HISTORICAL BACKGROUND ABOUT URANUS AND NEPTUNE SPECTRA

A SYNTHETIC GUIDE FOR STUDENTS & AMATEUR OBSERVERS

SUPPLEMENT I
MEASUREMENT OF BARYCENTERS

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(v.01)

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Introduction

This first Supplement is the result of 87 measurements of lines and absorption bands, registered in the spectra of Uranus and Neptune. The wavelength values published in *Historical Background about Uranus and Neptune Spectra* (Tobal & Pueyo, 2020) were obtained through the use of a cursor on the profile, estimating the point with the highest intensity. This already enabled an accurate comparison with historical observations by establishing a proper relation between lines and bands.

The Supplement contains the values of the barycenter for 34 lines and bands for Uranus and 31 for Neptune, based on a normalised spectra on the continuum (N=1). We have solely included lines and bands that could clearly be defined in an interval of [λ1-λ2] with an EW>0,05 value. The observations have been done with an Alpy600 spectrograph (3,5Å/pix) dispersion. Images were taken with a 90-minute cumulative exposure (in contrast with the 60-minute one from 2020). This enabled a better registry of extreme regions of the spectra. The barycenter has been calculated through the RSpec1.9 software (T.Field, updated 2020). Additional measurements were obtained with a Star Analyser diffraction grating (22Å/pix).

The tables of this Supplement follow the established numbering system from the first publication (Tobal & Pueyo, 2020). Tables VIII and X include the measurements of the barycenter together with the 2020 observations and historical registries by Slipher-Lowell, which constitute an excellent reference. We hope these materials will enable observers and students to identify with higher accuracy absorption lines and bands.

Consulting specialised publications will facilitate the accurate identification of chemical elements that compose the Uranus and Neptune spectra. Finally, we have also updated the bibliography with additional publications from 1959-2020.

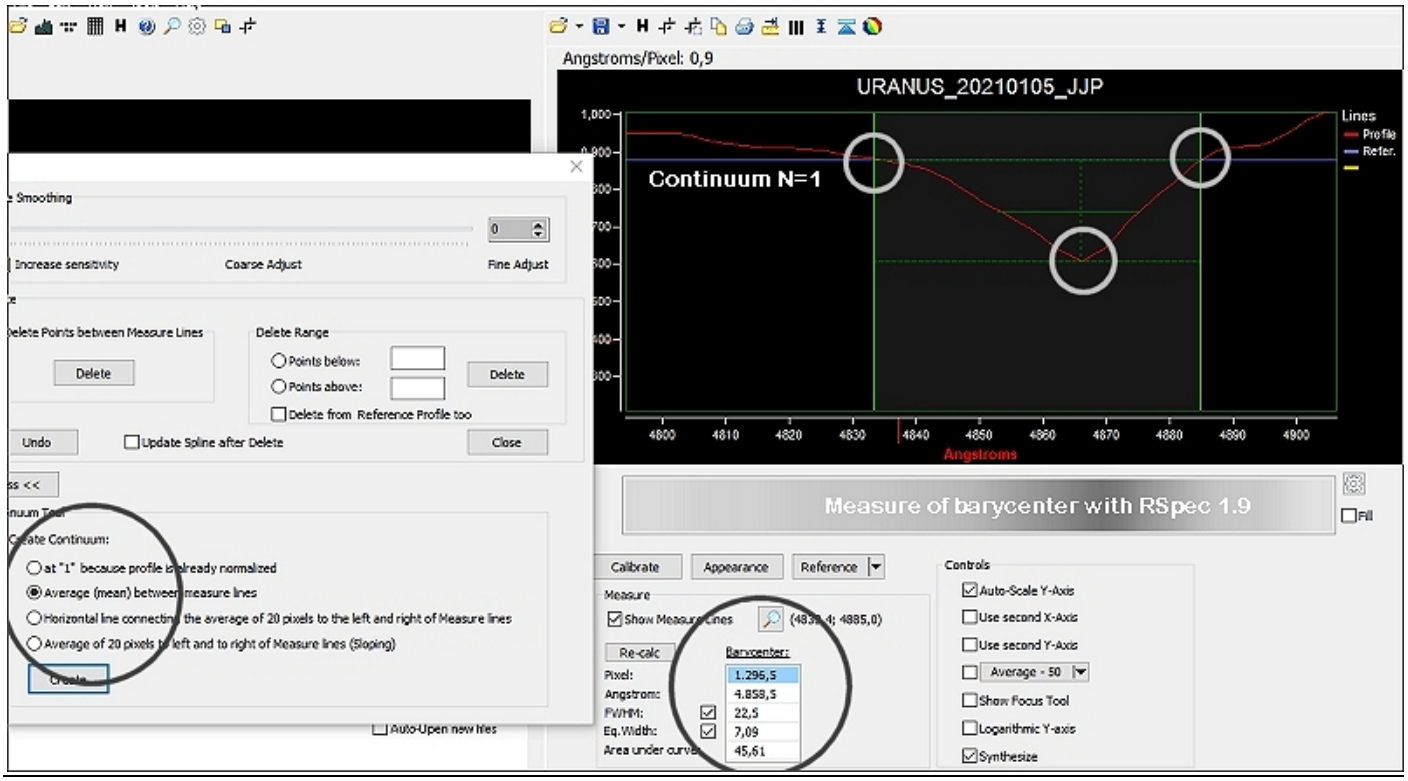

Fig. 1 Measurement of barycenter with RSpec 1.9

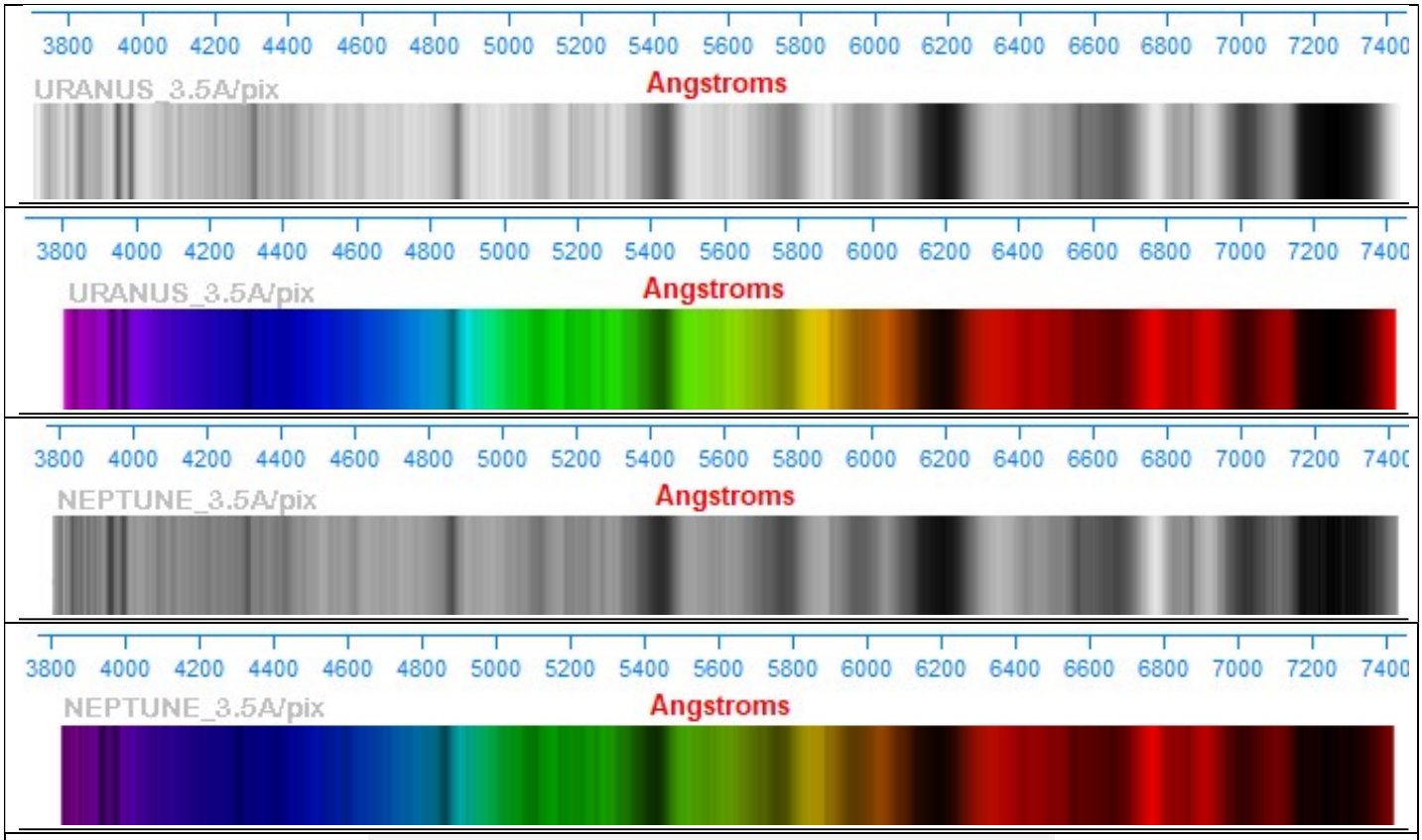

Fig.2 Synthetic spectra generated with RSpec.
Observations: J.J.Pueyo. Processing and analysis: T.Tobal .

Tables VII and IX Content

Column 1: Continuum (N=1)

Column 2: λ of barycenter in Å

Column 3: Full width at Half Maximum Height en Å (FWHM)

Column 4: Equivalent Width (EW)

Column 5: Area under the curve (S)

Column 6-7: λ1-λ2, interval for the measurement of barycenter

Column 8: Dispersion (J.J.Pueyo = 3,5Å/pix) / (T.Tobal= 22Å/pix)

PART I

THE SPECTRA OF URANUS

MEASUREMENT OF BARYCENTERS

TABLE VII / URANUS

CONT.	λ_Baryc	FWHM	EW	S	λ_1	λ_2	Disp
1	3748,4	11,1	1,46	33,01	3731,6	3765,6	3,5Å/pix
1	3771,1	3,0	0,19	7,75	3764,4	3779,7	3,5Å/pix
1	3798,8	3,0	0,54	12,17	3793,4	3804,2	3,5Å/pix
1	3802,0	1,7	0,07	4,32	3800,2	3803,5	3,5Å/pix
1	3833,3	5,3	0,69	8,82	3828,8	3837,6	3,5Å/pix
1	3875,0	7,4	11,82	69,90	3869,9	3880,2	3,5Å/pix
1	3936,6	11,9	2,88	13,92	3827,8	3945,6	3,5Å/pix
1	3971,7	11,0	2,92	14,66	3963,2	3980,4	3,5Å/pix
1	4072,6	11,1	1,13	29,56	4959,0	4086,1	3,5Å/pix
1	4107,4	7,5	0,56	18,59	4099,6	4115,2	3,5Å/pix
1	4201,8	13,0	0,53	19,59	4192,7	4211,0	3,5Å/pix
1	4306,9	12,8	2,16	20,36	4295,9	4318,4	3,5Å/pix
1	4401,2	17,4	2,72	55,24	4374,6	4428,3	3,5Å/pix
1	4597,8	20,8	1,62	35,88	4582,8	4612,9	3,5Å/pix
1	4855,7	24,6	8,40	52,95	4828,9	4884,4	3,5Å/pix
1	5097,0	37,1	4,16	55,91	5071,0	6025,0	3,5Å/pix
1	5177,7	5,6	0,26	13,03	5172,4	5182,9	3,5Å/pix
1	5191,9	6,8	0,16	14,11	5186,1	5197,7	3,5Å/pix
1	5233,5	9,1	0,36	17,84	5226,0	5241,1	3,5Å/pix
1	5275,1	8,3	0,57	18,49	5267,5	5282,7	3,5Å/pix
1	5418,1	64,5	28,95	70,77	5366,6	5473,0	3,5Å/pix
1	5584,2	17,2	1,22	58,60	5559,2	5609,0	3,5Å/pix
1	5747,4	66,4	22,56	105,44	5685,2	5613,9	3,5Å/pix
1	5978,9	59,0	10,14	80,66	5933,8	6023,5	3,5Å/pix
1	6182,1	116,1	62,21	79,96	6102,8	6267,2	3,5Å/pix
1	6430,9	21,1	1,13	37,76	6414,7	6547,2	3,5Å/pix
1	6569,9	9,2	1,15	17,31	6559,8	6580,1	3,5Å/pix
1	6630,3	152,1	41,00	153,30	6636,9	6726,9	3,5Å/pix
1	6853,2	16,8	8,51	92,26	6813,1	6894,3	3,5Å/pix
1	7034,3	62,8	22,42	74,89	6979,,1	7088,2	3,5Å/pix
1	7265,1	57,2	60,77	69,15	7167,9	7361,3	3,5Å/pix
1	4407,4	119,1	3,85	9,78	4316,8	4497,6	22Å/pix
1	4878,9	63,4	3,35	5,52	4831,2	4926,8	22Å/pix
1	5120,4	78,3	3,81	7,6	5056,3	5184,3	22Å/pix
1	5425,9	89,6	17,5	6,61	5355,0	5498,0	22Å/pix
1	5756,8	82,5	9,93	7,52	5691,7	5822,3	22Å/pix
1	5993,0	51,2	1,46	5,93	5952,6	6033,2	22Å/pix
1	6193,9	85,7	15,32	5,66	6131,2	6256,9	22Å/pix
1	6632,5	128,6	18,26	9,34	6534,9	6731,4	22Å/pix
1	6891,0	24,5	0,45	4,03	6866,6	6915,5	22Å/pix
1	7014,7	74,5	2,31	6,69	6962,0	7067,3	22Å/pix
1	7239,2	82,1	2,68	6,68	7186,0	7292,5	22Å/pix

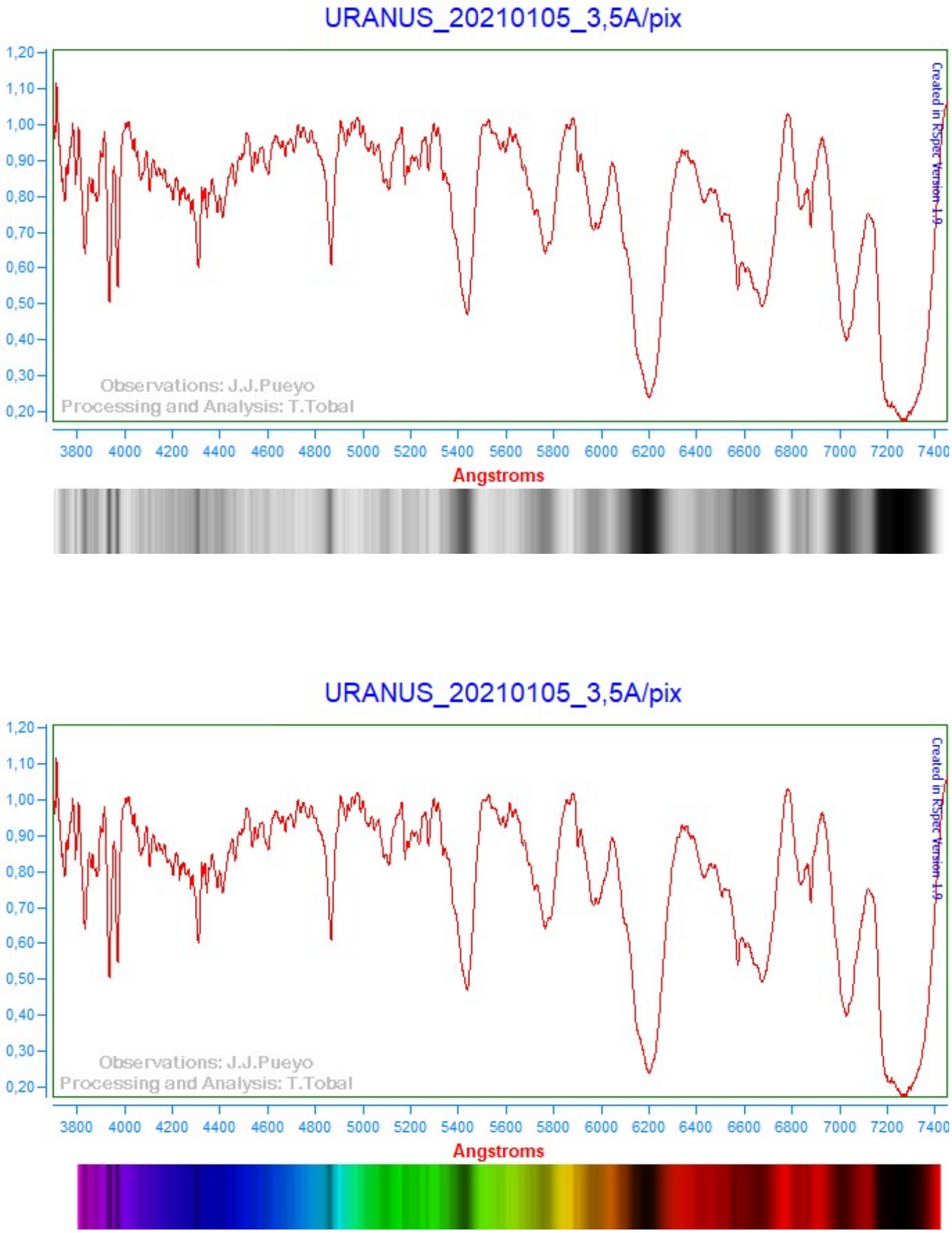

Fig.3 Uranus spectra: BW & Colour

TABLE VIII URANUS: SLIPHER-LOWELL (1904) DESCRIPTIONS INCLUDED TOBAL-PUEYO OBSERVATIONS & BARYCENTERS

Author	λ	Description
Pueyo	3737	Measurement with the cursor on the profile
Tob-Pueyo B	3748	Measurement of barycenter
Measurement	3771	Measurement of barycenter
Measurement	3798	Measurement of barycenter
Tob-Pueyo B	3802	Measurement of barycenter
Pueyo	3829	Measurement with the cursor on the profile
Pueyo	3829	Measurement with the cursor on the profile
Tob-Pueyo B	3833	Measurement of barycenter
Pueyo	3869	Measurement with the cursor on the profile
Tob-Pueyo B	3875	Measurement of barycenter
Pueyo	3930	Measurement with the cursor on the profile
Tob-Pueyo B	3936	Measurement of barycenter
Pueyo	3964	Measurement with the cursor on the profile
Tobal	3966	Measurement with the cursor on the profile
Tob-Pueyo B	3971	Measurement of barycenter
Tobal-Pueyo B	3989	Measurement with the cursor on the profile
Tobal	4016	Measurement with the cursor on the profile
Tob-Pueyo B	4072	Measurement of barycenter
Pueyo	4094	Measurement with the cursor on the profile
Tob-Pueyo B	4107	Measurement of barycenter
Tobal	4158	Measurement with the cursor on the profile
Tob-Pueyo B	4201	Measurement of barycenter
Tobal	4290	Measurement with the cursor on the profile
Pueyo	4304	Measurement with the cursor on the profile
Tob-Pueyo B	4306	Measurement of barycenter
Tobal	4350	Measurement with the cursor on the profile
Tobal-Pueyo B	4351	Measurement of barycenter
Tob-Pueyo B	4401	Measurement of barycenter
Pueyo	4402	Measurement with the cursor on the profile
Tob-Pueyo B	4407	Measurement of barycenter
Tobal	4410	Measurement with the cursor on the profile
Pueyo	4590	Measurement with the cursor on the profile
Tob-Pueyo B	4597	Measurement of barycenter
Tobal	4615	Measurement with the cursor on the profile
Slipher	4647	Solar line
Tobal	4684	Measurement with the cursor on the profile
Slipher	4704	The middle one three solar lines. Between this F are a number of lines and bands, which appear to be due to solar absorption

Tob-Pueyo B	4855	Measurement of barycenter
Pueyo	4861	Measurement with the cursor on the profile
Slipher	4861	F line stronger and broader than in Sun: no certain deviation from solar spectrum in wavelengths shorter than this. Band, due to solar absorption. F, stronger and slightly broader than same line in the lunar comparison spectrum
Lowell	4861	Measurement with the cursor on the profile
Tobal	4862	Measurement with the cursor on the profile
Tobal-Pueyo B	4864	Measurement of barycenter
Slipher	4872	Solar line
Slipher	4878	Solar line
Tob-Pueyo B	4878	Measurement of barycenter
Slipher	4891	Band, due to solar absorption
Slipher	4911	Solar line
Slipher	4921	Solar line
Slipher	4937	Middle of ban, apparently due to solar lines partially blended
Slipher	4957	Line; solar origin
Slipher	4983	Band of solar origin
Slipher	5004	Middle of band, apparently due to partial blending of a pair of solar lines
Slipher	5040	Band of solar origin
Slipher	5051	Weak band: solar origin
Pueyo	5076	Measurement with the cursor on the profile
Slipher	5091	Broad weak band
Slipher	5092	Solar absorption. A weak band, due to planet's absorption
Tob-Pueyo B	5097	Measurement of barycenter
Pueyo	5106	Measurement with the cursor on the profile
Slipher	5101	Solar absorption. A weak band, due to planet's absorption
Tobal	5104	Measurement with the cursor on the profile
Lowell	5110	Narrow
Slipher	5111	Solar absorption. A weak band, due to planet's absorption
Tob-Pueyo B	5120	Measurement of barycenter
Tobal-Pueyo B	5122	Measurement of barycenter
Slipher	5126	Solar absorption
Pueyo	5170	Measurement with the cursor on the profile

Slipher	5170	b2 and b3, blended together
Tob-Pueyo B	5177	Measurement of barycenter
Slipher	5184	b1
Tob-Pueyo B	5191	Measurement of barycenter
Slipher	5230	Band, due wholly or in part to solar absorption
Tob-Pueyo B	5233	Measurement with the cursor on the profile
Tobal	5258	Very slight drop in intensity from the continuous
Slipher	5267	Solar ban including E
Pueyo	5268	Measurement with the cursor on the profile
Tob-Pueyo B	5275	Measurement of barycenter
Pueyo	5328	Measurement with the cursor on the profile
Slipher	5300	Solar band
Slipher	5324	Solar line
Slipher	5328	Solar line
Lowell	5340	Narrow. But Slipher said this band in Neptune only
Slipher	5370	Solar line
Slipher	5392	What appears like a bright (emission) line, likely due to defect of film
Slipher	5404	Increased absorption; there are strong solar lines at this place
Tob-Pueyo B	5418	Measurement of barycenter
Tob-Pueyo B	5420	Measurement of barycenter
Tob-Pueyo B	5425	Measurement of barycenter
Tobal-Pueyo B	5426	Measurement of barycenter
Slipher	5427	Maximum of the strongest absorption band in the spectrum
Slipher	5430	Middle part of very strong and broad band: unsymmetrical and apparently composite; rather weak in Jupiter, Saturn
Pueyo	5431	Measurement with the cursor on the profile
Tobal	5434	Measurement with the cursor on the profile
Slipher	5567	Weak and diffuse
Lowell	5430	Absent from de Moon, present in Jupiter, and darker an darker in Saturn, Uranus, Neptune
Tob-Pueyo B	5584	Measurement of barycenter
Slipher	5710	Weak band: edge of following one
Pueyo	5712	Measurement with the cursor on the profile
Tob-Pueyo B	5747	Measurement of barycenter
Slipher	5755	A first maximum in the strongest absorption band 5769
Tobal-Pueyo B	5756	Measurement of barycenter

Tob-Pueyo B	5756	Measurement of barycenter
Tobal	5760	Measurement with the cursor on the profile
Slipher	5763	One of strongest bands in spectrum - this the densest point in a broad band. Weak in Jupiter, Saturn
Pueyo	5765	Measurement with the cursor on the profile
Slipher	5769	Strong absorption band (see 5755 and 5783)
Lowell	5780	First appeared in Saturn and were wider in Uranus and Neptune; others more numerous began in Uranus and darkened in Neptune
Slipher	5783	A second maximum in this strong band 5769. There are groups of solar lines corresponding to these maxima which may cause the band to appear double
Slipher	5815	Reinforced
Slipher	5835	Slight increase in absorption
Slipher	5858	Solar line
Slipher	5875	Reinforced
Slipher	5890	D line
Pueyo	5898	Measurement with the cursor on the profile
Slipher	5910	Lower limit of spectrum
Slipher	5950	Narrow band, edge following one
Pueyo	5960	Measurement with the cursor on the profile
Slipher	5975	Fairly conspicuous band; irregular and composite in Neptune, diffuse in Saturn
Tob-Pueyo B	5978	Measurement of barycenter
Tob-Pueyo B	5993	Measurement of barycenter
Tobal	6002	Measurement with the cursor on the profile
Slipher	6087	A band
Slipher	6140	In Neptune, Saturn also
Lowell	6180	Absent from de Moon, present in Jupiter, and darker an darker in Saturn, Uranus, Neptune
Tob-Pueyo B	6182	Measurement of barycenter
Pueyo	6190	Measurement with the cursor on the profile
Tob-Pueyo B	6193	Measurement of barycenter
Slipher	6195	Middle of very strong intense band, the most conspicuous in the spectrum, more diffuse on upper edge. Conspicuous all four planets. This band not identical with the one in red stars and

		different character.
Tobal	6196	Measurement with the cursor on the profile
Tobal-Pueyo B	6197	Measurement of barycenter
Slipher	6260	Red edge of foregoing band. Keeler's visual chart did not extend to the wavelengths below
Slipher	6405	Region seems covered by broad weak band
Tob-Pueyo B	6430	Measurement of barycenter
Tobal	6443	Broad and faint band
Pueyo	6404	Measurement with the cursor on the profile
Slipher	6503	Absorptions too strong for solar lines alone
Tob-Pueyo B	6569	Measurement of barycenter
Slipher	6564	C line of H. Stronger than in solar spectrum, narrow
Pueyo	6562	Measurement with the cursor on the profile
Slipher	6600	Weak absorption
Tob-Pueyo B	6630	Measurement of barycenter
Tobal-Pueyo B	6631	Measurement of barycenter
Tob-Pueyo B	6632	Measurement of barycenter
Tobal	6641	Measurement with the cursor on the profile
Lowell	6720	First appeared in Saturn and were wider in Uranus and Neptune; others more numerous began in Uranus and darkened in Neptune
Pueyo	6658	Measurement with the cursor on the profile
Slipher	6678	Intense and composite band, the densest part of a very strong and broad band: broad and weak in Jupiter, Saturn
Tobal	6688	Measurement with the cursor on the profile
Slipher	6780	Bright place due to absence of absorption
Slipher	6802	Weaker component of narrow double band. Doubtful if present in Jupiter, Saturn
Tobal	6817	Faint line
Pueyo	6824	Measurement with the cursor on the profile
Slipher	6832	Stronger component. Doubtful if present in Jupiter, Saturn
Tob-Pueyo B	6853	Measurement of barycenter
Pueyo	6861	Measurement with the cursor on the profile
Slipher	6870	Oxygen group B in terrestrial spectrum; not reinforced in Uranus but region absorbed
Tobal	6886	
Tob-Pueyo B	6891	Measurement of barycenter
Tobal	7001	Measurement with the cursor on the profile
Pueyo	7011	Measurement with the cursor on the profile
Tob-Pueyo B	7014	Measurement of barycenter

Slipher	7025	Strong broad band, spectrum faint in this region; fairly definite band in Jupiter, Saturn, but doubtful in Neptune
Tob-Pueyo B	7034	Measurement of barycenter
Tobal	7051	Measurement with the cursor on the profile
Tobal-Pueyo B	7057	Measurement of barycenter
Slipher	7130:	Bright place in spectrum: continuous spectrum suddenly fades out below this point suggesting: (see 725:)
Pueyo	7175	Measurement with the cursor on the profile
Tobal	7216	Measurement with the cursor on the profile
Tob-Pueyo B	7239	Measurement of barycenter
Slipher	7250:	A possible strong band here. No part of the spectrum below 6780 free from absorption
Tob-Pueyo B	7265	Measurement of barycenter
Pueyo	7271	Measurement with the cursor on the profile
Tobal	7270	Measurement with the cursor on the profile
Tobal-Pueyo B	7277	Measurement of barycenter
Tobal	7282	Measurement with the cursor on the profile
Tobal	7339	Measurement with the cursor on the profile
Pueyo	7347	Measurement with the cursor on the profile
Tobal	7546	Measurement with the cursor on the profile
Tobal-Pueyo B	7708	Measurement of barycenter

PART II

THE SPECTRA OF NEPTUNE

MEASUREMENTMENT OF BARYCENTERS

TABLE IX / NEPTUNE

CONT.	λ_Baryc	FWHM	EW	S	λ_1	λ_2	DISP.
1	3749,7	18,5	2,95	41,18	3729,2	3769,8	3,5Å/pix
1	3795,7	9,7	0,81	14,85	6688,9	3802,5	3,5Å/pix
1	3822,0	12,5	2,18	19,05	3821,9	3844,0	3,5Å/pix
1	3879,0	19,7	1,11	24,24	3866,6	3891,6	3,5Å/pix
1	3935,9	11,3	3,44	13,95	3926,5	3945,2	3,5Å/pix
1	3970,6	12,3	3,83	15,85	3960,8	3980,5	3,5Å/pix
1	4105,6	7,9	0,49	14,30	4098,7	4112,4	3,5Å/pix
1	4200,5	8,6	0,38	16,98	4191,8	4209,3	3,5Å/pix
1	4231,4	4,9	0,23	11,17	4226,1	4236,8	3,5Å/pix
1	4277,2	4,2	0,13	8,45	4273,1	4281,4	3,5Å/pix
1	4306,7	13,3	2,26	17,75	4295,7	4318,1	3,5Å/pix
1	4345,4	6,0	0,42	10,77	4339,9	4350,9	3,5Å/pix
1	4388,5	7,4	0,29	12,35	4382,1	4394,9	3,5Å/pix
1	4411,2	7,9	0,31	12,83	4404,7	4417,7	3,5Å/pix
1	4463,8	9,2	0,45	17,02	4455,9	4471,7	3,5Å/pix
1	4536,4	7,2	0,19	13,21	4530,8	4542,0	3,5Å/pix
1	4597,9	19,3	0,83	28,18	4584,6	4611,2	3,5Å/pix
1	4673,5	6,4	0,19	12,95	4667,7	4679,4	3,5Å/pix
1	4708,7	10,3	0,30	21,56	4699,7	4717,8	3,5Å/pix
1	4862,1	20,2	5,92	35,20	4841,6	4883,0	3,5Å/pix
1	4932,4	9,6	0,57	37,81	4916,0	4948,7	3,5Å/pix
1	5098,1	34,1	2,60	47,68	5074,3	5122,2	3,5Å/pix
1	5186,5	8,3	1,01	31,41	5171,3	5201,5	3,5Å/pix
1	5275,7	10,2	0,74	19,99	5266,6	5284,8	3,5Å/pix
1	5418,8	53,3	18,68	63,93	5373,1	5468,0	3,5Å/pix
1	5758,2	55,4	10,80	81,84	5708,6	5809,3	3,5Å/pix
1	5982,0	53,1	6,05	71,43	5840,2	5623,4	3,5Å/pix
1	6192,3	102,3	53,87	57,15	6122,3	6263,7	3,5Å/pix
1	6573,0	9,7	0,85	11,34	6565,1	6581,3	3,5Å/pix
1	6633,3	121,7	38,28	126,66	6539,2	6730,9	3,5Å/pix
1	6853,7	12,9	5,93	75,61	6812,2	6895,4	3,5Å/pix
1	7033,3	61,2	21,72	59,51	6980,5	7085,2	3,5Å/pix
1	7270,4	162,4	78,62	51,21	7170,2	7365,3	3,5Å/pix
1	3989,8	73,8	2,38	5,86	3944,2	4035,3	22Å/pix
1	4351,3	106,0	3,32	8,49	4270,0	4432,1	22Å/pix
1	4864,9	67,7	3,61	6,73	4804,9	4925,1	22Å/pix
1	5122,1	61,5	2,17	7,91	5053,3	5190,7	22Å/pix
1	5426,8	92,4	15,88	7,66	5351,5	5503,0	22Å/pix
1	5756,0	96,6	9,76	7,68	5683,6	5828,0	22Å/pix
1	6197,6	127,0	42,43	8,19	6098,2	6298,1	22Å/pix
1	6631,3	141,3	19,10	11,34	6532,3	6732,1	22Å/pix
1	7057,1	49,2	28,40	4,74	7020,4	7093,7	22Å/pix
1	7277,9	97,6	11,52	7,80	7198,8	7356,4	22Å/pix
1	7708,9	21,1	1,56	6,02	7656,7	7761,1	22Å/pix

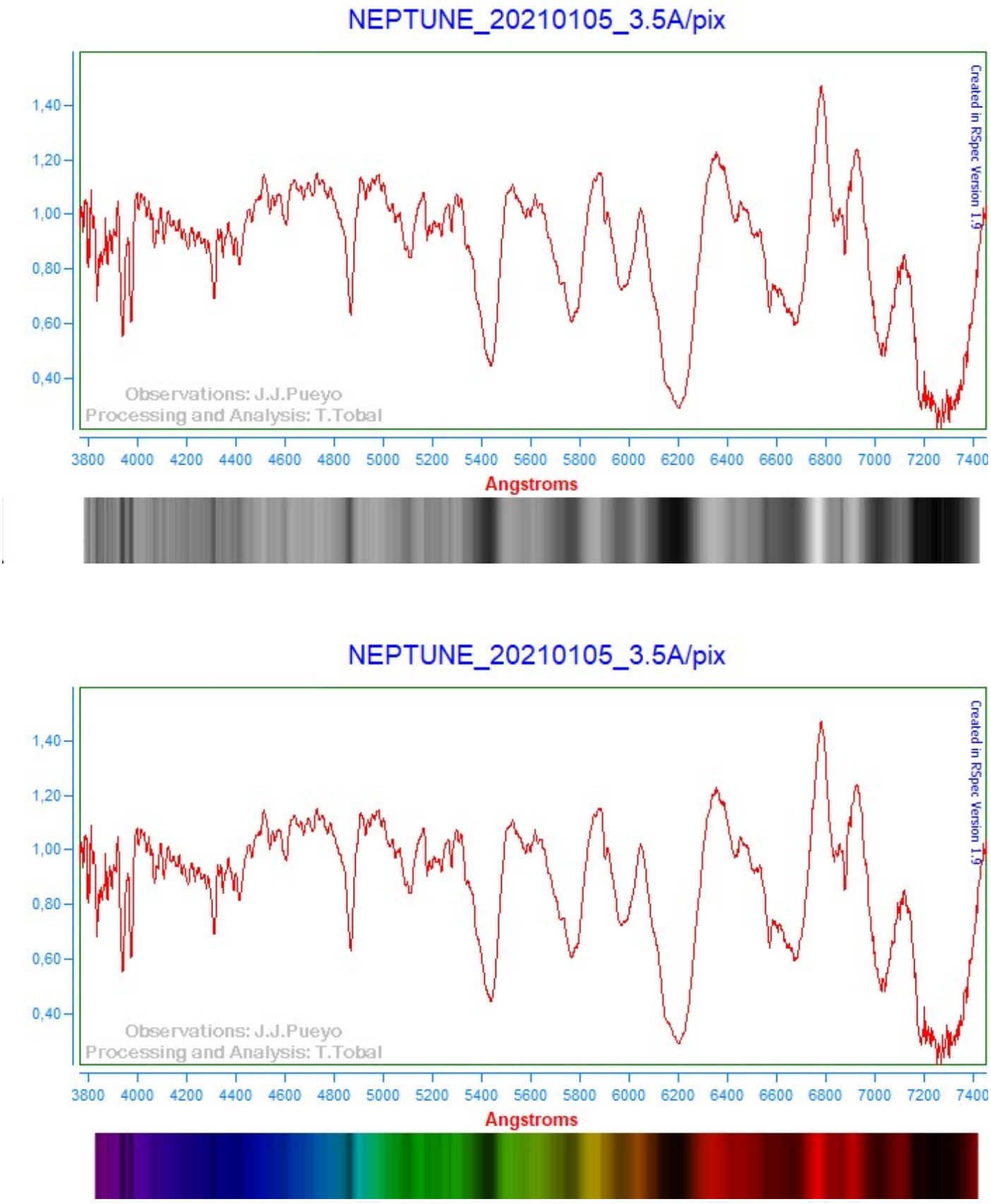

Fig.4 Neptune spectra: BW & Colour

TABLE X NEPTUNE: SLIPHER (1904) DESCRIPTIONS INCLUDED TOBAL-PUEYO OBSERVATIONS & BARYCENTERS

Author	λ	Description
Pueyo	3737	Measurement with the cursor on the profile
Tobal-Pueyo B	3749	Measurement of barycenter
Pueyo	3782	Measurement with the cursor on the profile
Tobal-Pueyo B	3795	Measurement of barycenter
Tobal-Pueyo B	3822	Measurement of barycenter
Pueyo	3829	Measurement with the cursor on the profile
Tobal-Pueyo B	3935	Measurement of barycenter
Pueyo	3930	Measurement with the cursor on the profile
Pueyo	3964	Measurement with the cursor on the profile
Tobal-Pueyo B	3970	Measurement of barycenter
Tobal	4102	Measurement with the cursor on the profile
Tobal-Pueyo B	4105	Measurement of barycenter
Tobal-Pueyo B	4200	Measurement of barycenter
Tobal-Pueyo B	4231	Measurement of barycenter
Tobal-Pueyo B	4277	Measurement of barycenter
Pueyo	4304	Measurement with the cursor on the profile
Tobal-Pueyo B	4306	Measurement of barycenter
Tobal	4340	Measurement with the cursor on the profile
Tobal-Pueyo B	4345	Measurement of barycenter
Slipher	4400	Upper limit of spectrum
Pueyo	4402	Measurement with the cursor on the profile
Tobal-Pueyo B	4411	Measurement of barycenter
Slipher	4413	Band, possibly due to the solar lines 4405, 4408 and 4415 thought it seems too far to the red
Slipher	4458	Band, due to the group of solar lines 4455-4462
Tobal-Pueyo B	4466	Measurement of barycenter
Slipher	4526	Narrow ban, probably due to the group of solar lines at his place
Tobal-Pueyo B	4536	Measurement of barycenter
Pueyo	4590	Measurement with the cursor on the profile
Tobal-Pueyo B	4597	Measurement of barycenter
Slipher	4597	Middle of a weak band, which may or may not be due to solar lines
Tobal-Pueyo B	4697	Measurement of barycenter
Slipher	4706	A weak ban, du, no doubt, to the strong solar lines 4703 and 4709
Tobal	4860	Measurement with the cursor on the profile
Pueyo	4861	Measurement with the cursor on the profile

Slipher	4861	A rather narrow, strong band, one of the three strongest in the spectrum. It is well defined and its position determined with considerable accuracy. Its position coincides with that of the F line of the solar spectrum.
Tobal-Pueyo B	4862	Measurement of barycenter
Slipher	4873	Line
Slipher	4889	Narrow band, due to strong solar lines.
Slipher	4895	A bright place in the spectrum which decrease toward F
Slipher	4921	A darkening, due to solar lines at 4920. From this point to 4992 the spectrum is of about uniform intensity. At 4992 the intensity begins to increase, reaching a maximum at 5027.
Tobal-Pueyo B	4932	Measurement of barycenter
Slipher	5018	A weak ban
Slipher	5042	Slight increase in absorption, probably due to solar lines
Pueyo	5076	Measurement with the cursor on the profile
Slipher	5077	An increase in absorption, due possibly to solar line, or may be a violet component of the following band
Tobal	5090	Measurement with the cursor on the profile
Tobal-Pueyo B	5098	Measurement of barycenter
Slipher	5104	Point of maximum intensity of a rather strong band, which is somewhat less definite toward the violet.
Pueyo	5106	Measurement with the cursor on the profile
Slipher	5137	A slightly increased absorption, possibly due to solar lines
Slipher	5104-5162	There is a rather rapid increase in density from 5104. This reaches its maximum at 6162, and again very rapidly decrease, due, no doubt, to the *b* group of solar lines
Slipher	5172	Dark place, violet members of *b* group of solar lines.
Tobal-Pueyo B	51275	Measurement of barycenter
Pueyo	5200	Measurement with the cursor on the profile
Slipher	5225	The middle of a broad, but weak absorption band, which begins not far below the *b* group and extends to 5245- It is equally intense for some distance.
Slipher	5269	A slight absorption, *E* of solar spectrum.
Slipher	5332	A slight absorption, possibly due to solar line
Slipher	5373	Increased absorption. There is a strong solar line at this point. This is the violet edge of the absorption band 5377 in the planet's spectrum.
Slipher	5374	A pair of lines.
Slipher	5377	Increased absorption which does not seem to be due to solar lines. Probably an atmospheric band.
Slipher	5396	Slight local absorption, probably due to a pair of solar lines
Slipher	5408	Slight local absorption, probably due to a pair of solar lines
Tobal-Pueyo B	5418	Measurement of barycenter

Slipher	5425	A secondary maximum in the strongest absorption band in the spectrum
Tobal	5430	Measurement with the cursor on the profile
Pueyo	5431	Measurement with the cursor on the profile
Slipher	5432	The point of maximum intensity of this band
Slipher	5482	The lower edge of the band
Slipher	5567:	The middle of a weak band. Te great density of the plate at this point makes this observations very uncertain
Slipher	5693:	About the violet limit of the second strongest band in the spectrum. Its appears to be double.
Slipher	5722	A line
Slipher	5755	A line
Tobal-Pueyo B	5758	Measurement of barycenter
Tobal	5760	Measurement with the cursor on the profile
Pueyo	5765	Measurement with the cursor on the profile
Slipher	5771	Point of maximum intensity of the violet component of this band
Slipher	5800	Maximum of red and weaker component.
Slipher	5813	Red edge of band
Slipher	5828	Perhaps a line
Slipher	5840	A slight absorption. The spectrum is very weak at his point
Slipher	5862	Perhaps a line
Slipher	5888	Lower limit of spectrum. Line D.
Pueyo	5958	Measurement with the cursor on the profile
Tobal	5960	Measurement with the cursor on the profile
Tobal-Pueyo B	5982	Measurement of barycenter
Tobal	6190	Measurement with the cursor on the profile
Tobal-Pueyo B	6192	Measurement of barycenter
Pueyo	6195	Measurement with the cursor on the profile
Tobal-Pueyo B	6573	Measurement of barycenter
Tobal-Pueyo B	6633	Measurement of barycenter
Tobal	6680	Measurement with the cursor on the profile
Tobal-Pueyo B	6853	Measurement of barycenter
Pueyo	6854	Measurement with the cursor on the profile
Pueyo	7011	Measurement with the cursor on the profile
Tobal-Pueyo B	7033	Measurement of barycenter
Tobal-Pueyo B	7270	Measurement of barycenter
Tobal	7270	Measurement with the cursor on the profile
Tobal	7635	Measurement with the cursor on the profile

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