REPEATABILITY OF THE FOS G130H GRATING EXTERNAL WAVELENGTH ZEROPOINT

ANURADHA KORATKAR and IAN EVANS
Space Telescope Science Institute,3700 San Martin Drive, Baltimore, MD 21218

Abstract. Measurements of the position of the geo-coronal Lyα are used to determine the repeatability of the G130H grating and the external wavelength zeropoint for the first time since launch. From 13 observations with the 0.3 aperture we find the offset from the rest wavelength (vacuum) of the geo-coronal Lyα to be 1.43±0.66 pixels (4 pixels = 1 diode), which translates to 0.356±0.165Å or 88±41 kms^{-1}. The 1σ repeatability of the wavelength calibration is 0.159Å (0.64 pixels or 39 kms^{-1}). Pre-flight measurements for the FOS blue detector showed that the filter-grating wheel repeatability was ~0.8 pixels which is similar to that observed in the present analysis (~0.6 pixels).

Key words: FOS – Wavelength Calibration

1. Introduction

Pre-flight measurements of the FOS filter-grating wheel (FGW) repeatability showed that the FGW repeatability was of the order of 10 microns (12.8 y-base units in Y and 0.2 diodes in X) in both the X and Y directions of the FOS blue detector (CAL/FOS-12, CAL/FOS-17, CAL/FOS-49). This non-repeatability of the FGW leads to photometric and wavelength calibration errors. The FGW repeatability has not been determined accurately since launch. An independent technique to determine the FGW non-repeatability at least in the dispersion direction (FOS X-direction) is to use the geo-coronal Lyα. We have analyzed all G130H grating observations using the 0.3 aperture obtained so far in cycle 4 to estimate the FGW repeatability in the dispersion direction and the errors in the wavelength calibration.

2. Data Analysis

All cycle 4 observations (31 observations of 13 independent objects) obtained so far which used the G130H grating and the 0.3 aperture were used in the following analysis. The location of the geo-coronal Lyα feature in each spectrum is determined by fitting a Gaussian to the line between 1214Å and 1218Å. The measurement error in the position of the geo-coronal Lyα is 0.02Å (determined by fitting the line many times at different continuum levels). For objects with multiple exposures, the individual spectra are co-added before the location of the geo-coronal Lyα is determined. Table 1 shows the position of the geo-coronal Lyα for each individual object used in the analysis. To calculate the zero-point wavelength offset, the vacuum wavelength for the geo-coronal Lyα (1215.6701Å) is used.

TABLE I
Position of the geo-coronal Lyα

Prop ID	Object	Line Center (Å)	Line Width (Å)	Internal Repeatability (Å)
5339	PK316+8D1	1216.030	0.910	0.000
5346	SK-69D43	1216.100	1.098	0.070
5346	SK-69D228	1216.047	0.911	0.017
5460	BR93	1216.184	1.102	0.154
5460	HD32125	1215.835	1.188	-0.195
5379	3C279	1215.824	0.975	-0.206
5664	OJ287	1216.060	0.985	0.030
5664	PKS1302-102	1216.121	0.905	0.091
5723	HD32402	1216.271	0.834	0.240
5723	HD37026	1216.118	0.837	0.088
5723	HD37680	1215.853	1.175	-0.177
5723	HD32257	1215.732	1.077	0.298
5723	HD32402	1216.185	1.218	0.155
Average		1216.028		
Standard	Deviation	0.165		0.159

3. Results

3.1 Repeatability of the Wavelength Calibration

The uncertainty of the wavelength calibration can be determined by investigating the repeatability of the position of the geo-coronal Lyα. The uncertainty of the wavelength calibration is mostly due to internal effects associated with grating wheel movement and residual magnetic field errors. It is very difficult to separate the effects of the grating wheel from the effects of the residual magnetic field to understand the exact source of the wavelength calibration uncertainties. The repeatability of the position of the geo-coronal Lyα is determined by comparing the location of the geo-coronal Lyα in each observation relative to a given observation. From Table 1 column 5 we see that the repeatability of the position of the geo-coronal Lyα has a 1σ uncertainty of 0.159Å and a range of $\pm$0.3Å. This uncertainty translates to a 1σ uncertainty of 0.64 pixels (4 pixels = 1 diode) and a range of $\pm$1.2 pixels for the G130H grating. The FGW repeatability seen in this analysis is of the same order as was observed during the preflight measurements. Since all the gratings are on the same grating wheel, they are likely to have similar repeatability in pixel units. However, to check this a proper FGW repeatability test has to be done, since the individual mechanical indents associated with the gratings may have different wear histories. Thus, the relative uncertainty of the FOS wavelength calibration from the present analysis of the G130H grating observations is 0.159Å (0.64 pixels) with a range of ±0.3Å (1.2 pixels).

3.2 The Zeropoint Offset of the G130H Grating

The zeropoint offset of the G130H grating can be determined by comparing the observed average position of the geo-coronal Lyα with the vacuum rest wavelength of the line. This offset is mostly due to the errors in the wavelength dispersion solution and the internal and external offset corrections applied in the pipeline. There is no contribution to the zeropoint offset from the external effects associated with target acquisition, because the geo-coronal Lyα fills the aperture. The measurements of the geo-coronal Lyα from column 3 of Table 1 show that the line center is offset from the vacuum rest wavelength position by -0.358Å± 0.165Å. This offset translates to 1.43±0.66 pixels, or 88±41 kms^{-1}. This uncertainty is a measure of the absolute accuracy of the FOS wavelength calibration for the G130H grating.

References

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