Obscured AGN in the field of J1030: the X-ray and optical/infrared perspective

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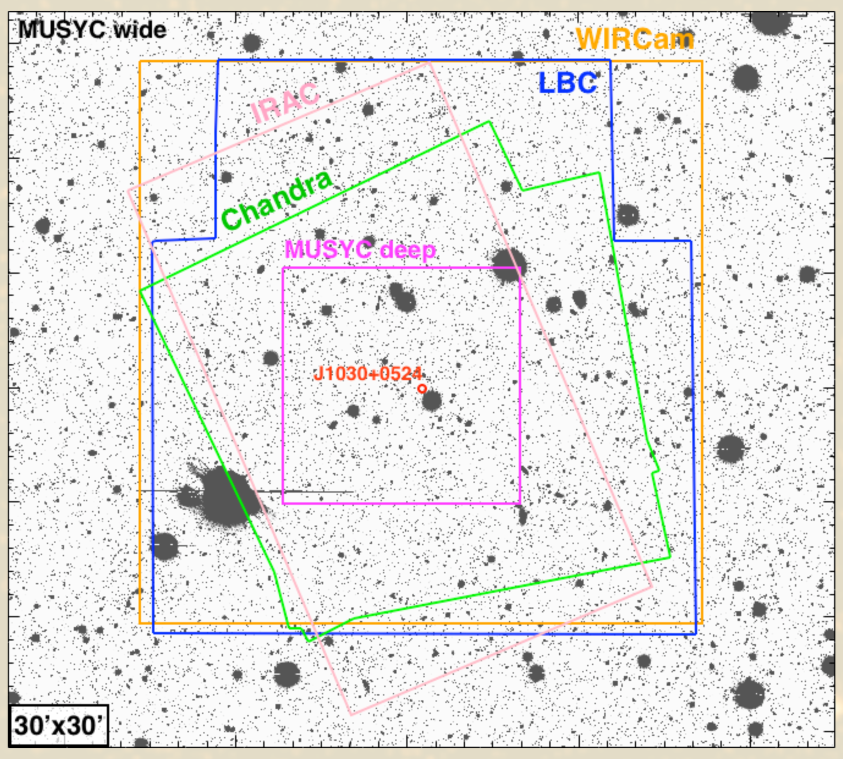
Abstract

Deep X surveys are an essential tool for the study of obscured AGN. These objects are very faint even in the X-ray band, due to the large column densities responsible for the obscuration. We studied obscured AGN candidates in the deep field around the z=6.31 QSO SDSS J1030+0524. The goal of this project is the selection and characterization of obscured AGN using a multi-wavelength approach. We used X-ray spectral features such as Fe Kα line or Fe absorption edge to estimate the still unknown redshift of these sources from the X-ray band, and compared the results with the outcomes of a standard SED-fitting procedure (hyperz code, Bolzonella+00) using optical/NIR/MIR photometry. The obtained results show the possibility to use X-ray spectra in support in the search for redshift of obscured AGN.

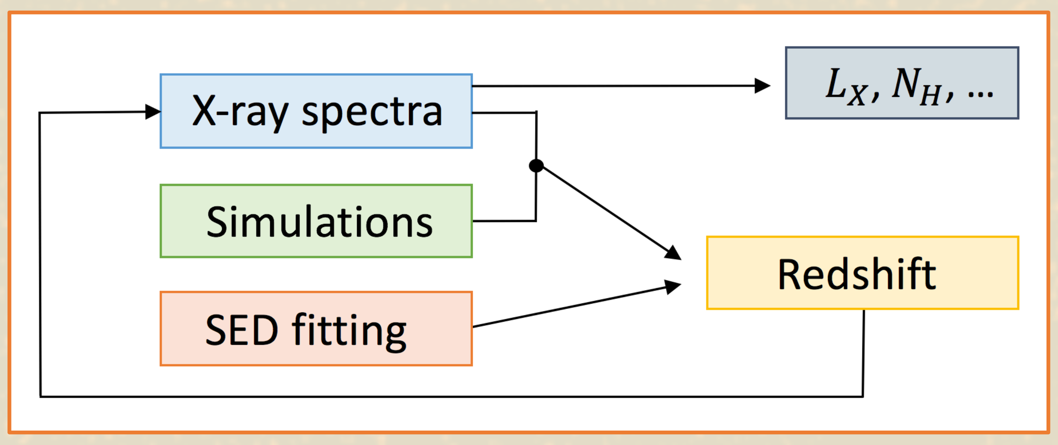
The J1030 multi-wavelength coverage



- The Chandra ACIS-I observation of J1030 is the 4th deepest X-ray survey in general (500 ks), with fluxes down to $\approx 9 \times 10^{-17}$ $\mathrm{erg\,s^{-1}\,cm^{-2}}$ in the soft band (0.5-2 keV).
- J1030 is part of a strategic program that includes a large multi-wavelength coverage, making it an INAF legacy.

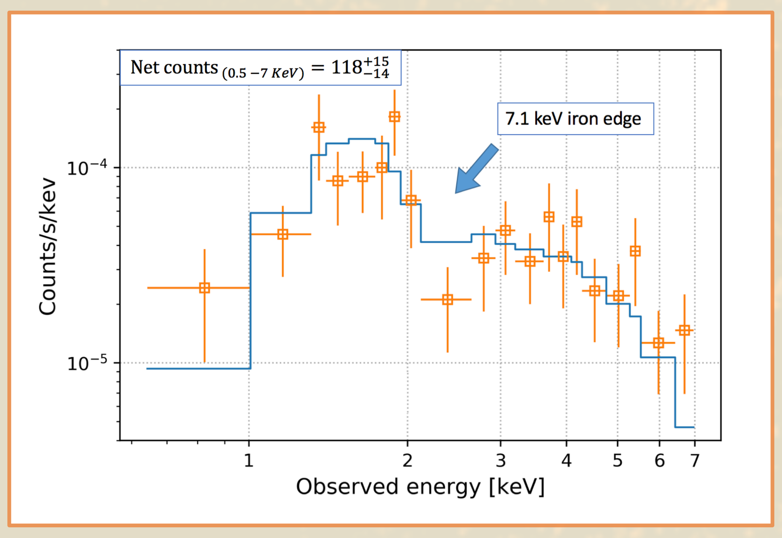
Figure. Multi-wavelength used data: Chandra 500 ks (X-ray), LBC/LBT (optical), WIRCam/CFHT (NIR), MUSYC survey (optical/NIR) and IRAC/Spitzer (MIR).

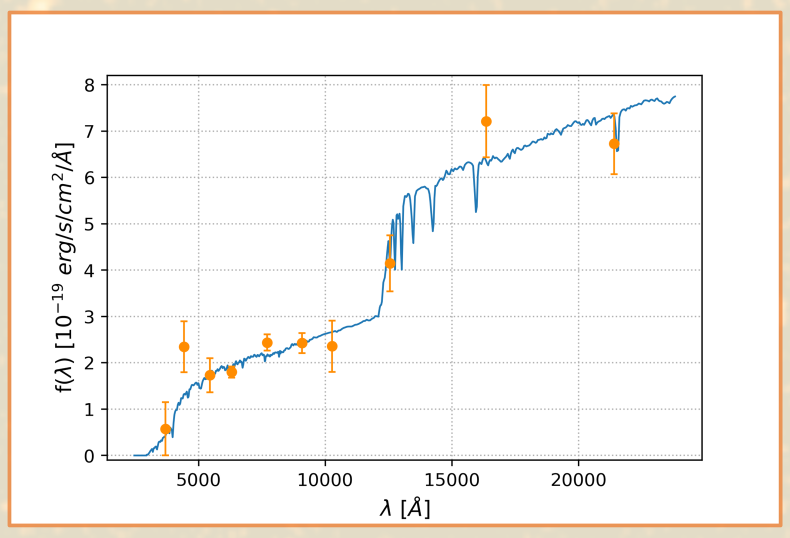
Finding redshift



- X-ray spectral solutions are supported by state of art simulations
- Simulations reproduce the spectral features (6.4 keV Fe Kα line, 7.1 keV Fe edge) which are used to estimate the redshifts
- Redshifts are also calculated through a SED fitting procedure
- The comparison between the obtained solutions allows us to calculate AGN properties

Example of spectroscopic validation





→ Spectroscopic redshift from Kriek+08 is used to verify both photometric and X-ray methods

Spectroscopic	Photometric	X-ray
$z_{spec} = 2.511$	$z_{phot} = 2.28^{+0.20}_{-0.53}$	$z_X = 2.55^{+0.32}_{-0.64}$

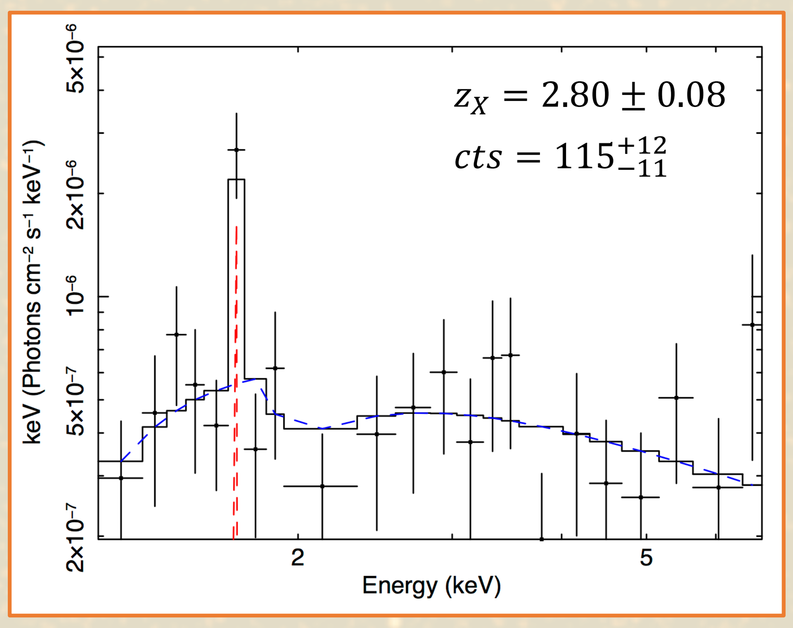
Sample of obscured candidates

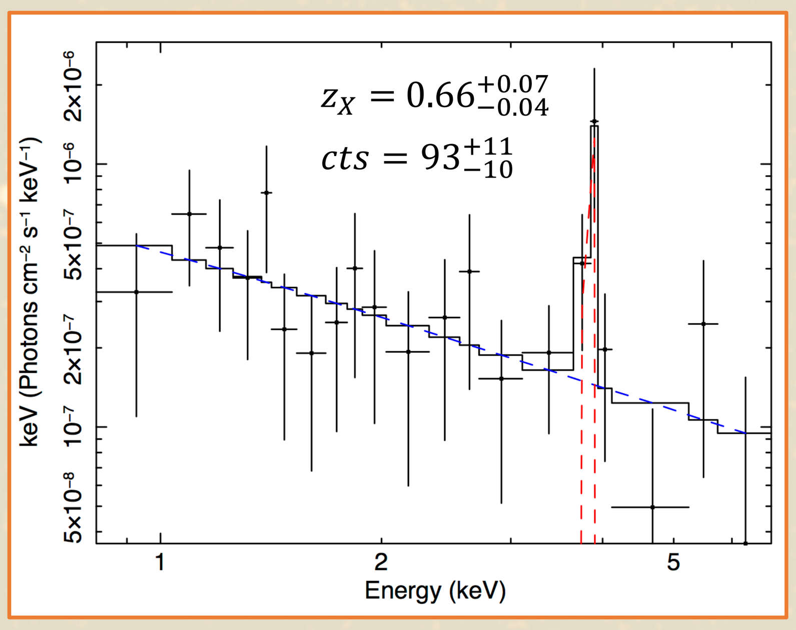
- 22 sources with $HR > 0$ and net counts > 100
- 8 sources with $HR > 0$ and red colours

→ **30 sources** with a median value of $\approx$ **100 net counts**

- 28/30 sources without spectroscopic redshift, but z **is needed** to study AGN properties

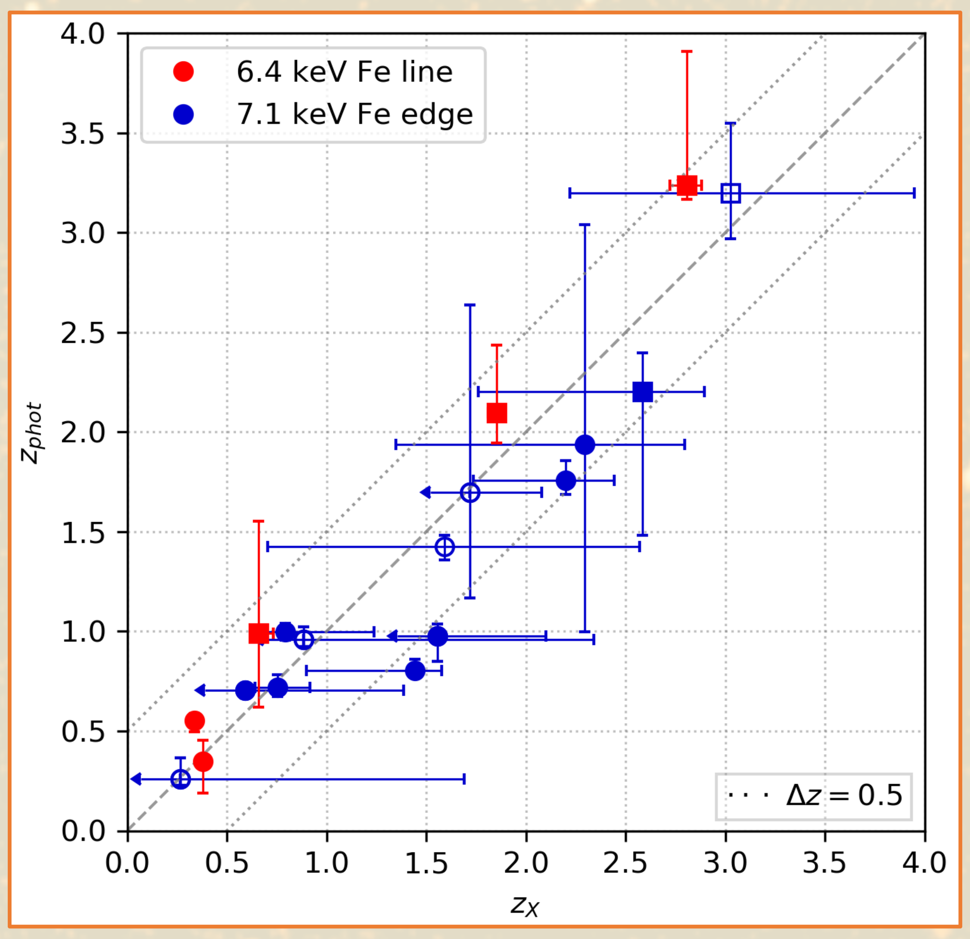
Finding z from X-ray analysis

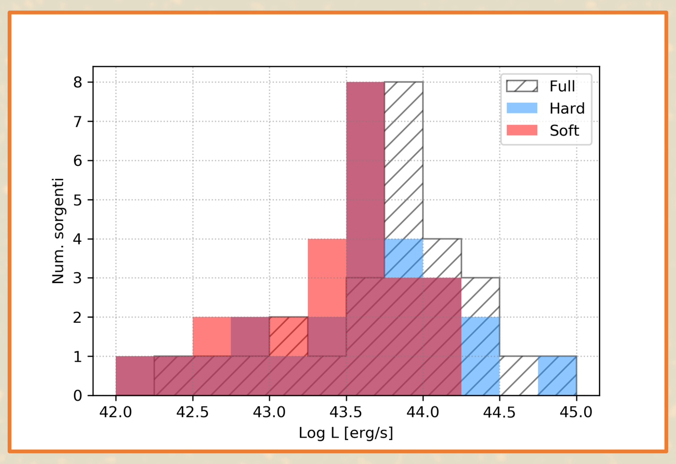


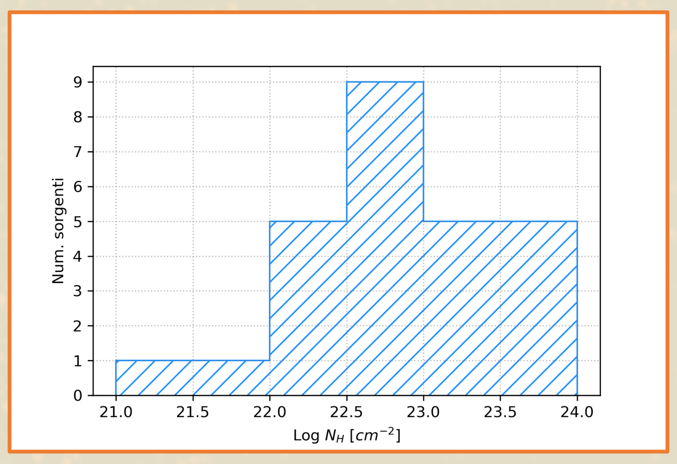


Figures. Two of the best cases of sources for which we obtain an X-ray redshift. The underlying model is an absorbed powerlaw (blue) with a Fe Kα line (red).

Comparison and results







- X-ray redshifts are compatible (within $\Delta z \approx 0.5$) with photometric ones: this proves the goodness of the X-ray method (spectral analysis + simulations)
- The sources are Compton thin AGN ($N_H = 10^{21-24}$ $\mathrm{cm^{-2}}$) with typical AGN luminosities ($L_X = 10^{42-45}$ $\mathrm{erg\,s^{-1}}$)

Summary & future prospects

Obscured AGN are usually faint objects in the optical/NIR bands, making spectroscopic-z identification challenging and photo-z solutions uncertain. The comparison between X-ray and photometric redshifts shows the possibility to use X-ray spectra in support to traditional methods (Iwasawa+12), even in the case of low statistics. In particular, the use of X-ray spectral simulations provides an estimate on the reliability of the X-ray redshifts, allowing the study of these objects.

- Spectroscopic programs already approved in the field of J1030 (LBT and VLT) will provide more accurate redshifts, which will be able to confirm these results.
- The development of these simulations can be used for future X-ray missions such as *eRosita* (2019), in particular in cases where there will not be a large multi-wavelength coverage, and *Athena* (2030), where preparatory work can be carried out.

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