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Faint NUV/FUV Standards From Swift UVOT Photometry

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Abstract

In an effort to improve the calibration of faint ultraviolet photometry, we present a catalog of eleven faint (u~17) new ultraviolet standard stars. The sample consists of hot (20,000-50,000 degree) DA white dwarfs with published spectra from the Sloan Digital Sky Survey. High-precision photometry is taken from the SDSS, the Galaxy Evolution Explorer and the Swift Ultraviolet Optical Telescope, providing precise measures from the near infrared to the far ultraviolet. Using hot DA white dwarfs allows us to compare this unique photometric dataset to models of pure hydrogen atmospheres. We find that the existing models reproduce the measured photometry within the 1-5% precision of the measures. This excellent consistency between models and data demonstrates both the utility of the models and the unique ability of Swift/UVOT to apply tight photometric constraints on the properties of white dwarfs. The publication of these new standards also creates a legacy for future missions that can now confidently use these comparatively simple stellar systems to calibrate future FUV and NUV instruments.

Why White Dwarfs?

DA white dwarfs are ideal calibrators for UV instruments because:

- Only hydrogen lines are expected, none of which appear in the wavelength range of Swift/UVOT’s UV filters.
- Comparative simplicity means they can be modelled to 1% precision.
- Trigonometric parallaxes have confirmed the accuracy of photometric parallaxes and theoretical models.
- DA white dwarfs of sufficient temperature (20,000-50,000 K) are not thought to be variable (we confirm that our standards are stable).
- Large catalogs of spectroscopically confirmed white dwarfs are now available from the Sloan Digital Sky Survey.

Methods and Results

Data have been taken from GALEX, Swift/UVOT and SDSS. We then used the TLUSY NLTE code to generate white dwarf models. We convolved these models with latest filter function to derive predicted magnitudes. The comparison (above, right and left), shows excellent agreement between the models and the photometry. They agree to within the systematic photometric uncertainties.

Monte Carlo simulations quantified the effect of photometric error on the derived effective Temperatures (right and left). We find we can constrain white dwarf temperatures to at least 500 K precision. Our results are consistent with those derived from spectroscopic studies (below).

Conclusions and Future Directions

Swift/UVOT has a unique ability to constrain the properties of hot stars. In the case of white dwarfs, this allows excellent photometric constrain on their temperatures.

Our 11 stars are exceptional photometric standards. Ongoing analysis of the SDSS will provide additional standards for current/future UV missions.