EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

Faculty of Science
Institute for Astronomy and Astrophysics

DA-Type White Dwarfs: Soft X-Ray Standards for the Calibration of X-Ray Instruments

T. Rauch

Institute for Astronomy and Astrophysics, Kepler Center for Astro and Particle Physics, Eberhard Karls University, Sand 1, D-72076 Tübingen, Germany

The absolute calibration of space-borne instruments in the soft X-ray regime rests strongly on model spectra of white dwarfs. The hot, hydrogen-rich white dwarfs HZ43 A und Sirius B were established as standard stars in the soft X-ray by cross-correlation between the Chandra LETG+HRC-S, the EUVE spectrometer, and the ROSAT PSPC.

Hot, Hydrogen-Rich White Dwarfs

Thermal soft X-ray emission is detected from many hot hydrogen-rich white dwarfs (spectral type DA) with an effective temperature in excess of 20000 K. Most of the objects with Teff < 40000 K have virtually pure hydrogen atmospheres while the majority of the hotter ones emit X-ray fluxes lower than predicted by hydrogen model atmospheres and therefore must contain heavier elements as absorbers.

Although such objects have a relatively soft X-ray spectrum, they are invaluable for the calibration of X-ray instruments. The DA-type white dwarfs HZ43 A and Sirius B with effective temperatures of 51100 K and 24900 K, respectively, were used to establish soft X-ray standards: A cross-calibration between Chandra LETG+HRC-S, EUVE spectrometer, and ROSAT PSPC was successfully performed (Beuermann et al. 2006).

HZ43 A provides, thus, an ideal calibration target for eROSITA and other space-borne X-ray missions, that cover the soft X-ray range, as well.

Cross-Correlation - X-Ray Calibration

Beuermann et al. (2006) fitted simultaneously Chandra LETG+HRC spectra of the DA-type white dwarfs HZ43 A and Sirius B, and the neutron star RX J1856 with the best available model spectra. This ties white-dwarf and neutron-star spectra together. While HZ43 A and, thus, Sirius B are well calibrated in the optical and ultraviolet, their spectrum is fixed in the soft X-ray as well. RX J1846 is then used for calibration at energies higher than about 0.3 keV.

The Model Atmospheres - *TMAP*

For our model-atmosphere calculations, we used the state-of-the-art Tübingen NLTE Model-Atmosphere Package (http://astro.uni-tuebingen.de/~TMAP, *TMAP*) that assumes hydrostatic and radiative equilibrium and a plane-parallel geometry. It is suitable for the spectral analysis of hot, compact stars. *TMAP* uses atomic data from *TMAD* (see below). *TMAP* can calculate fully metal-line blanketed model atmospheres with about 1500 atomic levels and 4000 individual lines of the elements H - K can be treated in NLTE and, due to a statistical treatment, about 200 millions of lines of the iron-group elements (Ca - Ni).

The Atomic Data - *TMAD*

The Tübingen Model-Atom Database (http://astro.uni-tuebingen.de/~TMAD, *TMAD*) provides ready-to-use, *TMAP*-compliant model atoms of the elements H – Ca. *TMAD* is continuously updated for the most recent atomic data.

The Access - *TheoSSA*

The Virtual Observatory service *TheoSSA* (http://dc.g-vo.org/theossa) provides easy access to spectral energy distributions (SEDs) of hot white dwarfs. For further details, see Poster of Ringat et al.

References

Beuermann, K., Burwitz, V., & Rauch, T. 2006, A&A, 458, 541

University of Tuebingen · Faculty of Science
Institute for Astronomy and Astrophysics
Sand 1 · 72076 Tuebingen · Germany
Phone: +49 7071 29 78614· E-Mail: rauch@astro.uni-tuebingen.de

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