A TEST OF THE SWP ECHELLE-MODE CALIBRATION FOR LATE-TYPE EMISSION-LINE SOURCES

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ABSTRACT

I have conducted a test of the Cassatella, Ponz, and Selvelli absolute calibration of the SWP echelle mode for emission-line sources. The authors' exposure ratios C_λ appear to be reliable within the quoted range of validity ($\lambda > 1400$ Å), and probably down to 1300 Å, as well. Even at H I λ1216 Lyα, the linear extrapolation of their relation predicts SWP-HI fluxes only $\approx 20\%$ too low.

1. INTRODUCTION

Cassatella, Ponz, and Selvelli (1983: CPS) have proposed a calibration for the SWP echelle mode based on apparent exposure ratios between low-dispersion and high-dispersion observations of reference stars, including pure emission-line sources like RR Tel. The authors recognized that echelle-mode observations of *continuum* sources (like early-type stars) differed in an important way from those of pure emission-line objects. Due to the crowding of the orders at the short-wavelength end of the echelle pattern, the inter-order background contains some contribution from the on-source continuum: thus, the background-corrected net flux is diminished systematically. A high-dispersion calibration for continuum sources must compensate for the reduction in the net flux in the high orders. An emission-line source would not suffer the background over-correction problem, however, and thus requires an independent high-dispersion calibration.

The CPS echelle-mode calibration for *continuum* sources has been adopted by the Regional Data Analysis Facilities as the default for assigning absolute fluxes to high-dispersion spectra of *all* classes of objects. However, the important differences between the CPS continuum and emission-line calibrations occur below 1500 Å, where virtually all late-type stars are pure emission-line sources with little, if any, sensible continuum. Thus, the default absolute calibration likely is not appropriate for a wide class of objects. Nevertheless, the CPS emission-line calibration, itself, is defined only down to 1400 Å. Several critical features – H I λ1216, O I λ1305 triplet, and C II $\lambda\lambda$1334,35 – lie below the cutoff point. Accordingly, I have obtained a nearly contemporaneous sequence of SWP-LOs and SWP-HIs of the bright UV source Capella (α Aur: HD

TABLE 1. CATALOG OF IUE EXPOSURES

Exp. begin (ddd/hh:mm)	SWP Image No.	t_{exp} (mm:ss)	t_{TF} (s)	FPM V	THDA °C	Offset RP (FES units)
089/19:41	28058H	35:00	0.9	1.89	10.2	$(-16, -208)$
089/20:53	28059L	03:54	2.9	2.16	10.5	triple
089/21:50	28060L	03:33	2.5	2.45	10.8	triple
089/22:42	28061L	03:15	2.1	2.62	10.8	triple
089/23:32	28062L	03:15	2.1	2.49	11.2	triple
090/00:27	28063H	35:00	1.7	1.91	11.2	$(+05, -212)$
090/01:39	28064H	35:00	2.5	0.32	11.5	$(-37, -204)$

34029), in order to test whether the extrapolation of the CPS emission-line calibration is valid down to the shortest wavelengths accessible to the SWP camera.

2. OBSERVATIONS

Capella displays the intense far-UV emission-line spectrum of a magnetically-active late-type star, yet its emissions are remarkably stable in time (Ayres 1984); thus qualifying it as a calibration source. During a single US2 shift in late-March 1986, I took three high-dispersion SWP spectra, all 35 minutes in duration, and four low-dispersion spectra, all triple-exposures of $\lesssim$ 4 minutes total duration each. In addition to a standard SWP-HI with the stellar image centered in the large aperture, I exposed two of the echellograms with the star placed $\approx \pm 5\widehat{''}$ off-center, along the major axis of the oval. The three echellograms sampled different portions of the Vidican target, and thus were affected differently by artifacts like reseau marks, hot pixels, and "fixed-pattern noise". Each of the low-dispersion triple-exposures was taken at the same set of three Offset Reference Points as used (separately) in the series of SWP-HIs. The trapped particle radiation background varied considerably during the shift. I equalized the background fogging by exposing on top of each stellar spectrum a short TFLOOD (TF: flat-field lamp) matched to the FPM rate. A catalog of the *IUE* exposures is provided in Table 1.

I merged the SWP-LO triple-exposures from the ELBL file by co-adding the 18 traces centered on line 56 to obtain the on-source spectrum; and co-adding two blocks of 9 traces each, displaced symmetrically by 2 traces from the edges of the central zone, for the background. Following merging, the SWP-LOs were processed and calibrated in the usual way (e.g., Schiffer 1982).

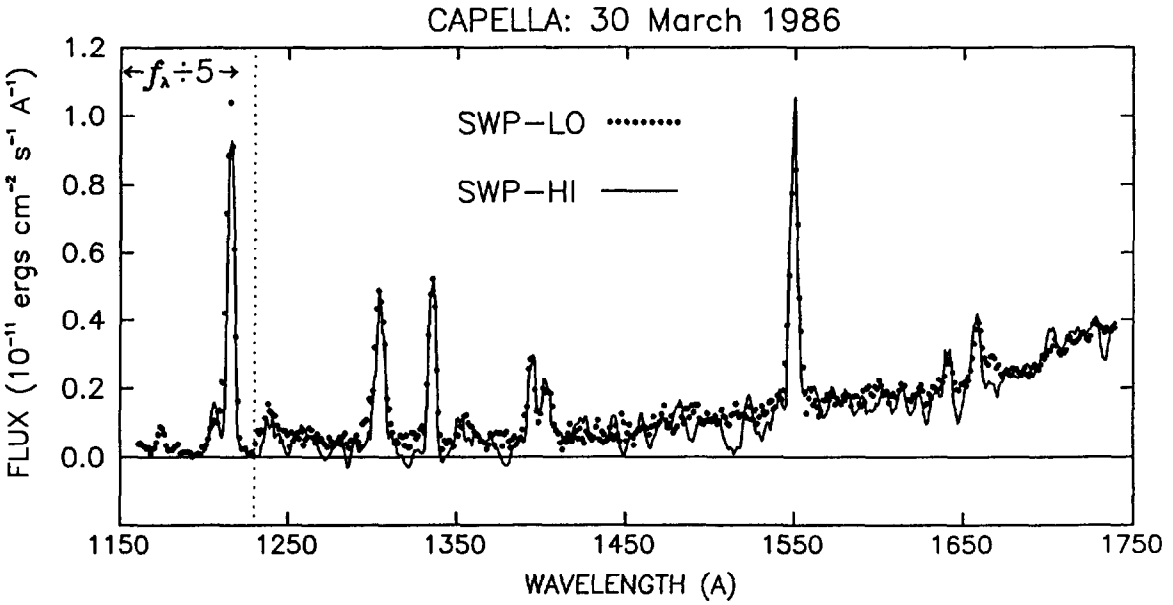

Figure 1: Co-added SWP-LOs and smoothed SWP-HIs of Capella.

I calibrated the SWP-HIs also using standard (RDAF) procedures, with the exception of the CPS HI/LO exposure ratios for *emission-line* sources. I co-added the two off-center SWP-HIs and the aperture-center spectrum on a common wavelength scale, filtering the spectra in pairs to remove cosmic-ray spikes and camera artifacts (Ayres *et al.* 1986). The co-addition of the shifted images improves the S/N through the statistical increase in the signal levels, and the suppression of fixed pattern noise.

3. ANALYSIS AND CONCLUSIONS

I spliced, smoothed, and resampled the co-added SWP-HI spectrum down to the resolution of the low-dispersion mode using the approach described by Ayres *et al.* (1986). For display purposes, I also co-added the four merged SWP-LO triple-exposures. The resulting spectra are compared in Figure 1.

I measured the emission fluxes in the four SWP-LOs independently using the automated line-finding and line-fitting procedure devised by Bennett (1987). The average values are listed in Table 2: uncertainties are standard errors of the means (i.e., $\sigma/\sqrt{4}$). Also listed are the fluxes measured in the smoothed, co-added high-dispersion spectrum, and the ratio HI/LO.

The CPS emission-line calibration appears to be appropriate in its quoted range of validity ($\lambda > 1400$ Å), and probably down to at least 1300 Å, as well. A small departure of $\approx 20\%$ apparently occurs near Lyα; not surprising given the limited wavelength coverage of the original calibration. (Indeed, even the CPS *continuum* calibration is defined only down to 1250 Å.)

TABLE 2. MEASURED SWP-LO AND SWP-HI FLUXES

λ_{lab} (Å)	Spectrum	f_{SWP-LO} (10^{-11} ergs cm^{-2} s^{-1})	f_{SWP-HI}	HI/LO
1216	H I	31.8 ± 0.4	25.5 ± 0.5	0.80 ± 0.02
1304	O I	3.13 ± 0.04	3.22 ± 0.19	1.03 ± 0.06
1335	C II	2.50 ± 0.03	2.74 ± 0.05	1.10 ± 0.02
1400	Si IV	2.20 ± 0.13	2.14 ± 0.20	0.97 ± 0.11
1550	C IV	4.72 ± 0.15	4.63 ± 0.22	0.98 ± 0.06

I undertook the present study specifically as a *check* of the CPS SWP echelle-mode calibration. The major source of uncertainty is the high-dispersion spectroscopy, which was optimized for the bright Lyα feature of Capella, at the expense of the fainter emissions below 1600 Å. A proper calibration of the SWP echelle-mode below 1400 Å could be accomplished using the same strategy as described here, but applied to deeper pairs of SWP-LO and SWP-HI exposures. Until such time, I recommend using the simple (linear) extrapolation of the CPS emission-line calibration for late-type sources.

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