Uncertainty determination of X-ray spectral parameters in the low photon statistics regime in *Chandra* ACIS-I spectra

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Abstract / The aim of this work is to estimate the uncertainty of the X-ray flux and the stellar parameters that are obtained from a set of X-ray spectral fits. We adopted two different X-ray emission models: i) an absorbed thermal (APEC) model; ii) a non-thermal (POWER-LAW) model. We use Monte-Carlo (MC) simulations to construct a set of fake X-ray spectra in the low photon statistic regime, i.e. 10 to 350 net counts. We initially assume a low source background fraction. We perform the analysis from the true instrumental responses of Chandra ACIS-I camera, to get more than 112000 and 46000 MC simulations of thermal and non-thermal absorbed models, respectively. The set of spectra were fitted and analyzed according to a set of input parameters: source net count of the spectra (net_cnts) , the stellar-interstellar absorption (N_H) , and the X-ray plasma temperature (kT) in thermal models, or the power-law index (Γ) for non-thermal models. The spectra were simulated in low photon statistic regime and fitted with a set of different input parameters. We computed residuals according to the C-statistic minimization criteria to get quantitative estimation of the error for spectral parameters and fluxes. We study these errors as a function of the 1σ Quantiles (Q) to perform numerical estimation on how it correlate with different stellar parameters and photon spectra statistics. We computed bi-dimensional maps of 1σ Quantiles in terms of N_H-kT or N_H-Γ parameters, according to a source emission from a thermal or non-thermal model, respectively. We also fit MC simulated spectra by considering different source background contamination and bi-dimensional Quantile maps were corrected as a function of the source background fraction. We use our results for Cyg OB2 sources that were detected in the new Chandra Cygnus OBS Legacy Survey, to give explicit determination of X-ray flux uncertainty in 1690 X-ray sources detected in the low photon statistic regime.
All the results presented here becomes a valuable tool to determine the uncertainty of the X-ray spectral parameters and flux in faint sources detected or to be detected with the Chandra ACIS-I camera. The on-line implementation of these results could be used interactively to compute exposure times for further Chandra ACIS-I proposals.

Keywords / Method: X-ray data analysis – spectral fitting – statistical – X-rays: general

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