Sensitivity Analysis Applied to Atomic Data Used for X-ray Spectrum Synthesis

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Abstract

A great deal of work has been devoted to the accumulation of accurate quantities describing atomic processes for use in analysis of astrophysical spectra. But in many situations of interest the interpretation of a quantity which is observed, such as a line flux, depends on the results of a modeling- or spectrum synthesis code. The results of such a code depends in turn on many atomic rates or cross sections, and the sensitivity of the observable quantity on the various rates and cross sections may be non-linear and if so cannot easily be derived analytically. In such cases the most practical approach to understanding the sensitivity of observables to atomic cross sections is to perform numerical experiments, by calculating models with various rates perturbed by random (but known) factors. In addition, it is useful to compare the results of such experiments with some sample observations, in order to focus attention on the rates which are of the greatest relevance to real observations. In this paper I will present some attempts to carry out this program, focussing on two sample datasets taken with the Chandra HETG. I will discuss the sensitivity of synthetic spectra to atomic data affecting ionization balance, temperature, and line opacity or emissivity, and discuss the implications for the ultimate goal of inferring astrophysical parameters.

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