Distribution of Matter in Galaxies

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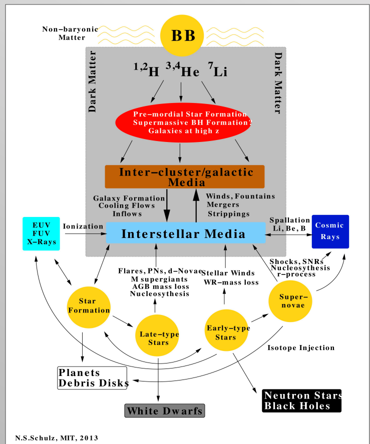
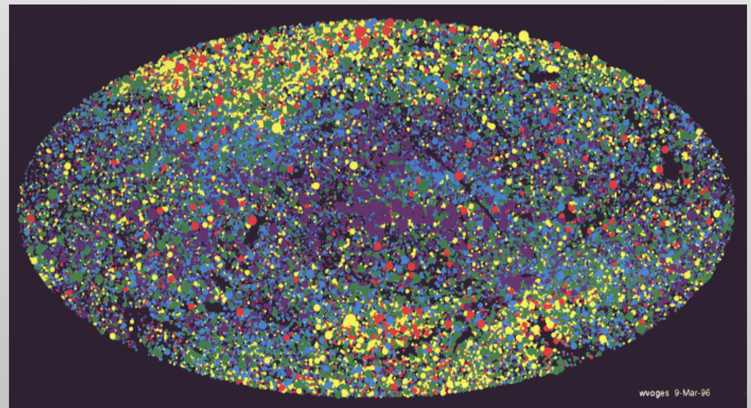
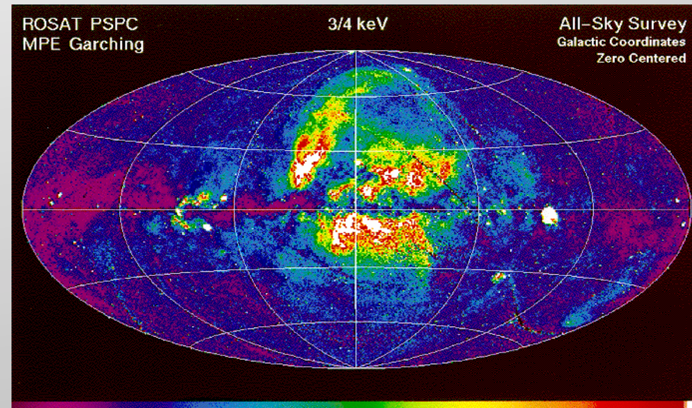
Context: *High Resolution X-ray Absorption Spectroscopy*

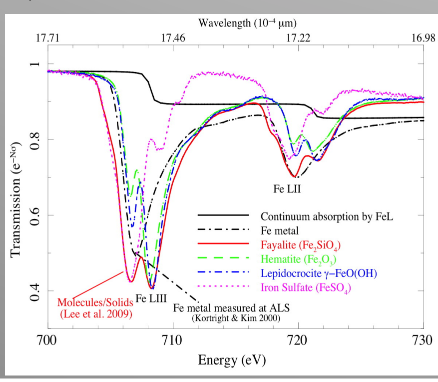


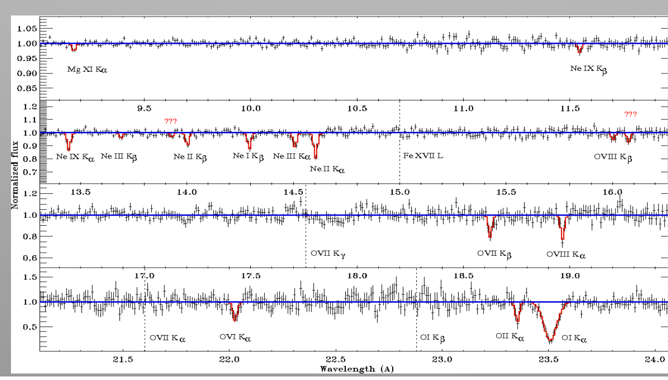


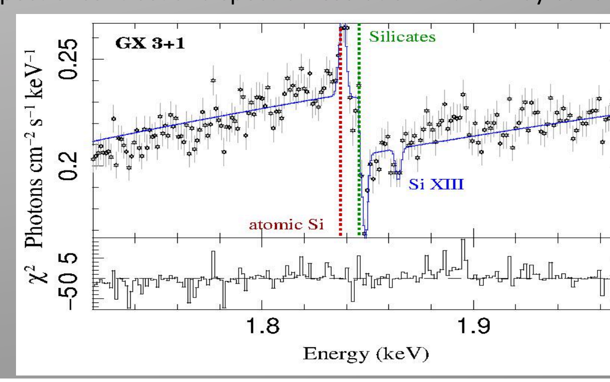


The recycling of matter is an ongoing process in the evolution of the universe. Central to the process are interstellar and intergalactic media which evolved from period of pre-mordial star and black hole formation in galaxies observed at high redshifts (see top left Figure for an overview). The study of chemically evolving matter in X-rays involves elements [C, O Ne, Mg, Si, S, Ar, Ca, Fe, and Ni] and abundant molecules [CO_2, CO, O_2, H_2O, C_sH_6O, CH_2 O_2 and silicates]. We measure neutral and ionized abundances, ionization fractions, kinematics such as turbulence, thermal and magnetic motions, temperatures, solid state propertics, determine star formation rates and search for missing baryons (WHIM).

Using the method of backlighting we can use over 10^5 X-rays sources as for example provided by the RASS (top middle Figure) to map out diffuse matter in our own Milky Way (top right Figure) and in galaxies of the Local group. High resolution spectra primarily from the Chandra HETG but also from the XMM-Newton RGS instruments have provided us with initial small surveys using the brightest available X-ray sources in the Galaxy to study all phase of the ISM (see three examples below). However these studies also revealed severe limitations in terms source flux, spectral contrast and spectral resolution in the X-ray band.

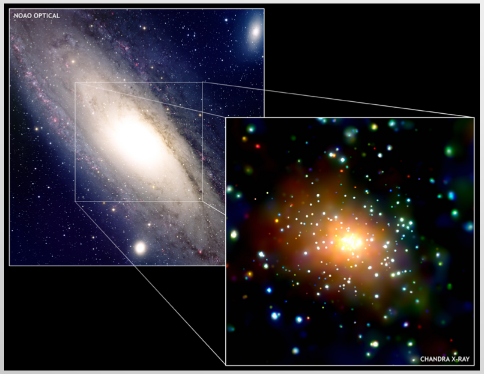




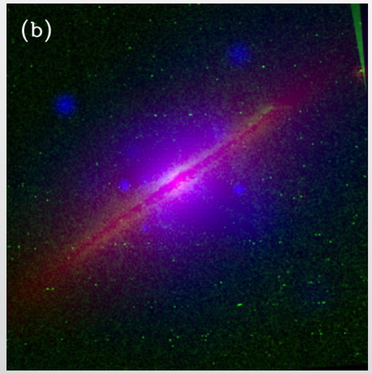


Context: ***Future High Resolution X-ray Absorption Surveys***

Local Group



Galaxy Halos

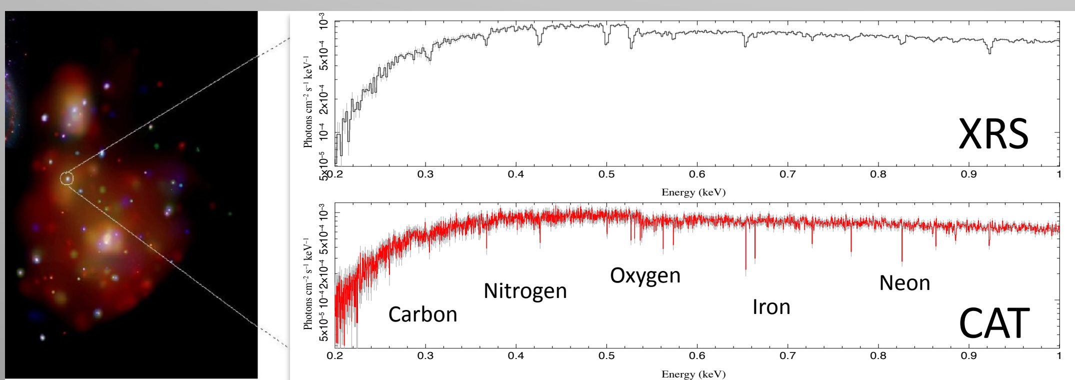


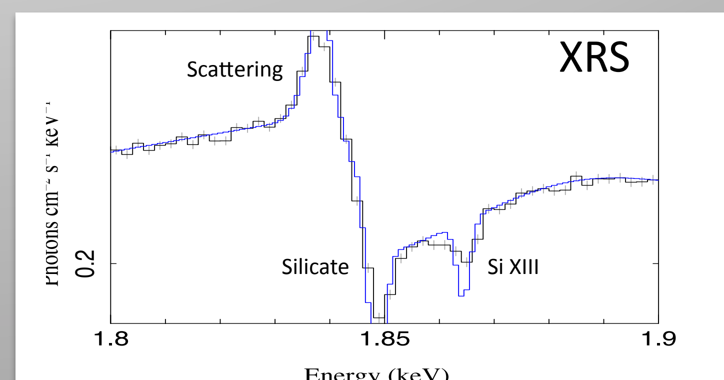
Starburst

Outflows&Jets

The X-ray Surveyor mission provides a first real opportunity to conduct X-ray absorption surveys that allow to significantly map diffuse matter properties across the entire Galactic disk and bulge, extent such surveys to X-ray sources in the Local group, diagnose X-ray emissions from galactic halos, measure kinematic and matter properties of starburst gala-xies as well as large scale outflows. For the first time X-ray absorption from missing bary-onic matter can be studied in a systematic fashion. Effective Galactic surveys including over several hundred of X-rays sources with fluxes of 10^{-12} erg s^{-1} cm^{-2} with average exposures of less than 100 ks can provide a first full description of abundances and kinematics of all phases of the ISM in our Galaxy. These surveys can be extended to Sources in galaxies of the Local Group with average exposure of less than 120 ks. Warm absorbers with fluxes down to 10^{-14} erg s^{-1} cm^{-2} can be done with similar efficiency. Here we identify over 30 AGN sources with average exposures of about 150 ks. Below we show two examples of X-ray Surveyor spectra. Left is the absorption spectrum of an X-ray source in M51 for about 100 ks showing line absorption of neutral, warm, and hot ISM phases (below, left) and velocity dispersions of 50 km s^{-1}.

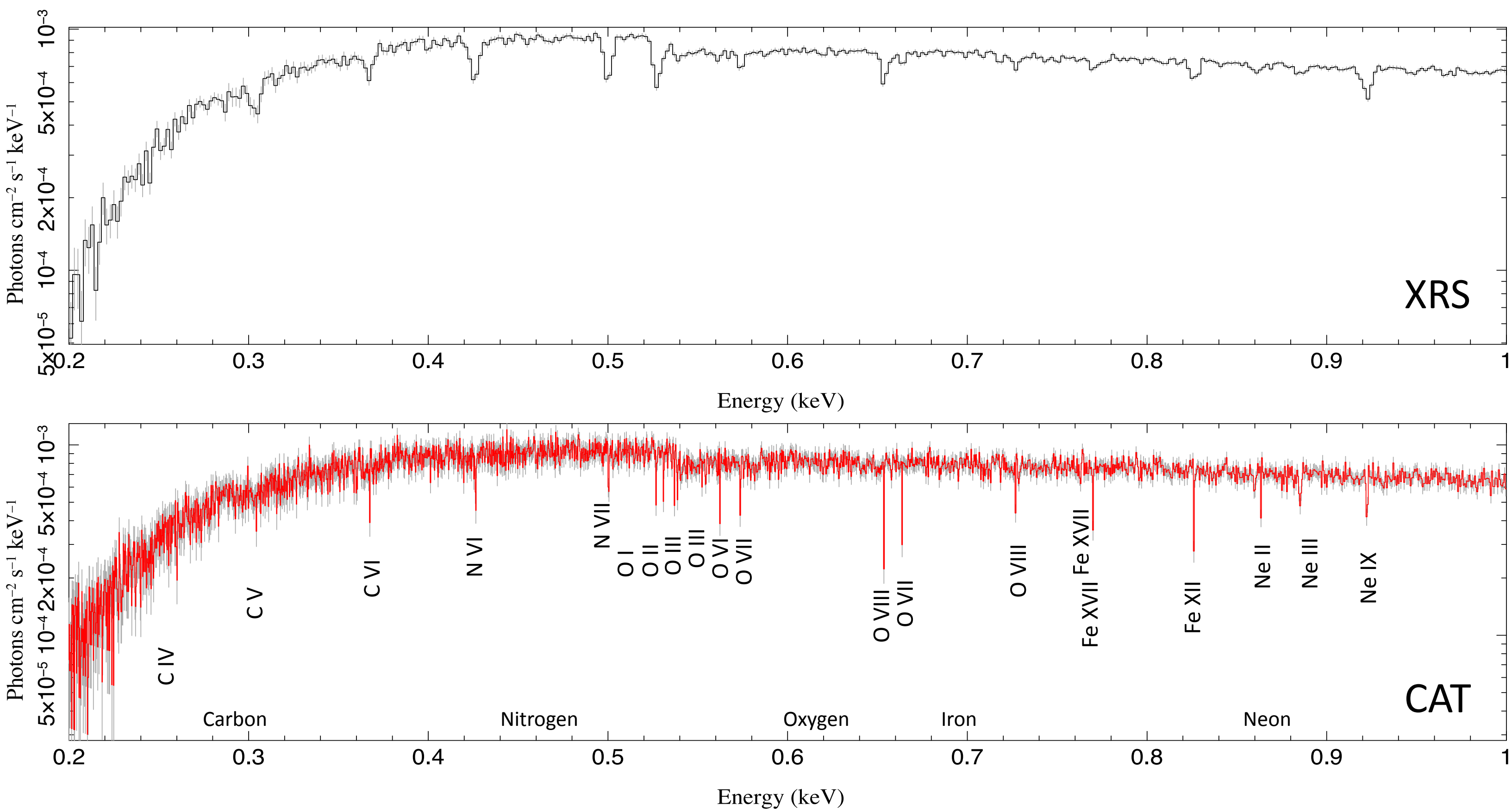
Right shows solid state properties of a bright Galactic source (10^{-10} erg s^{-1} cm^{-2}) around Si K for only 7 ks identifying compound silicon signatures.





X-ray absorption spectroscopy is a powerful tool to study existing forms of matter in our Universe. The roadmap for the next 15 years needs to lead to means and strategies which allows us to perform such absorption surveys as effectively as surveys are now or in very near future quite common in astronomy pursued in other wavelength bands such as optical, IR, and sub-mm.

Context: ***Future High Resolution X-ray Absorption Surveys***



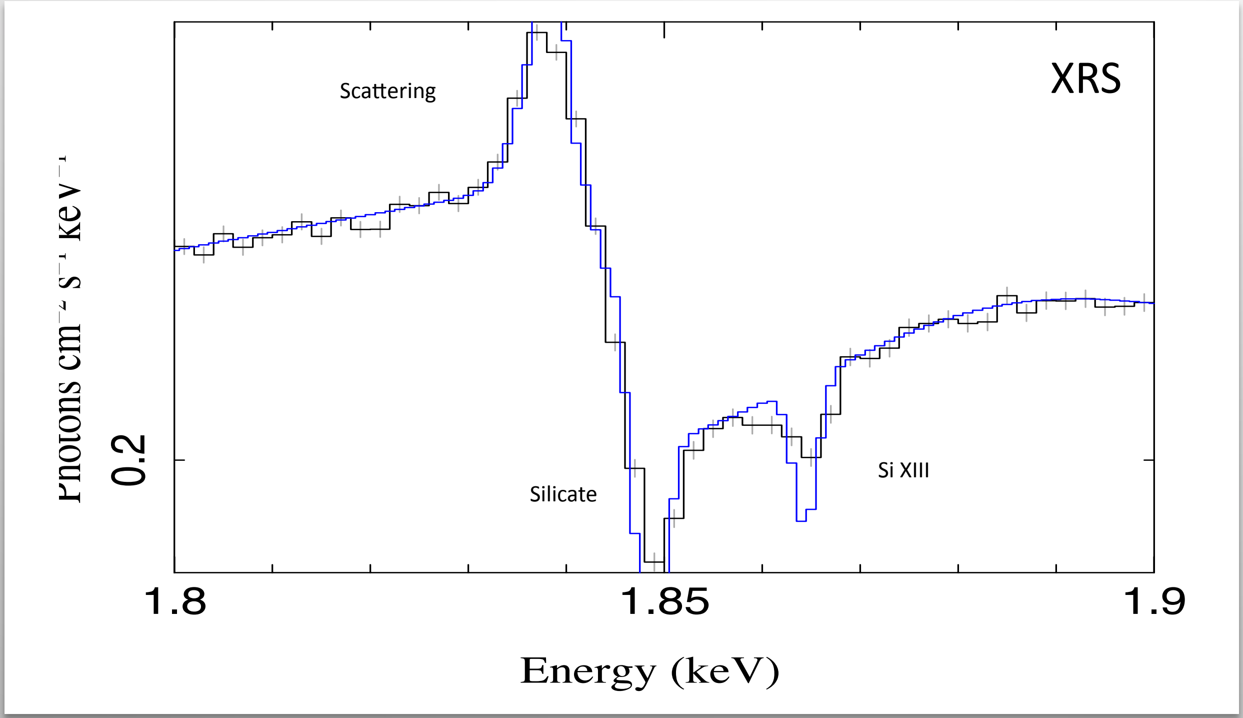
XRS: v = 200-250 km s^{-1}, line blends

CAT: v = 40 -50 km s^{-1}

Source fluxes : ~[10^{-12} ;10^{-14}] erg cm^{-2} s^{-1} ➔ ~[10 ; 160] ks ; >> 500 Galactic sources

> 120 extragalactic sources

Context: ***Future High Resolution X-ray Absorption Surveys***



Galactic Bulge LMXB:

7 ks !!!

X-ray absorption spectroscopy is a unique and powerful tool to study existing forms of matter in our Universe. The X-Ray Surveyor Mission provides the means and strategies which allows us to perform such absorption surveys as effectively as surveys are now or in very near future quite common in astronomy pursued in other wavelength bands such as optical, IR, and sub-mm.