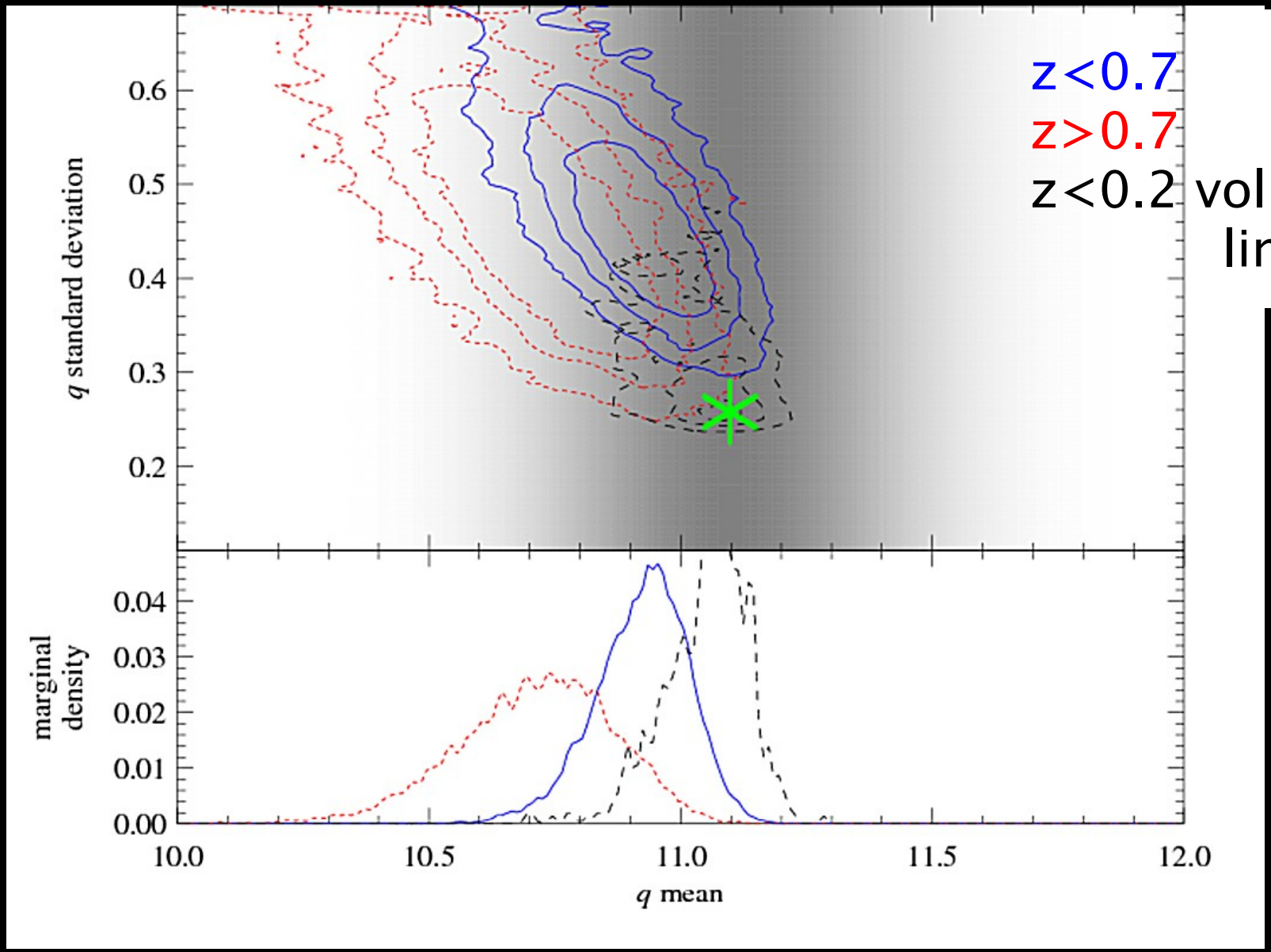
Evolution of parameters: radio/X-ray ratio

3 bins:

* z<0.7
* z>0.7
* z<0.2 volume limited



Distribution of q=Log(F_0.5-2 keV / F_1.4 GHz)



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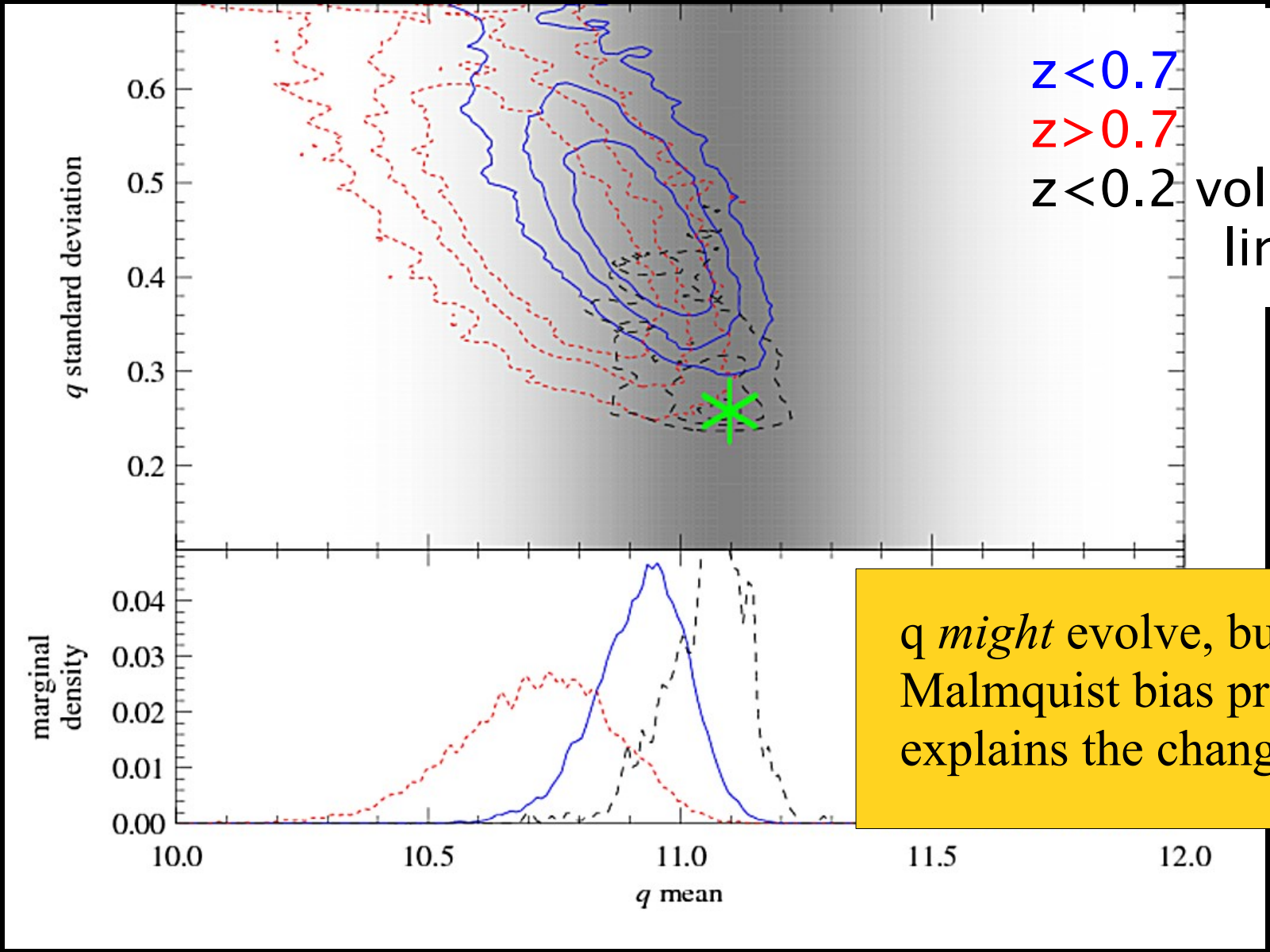

q *might* evolve, but Malmquist bias probably explains the change

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Still unknown.