Hard X-ray luminosity function and absorption distribution of nearby AGN: INTEGRAL all-sky survey

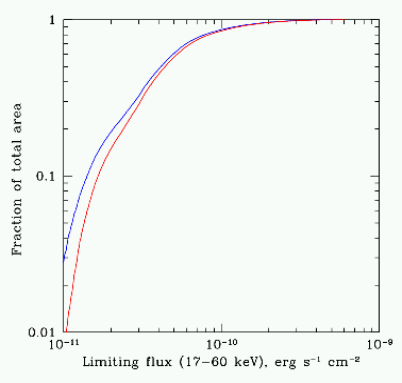
S. Sazonov, M. Revnivtsev, R. Krivonos, E. Churazov, R. Sunyaev

Max-Planck Institute for Astrophysics, Garching, Germany
Space Research Institute, Russian Academy of Sciences, Moscow, Russia

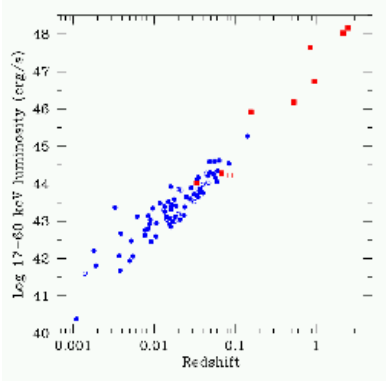
Aim: We use the INTEGRAL all-sky survey to study the hard X-ray (17-60 keV) luminosity function and absorption distribution of local ($z<0.1$) AGN, and discuss the implications for AGN cosmological evolution and for the cosmic X-ray background.

Properties of the survey and AGN sample

Our all-sky sample consists of 127 AGN, of which 91 are detected (>5 sigma) on the average IBIS/ISGRI map (main sample) and 36 were detected only during single observations. Among the former there are 66 non-blazar AGN located at $|b|>5$ deg, where the survey's identification is 93%complete, which we use for statistical analysis.



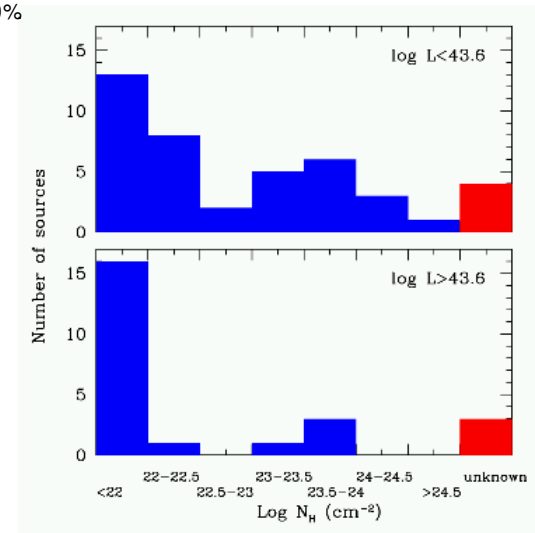
Coverage of the whole sky (blue) and of the $|b|>5$ deg region (red).



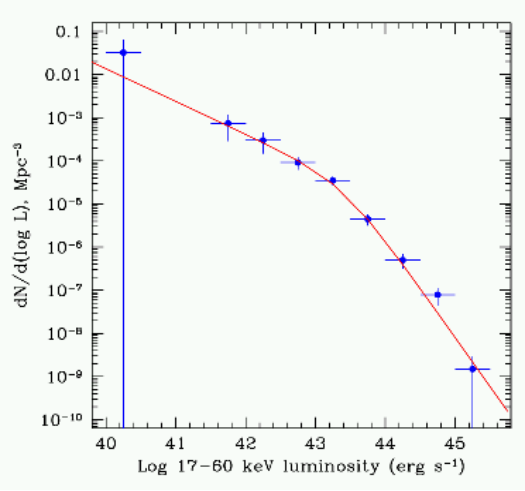
Luminosity vs. redshift for the main AGN sample. Blue and red symbols are emission-line AGN and blazars, respectively. Empty symbols indicate AGN located at $|b|<5$ deg.

Absorption distribution

The fraction of obscured ($\log(N_H)>22$) objects is much higher (~70%) in the faint end of the luminosity function ($L_x<10^{43.6}$ erg/s) than in the bright end (~25%). The fraction of Compton-thick AGN is < 20%



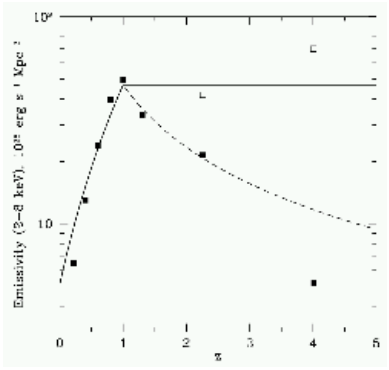
Luminosity function



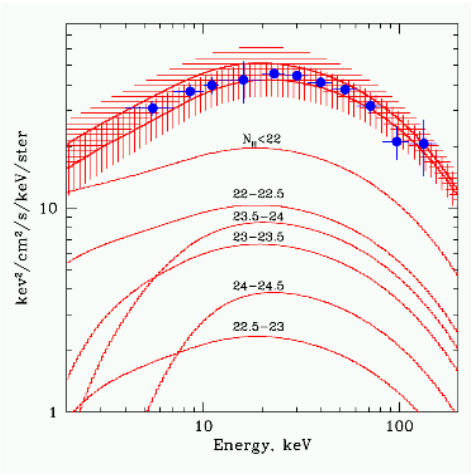
$$\phi(L_{\rm hx}) = \frac{A}{(L_{\rm hx}/L_*)^{\gamma_1} + (L_{\rm hx}/L_*)^{\gamma_2}}$$

Parameter	Value and 1σ range
$\log L_*$	43.40 (43.12 ÷ 43.68)
γ_1	0.76 (0.56 ÷ 0.94)
γ_2	2.28 (2.06 ÷ 2.56)
A (Mpc^{-3})	3.55×10^{-5}
$n_{17-60\ \rm keV}(>40)$ (10^{-3} Mpc^{-3})	9 (4 ÷ 18)
$n_{17-60\ \rm keV}(>41)$ (10^{-3} Mpc^{-3})	1.4 (0.9 ÷ 2.0)
$\rho_{17-60\ \rm keV}(>40)$ (10^{38} erg s^{-1} Mpc^{-3})	14.1 (11.8 ÷ 17.1)
$\rho_{17-60\ \rm keV}(>41)$ (10^{38} erg s^{-1} Mpc^{-3})	12.4 (11.0 ÷ 14.0)
$P_{\rm KS}$	> 0.9

Cosmological implications



Redshift evolution of the rest-frame 2-8 keV AGN luminosity density inferred from Chandra extragalactic surveys (Barger er al. 2005).
Taking into account the incompleteness, the true evolution is likely bounded by the dashed and solid curves.

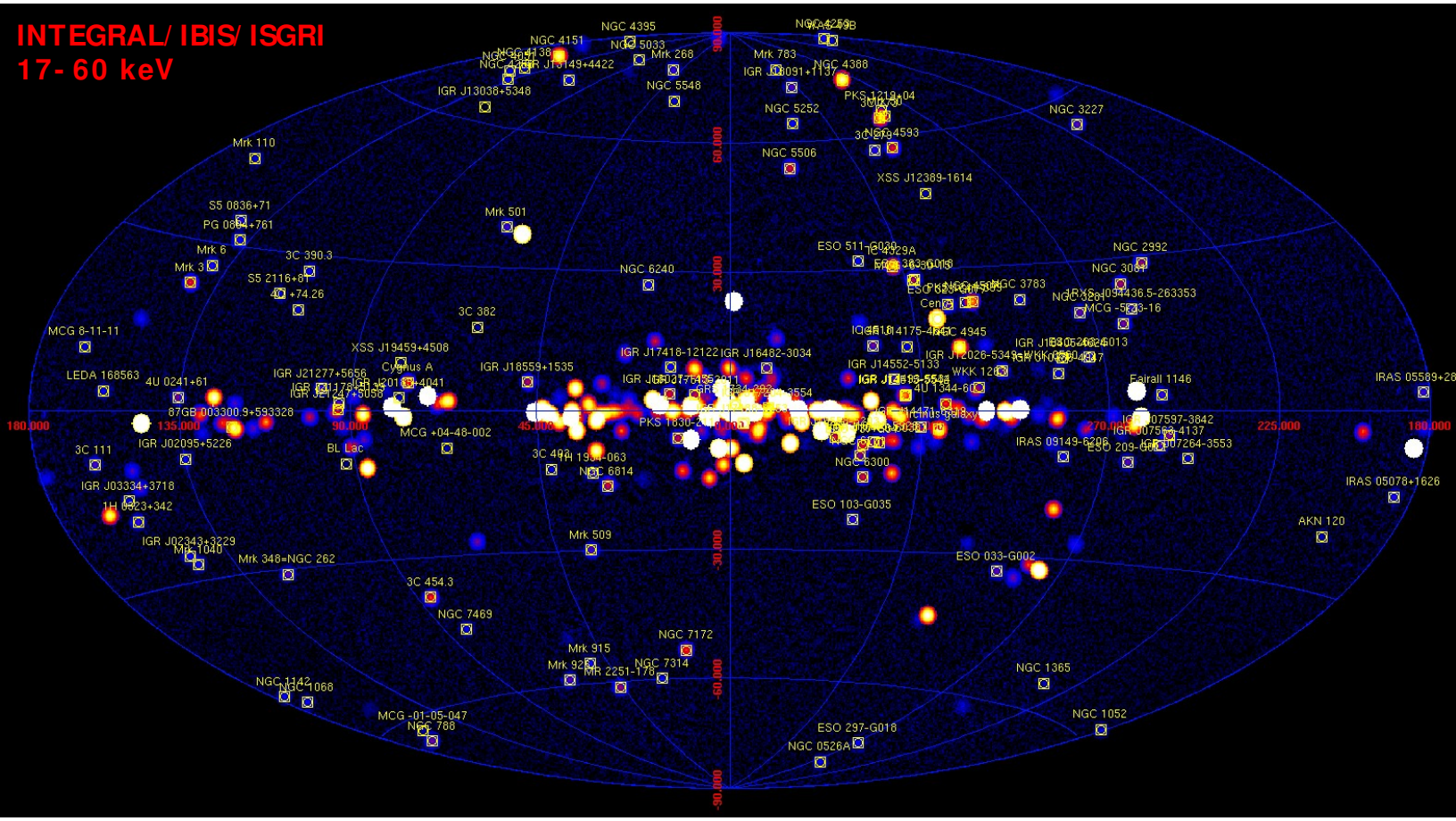


Comparison of the CXB spectrum measured by INTEGRAL during Earth observations (blue, Churazov et al. 2006) with a spectrum (red) that would result if the AGN population experienced pure luminosity evolution since $z\sim1.5$, the NH distribution remained such as measured locally by INTEGRAL, given the INTEGRAL measurement of the AGN luminosity density at $z=0$ and assuming a universal intrinsic cutoff power spectrum with reflection (slope= 1.8, E_c= 200 keV, R= 0.5) for all AGN. Also shown are the contributions to the CXB from AGN with different NH.

The spectral shape and amplitude of the CXB are consistent with the simple scenario in which the NH distribution in the faint and bright ends of the AGN luminosity function has not evolved since z~ 1.5 while AGN experienced pure luminosity evolution.

Publications:

Churazov et al., Astronomy & Astrophysics 467, 509 (2007)
Sazonov et al., Astronomy & Astrophysics 462, 57 (2007)



In the above map the sizes of all detected sources are greatly blown up for better visibility. Only AGNs are labelled.