International Astronomical Consortium for High-Energy Calibration

IACHEC Report Series#3

Standards for spectral calibration data analysis

IACHEC Heritage Working Group
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1 Background

At its first meeting in Virginia, the IACHEC Heritage Working Group agreed to compile a list of "best practices" for the analysis of spectroscopic calibration data. The ultimate goal of this study is proposing a set of standards that calibration work in the framework of the IACHEC should comply to ensure homogeneity. The areas that these standards should cover were defined as:

- X-ray photo-electric absorption models, and associated cross-sections
- Elemental abundances
- Collisionally ionized optically-thin plasma equilibrium emission models

In order to base this proposal on state-of-the-art knowledge, the WG launched a survey involving leading experts in model development as well as in the analysis of X-ray spectroscopic data, particularly at the highest possible resolution (gratings on *Chandra* and XMM-Newton, as well as the future ASTRO-H micro-calorimeter). The following colleagues contributed to this survey: Elisa Costantini (SRON), Jelle Kaastra (SRON), Randall Smith (CfA), Martin C. Weisskopf (NASA), Jörn Wilms (University of Erlangen).

This document summarizes the results of the survey.

2 X-ray photo-electric absorption models

It is recognized that the most advanced effort in the field is embedded in the model `tbnew`[1]. This code represents an improvement with respect to `tbabs` (Wilms et al. 2000) insofar it improves the resolution of the cross sections around the K-edges of Oxygen and Neon, as well as in the vicinity of the Fe L-edge. The model has been available as "additional" as of September 2010 in XSPEC.

SPEX users can use to the model `hot`, corresponding to a collisionally ionized plasma with tunable temperatures that includes all photo-electric edges and bound-bound transitions of neutral atoms in a cold gas. In the limit of low temperatures ($T \simeq 0.5$ eV) it represents the cold InterStellar Medium, for higher temperatures it may be used to model the intermediate, warm, and hot phases of the ISM. The contribution of dust may be added to `hot` through the `amol` model (Costantini et al. 2012; Pinto et al. 2013). These modes do not include scattering yet. A list of references on the laboratory measurements on which these models are based can be found at Pag.53 and 85 of the current version of the SPEX manual (2.06.01)[2].

There is consensus that the most adequate set of photionisation cross sections are those described in Verner & Yakovlev (1995), covering ground state shells of all atoms and ions from H to Zn ($Z<30$). They can be reliably used up to energies ≤ 100 keV.

3 Elemental abundances

The survey expressed the consensus that the most reliable sets of solar abundances are those after Lodders & Palme (2009). XSPEC users should be aware that the abundance set `lodd` refers to an older set (2003). The most updated results shall be used via the `abund file` option.

4 Collisionally ionized emission models

The `apec` model with its associated ATOMDB[3] database is nowadays considered among the most advanced codes for collisionally ionized optically thin equilibrium plasma (Foster et al. 2012). The ATOMDB web pages offer some benchmark against similar models available in spectral fitting packages (Raymond-Smith, `mekal`, SPEX). A `NoLine` version (continuum only) was produced for the IACHEC Thermal Supernova Remnant Working Group, and used in the definition of the 1E0102-72 model (Plucinsky et al. 2012). SPEX users can recur to the `cie` model instead.

[1] http://pulsar.sternwarte.uni-erlangen.de/wilms/research/tbabs/index.html
[2] http://www.sron.nl/files/HEA/SPEX/manuals/manual.pdf
[3] http://www.atomdb.org/

References

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