THE IUE FLUX SCALE

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Abstract

One of the by–products of the IUE Final Archive has been the redefinition of the Ultraviolet Flux Scale. The method followed is a two stages process in which the relative and the absolute flux scales are derived separately. The relative flux scale is based on White Dwarf models, as is the case for other space experiments (HST, HUT). The zero point, which defines the Absolute Flux scale is set by the OAO-2 measurements in the band 2100-2300 Å.

Key words: IUE; Absolute Flux scale.

1 INTRODUCTION

One of the primary requirements in the design of the IUE Final Archive was the revision of the Absolute Flux Scale, and the derivation of new Inverse Sensitivity Curves for the three cameras.

The basis of the initial IUE Flux Scale was the flux of the bright (V=1.84) B3 V standard star η UMa as defined by Bohlin et al. (1980), based on previous space experiments. These authors derived correction factors which allowed to convert the fluxes given by other experiments to this scale. Being η UMa too bright to be observed in low resolution mode by IUE, the correction factors were used to define the fluxes of a set of fainter secondary standard stars. These fluxes were were used to derive the Sensitivity Functions of the cameras.

Along the years there were increasing evidences of disagreements between IUE observations and models of different objects. These deviations were maximum in the spectral regions where the difference between the original TD1 and OAO-2 was maximum. This, together with the fact that these discrepancies were the same for objects of different physical nature (BL Lac, White Dwarfs) was taken as a clear indication for the presence of systematic errors in the η UMa Flux scale.

The definition of the IUE Flux Scale for the Final Archive was made following a different approach. Relative and the absolute Flux scales were derived separately. The relative shape of the Inverse Sensitivity Curves was derived from White Dwarf models, and the zero point of the absolute scale was set by comparison with measurements performed with OAO-2 (Meade (1978)).

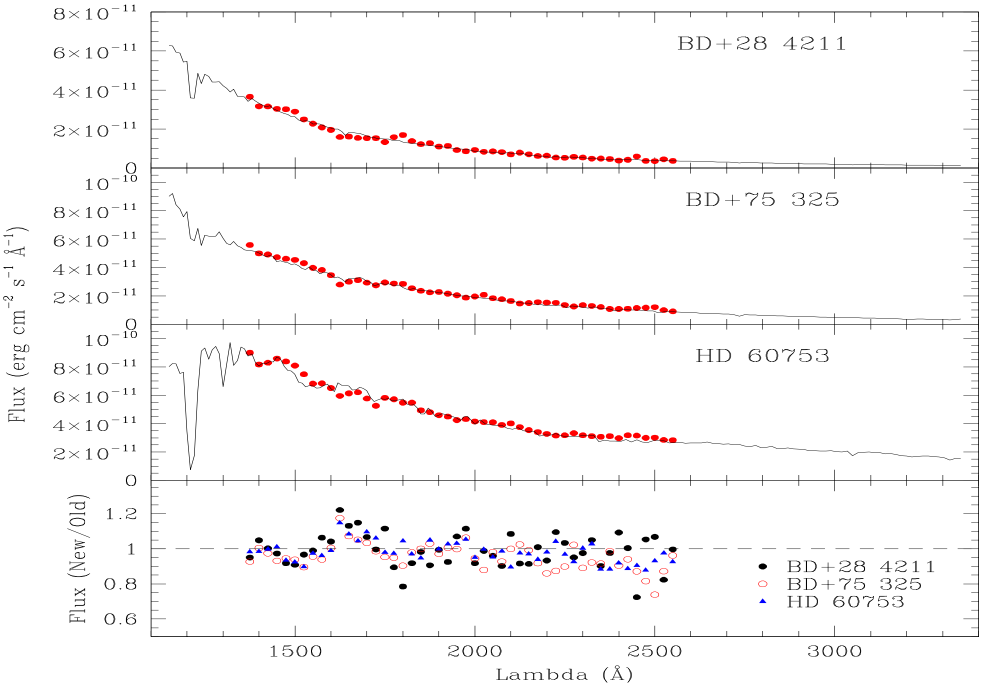

Figure 1: *Comparison of new (continuous line) and old (dots) fluxes for the three TD1 standard stars. The bottom panel shows the ratio between new and old fluxes*

2 THE RELATIVE FLUX SCALE

The spectral distribution of hot DA White Dwarfs can be modeled with great accuracy (Finley (1993)). Basic stellar parameters (effective temperature and gravity) can be accurately derived from the profiles of the Balmer lines. Since in the spectrum of these stars, in the IUE spectral range, there are no features other than Lyman α, they are ideal objects for the derivation of the shape of the Inverse Sensitivity Curves. The White Dwarf G191 B2B was chosen as primary standard star for its brightness, high temperature – which implies a narrow Lyman α line –, and negligible interstellar extinction.

The model used for this star was provided by D. Finley (calculated with the atmosphere code of D. Koester), and has the following characteristics: characteristics:

- Pure Hydrogen
- T_{eff} = 58000 K
- log g =7.5
- Normalized to optical spectrophotometry in the range 3200-8100 Å (Massey et al. (1988))

The atmosphere of G191 B2B contains trace quantities of heavy elements (e.g. Bruhweiler and Kondo (1981), Barstow et al. (1993)), but the influence of the presence of metals in the IUE range is nearly negligible (Finley (1993)). The difference in the slope of the model over the IUE spectral range with respect to a model with a more recent determination of the effective temperature (61300 K) is less than 2%.

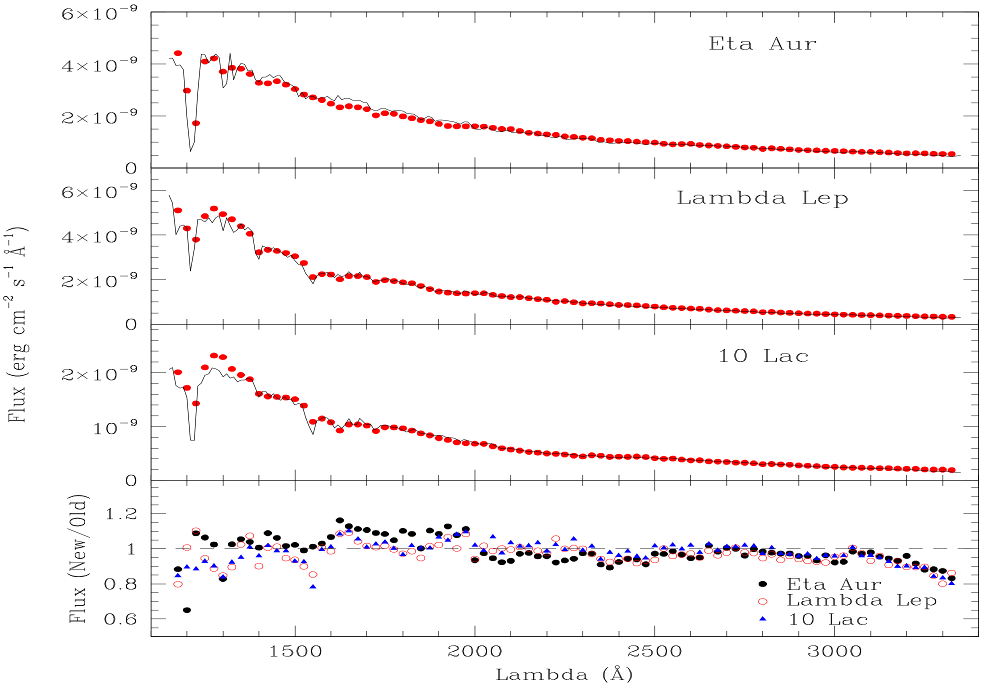

Figure 2: *Same as Figure 1, but for the OAO standard stars*

3 THE ABSOLUTE FLUX SCALE

The direct use of White Dwarf model atmospheres to define the Absolute Flux scale was excluded *a priori* because of the errors implied in the determination of the stellar parameters. Normalization to optical photometry and/or spectrophotometry was also excluded to avoid extrapolation over a wide spectral range, in which errors could be amplified. The final choice was to define the zero point of the Absolute Flux scale by comparison of the IUE fluxes of several of the brightest standard stars (η Aur, 10 Lac, λ Lep and ζ Dra), derived through the G191 B2B model, with the OAO-2 fluxes of these stars. The spectral range selected to perform this comparison was the band 2100-2300 Å, where the agreement between previous space experiments is best (e.g. OAO-2 and TD1 fluxes agree within a 2%).

As a result of this comparison, the flux of the model of G191 B2B, with the normalization to optical spectrophotometry detailed above, had to be decreased by a factor 1.042 in order to match the OAO-2 flux scale. This value defines the UV absolute flux scale currently applied to the IUE data. This normalization and the relative response curves obtained from the WD model were used to derive the fluxes of the following standard stars: BD+28 4211, BD+75 325, HD 60753, η Aur, λ Lep and 10 Lac. These fluxes are the basis of the new IUE Flux Scale and, as such, have been used to compute the Inverse Sensitivity Curves of the three IUE cameras. These curves can be found in Garhart et al. (1997, Chapter 11). Figures 1 and 2 compares the new and old IUE fluxes for some of the standard stars.

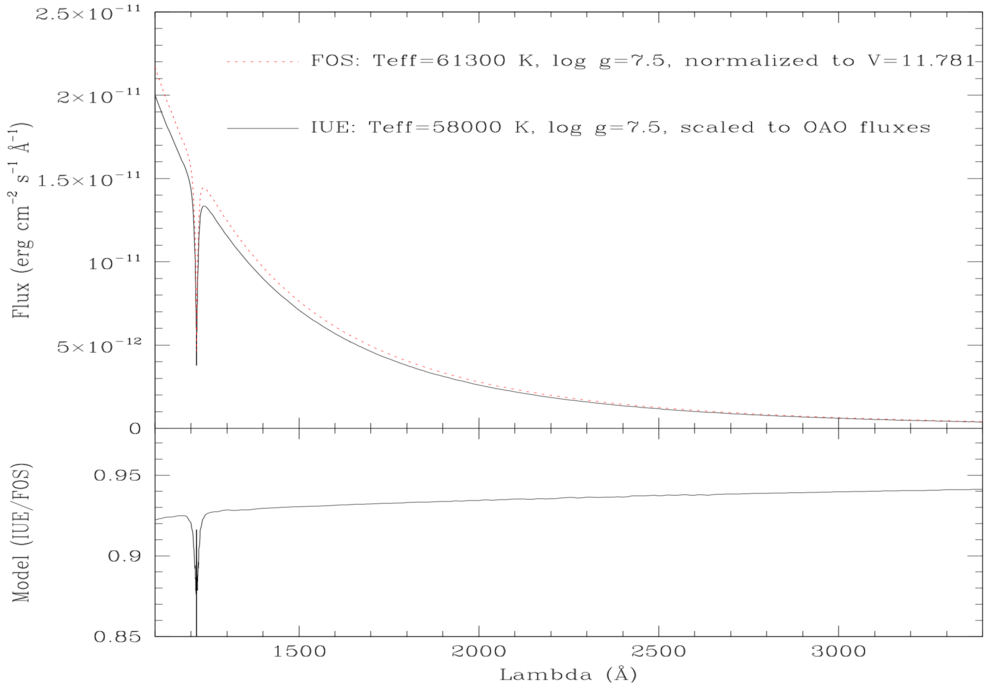

Figure 3: *Models of the White Dwarf G191 B2B used for the flux calibration of IUE and HST-FOS*

4 COMPARISON WITH THE HST FLUX SCALE

Other Ultraviolet experiments have used White Dwarf models for the calibration of its instruments. This is the case of the Hubble Space Telescope and the Hopkins Ultraviolet Telescope (HUT, Kruk et al. (1997)). The zero point of the HUT absolute flux scale is 1.63 % lower than that adopted by HST, due to a slightly different normalization to the V magnitude. In the following we will compare the IUE and HST-FOS flux calibrations.

The absolute calibration of the HST instruments is also based on models of the White Dwarf G191 B2B (Bohlin et al. (1995)). In the case of FOS, the model used is also a pure Hydrogen model, with an effective temperature of 61300 K, log g=7.5, and normalized to V=11.781 (Colina and Bohlin (1994)).

Due to this different normalization, the flux of the model used in the IUE calibration (with the original scaling to optical spectrophotometry) is lower than the model used for FOS by 1.1 % at 5500 Å. The additional 4.2% scaling factor makes this difference 5% at V (in the sense that the FOS model is brighter, see Figure 3). The slightly different slope of the models increases this discrepancy in the IUE range. The average ratio in the range 1150-3350 Å(excluding the region around Lyman α) is 0.933, i.e. the IUE model is 7.2% lower.

A further test can be made by comparing the IUE and FOS fluxes of standard stars, as shown in Figure 4 for BD+28 4211 and BD+75 325. Average ratios over the IUE range are 0.933±0.029 and 0.925±0.034, respectively. The continuous line in the plots represents the ratio between the models used for the IUE and FOS calibrations. It can be seen that the

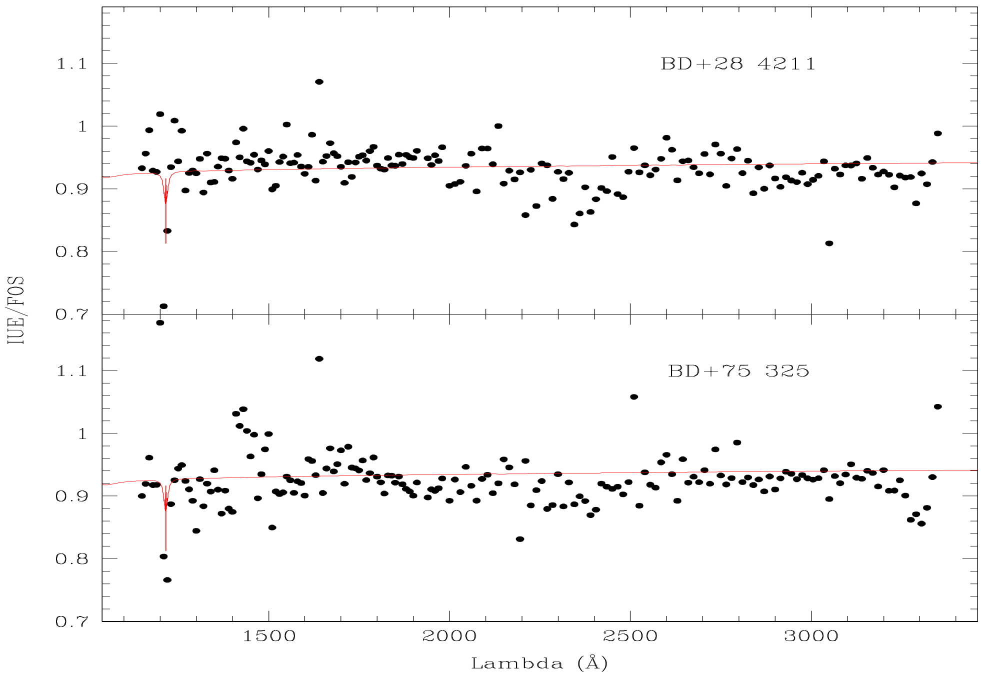

Figure 4: *Ratio of the fluxes of the two standard stars BD+28 4211 and BD+75 325, as derived from the IUE and the HST-FOS calibrations. The continuous line in each panel is the ratio between the white Dwarf models used to define the flux scale (the same as shown at the bottom panel of Figure 3)*

overall agreement (in the relative scale) is good although there are some broad features, which are thought to be induced by the effects of the residual non-linearities of the IUE cameras on the spectra used for the calibration (see González-Riestra, this volume).

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