

- **tbabs, ztbabs, tbgrain, tbvarabs: ISM grain absorption**

The Tuebingen-Boulder ISM absorption model. This model calculates the cross section for X-ray absorption by the ISM as the sum of the cross sections for X-ray absorption due to the gas-phase ISM, the grain-phase ISM, and the molecules in the ISM. In the grain-phase ISM, the effect of shielding by the grains is accounted for, but is extremely small. In the molecular contribution to the ISM cross section, only molecular hydrogen is considered. In the gas-phase ISM, the cross section is the sum of the photoionization cross sections of the different elements, weighted by abundance and taking into account depletion onto grains.

In addition to the updates to the photoionization cross sections, the gas-phase cross section differs from previous values as a result of updates to the ISM abundances. These updated abundances are available through the **abund** `wilm` command. Details of updates to the photoionization cross sections as well as to abundances can be found in Wilms, Allen and McCray (2000, ApJ 542, 914).

tbabs allows the user to vary just the molecular hydrogen column.

par1 equivalent hydrogen column (in units of 10^{22} atoms/cm⁻²)

ztbabs is similar, but allows the user to set a fixed redshift parameter

par1 equivalent hydrogen column (in units of 10^{22} atoms/cm⁻²)

z redshift

tbgrain allows the user to vary the molecular hydrogen column and the grain distribution parameters.

par1 equivalent hydrogen column (in units of 10^{22} atoms cm⁻²)

par2 molecular hydrogen column (in units of 10^{22} atoms cm⁻²)

par3 grain density (in gm/cm⁻³)

par4 grain minimum size (in μ m)

par5 grain maximum size (in μ m)

par6 power-law index of grain sizes

tbvarabs additionally allows the user to vary the elemental abundances and the redshift

par1	equivalent hydrogen column (in units of 10^{22} atoms cm^{-2})
par2 -par18	abundance (relative to Solar) of He, C, N, O, Ne, Na, Mg, Al, Si, S, Cl, Ar, Ca, Cr, Fe, Co, Ni
par19	molecular hydrogen column (in units of 10^{22} atoms cm^{-2})
par20	grain density (in gm/cm^{-3})
par21	grain minimum size (in μm)
par22	grain maximum size (in μm)
par23	power-law index of grain sizes
par24 par41	- grain depletion fractions of He, C, N, O, Ne, Na, Mg, Al, Si, S, Cl, Ar, Ca, Cr, Fe, Co, Ni}
par42	redshift