The Swift UVOT Grism: Verification of the Flux Calibration of the uv-grism

Release 0.9.7

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CONTENTS

CHAPTER

ONE

VERIFICATION OF THE FLUX CALIBRATION IN THE UV CLOCKED GRISM

1.1 Overview

The new uv-grism flux calibration is valid over the whole detector, and makes also a correction for coincidence-loss. The first integrated software version is `UVOTPY-0.9.7.0`, but we will do the verification to the 0.9.7.1 version which has patches for the sensitivity-loss and flux model interpolation.

With the choice of data, we have an independent set from the spectra used to construct the effective area. Of course, spectra from the same targets are used.

1.1.1 Method

Calibration spectra that were not used in the flux calibration are reprocessed using the new flux calibration and then compared to the known stellar flux. The spectra for verification are located on the detector between the areas with the spectra used to determine the effective areas for the flux calibration.

1.1.2 Data used for verification

The approximate location of the anchor of the spectra, their `obsid`, and number of the `fits extension` is listed. First the cool stars are listed, followed by the hot white dwarfs.

GSPC-P041C spectra (F0 V)

anchor	obsid	ext	% err	plot
781,1459	00057965002	1,2	-24	*GSPC-P041C Figure 1*
641,1275	00057964002	2	+18	*GSPC-P041C Figure 2*
940,1553	00057972002	1	1	*GSPC-P041C Figure 3*
1361,1051	00057960002	1,2,3	-1.5	*GSPC-P041C Figure 4*
1578,1151	00057969001	3	-6	*GSPC-P041C Figure 5*
1454,1494	00057958001	2	1	*GSPC-P041C Figure 6*
1506,1464	00057958001	1	4	*GSPC-P041C Figure 7*

GSPC P177D spectra (F0 V)

anchor	obsid	ext	% err	plot
1586,1756	00056762002	4	17	*GSPC-P177D Figure 1*
993,1496	00056763002	6	-1	*GSPC-P177D Figure 2*
821,1491	00056763002	2	3	*GSPC-P177D Figure 3*
1229, 889	00056760002	1	-8	*GSPC-P177D Figure 4*

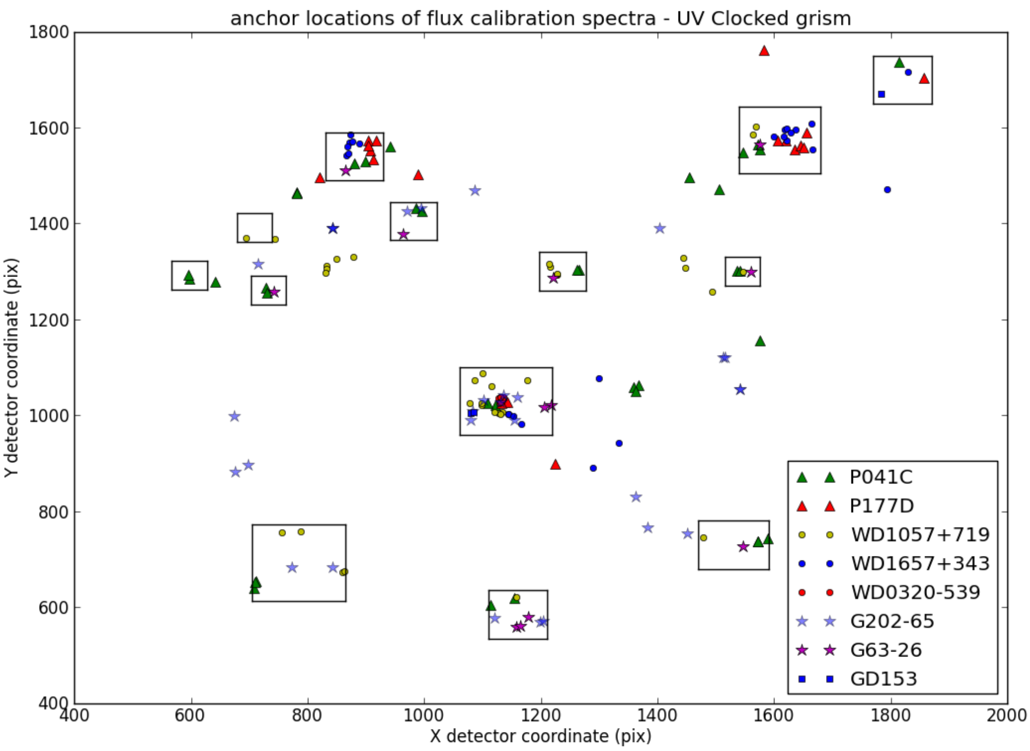

Figure 1.1: Figure 1: The anchor positions of the calibration spectra marked by target. The boxes are enclosing sources used to derive an effective area for the location of the box.

The error is calculated as the mean of the flux difference over a good region of the spectrum, and is considered to be a measure of the error in the flux level. The flux was calibrated using `uvotpy.uvotio.rate2flux` default option with anchor position given.

WD1657+343 spectra

anchor	obsid	ext	% err	plot
1797,1467	00055903006	1	1	*WD1657+343 Figure 1*
1338, 941	00055900050	1	4	*WD1657+343 Figure 2*
1291, 891	00055900050	3	9	*WD1657+343 Figure 3*
1302,1082	00055900050	2	5	*WD1657+343 Figure 4*

WD1057+719 spectra

anchor	obsid	ext	% err	plot
833,1307	00055203007	1,2,3	+11.3	*WD1057+719 Figure 1*
833,1307	00055203008	1	+13	*WD1057+719 Figure 1*
876,1334	00055203007	4	-2	*WD1057+719 Figure 2*
1447,1324	00055201011	1,2	-4	*WD1057+719 Figure 3*
1496,1255	00055201011	3	14	*WD1057+719 Figure 4*

1.1.3 Result

Although the number in the table for the error is based on the mean, since the total exposure time was not long enough to beat down the noise enough, it appears that over most of the detector the flux calibration is within 10% or better. As expected, the flux is most uncertain near the sudden drop in response. The current calibration file (version 002) used with the current `uvotpy` version (0.9.7.1) give a fit to within about 15%. The largest deviations seem related to contamination of the spectrum by the spectra from other sources in the field, and of course from the second order.

I should mention that the limit on the errors is so some degree dominated by the noise in the data. The error in the flux calibration as determined from the calibrated areas (see the boxes in the figure above,) is more reliable since the total exposure time in those areas is larger.

CHAPTER

TWO

VERIFICATION OF THE FLUX CALIBRATION IN THE UV NOMINAL GRISM

2.1 Overview

The new uv-grism flux calibration is valid over the whole detector, and makes also a correction for coincidence-loss. The first integrated software version is `UVOTPY-0.9.7.0`, but we will do the verification to the 0.9.7.1 version which has patches for the sensitivity-loss and flux model interpolation.

With the choice of data, we have an independent set from the spectra used to construct the effective area. Of course, spectra from the same targets are used.

2.1.1 Method

Calibration spectra that were not used in the flux calibration are reprocessed using the new flux calibration and then compared to the known stellar flux. The spectra for verification are located on the detector between the areas with the spectra used to determine the effective areas for the flux calibration.

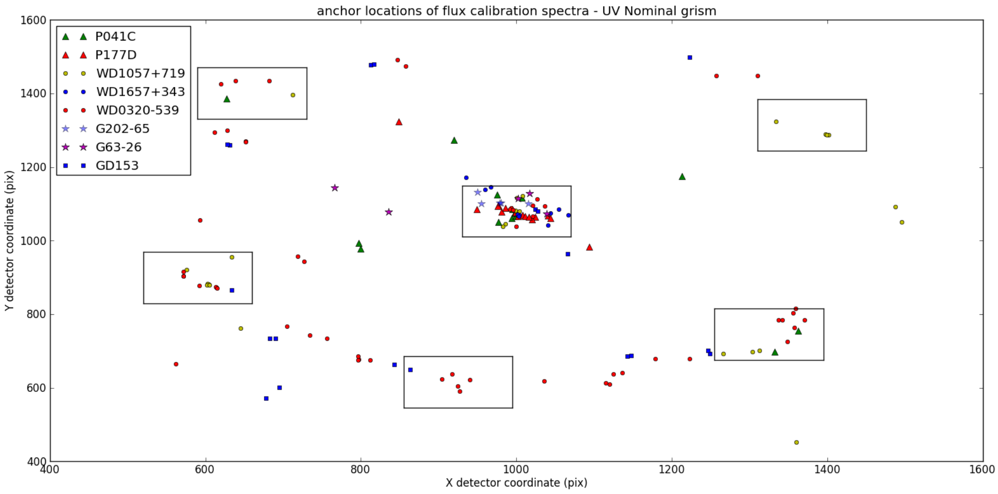

Figure 2.1: Figure 2: The anchor positions of the calibration spectra marked by target. The boxes are enclosing sources used to derive an effective area for the location of the box.

2.1.2 Data used for verification

The approximate location of the anchor of the spectra, their `obsid`, and number of the `fits extension` is listed. First the cool stars are listed, followed by the hot white dwarfs.

GSPC-P041C spectra (F0 V)

anchor	obsid	ext	% err	plot
800, 980	00057953006	1	12	*GSPC-P041C Figure 8*
800, 980	00057953003	1	14	*GSPC-P041C Figure 8*

GSPC P177D spectra (F0 V)

anchor	obsid	ext	% err	plot
850,1320	00056760022	5	-8	*GSPC-P177D Figure 5*

WD1057+719 spectra

anchor	obsid	ext	% err	plot
645, 762	00055201005	1	7.4	*WD1057+719 Figure 5*
1490,1066	00055201009	1,2	-4	*WD1057+719 Figure 6*

WD0320-539 spectra

anchor	obsid	ext	% err	plot
562, 665	00054254008	2	16	*WD0320-539 Figure 1*

GD153 spectra

anchor	obsid	ext	% err	plot
685, 590	00055501008	1	2	*GD153 Figure 1*
685, 590	00055501010	1	4	*GD153 Figure 1*

2.1.3 Result of the verification

The errors are typically 10% or less. The response below 1750A shows some inconsistencies which is partly due to the low sensitivity, partly to the coincidence-loss correction as can be seen in GD153, which has a correction of about 50% due to coincidence-loss in the bright part of the spectrum.

CHAPTER

THREE

FIGURES FOR VERIFICATION OF THE FLUX CALIBRATION FOR THE CLOCKED UV GRISM

These figures go with the description *Verification of the flux calibration in the UV clocked grism*, and show in the top panel the observed flux and the reference spectrum which is usually taken by HST. The sources are calibration sources with the exception of G202-65.

In the bottom panel is plotted (observed - reference)/reference as a percentage. Notice that the bottom plot gets very noisy when the source flux is low. This is due to noise in the data. Also, at longer wavelengths second order contamination raises the observed flux, setting in at a wavelength that depends on the location of the blue rise of the spectrum.

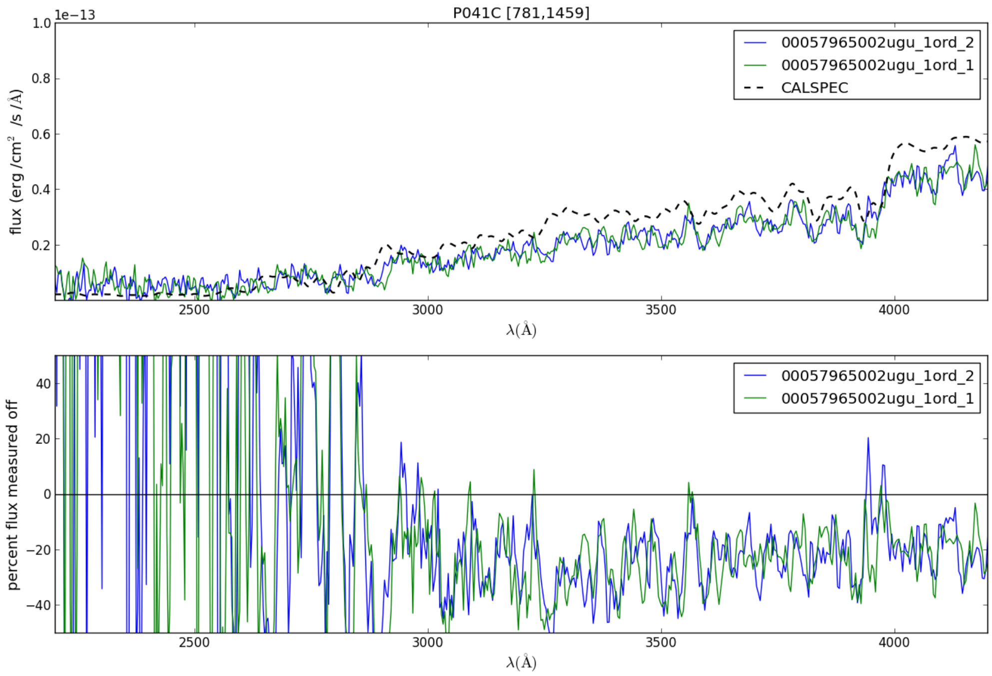

Figure 3.1: This spectrum with anchor at [781,1459] is affected by the decreasing sensitivity in this part of the detector.

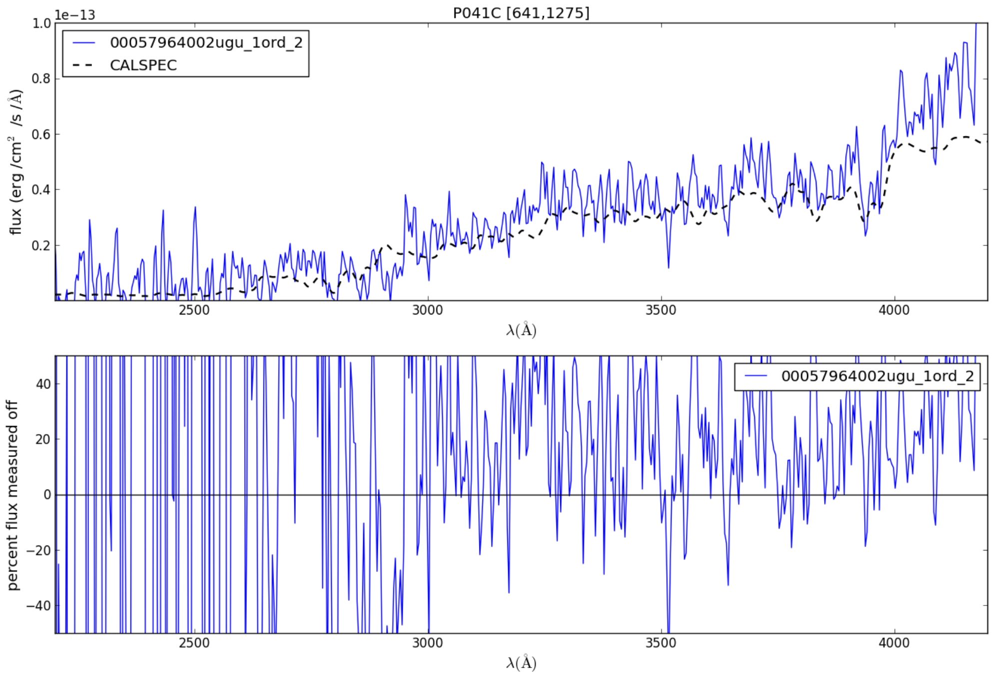

Figure 3.2: This spectrum with anchor at [641,1275] is affected by the decreasing sensitivity in this part of the detector.

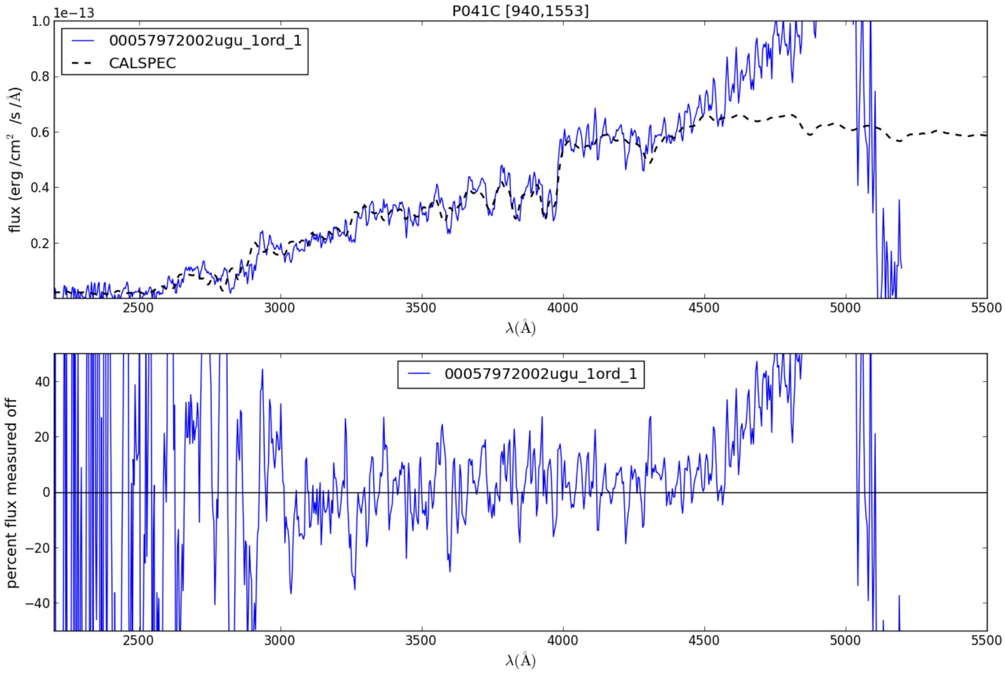

Figure 3.3: This spectrum has its anchor at [940,1553].

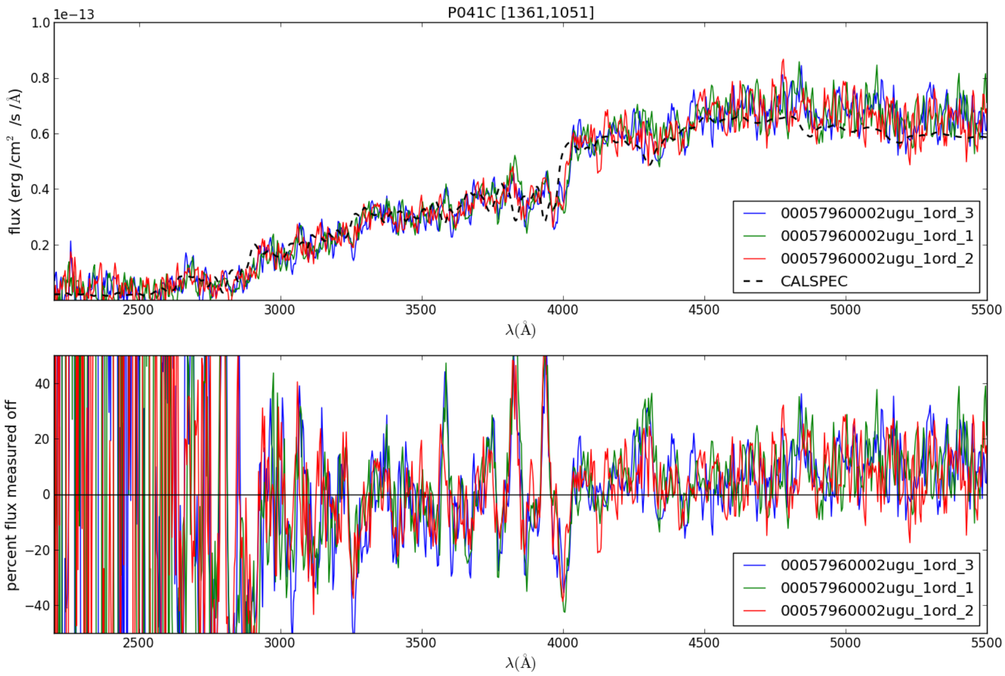

Figure 3.4: This spectrum has its anchor at [1361,1051].

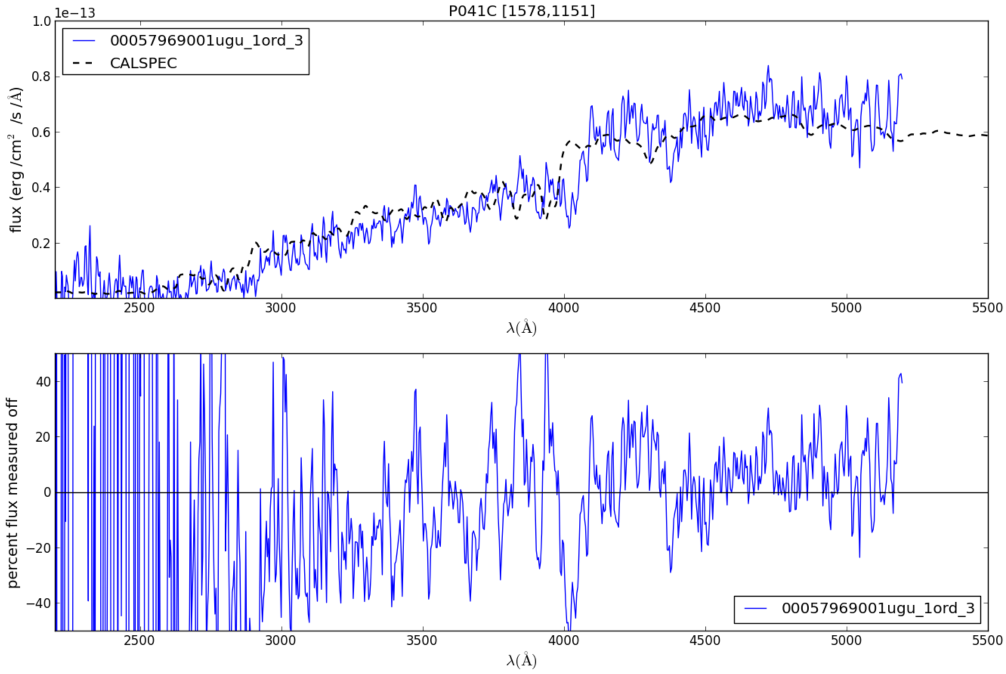

Figure 3.5: This spectrum has its anchor at [1578,1151].

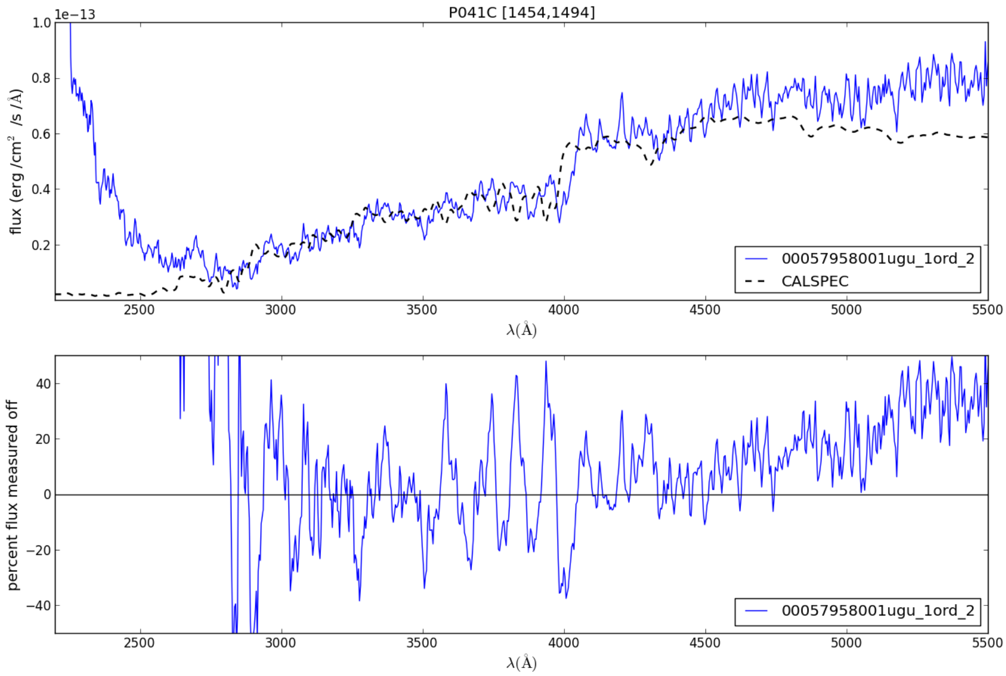

Figure 3.6: This spectrum has its anchor at [1454,1494].

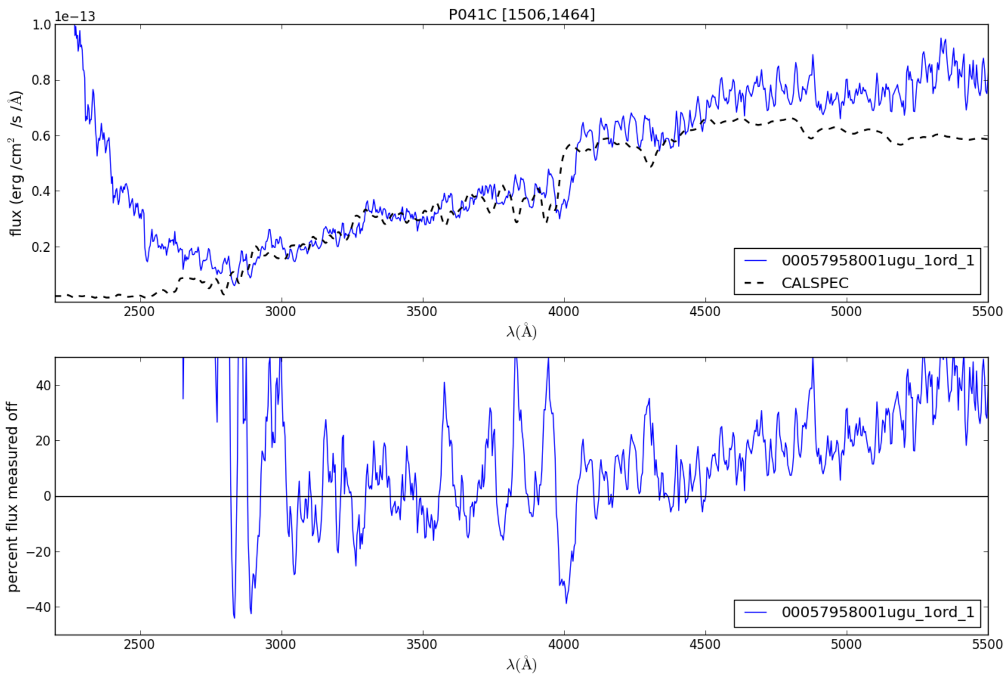

Figure 3.7: This spectrum has its anchor at [1506,1464].

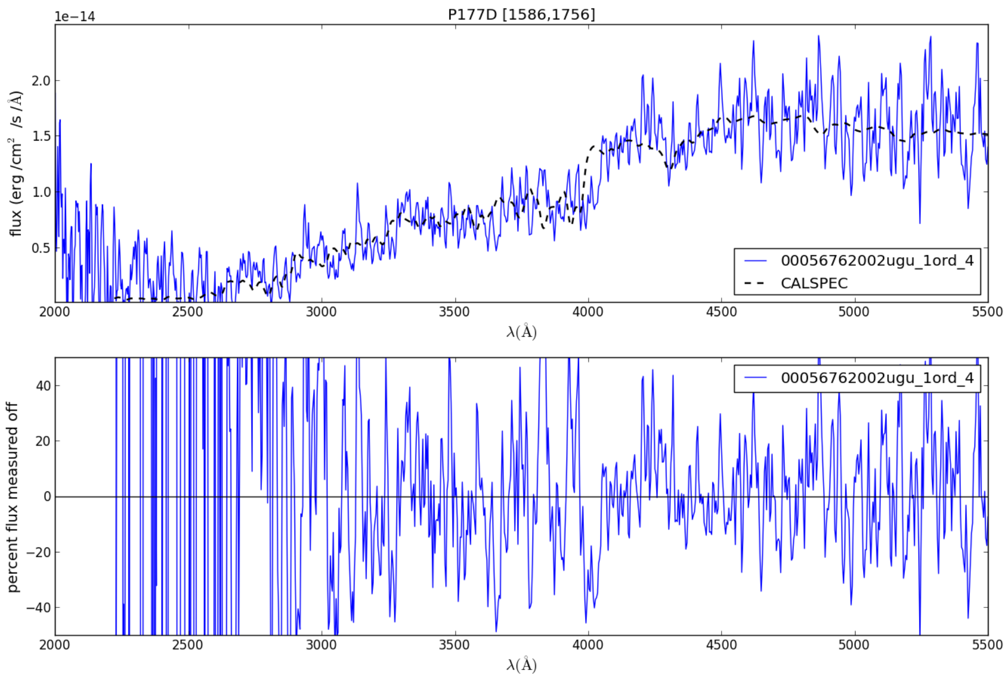

Figure 3.8: This spectrum has its anchor near [1586,1756].

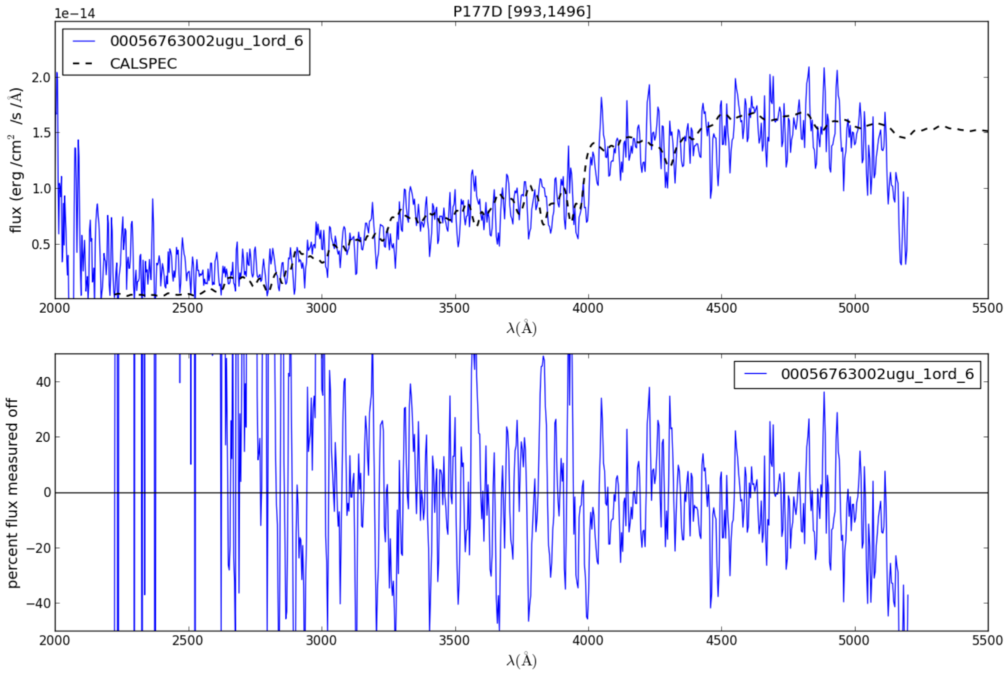

Figure 3.9: This spectrum has it anchor near [993,1496].

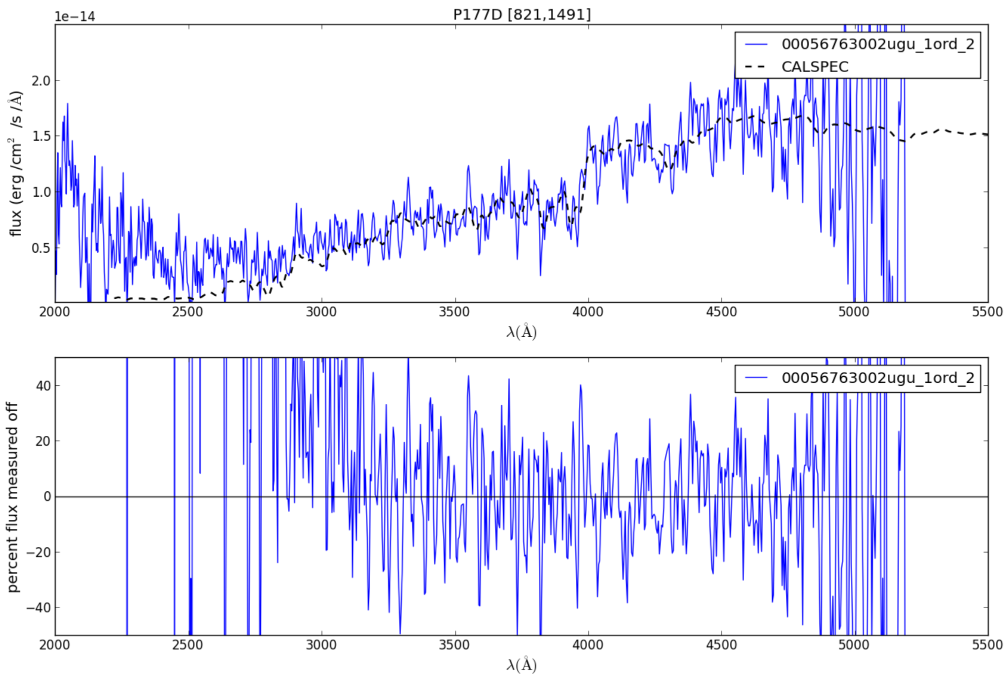

Figure 3.10: This spectrum has its anchor near [821,1491].

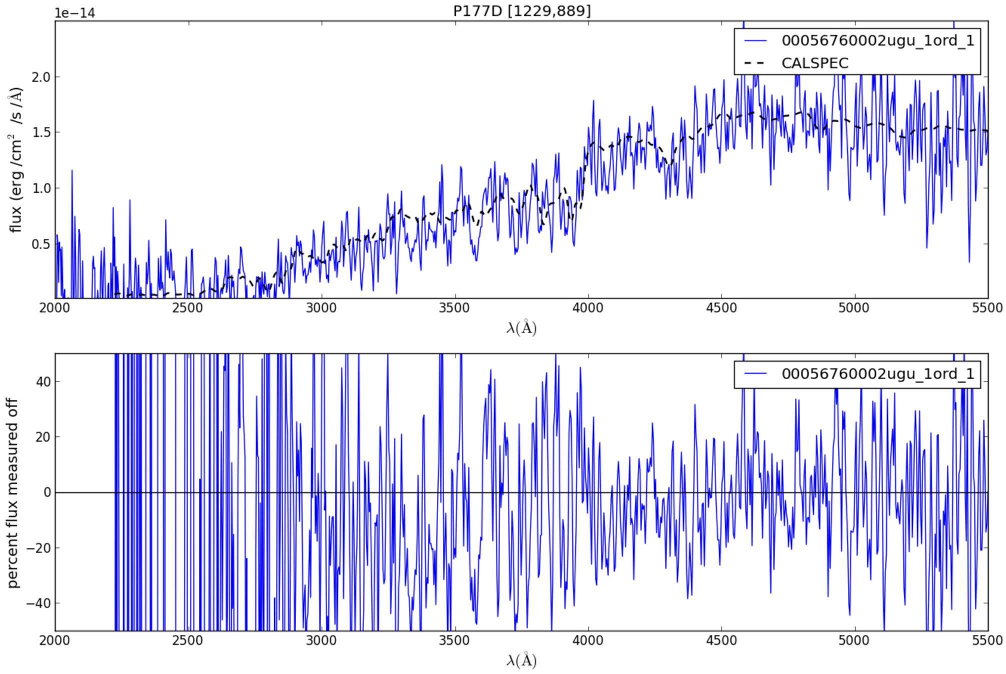

Figure 3.11: This spectrum has its anchor near [1229,889].

3.1 GSPC-P041C spectra (F0 V)

3.1.1 GSPC-P041C Figure 1

3.1.2 GSPC-P041C Figure 2

3.1.3 GSPC-P041C Figure 3

3.1.4 GSPC-P041C Figure 4

3.1.5 GSPC-P041C Figure 5

3.1.6 GSPC-P041C Figure 6

3.1.7 GSPC-P041C Figure 7

3.2 GSPC-P177D spectra (F0 V)

3.2.1 GSPC-P177D Figure 1

3.2.2 GSPC-P177D Figure 2

3.2.3 GSPC-P177D Figure 3

3.2.4 GSPC-P177D Figure 4

3.3 WD1657+343 spectra (DA)

3.3.1 WD1657+343 Figure 1

3.3.2 WD1657+343 Figure 2

3.3.3 WD1657+343 Figure 3

3.3.4 WD1657+343 Figure 4

3.4 WD1057+719 spectra (DA)

3.4.1 WD1057+719 Figure 1

3.4.2 WD1057+719 Figure 2

3.4.3 WD1057+719 Figure 3

3.4.4 WD1057+719 Figure 4

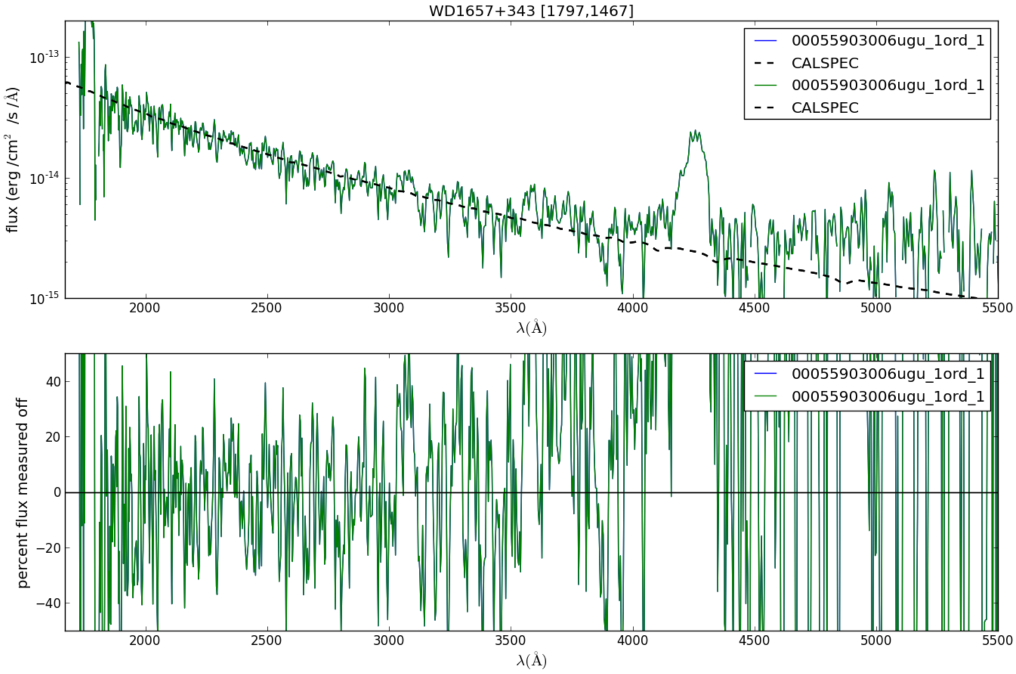

Figure 3.12: This spectrum has its anchor near [1797,1467].

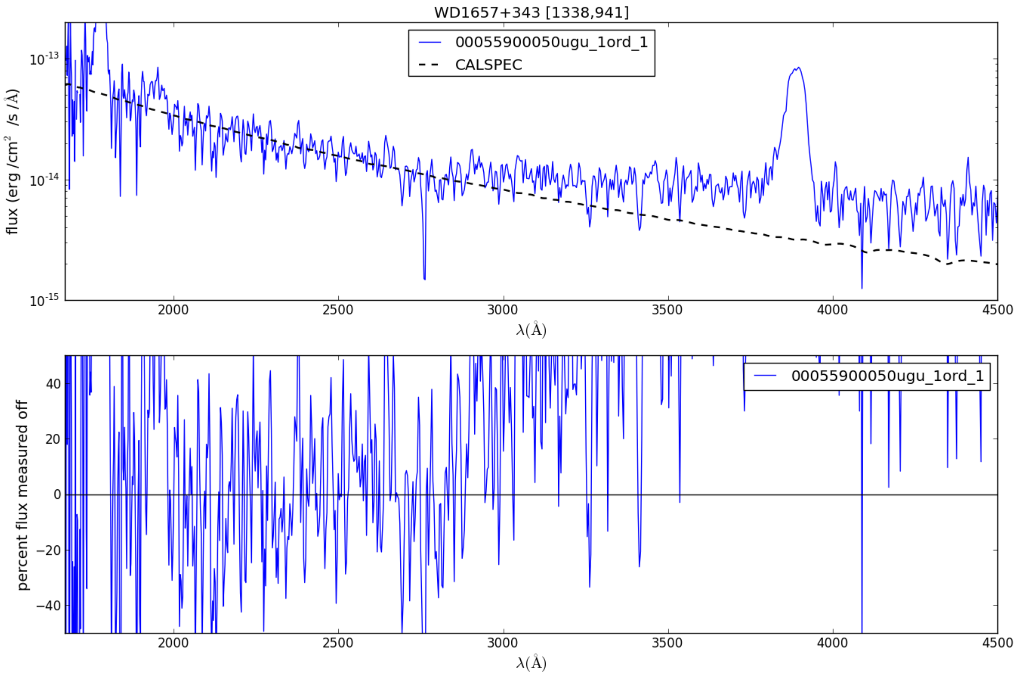

Figure 3.13: This spectrum has its anchor near [1338, 941].

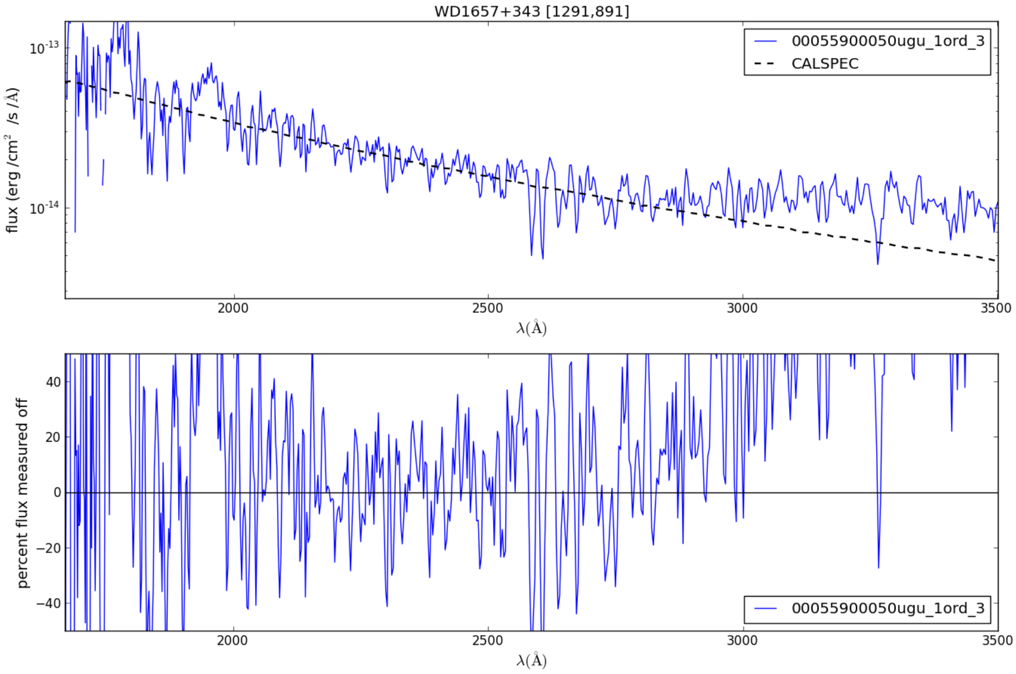

Figure 3.14: This spectrum has its anchor near [1291, 891].

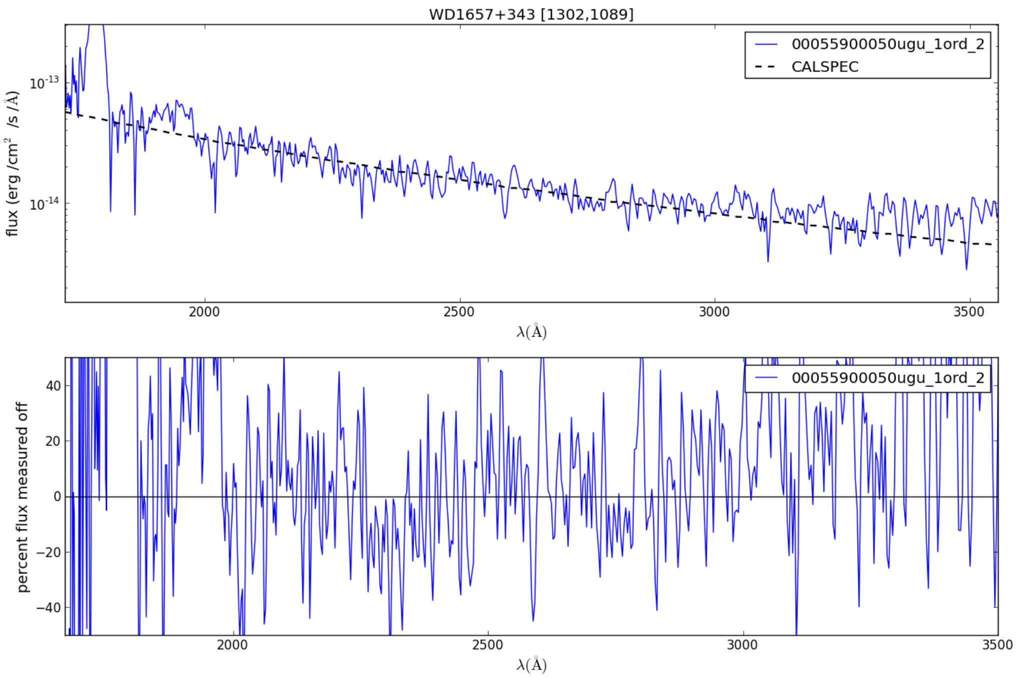

Figure 3.15: This spectrum has its anchor near [1302,1082].

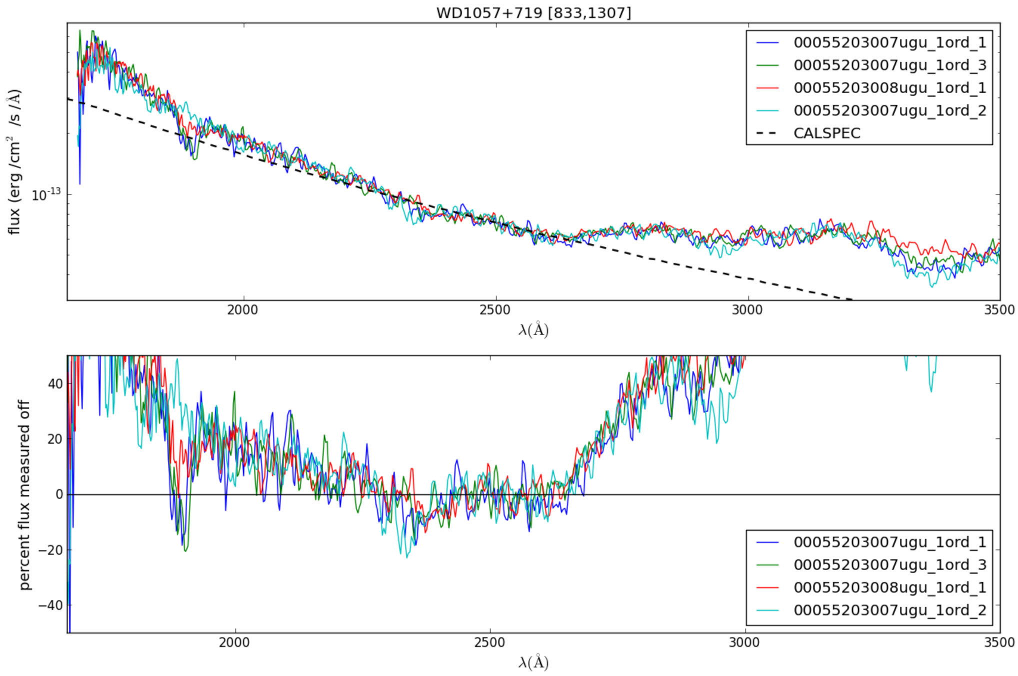

Figure 3.16: This spectrum has its anchor near [833,1307]. This spectrum is located near the region of the detector with reduced response.

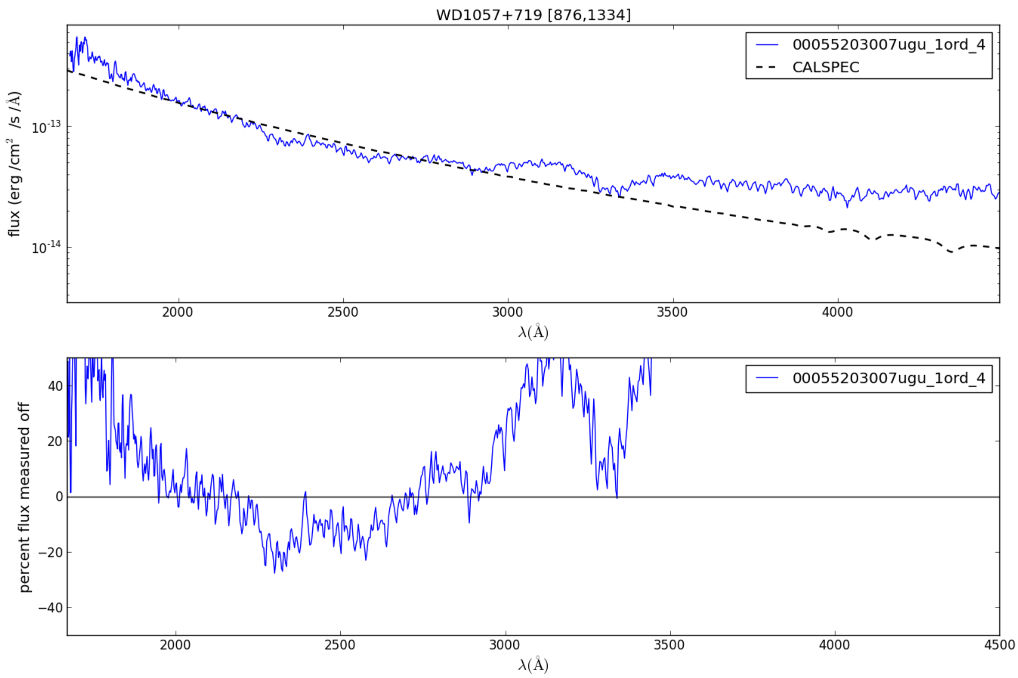

Figure 3.17: This spectrum has its anchor near [876,1334]. This spectrum is located near the region of the detector with reduced response.

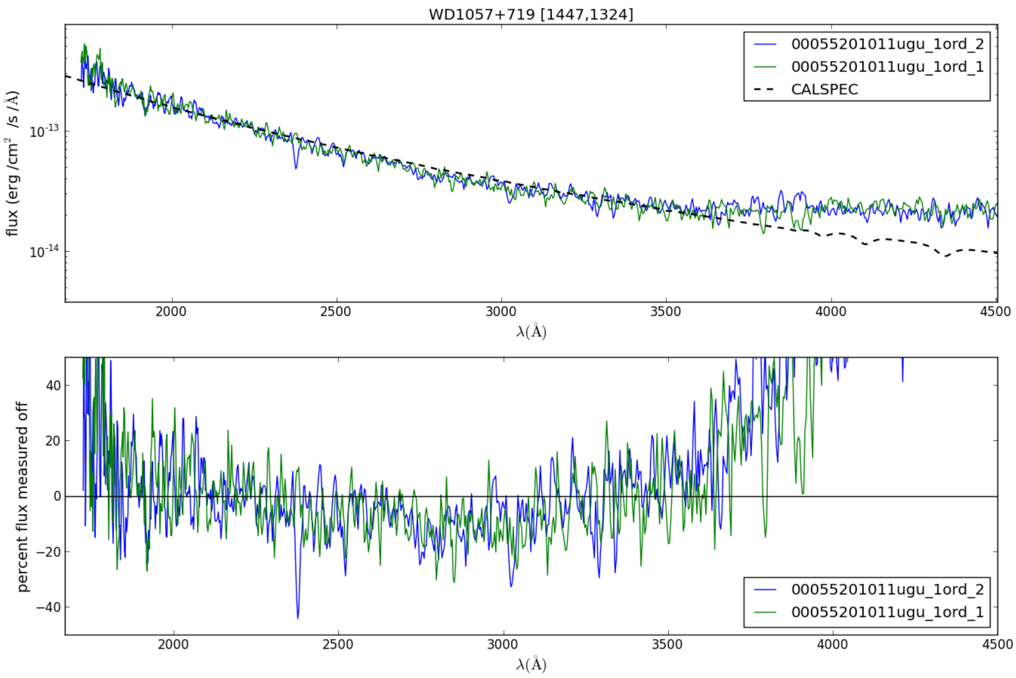

Figure 3.18: This spectrum has its anchor near [1447,1324.]

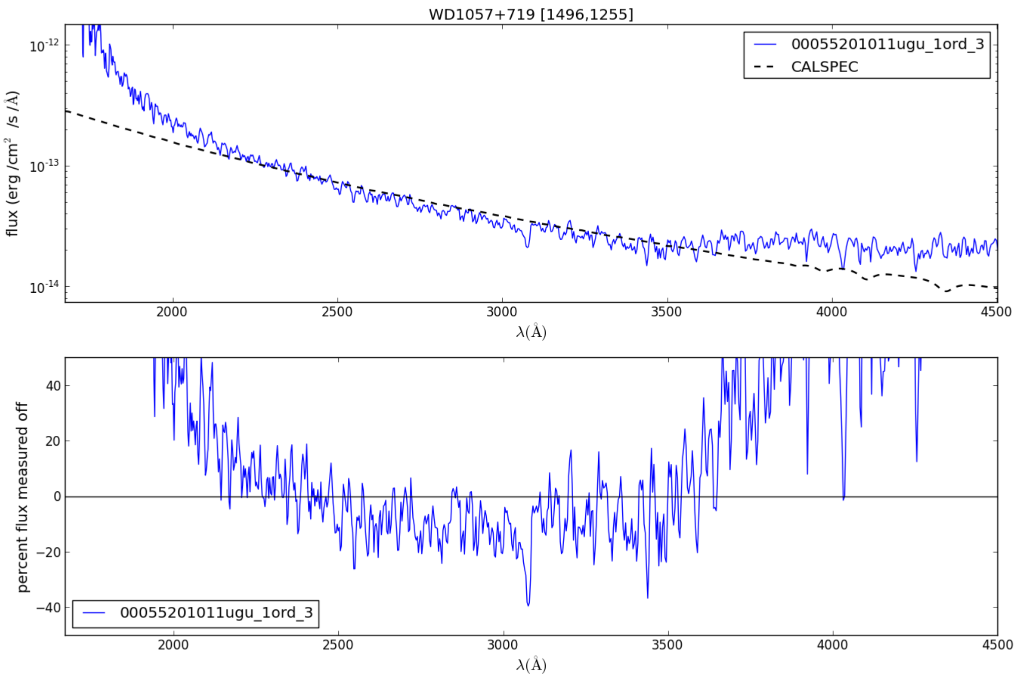

Figure 3.19: This spectrum has its anchor near [1496,1255].

CHAPTER

FOUR

FIGURES FOR VERIFICATION OF THE FLUX CALIBRATION OF THE NOMINAL UV GRISM

These figures go with the description *Verification of the flux calibration in the UV nominal grism*, and show in the top panel the observed flux and the reference spectrum which is usually taken by HST.

In the bottom panel is plotted (observed - reference)/reference as a percentage. Notice that the bottom plot gets very noisy when the source flux is low. This is due to noise in the data. Also, at longer wavelengths second order contamination raises the observed flux, setting in at a wavelength that depends on the location of the blue rise of the spectrum.

4.1 GSPC-P041C spectra (F0 V)

4.1.1 GSPC-P041C Figure 8

4.2 GSPC-P177D spectra (F0 V)

4.2.1 GSPC-P177D Figure 5

4.3 WD1057+719 spectra (DA)

4.3.1 WD1057+719 Figure 5

4.3.2 WD1057+719 Figure 6

4.4 WD0320-539 spectra (DA)

4.4.1 WD0320-539 Figure 1

4.5 GD153 spectra (DA)

4.5.1 GD153 Figure 1

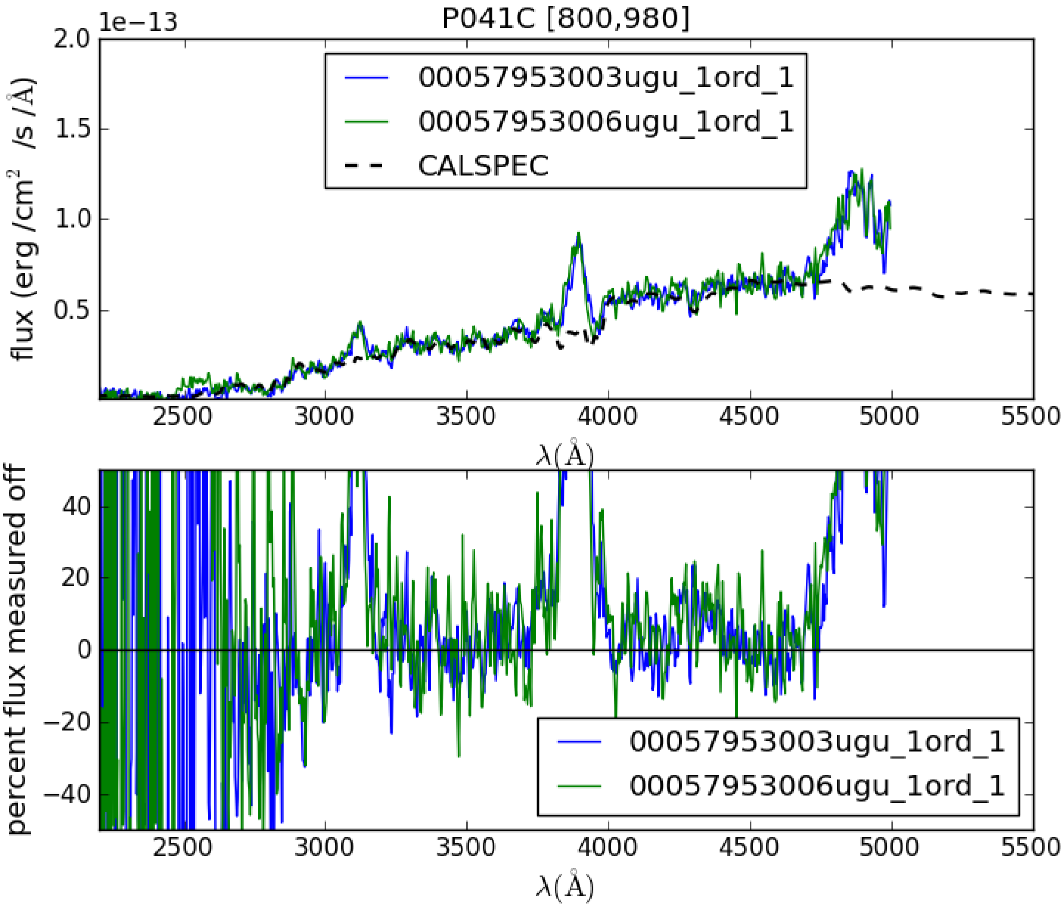

Figure 4.1: This spectrum with anchor at [800,980].

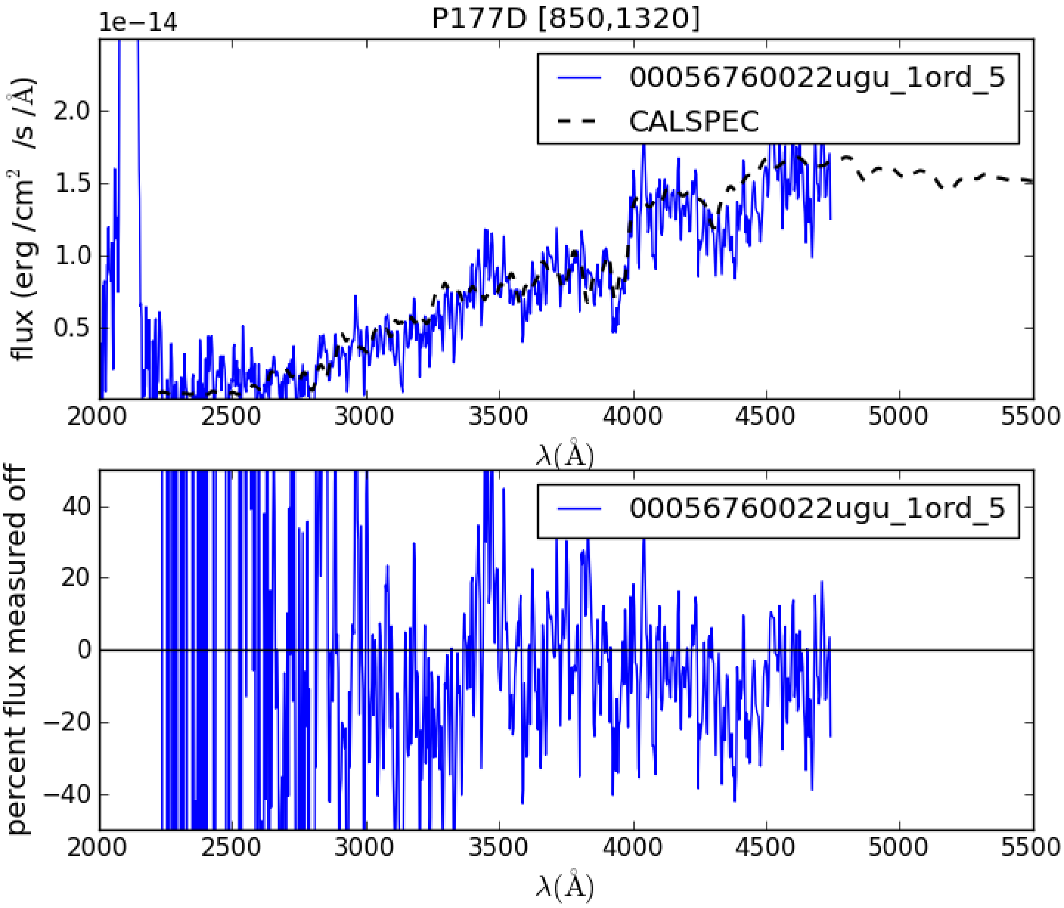

Figure 4.2: This spectrum with anchor at [850,1320].

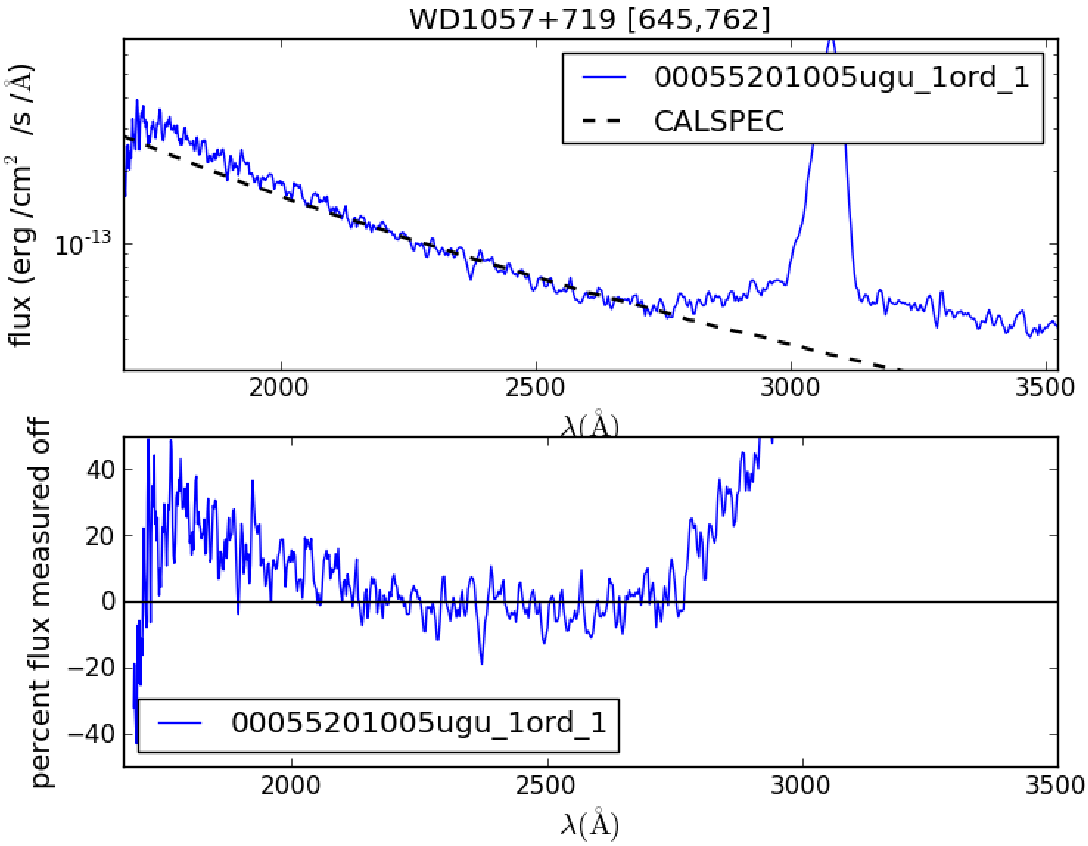

Figure 4.3: This spectrum with anchor at [645,762].

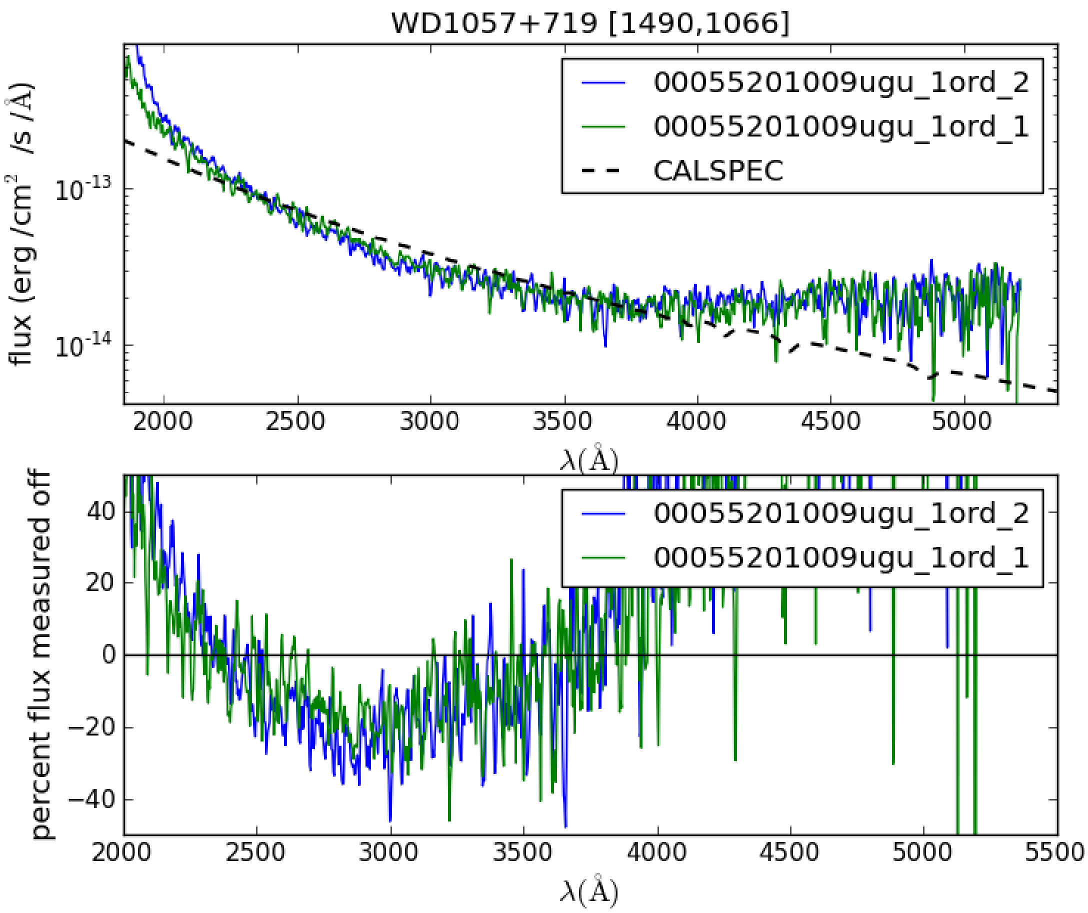

Figure 4.4: This spectrum with anchor at [1490,1066].

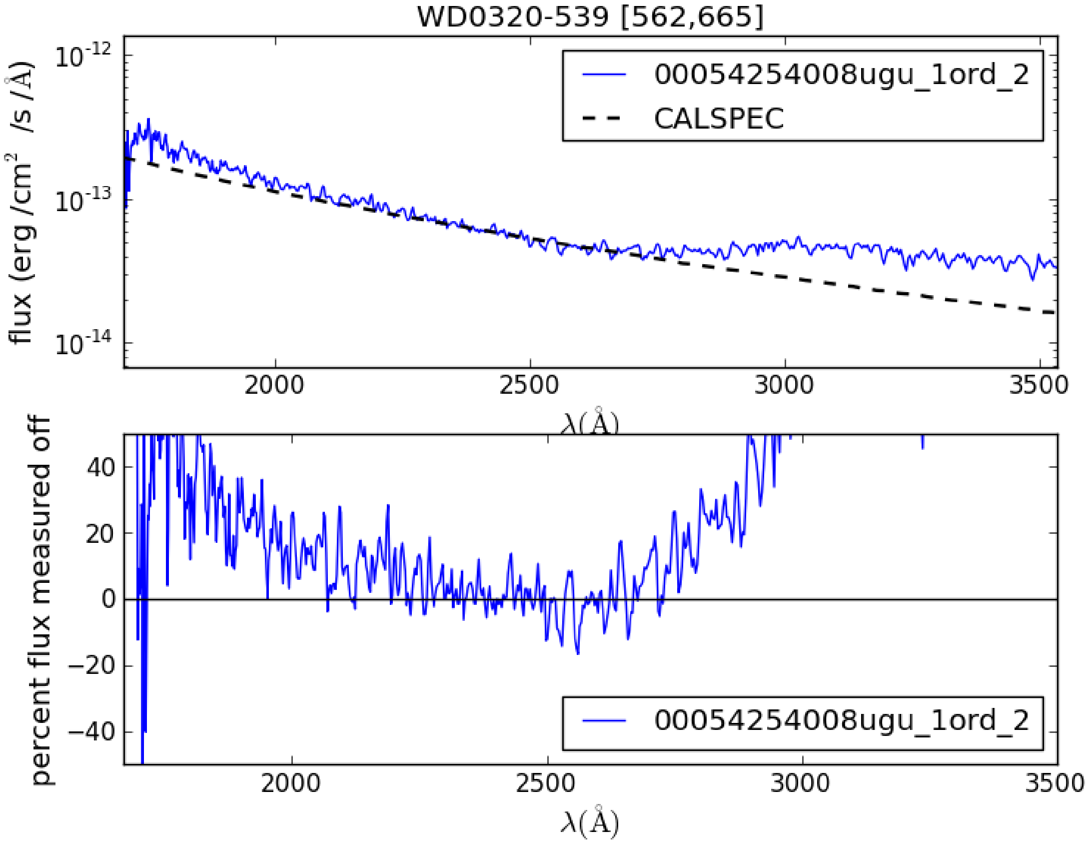

Figure 4.5: This spectrum with anchor at [562,665].

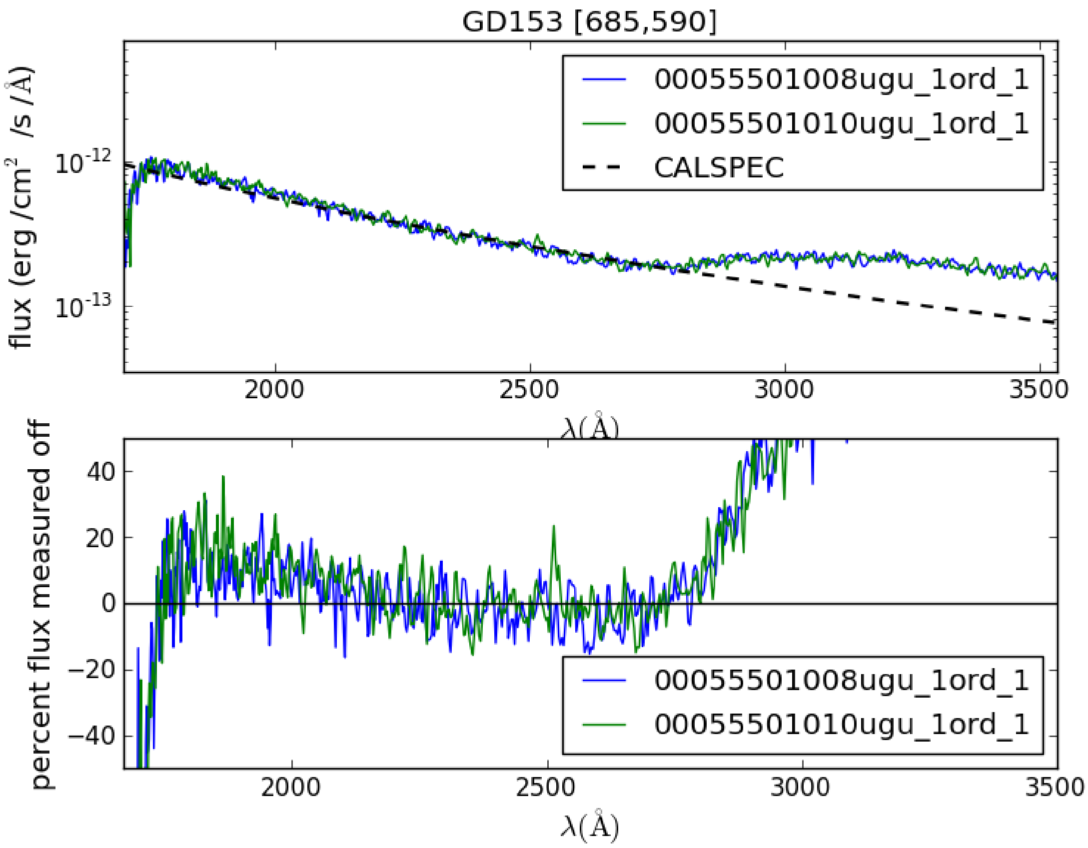

Figure 4.6: This spectrum with anchor at [685,590].

CHAPTER

FIVE

INDICES AND TABLES

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