THE X-RAY OPACITY OF THE INTERSTELLAR MEDIUM[+]

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In order to interpret soft X-ray spectra of cosmic X-ray sources, it is necessary to know the photoabsorption cross-section of the intervening interstellar material. Current models suggest that the interstellar medium contains two phases which make a substantial contribution to the X-ray opacity: cool, relatively dense clouds that exist in pressure equilibrium with hot, tenuous intercloud regions. We have computed the soft X-ray photoabsorption cross-section of each of these two phases. The calculations are based on a model of the interstellar medium which includes chemical evolution of the galaxy, the formation of molecules and grains, and the ionization structure of each phase.

We use these results to calculate the cross-section of the interstellar medium in the direction of the Crab Nebula, and find a total hydrogen column density of 2.6×10^{21} hydrogen atoms/cm^2 along this line-of-sight. If this result is interpreted in the framework of the two component model of the interstellar medium, the "discrepan cy" frequently cited between radio and X-ray measurements of the hydrogen column density is naturally resolved. Our analysis identifies the interstellar 21 cm absorption with the cool neutral hydrogen in clouds, and provides a prescription for calculating this quantity from X-ray observations. We find the column density of the neutral hydrogen in clouds to be 1.1×10^{21} H atoms/cm^2, in good agreement with the 21 cm data.

We also discuss the prospects for the study of the abundances of elements and the ionization structure of the interstellar medium, and properties of interstellar grains by X-ray observations.