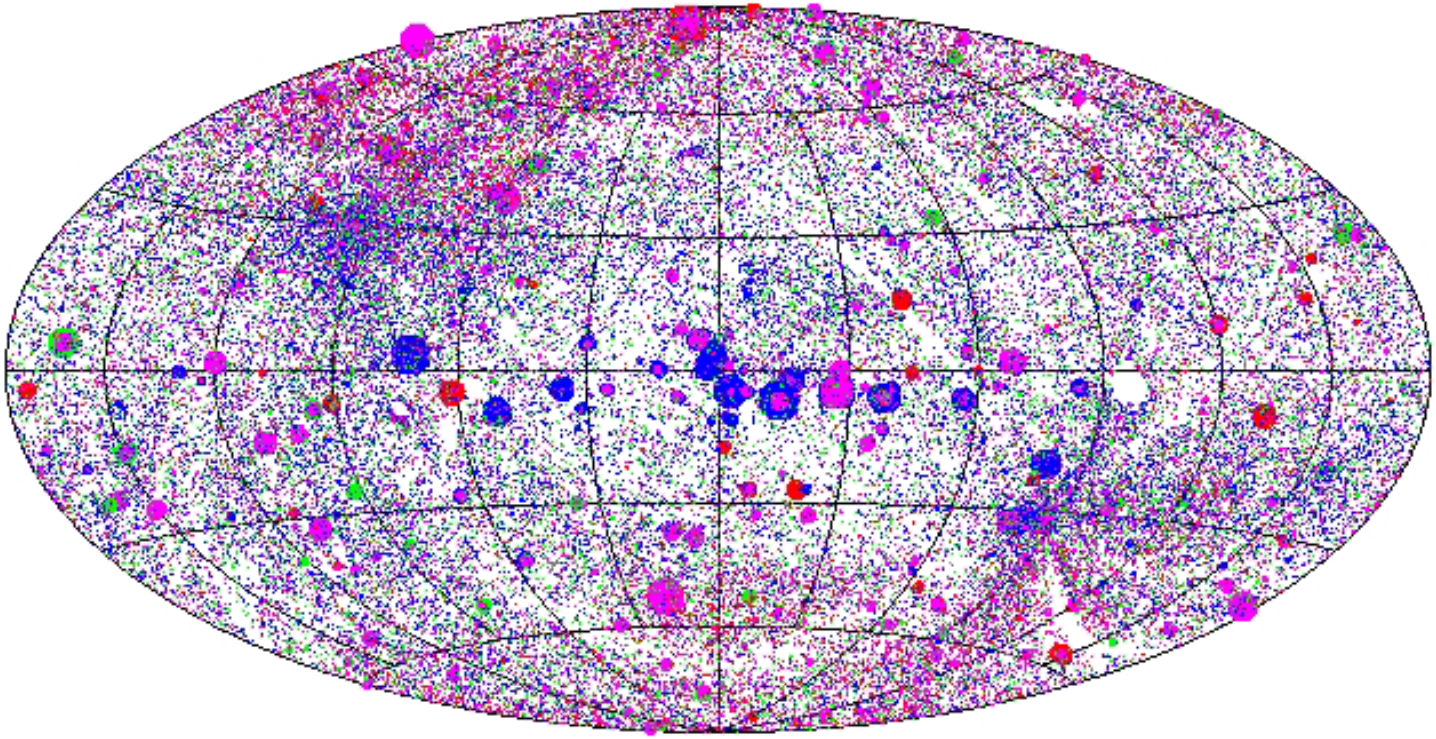
The second ROSAT All-Sky Survey source catalogue: the deepest X-ray All-Sky Survey before eROSITA

Th. Boller, M. Freyberg, J. Trümper, F. Haberl et al.

- **complete new-processing based on SASS III Photon Event Files (better attitude, larger sky coverage)**
- **improved detection algorithm, fully documented, reproducible for community**
- **new data products: images + light curves + spectral fits**
- **fully screened 2RXS**
- **thousands of new highly variable objects above the 3σ level**
- **thousands of new NLS1 objects**

The second ROSAT All-Sky Survey catalogue



113990 sources down to a detection likelihood of 7

24604 2RXS BSC

5800 additional BSC sources

89386 2RXS FSC

16210 less FSC sources

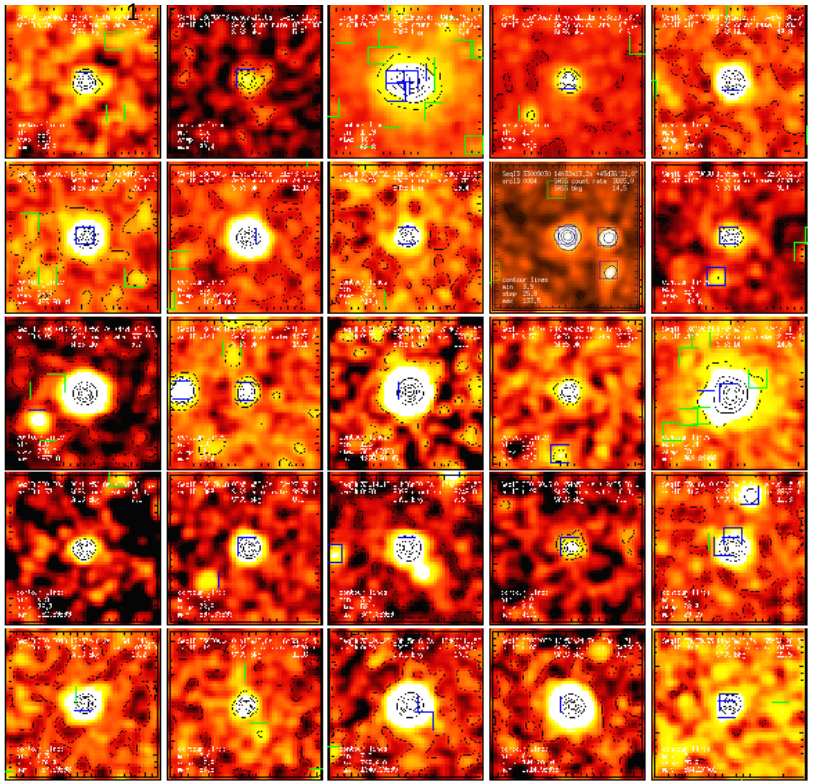
$$\sum = 113990$$

6147 flagged sources

the largest and and most reliable X-ray all-sky survey before eROSITA

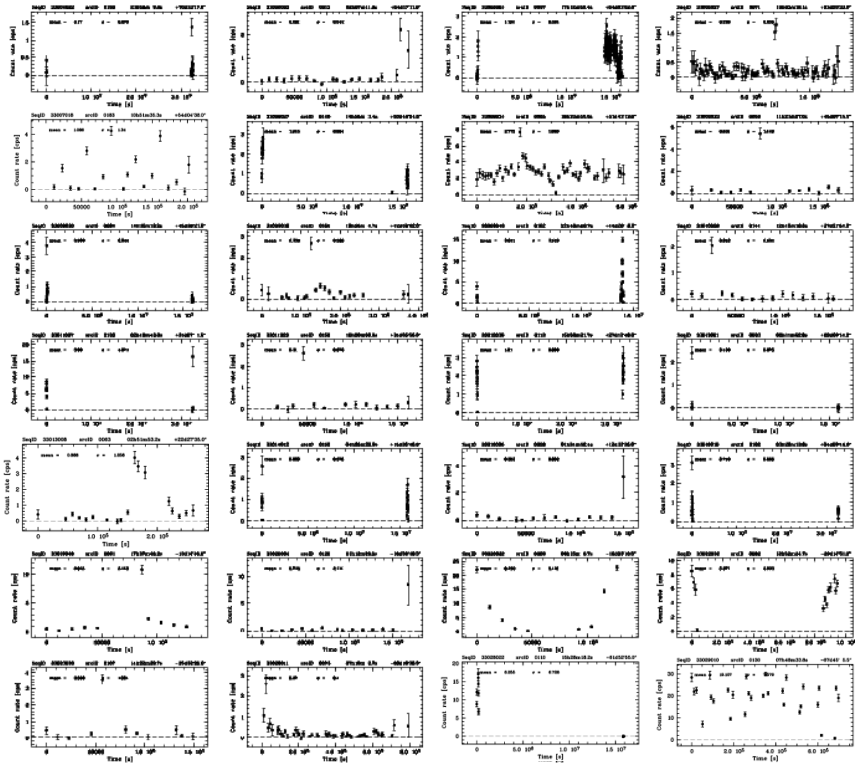
New data products and source parameters for 113390 sources

images



standard SASS output: RA,DEC,CTS,HR,exposure, detection likelihood

light curves



variability properties , amplitude variablity, timescales

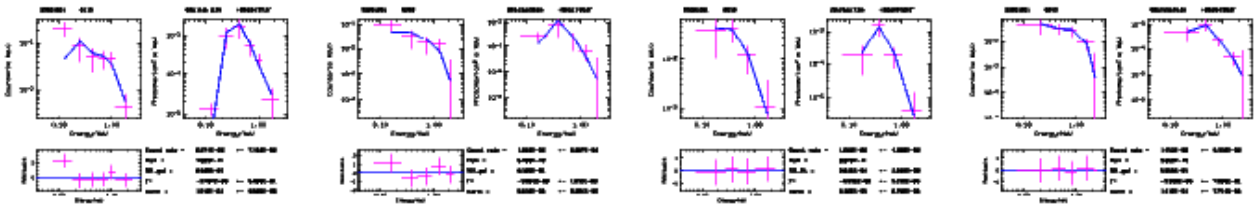
spectral fits

5: EK Uma(CV) Fuhrmeister&Schmitt(2003)

17: J02515408 (star) Fuhrmeister&Schmitt(2003)

27: EXO 0748 (LMXRB) new

28: J05015375(star) Fuhrmeister&Schmitt(2003)

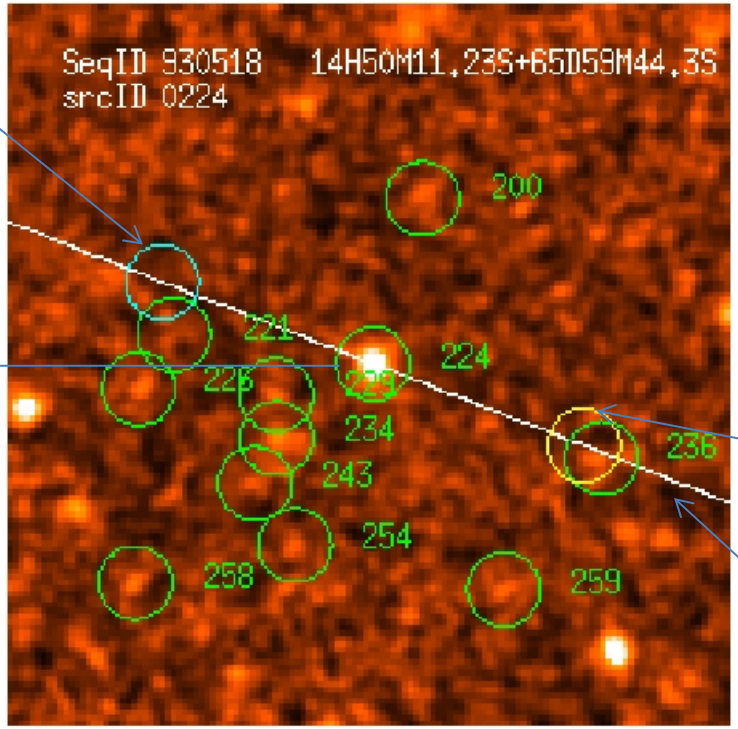


spectral fit parameters: Nh_fit, Γ, T, flux, χ^2

Improved timing and spectral algorithm

background region 1
- corrected for source contamination
- PLUS 8 seconds separated in time from source count region

source

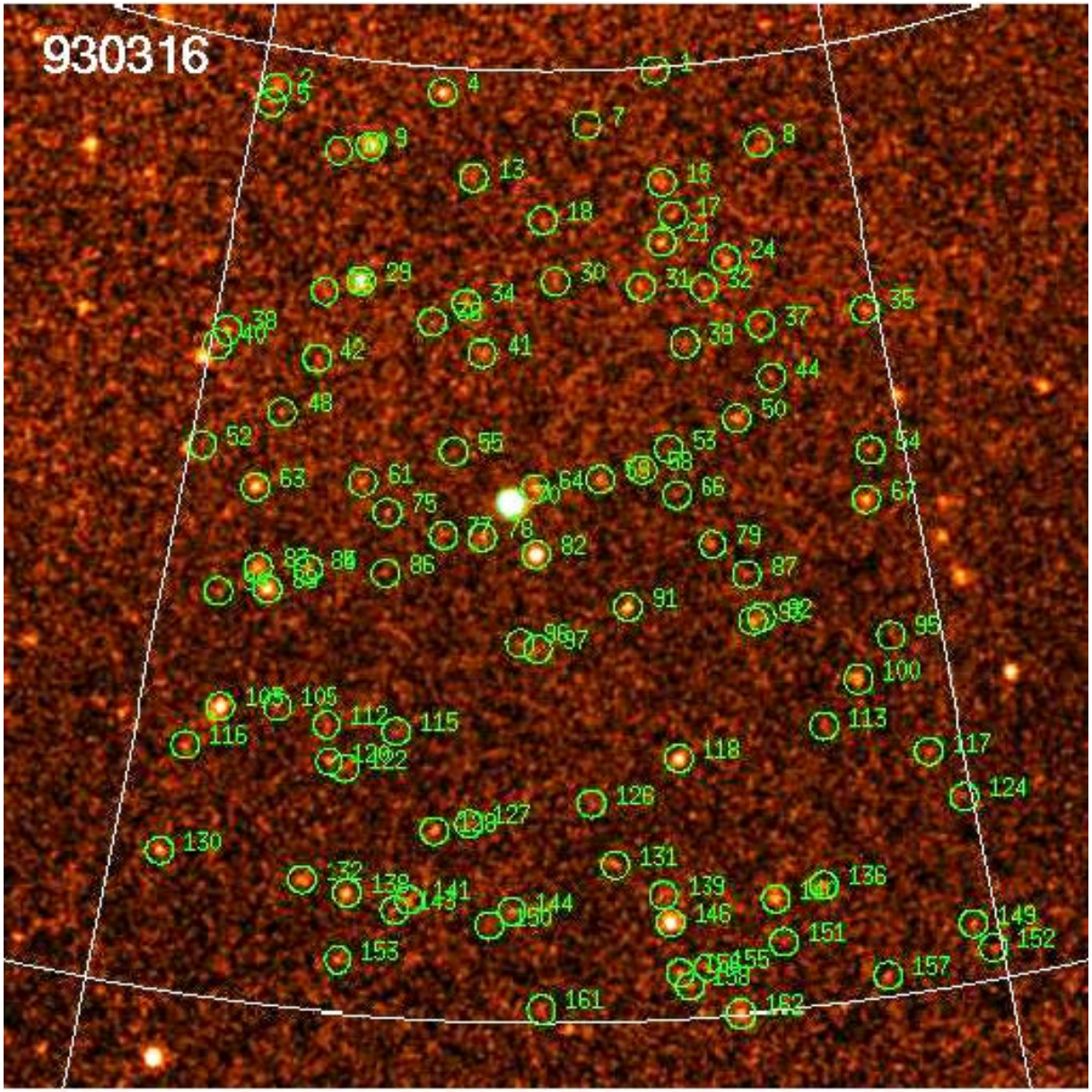


background region 2
- corrected for source contamination
- MINUS 8 seconds separated in time from source count region

scan direction

source and background taken in scan direction
background corrected for source contamination
background with lowest source contamination taken
event rates and attitude files checked for scan pathes with detector in OFF mode !

improved detection algorithm



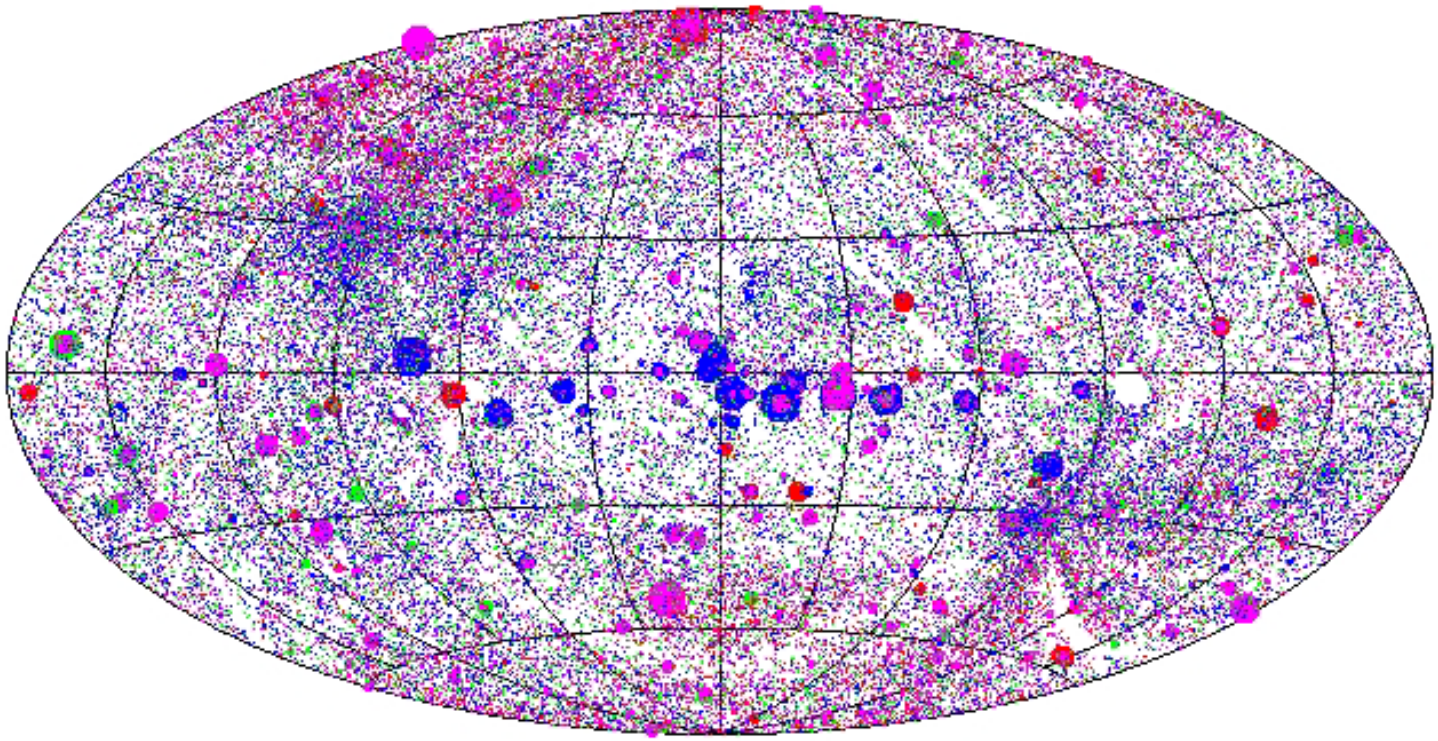
Visual inspection of all initial 2RXS sources

all initial ROSAT X-ray sources were visually inspected, and objects visually-classified as uncertain were removed

visually inspected
120137

confirmed 2RXS sources
113990 (94.9%)

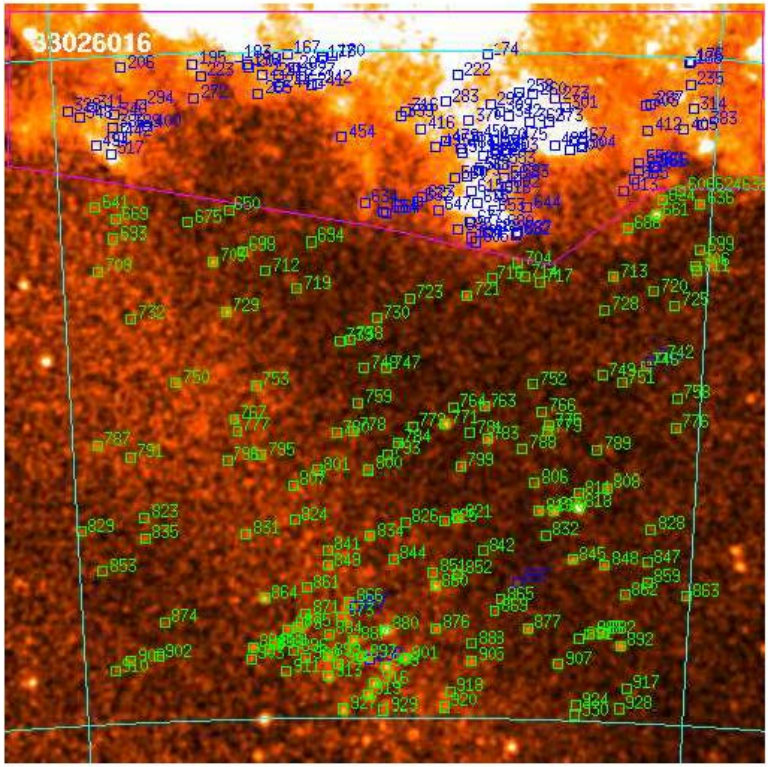
removed 2RXS sources
6147 (5.1%)



2RXS screening and validation results

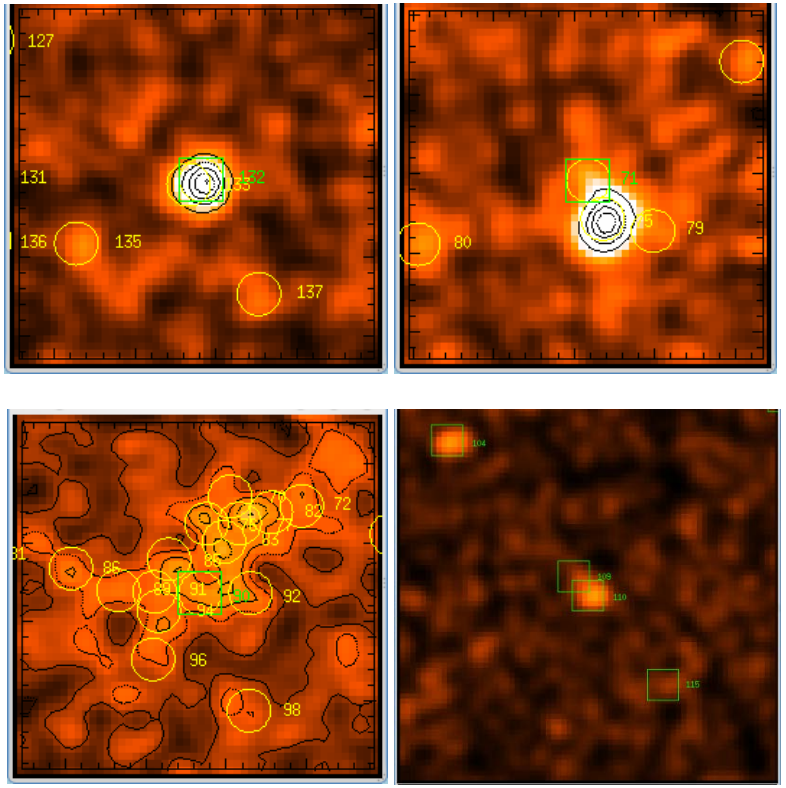
Large Extended Areas

Vela



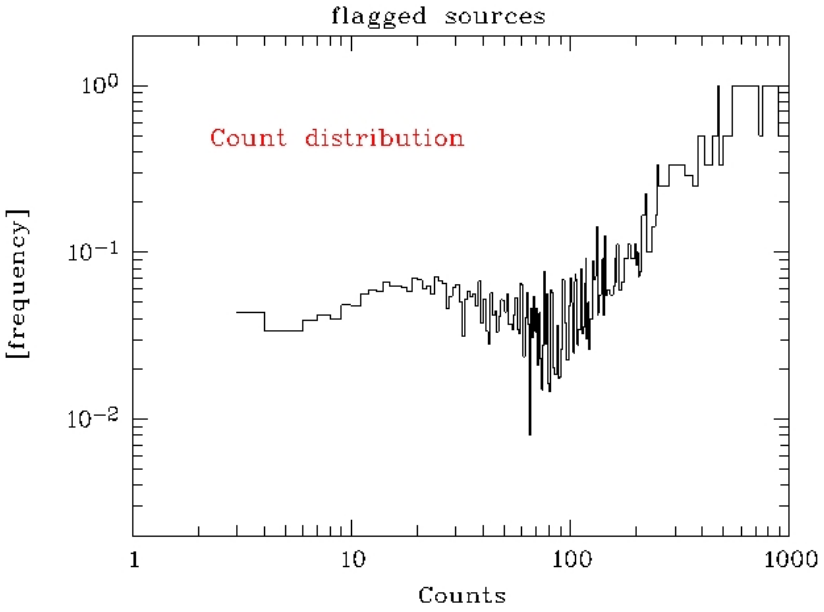
- 53 large extended regions identified
- excluded out from Point Source Catalogue
- important for foreground screening of Planck data

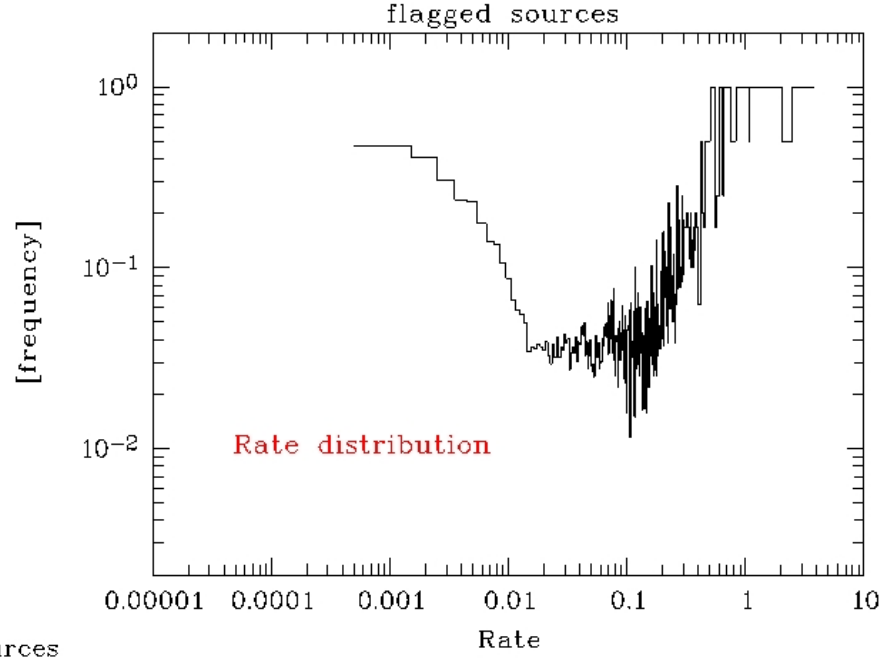
visual inspection of 120137 sources

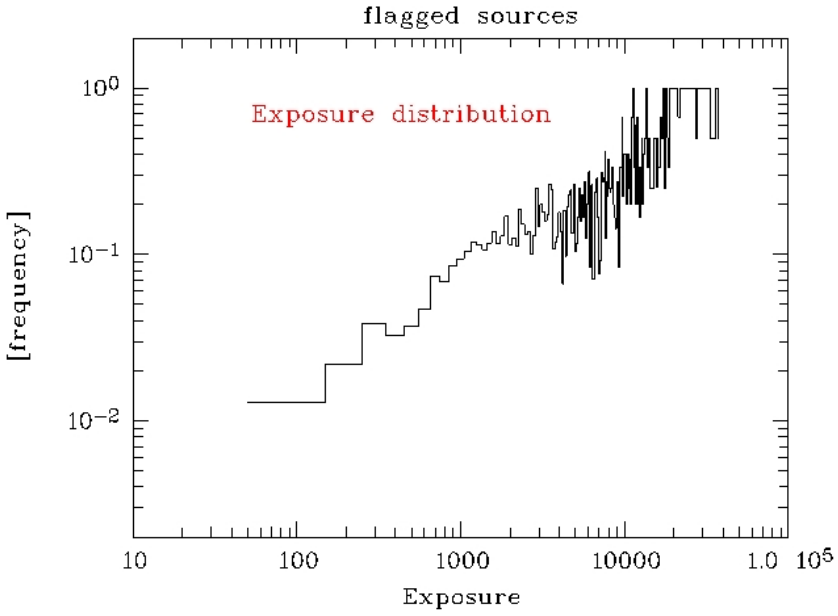


6147 uncertain detections

Screening results

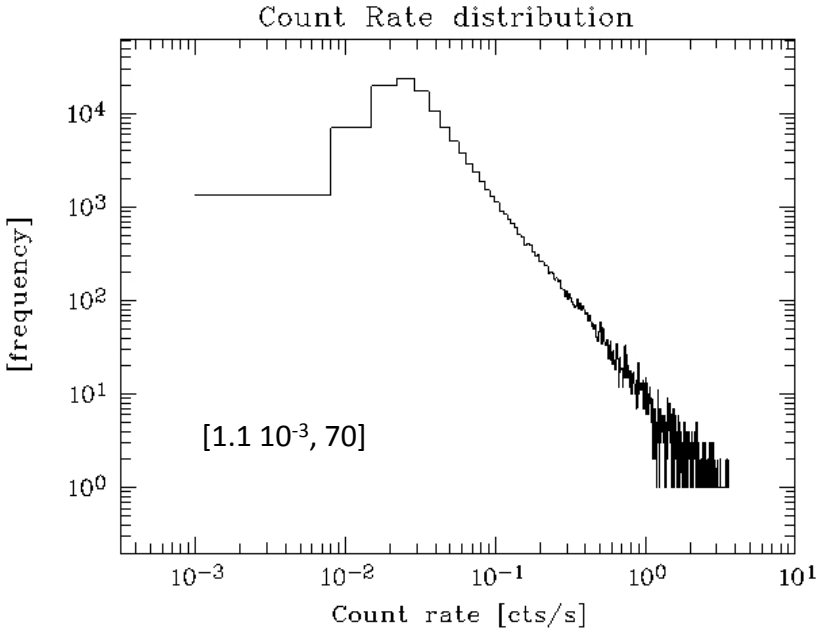


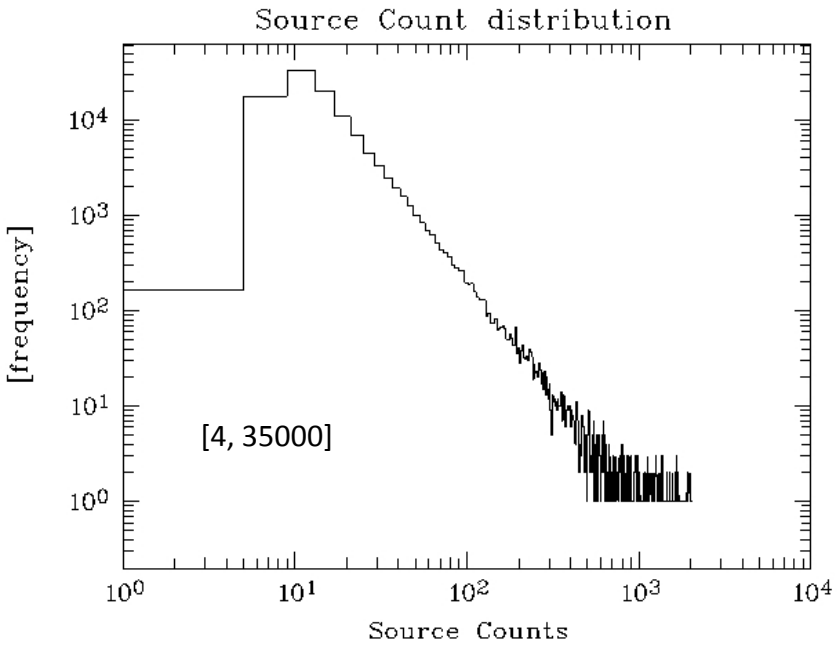


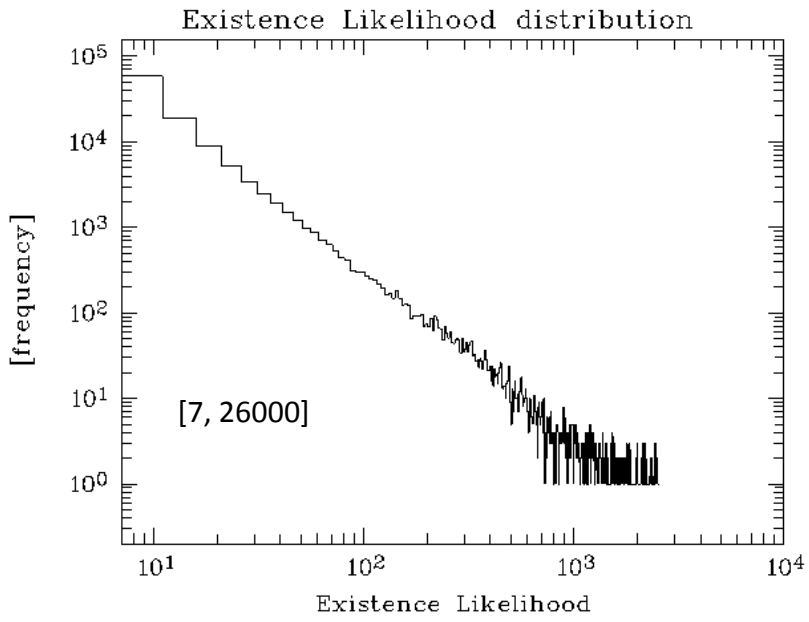


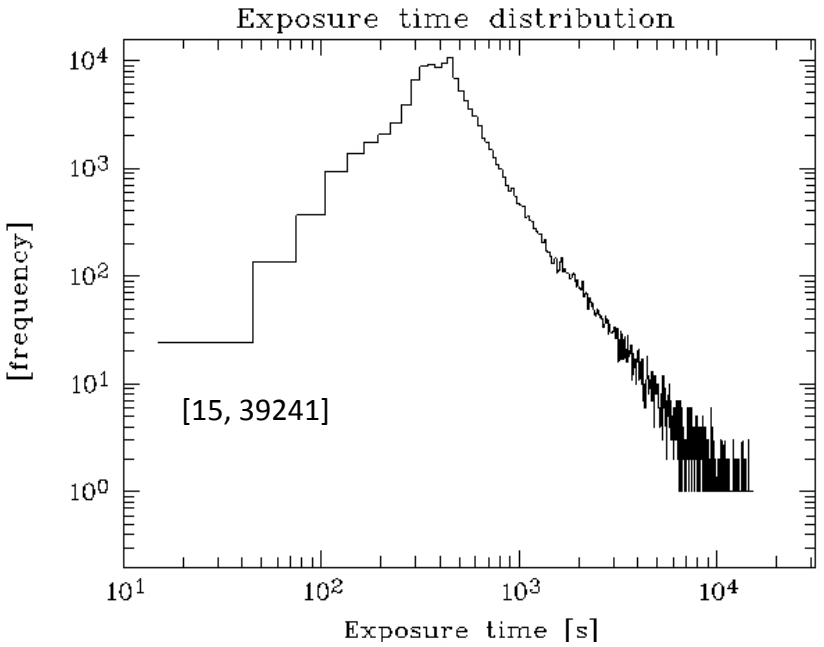
2RXS general properties

rate, counts, likelihood, exposure time - distributions

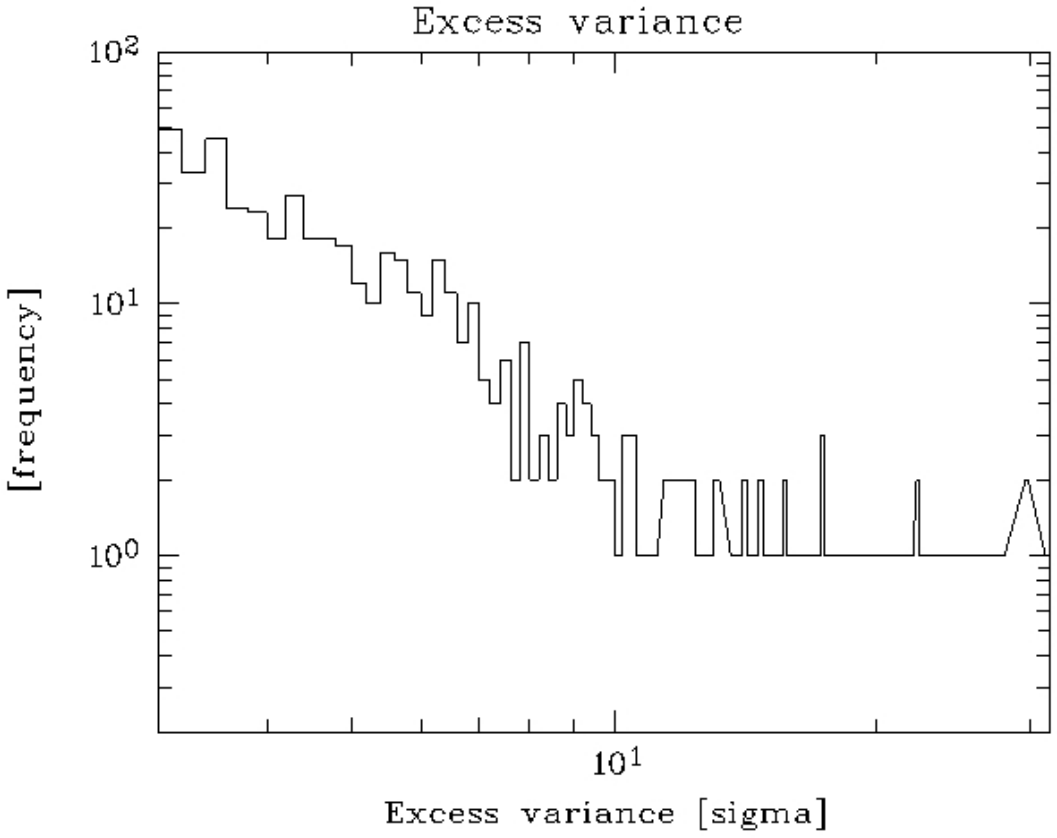








Source variability during survey scans: EXCESS VARIANCE



Nomalized excess variance

$$\sigma^2{}_{rms} = \frac{1}{N\,\mu^2}\sum_{i=1}^{N}\left[(X_i-\mu)^2 - \sigma_i^2\right]$$

1 σ uncertainty

$$(\Delta\sigma_{rms}{}^2)_{meas}$$

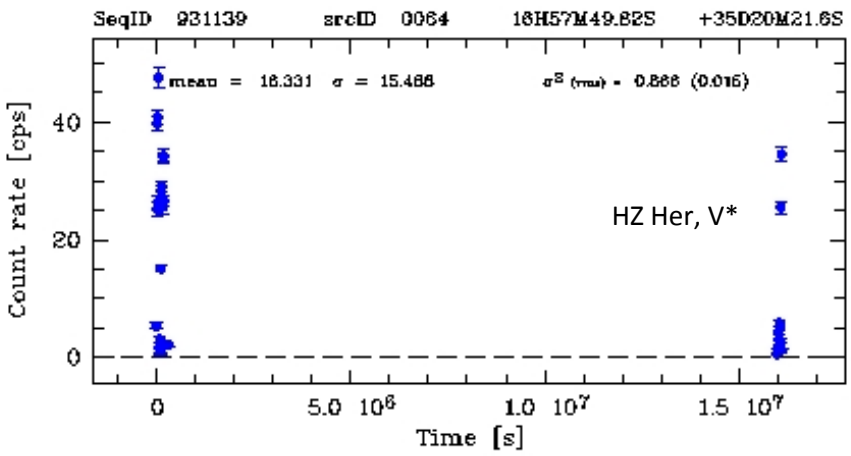
Nandra[97], Turner[99], Vaughan[03], Ponti[04], Ponti[12]

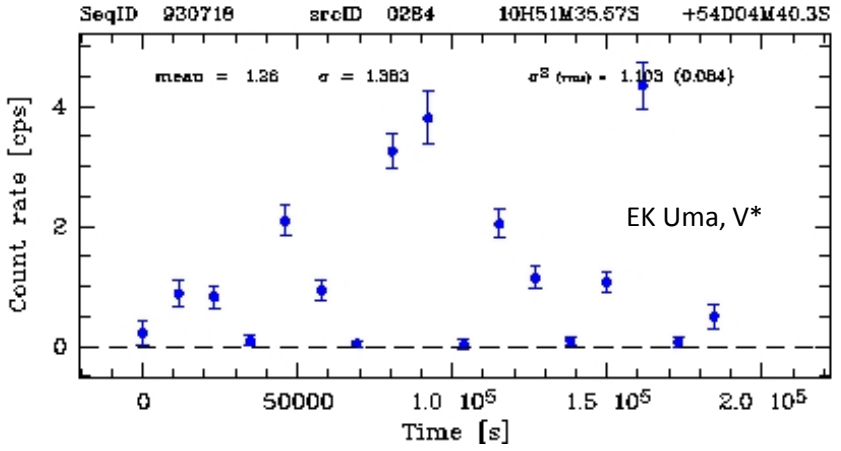
normalized excess variance with the 1σ uncertainty gives the probability that a 2RXS source is variable in units of SIGMA

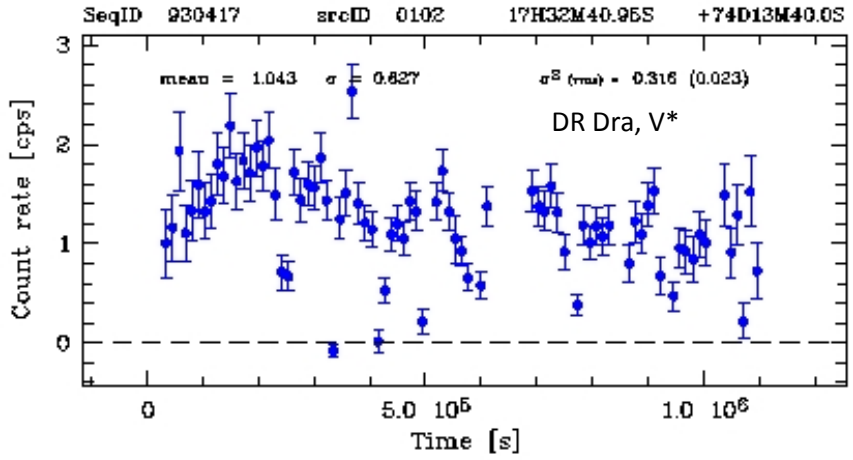
509 sources above the 3 σ limit

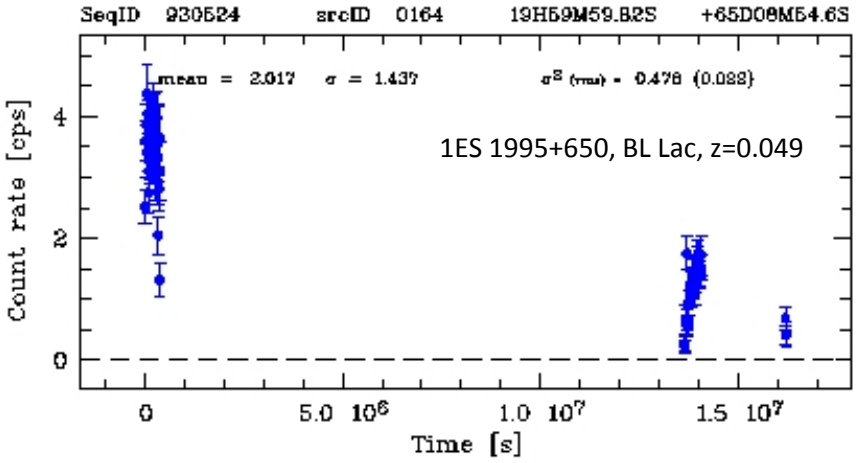
69 sources above the 10 σ limit

Source variability during survey scans: EXCESS VARIANCE EXAMPLES



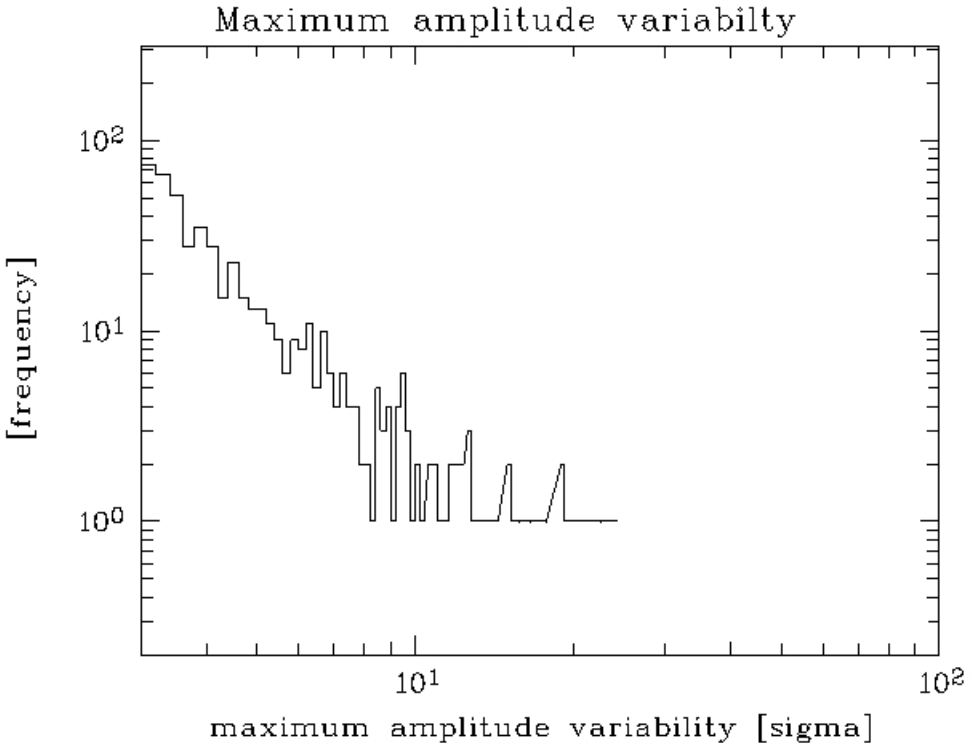






509 sources above the 3 σ limit, 69 sources above the 10 σ limit

Source variability during survey scans: MAXIMUM AMPLITUDE VARIABILITY

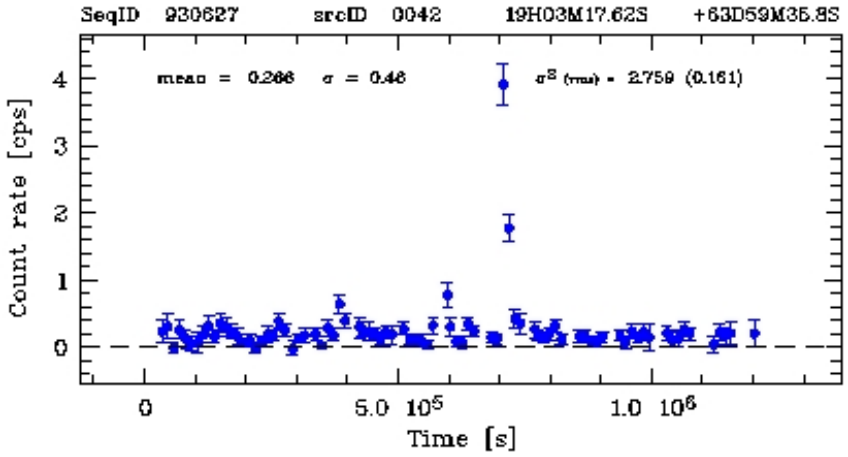


Maximum amplitude variability

$$maxampl = \frac{(Xi^{max} - errmax) - (Xi^{min} + errmax)}{errmax}$$

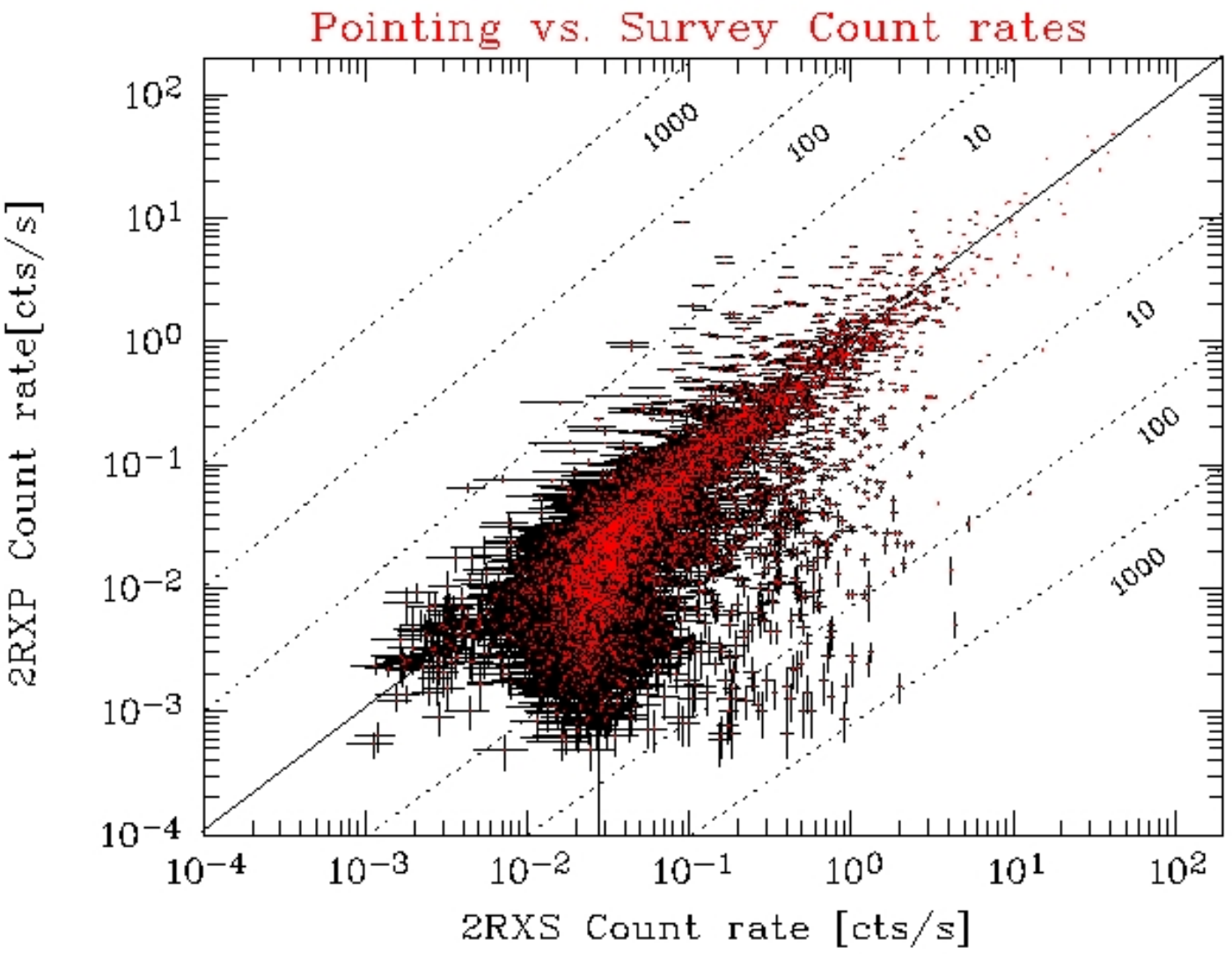
the maximum amplitude variability gives the ratio between the highest and lowest count rate in units of SIGMA

528 sources above the 3 σ limit
39 sources above the 10 σ limit

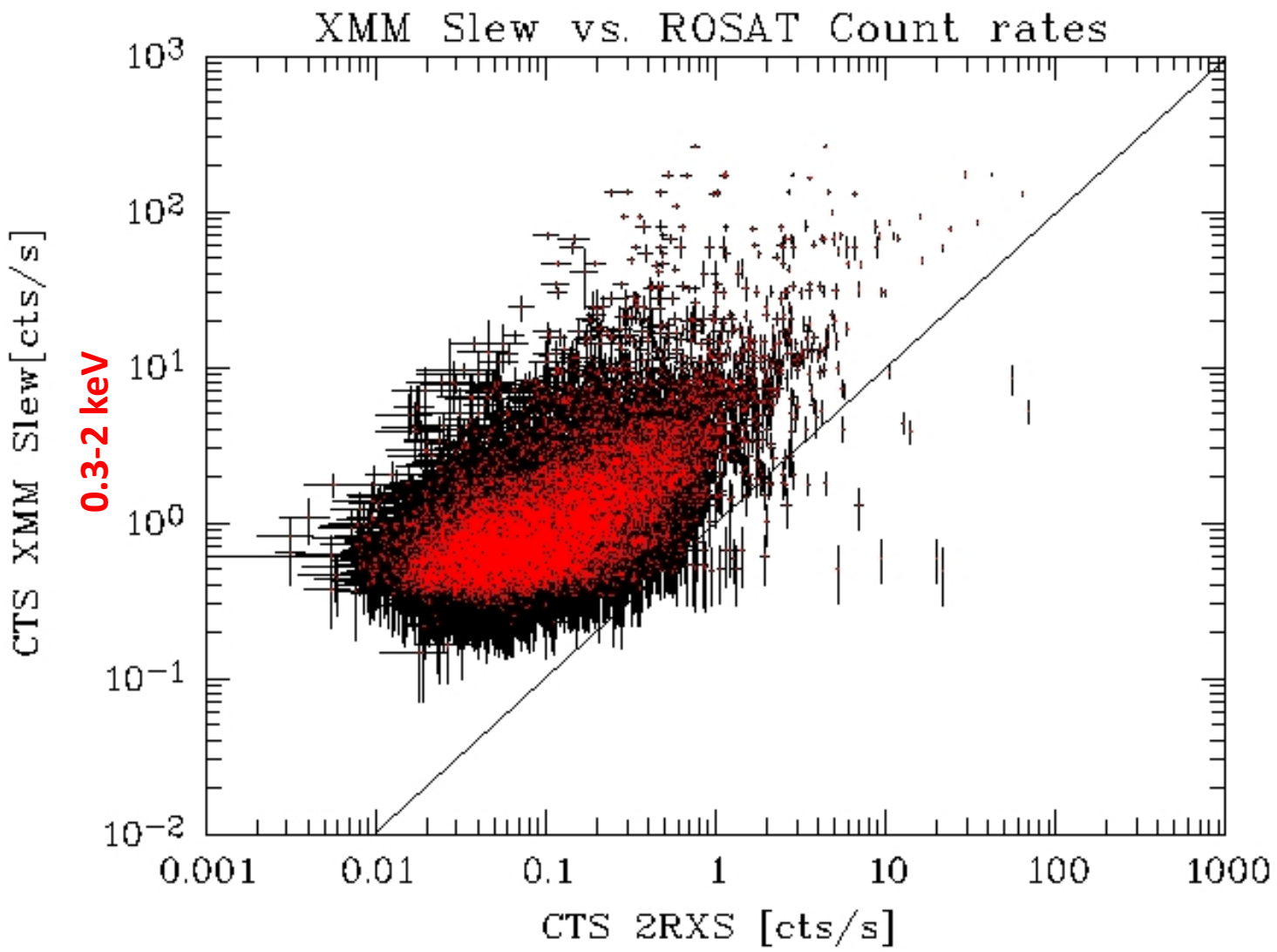


robust method to search for flaring events in the 2RXS light curves

Long term variability: 2RXS versus ROSAT Pointings

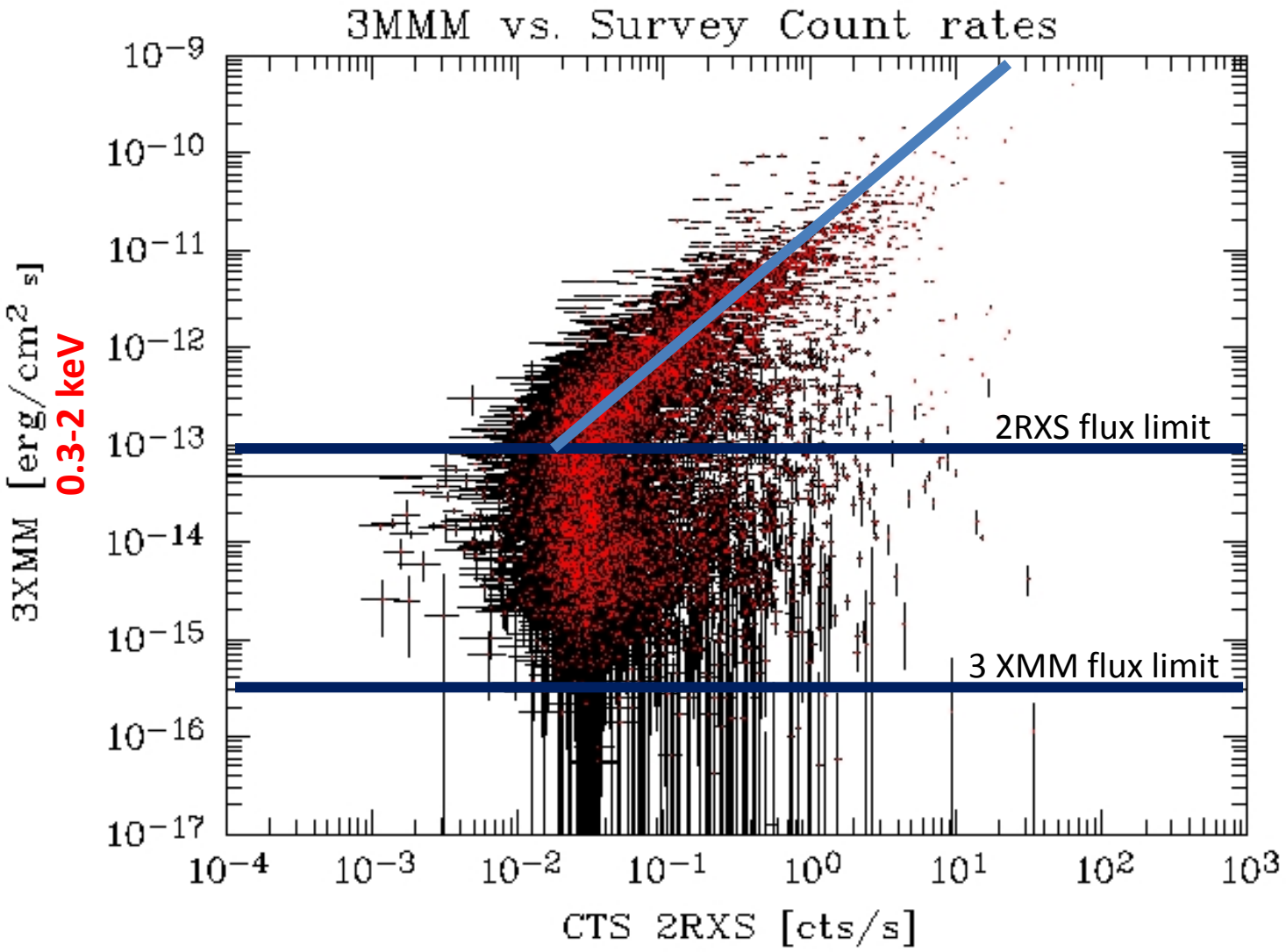


Long term variability: 2RXS versus XMM Slew

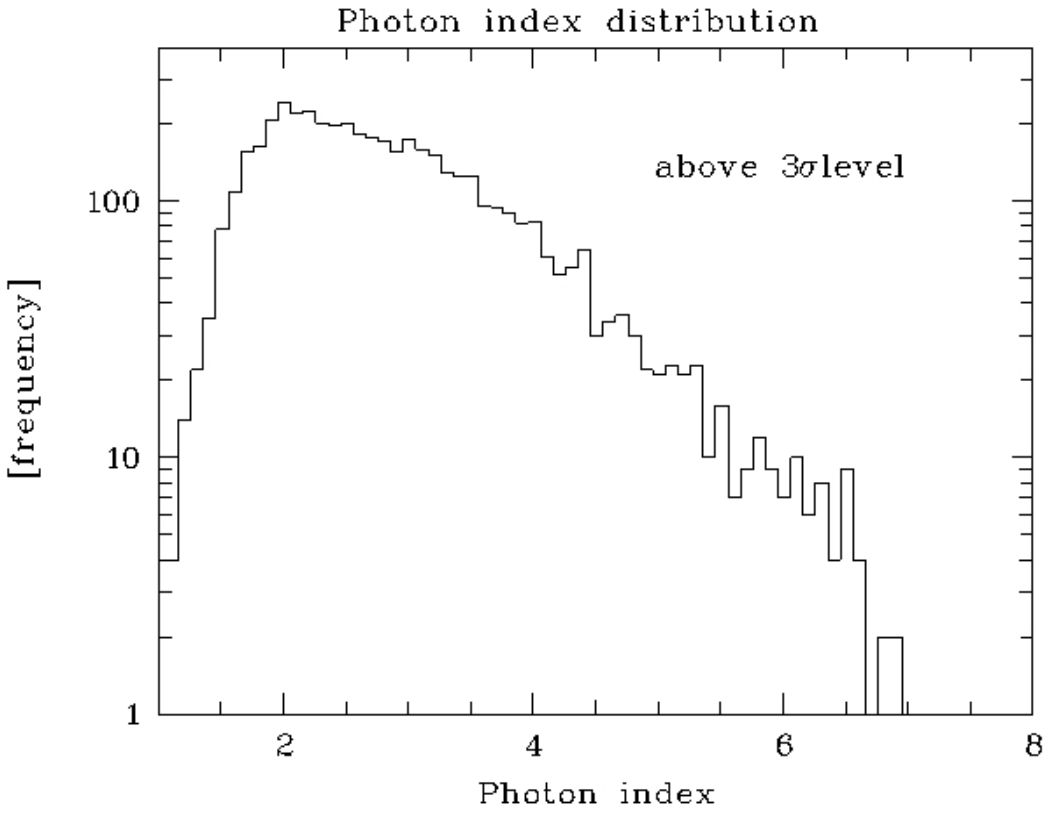


off-set as effective areas are different

Long term variability: 2RXS versus 3XMM

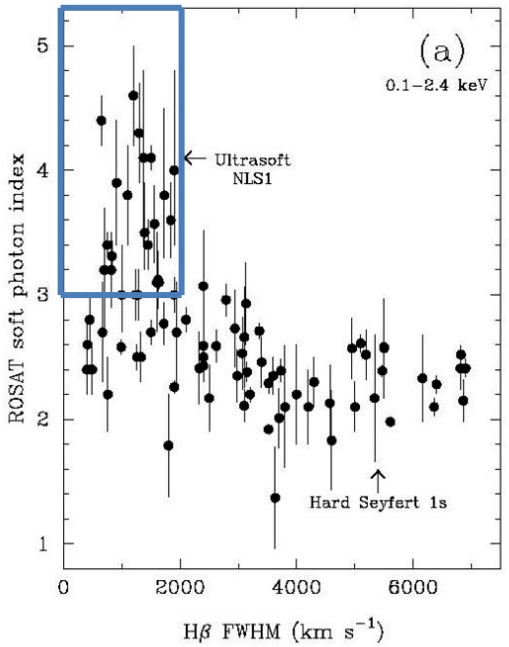


Spectral properties I: Photon index distribution new NLS1 catalogue

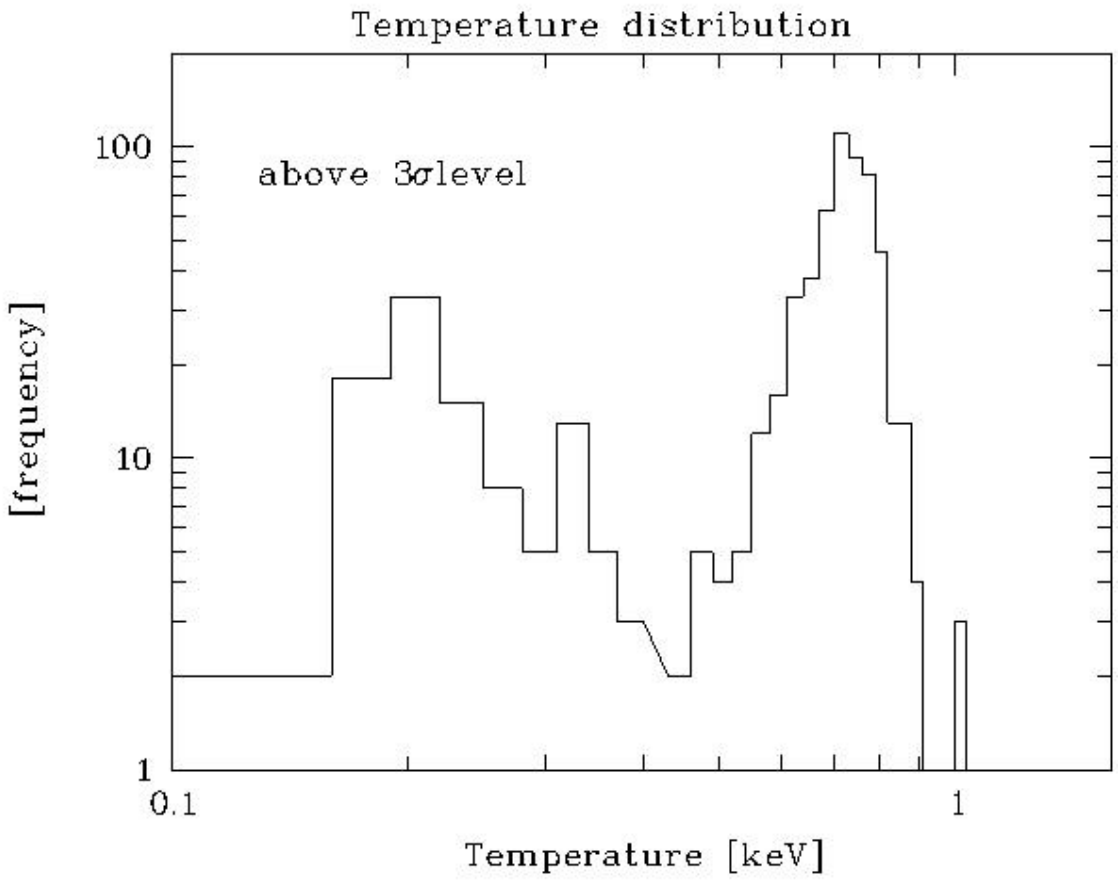


4860 sources with photon indices above the 3 σ limit

new NLS1 catalogue (>1000 sources)



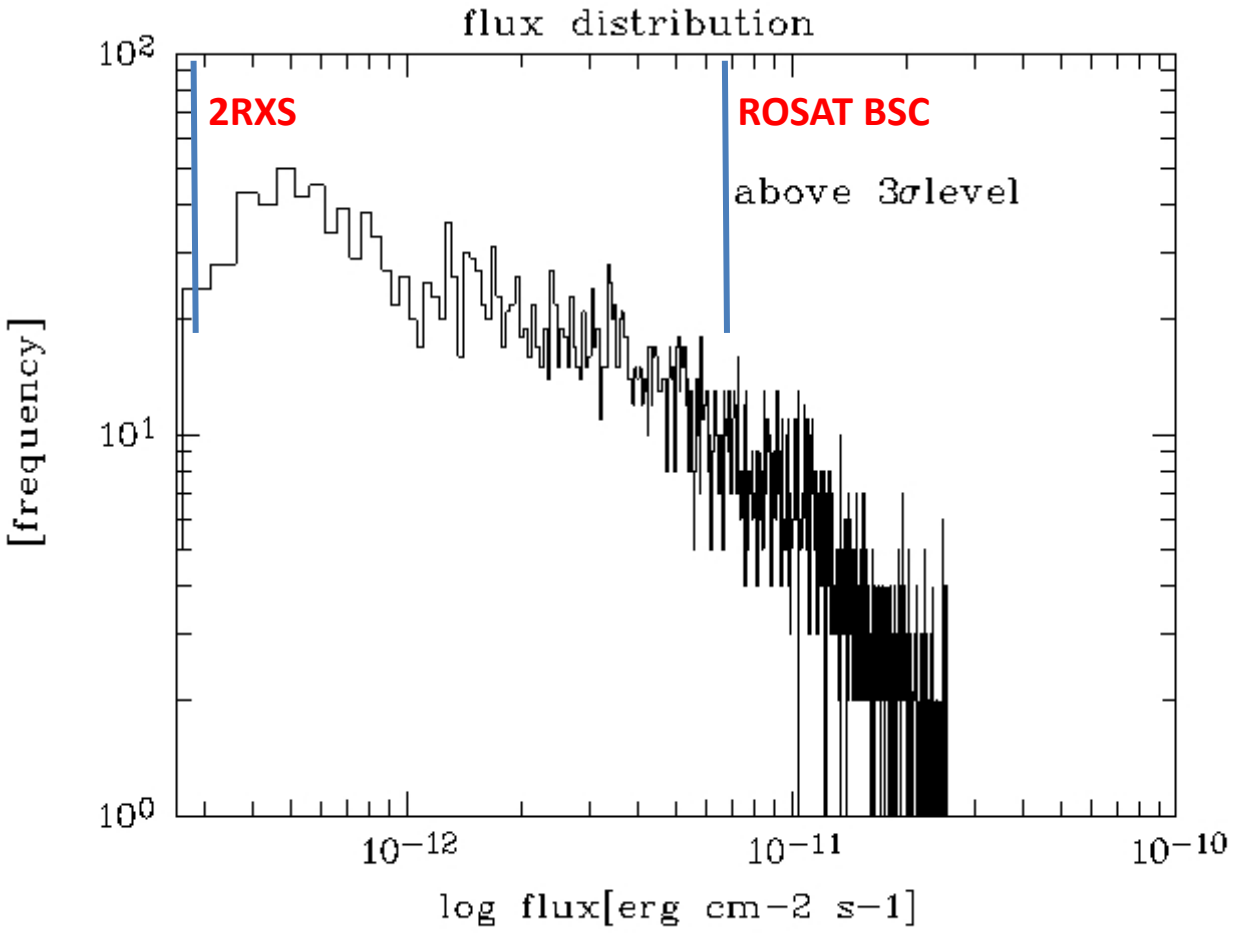
Spectral properties II:
Temperature distribution optically thin plasma fits



thousands of sources with constrained spectral parameters

Spectral properties III

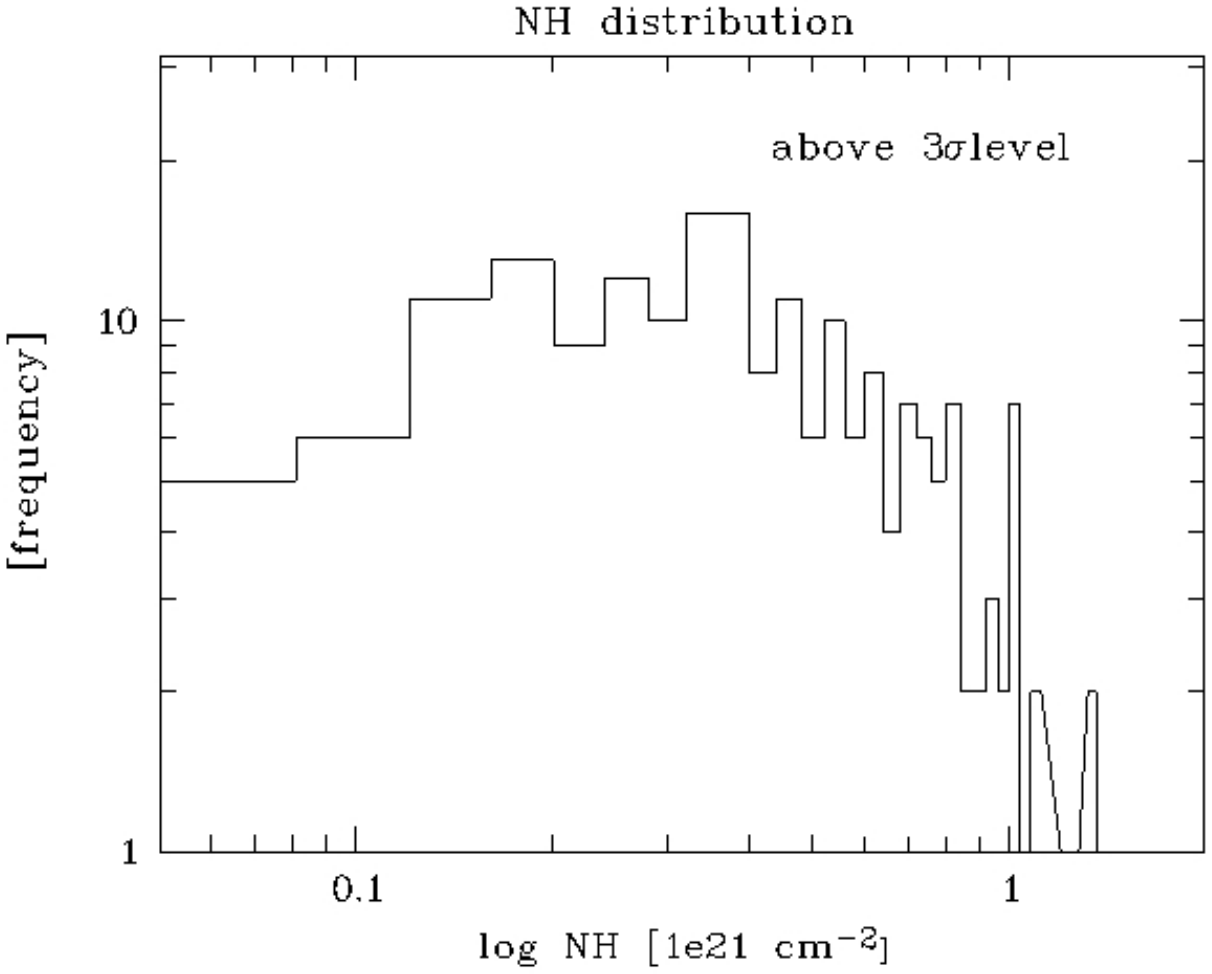
flux distribution



flux limit: $f(2RXS) = 1.3 \cdot 10^{-13}\ erg\ cm^{-2}\ s^{-1}$

Spectral properties IV

NH distribution



AGN ROSAT 2RXS Survey Science

Eigenvector 1 analysis of parameter space :

$[\Gamma_{soft}$ | Γ_{hard} | $FWHM(H\beta)$| $O[III]$ $strength$ | $\frac{Fe\ II}{H\beta}$ ratio | UV line strength | Δt_x | $\frac{\sigma_x}{cps_x}$]

accretion physics: $black\ hole\ growth$ ∪ $outflows\ and\ feedback$ ∪ $Comptonization$

Large-Scale Structure and BAO studies in preparation of eROSITA (**POSTER BY A. KOLODZIG**)

extreme X-ray variability and nonlinear X-ray variability

the Fe II problem

Comptonization and the origin of the soft and hard X-ray emission

α_{ox} science and the global X-ray Baldwin effect

multiwavelength source population properties

Science themes for more than 100.000 secure X-ray identifications

AGN physics

- timing and spectral properties down to lowest fluxes
- multiwavelength properties
- optical follow-up programme with SDSS data (15000 objects)

normal galaxies

- spectral properties
- interacting galaxies

Galactic Binaries, CVs, neutron stars

- new discovery space

stars

- timing properties from individual light curves

and much more !

The ROSAT 2RXS Catalgoue

the largest and most reliable X-ray all-sky survey before eROSITA

improved science exploration based on

- X-ray light curves
- X-ray spectral fits
- X-ray images

catalogue will become online on a week´s timescale

catalogue paper in submission