

The Echellograms and Response Functions from $zJ-$ to $M-$ bands Calculated by Echelle Simulator V0.9 for IRCS

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This report represents echelle spectral formats (echellograms) and response functions of Infrared Camera and Spectrograph (IRCS) from $zJ-$ to $M-$ bands. The response function of each setting in this report includes the transmittance of atmosphere, blaze functions of echelle and cross-disperser gratings, and transmittance of the filter.

- The infrared spectral lines shown on echellograms and response functions are as follows:

- (a) OH lines (Steed & Baker, 1979)
- (b) Ar lines (Rao, Humphreys, & Rank, 1966)
- (c) [Fe II] lines (Nussbaumer & Storey, 1988)
- (d) Atomic Hydrogen lines (Hummer & Storey, 1987)
- (e) Molecular Hydrogen lines (UKIRT Homepage)¹
- (f) He I and He II lines (UKIRT Homepage)
- (g) $^{12}\text{C}^{16}\text{O}$ and $^{13}\text{C}^{16}\text{O}$ bandheads (UKIRT Homepage)
- (h) $^{12}\text{C}^{16}\text{O}$ and $^{13}\text{C}^{16}\text{O}$ fundamental (1-0) band lines $4.50 - 5.00 \mu\text{m}$ (UKIRT Homepage)

Each line group is marked with different color as indicated at lower-left corner of each echellogram.

- Each value in ‘Intensity’ column of tables in this report indicates as follows:

- (a) Intensities in kR for OH lines (Steed & Baker, 1979)
- (b) Einstein coefficients for [Fe II] lines (Nussbaumer & Storey, 1988)
- (c) Relative intensities of $I(\text{line})/I(\text{H}\beta)$ for atomic Hydrogen lines (Hummer & Storey, 1987)
- (d) Relative intensities of $I(\text{line})/I(1-0\text{S}(1))$ at LTE ($T=4000 \text{ K}$) for H_2 lines (UKIRT homepage)

- The accuracies of ‘X’ and ‘Y’ columns are about ± 10 pixels ²

¹<http://www.jach.hawaii.edu/JACpublic/UKIRT/astronomy/lines.html>

²The current version of echelle simulator calculates echellograms without correction of optical abbreviations. We will correct the optical abbreviations for the higher fitting accuracies in the next version.

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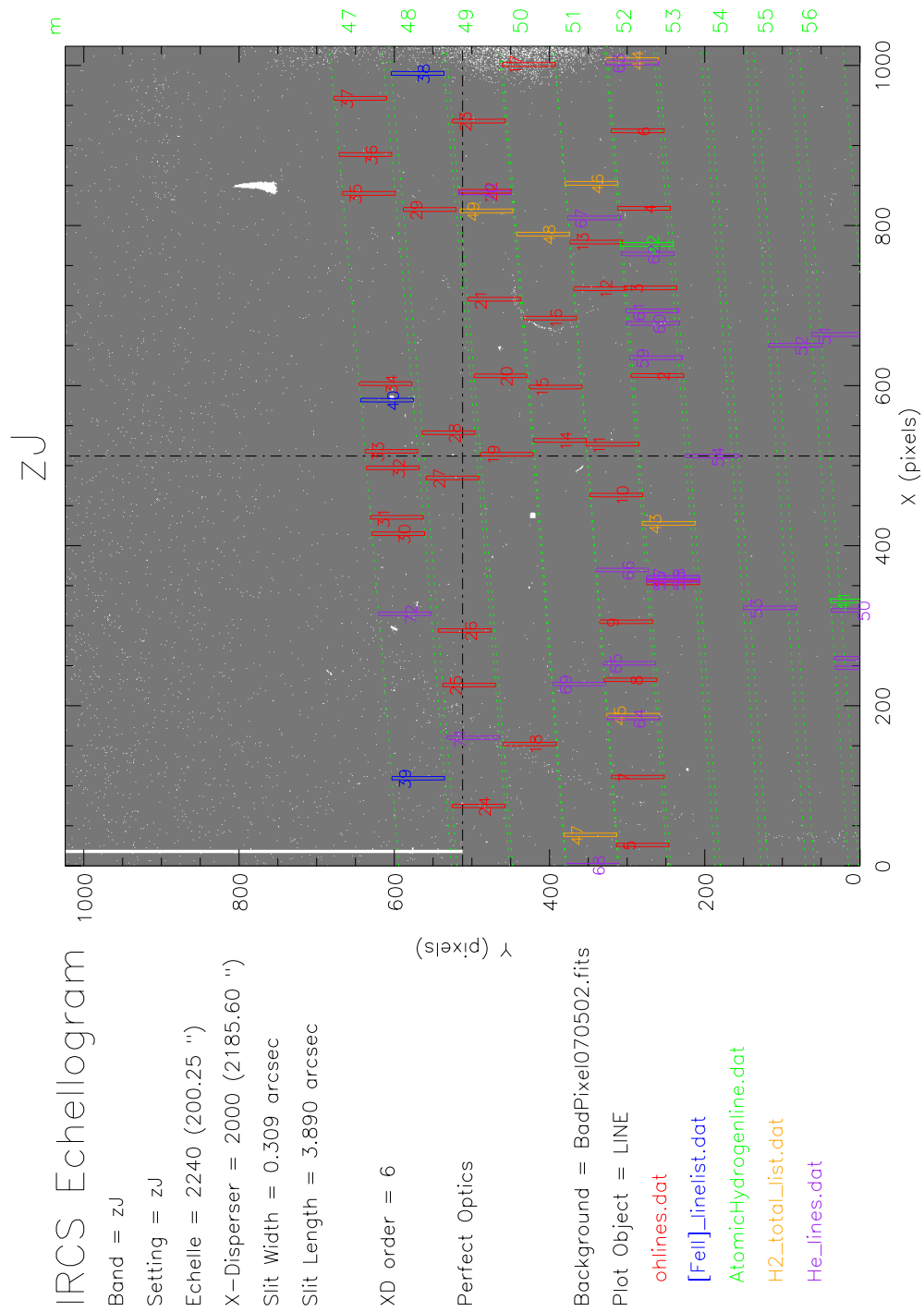
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Chapter 1

zJ- to *K*-bands : OH lines and other
infrared lines



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Figure 1.1: Echellogram of the zJ -band when echelle setting parameter (ESP) = 2240 and cross-disperser setting parameter (XSP) = 2000. The background is the badpixel image.

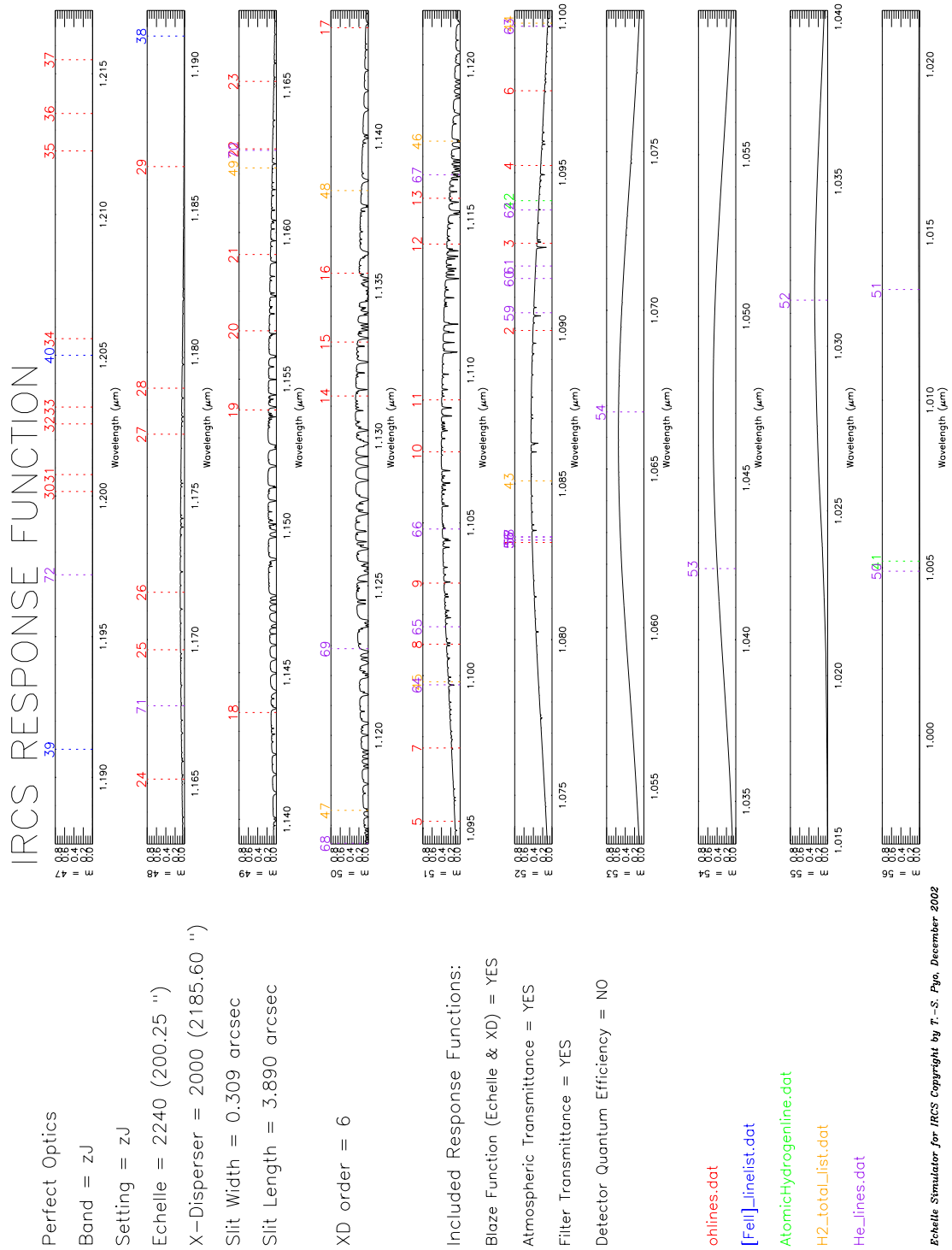
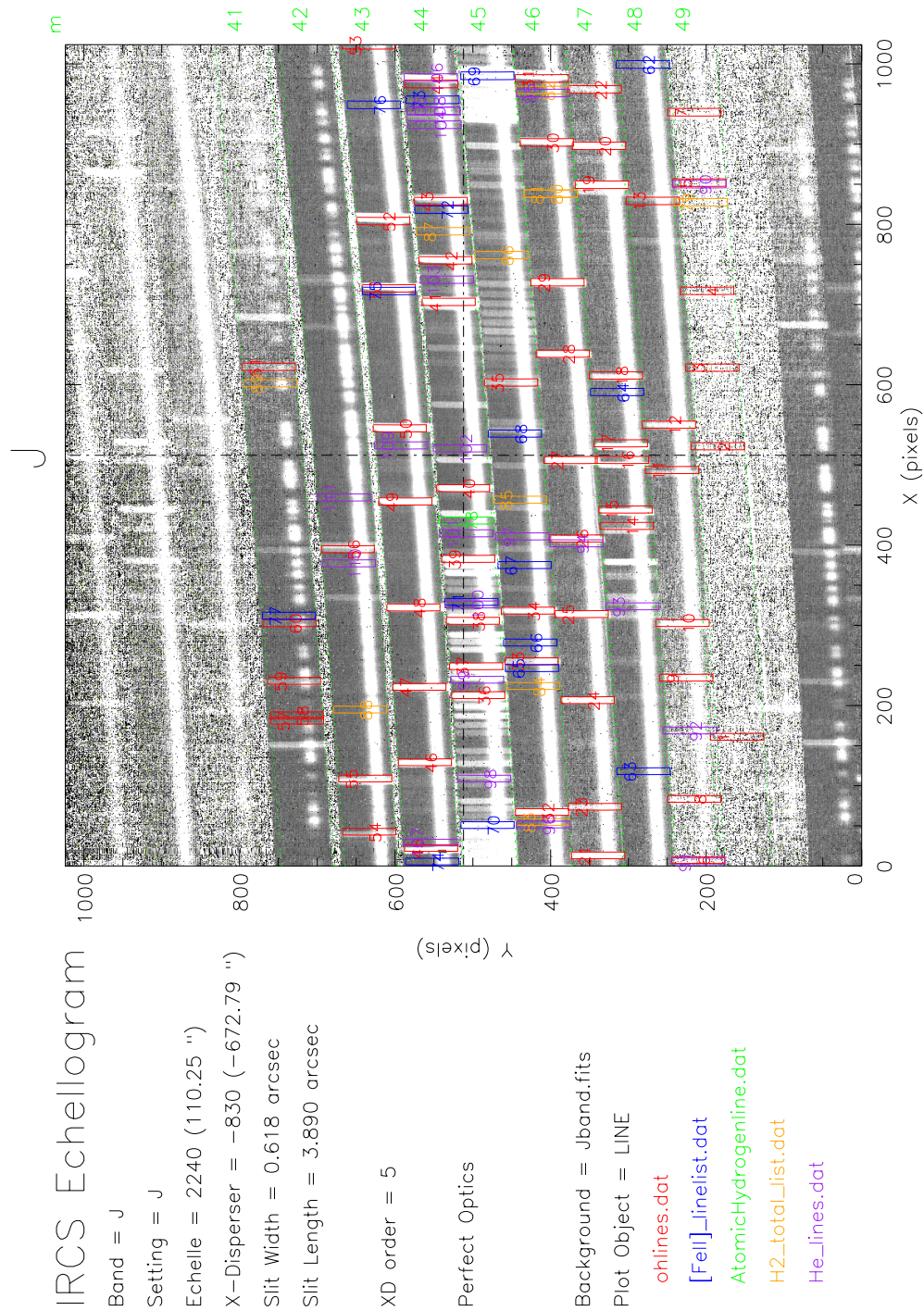


Figure 1.2: Response function of the zJ -band when ESP = 2240 and XSP = 2000.



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Figure 1.3: Echellogram of the J -band when ESP = 2240 and XSP = -830. The background image shows the sky OH emission lines.

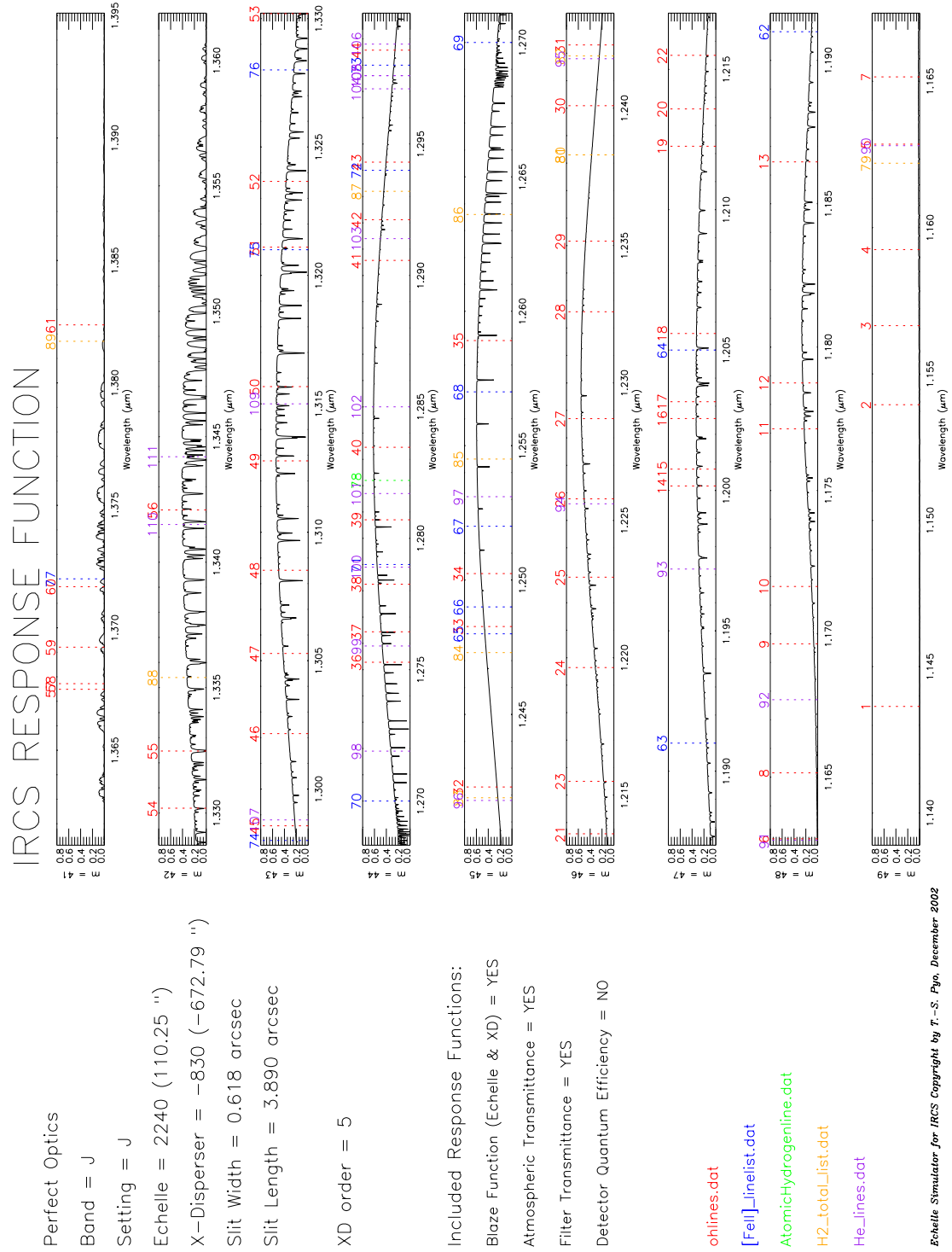
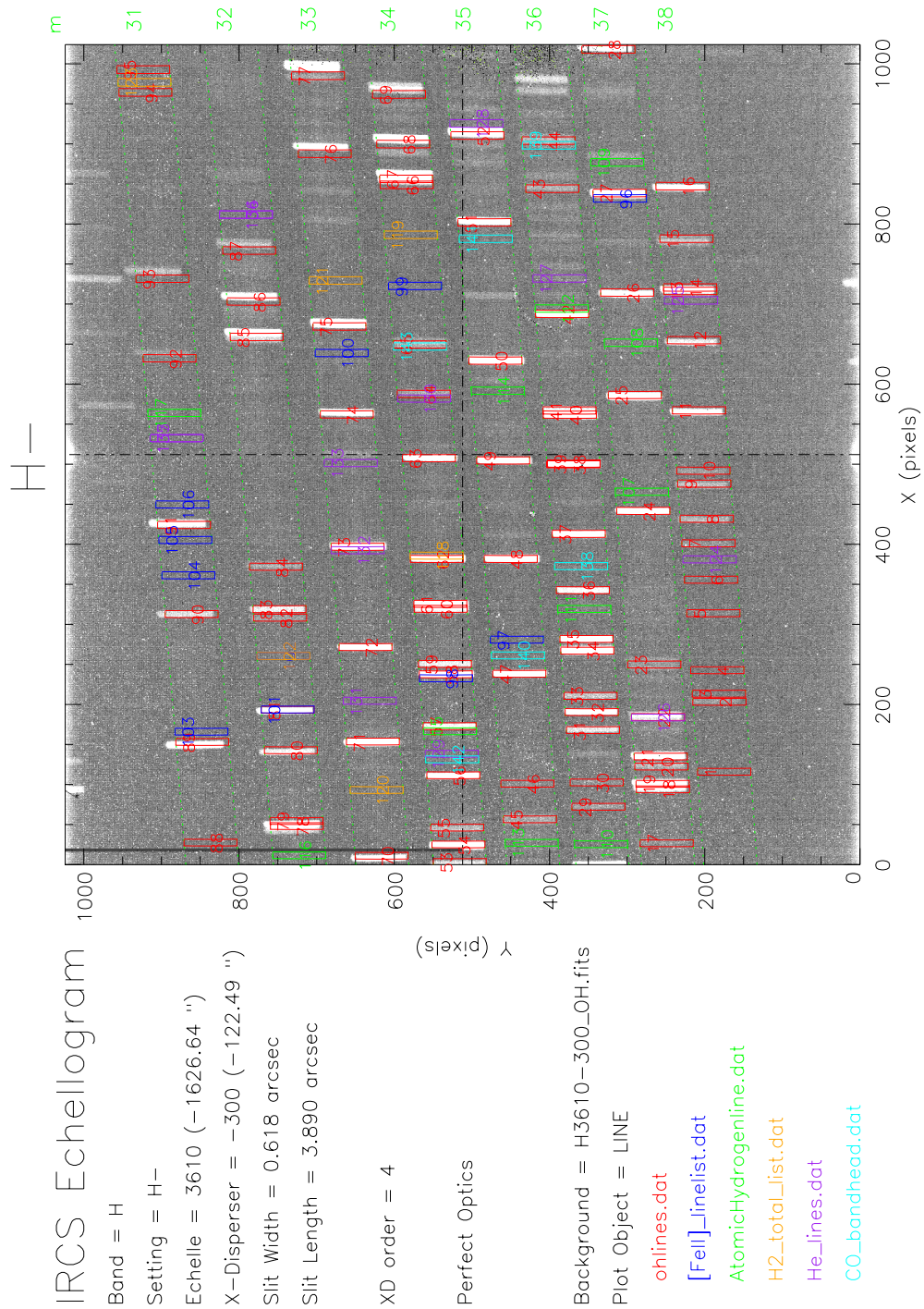


Figure 1.4: Response function of the *J*-band when ESP = 2240 and XSP = -830.



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Figure 1.5: Echellogram for part of the H -band when $ESP = 3610$ and $XSP = -300$. The background image shows the sky OH emission lines.

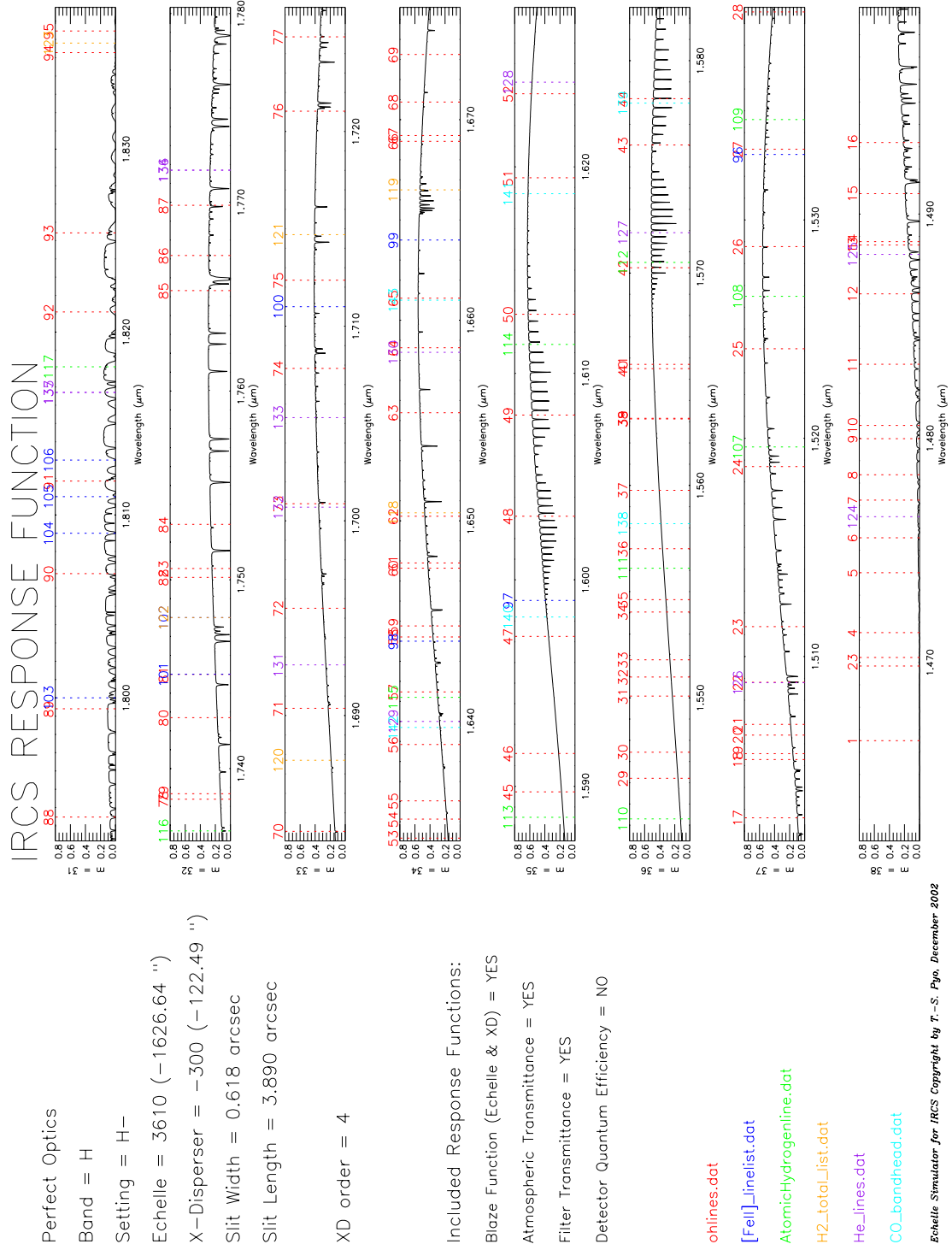
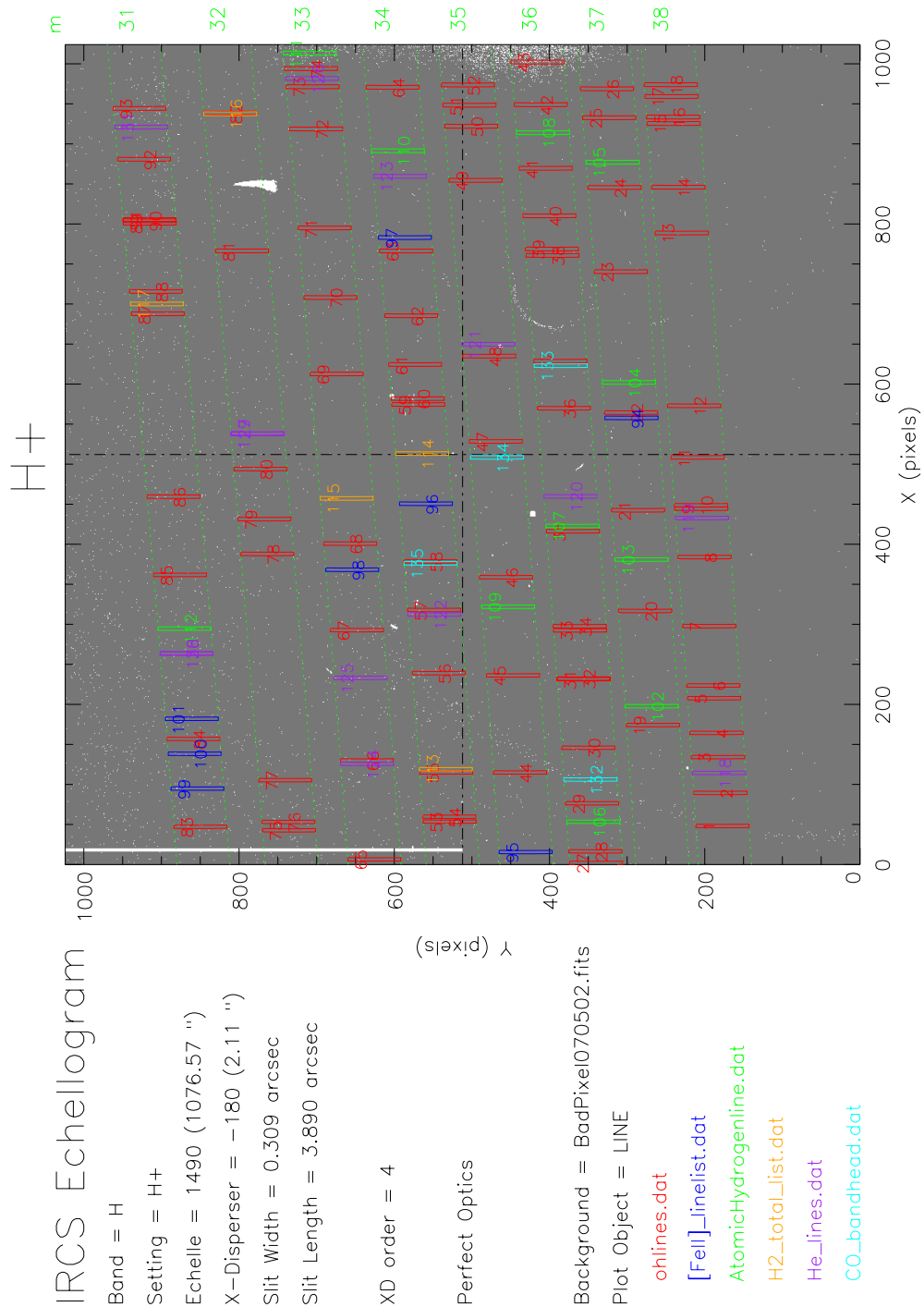


Figure 1.6: Response function for a part of the H -band when $ESP = 3610$ and $XSP = -300$.



Band = H

Setting $= H+$

Echelle = 1490 (1076.57 ")

X-Disperser = -180 (2.11 ")

Slit Width = 0.309 arcsec

Slit Length = 3.890 arcsec

XD order = 4

Perfect Optics

Background = BadPixel070502.fits

Plot Object = LINE

ohlines.dat

[Fell]_linelist.dat

AtomicHydrogenline.dat

H2_total_list.dat

He_lines.dat

CO_bandhead.dat

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Figure 1.7: Echellogram for part of the H -band when $\text{ESP} = 1490$ and $\text{XSP} = -180$. The background is the bad pixel image.

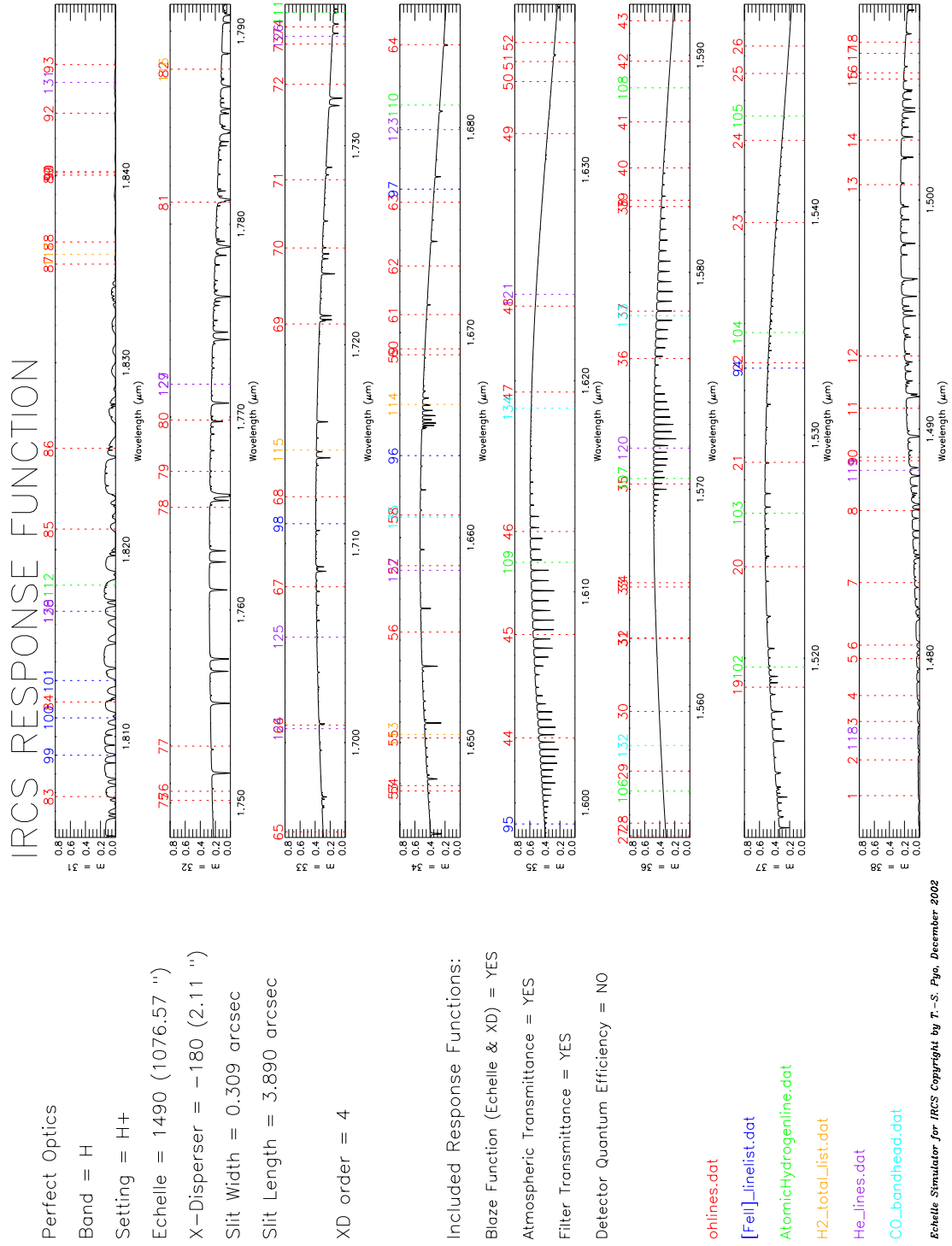
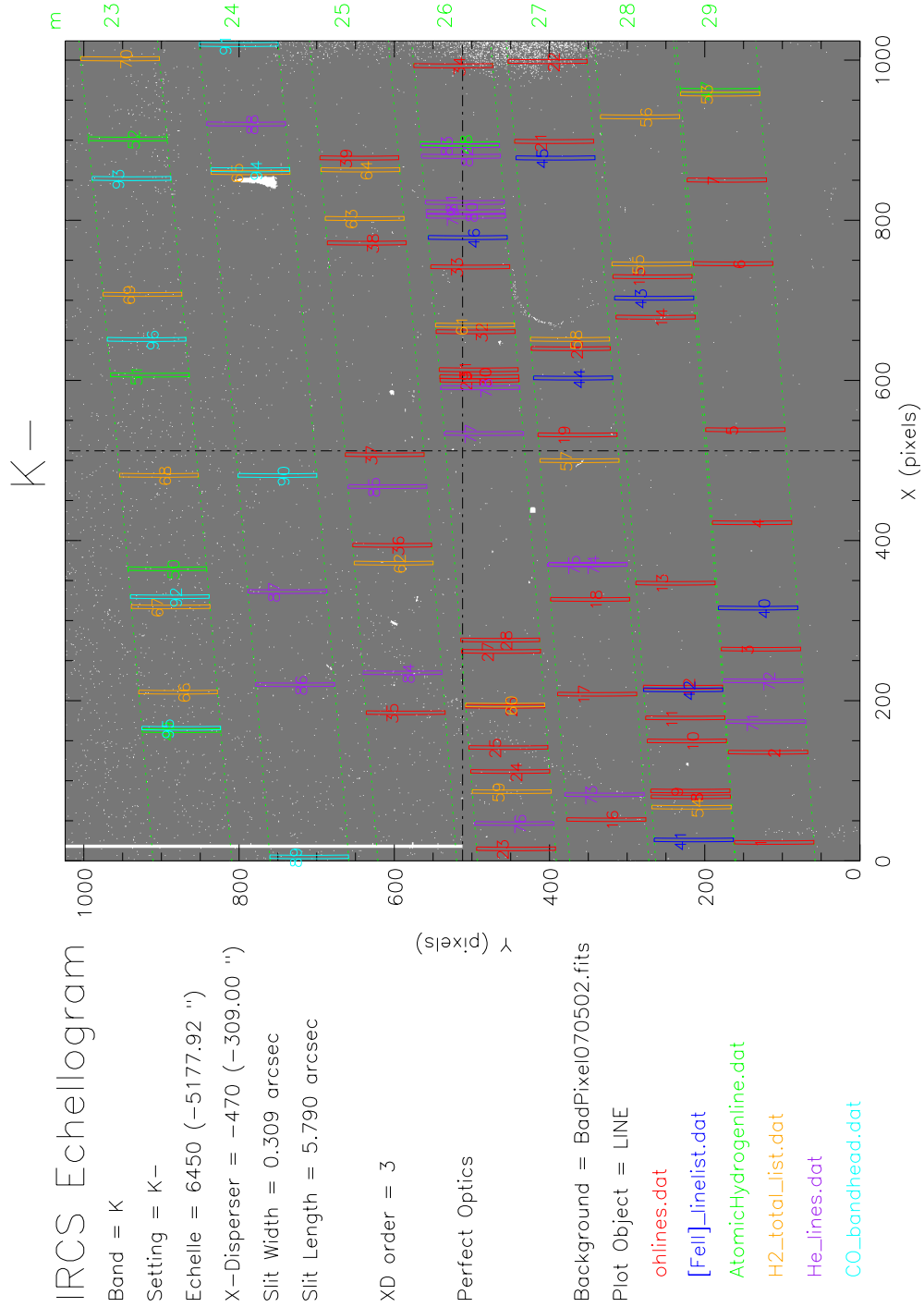


Figure 1.8: Response function for part of the H -band when ESP = 1490 and XSP = -180.



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Figure 1.9: Echellogram for part of the K -band when $ESP = 6450$ and $XSP = -470$. The background image is the bad pixel image.

IRCS RESPONSE FUNCTION

Perfect Optics

Band = K

Setting = K-

Echelle = 6450 (-5177.92 ")

X-Disperser = -470 (-309.00 ")

Slit Width = 0.309 arcsec

Slit Length = 5.790 arcsec

XD order = 3

Included Response Functions:

Blaze Function (Echelle & XD) = YES

Atmospheric Transmittance = YES

Filter Transmittance = YES

Detector Quantum Efficiency = NO

ohlines.dat

[FeII]_line1st.dat

AtomicHydrogenline.dat

H2_total_list.dat

He_lines.dat

CO_bandhead.dat

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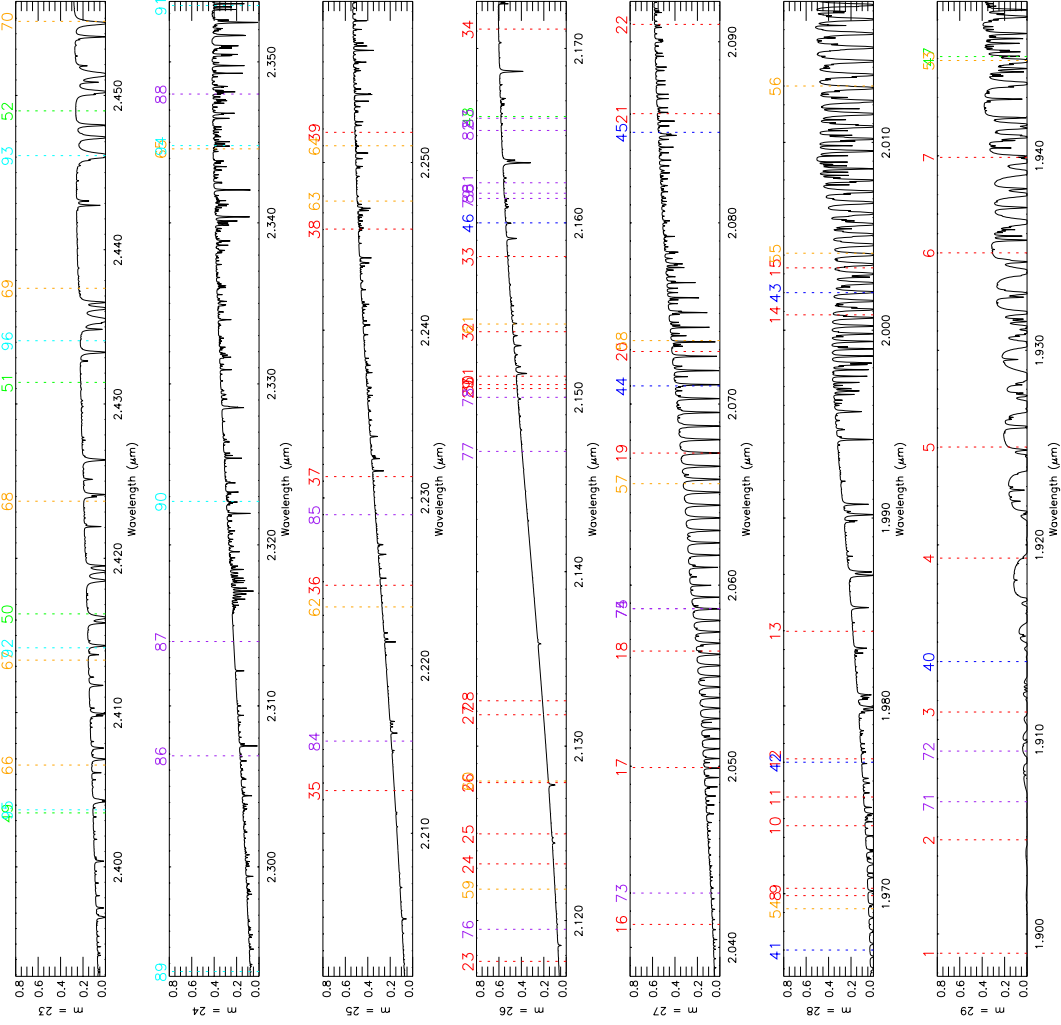
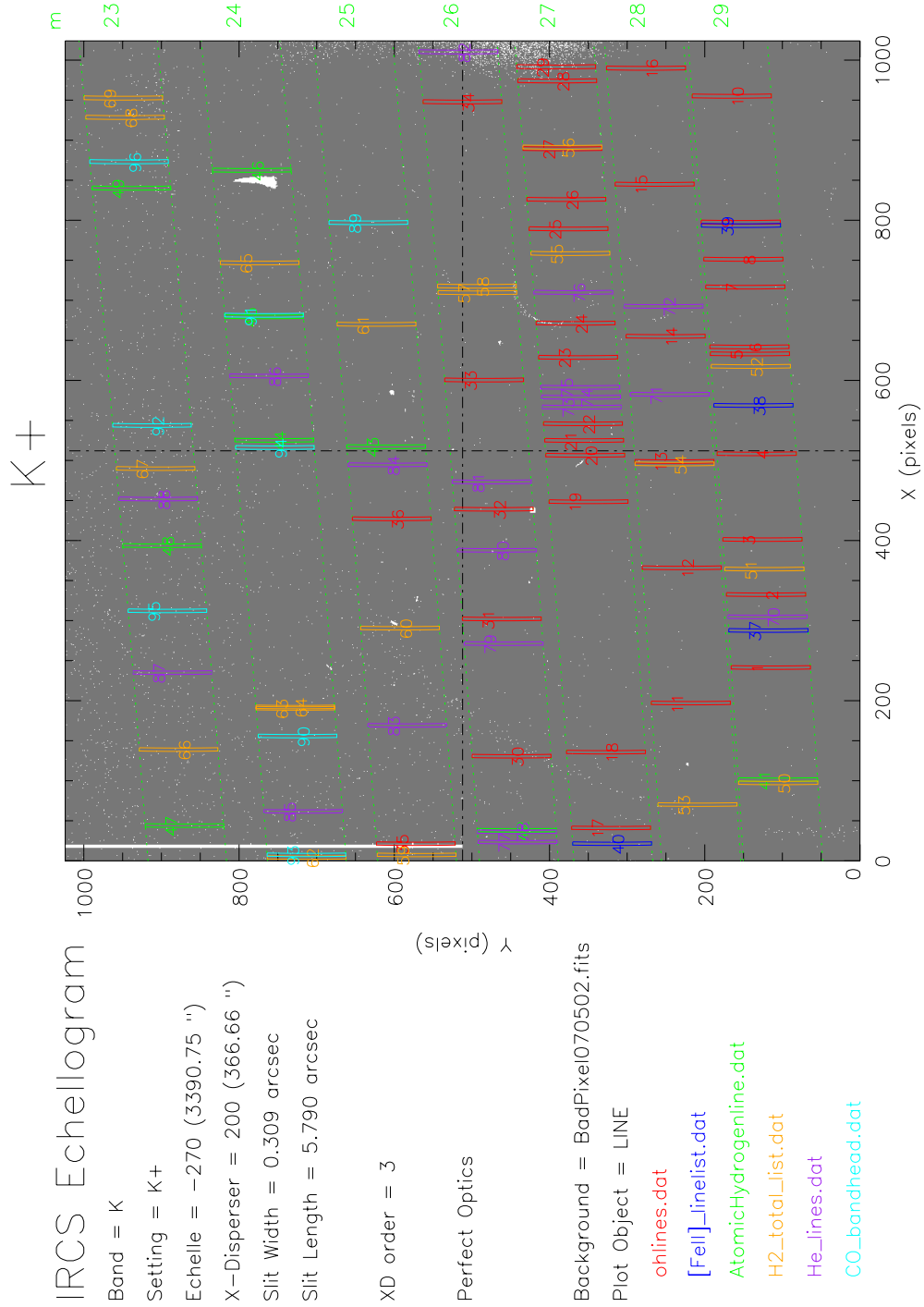


Figure 1.10: Response function for part of the *K*-band when ESP = 6450 and XSP = -470.



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Figure 1.11: Echellogram for part of the K -band when $\text{ESP} = -270$ and $\text{XSP} = 200$. The background is the bad pixel image.

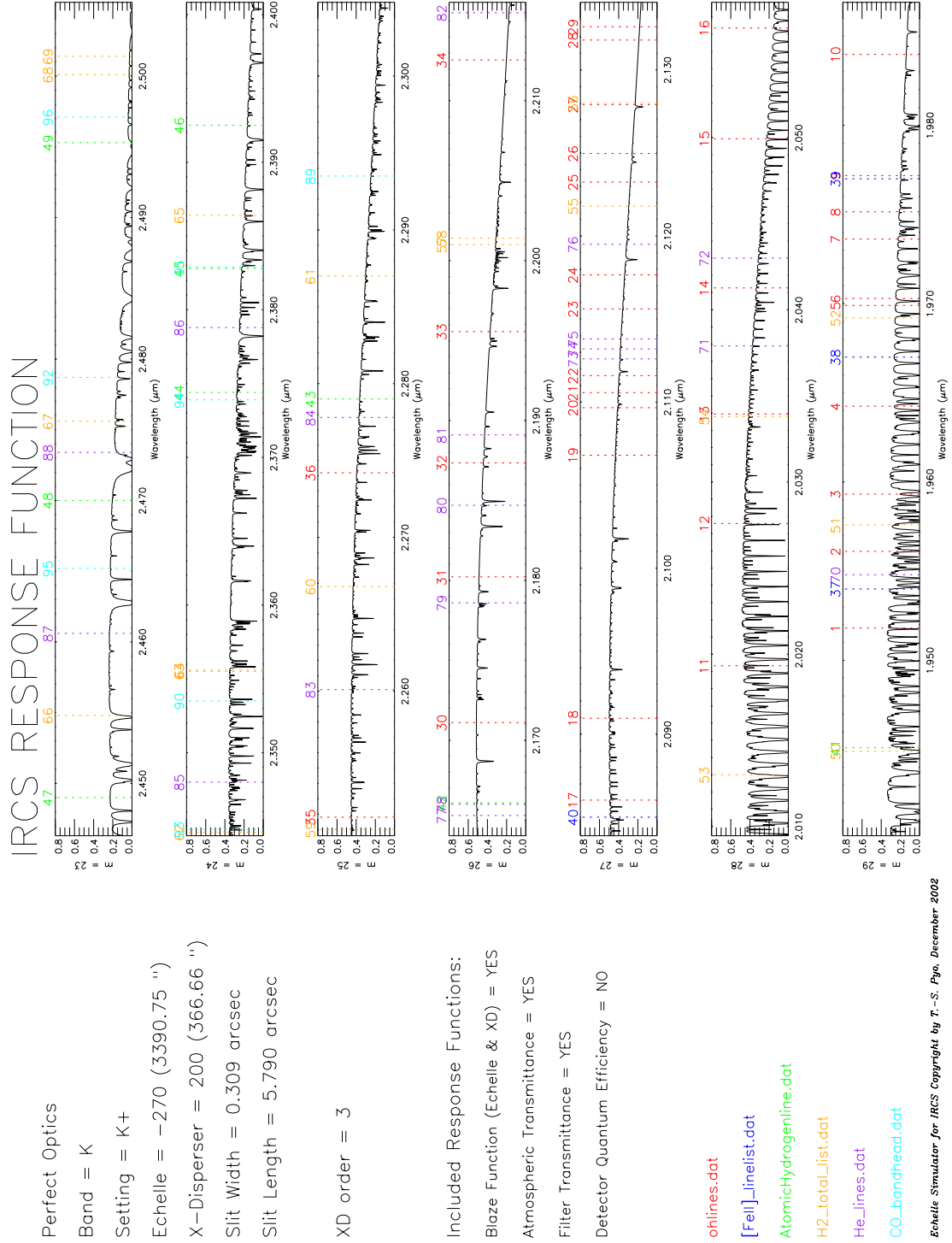


Figure 1.12: Response function for part of the *K*-band when $\text{ESP} = -270$ and $\text{XSP} = 200$.

Table 1.1: List of spectral lines displayed on zJ -band (Figures 1.1 and 1.2).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	52	1.08312	0.40		1	353.340
2	52	1.08993	0.10		2	612.527
3	52	1.09273	0.24		3	722.022
4	52	1.09523	0.10		4	821.367
5	51	1.09523	0.10		5	26.047
6	52	1.09763	0.35		6	918.227
7	51	1.09763	0.35		7	110.762
8	51	1.10103	0.10		8	232.378
9	51	1.10303	0.28		9	304.840
10	51	1.10733	0.05		10	463.117
11	51	1.10903	0.15		11	526.679
12	51	1.11413	0.02		12	721.017
13	51	1.11563	0.05		13	779.280
14	50	1.13134	0.12		14	531.450
15	50	1.13314	0.15		15	598.105
16	50	1.13544	0.10		16	684.251
17	50	1.14364	0.40		17	1001.108
18	49	1.14364	0.40		18	152.089
19	49	1.15395	0.32		19	514.188
20	49	1.15665	0.02		20	612.149
21	49	1.15925	0.35		21	707.853
22	49	1.16285	0.12		22	842.731
23	49	1.16515	0.30		23	930.434
24	48	1.16515	0.30		24	74.708
25	48	1.16965	0.08		25	225.786
26	48	1.17165	0.20		26	293.907
27	48	1.17715	0.04		27	484.587
28	48	1.17875	0.08		28	541.039
29	48	1.18646	0.02		29	819.921
30	47	1.20016	0.12		30	414.889
31	47	1.20076	0.20		31	435.359
32	47	1.20256	0.18		32	497.130
33	47	1.20316	0.24		33	517.839
34	47	1.20559	0.07		34	602.374
35	47	1.21226	0.54		35	840.078
36	47	1.21359	0.20		36	888.553
37	47	1.21550	0.05		37	958.835
38	48	1.19100	2.67e-6	6D(9/2)-4D(5/2)	990.014	569.960
39	47	1.19100	2.67e-6	6D(9/2)-4D(5/2)	109.279	569.100
40	47	1.20500	1.14e-6	6D(7/2)-4D(3/2)	581.753	609.370
41	56	1.00520	0.0000	Pa δ (7-3)	331.070	3.703
42	52	1.09410	0.0901	Pa γ (6-3)	776.276	274.466
43	52	1.08510	0.44	2-0	427.721	246.409
44	52	1.09980	0.15	2-0	1007.134	293.864
45	51	1.09980	0.15	2-0	188.158	292.179
46	51	1.11750	0.43	2-0	852.668	345.990
47	50	1.11750	0.43	2-0	38.634	347.307
48	50	1.13820	0.12	2-0	789.135	408.227
49	49	1.16220	0.23	2-0	818.166	481.096
50	56	1.00490	0	HEII	319.040	2.838
51	56	1.01330	0	HEII	663.774	28.282
52	55	1.03140	0	HEI	650.409	83.357
53	54	1.04220	0	HEII	322.190	116.409
54	53	1.06680	0	HEI	511.874	190.766
55	52	1.08320	0	HEI	356.331	240.846
56	52	1.08320	0	HEI	356.331	240.846
57	52	1.08330	0	HEI	360.073	241.136
58	52	1.08330	0	HEI	360.073	241.136
59	52	1.09050	0	HEI	634.676	262.889
60	52	1.09160	0	HEI	677.618	266.374
61	52	1.09200	0	HEI	693.305	267.653
62	52	1.09380	0	HEII	764.354	273.482
63	52	1.09970	0	HEI	1003.007	293.512
64	51	1.09970	0	HEI	184.575	291.903
65	51	1.10160	0	HEI	252.963	297.185

Table 1.1: List of spectral lines displayed on zJ -band (Figures 1.1 and 1.2).

66	51	1.10480	0	HEI	369.571	306.324
67	51	1.11640	0	HEII	809.397	342.318
68	50	1.11640	0	HEII	0.798	344.425
69	50	1.12290	0	HEI	227.057	361.930
70	49	1.16280	0	HEII	840.837	483.094
71	48	1.16770	0	HEII	159.960	498.123
72	47	1.19720	0	HEI	314.751	586.243
						(end)

Table 1.2: List of spectral lines displayed on J -band (Figures 1.3 and 1.4).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	49	1.14364	0.40		160.920	160.138
2	49	1.15395	0.32		523.202	185.010
3	49	1.15665	0.02		621.220	191.984
4	49	1.15925	0.35		716.983	198.898
5	49	1.16285	0.12		851.948	208.810
6	48	1.16285	0.12		7.370	210.287
7	49	1.16515	0.30		939.711	215.361
8	48	1.16515	0.30		83.505	215.368
9	48	1.16965	0.08		234.651	225.644
10	48	1.17165	0.20		302.805	230.361
11	48	1.17715	0.04		493.585	243.835
12	48	1.17875	0.08		550.068	247.902
13	48	1.18646	0.02		829.123	268.509
14	47	1.20016	0.12		423.849	302.199
15	47	1.20076	0.20		444.330	303.683
16	47	1.20256	0.18		506.135	308.190
17	47	1.20316	0.24		526.856	309.711
18	47	1.20559	0.07		611.439	315.969
19	47	1.21226	0.54		849.293	333.998
20	47	1.21359	0.20		897.801	337.753
21	46	1.21359	0.20		13.095	338.860
22	47	1.21550	0.05		968.133	343.245
23	46	1.21550	0.05		73.673	343.068
24	46	1.21964	0.11		206.605	352.451
25	46	1.22293	0.40		313.925	360.174
26	46	1.22578	0.18		408.172	367.065
27	46	1.22870	0.46		506.047	374.330
28	46	1.23259	0.17		638.624	384.347
29	46	1.23516	0.30		727.670	391.189
30	46	1.24009	0.11		902.016	404.848
31	46	1.24230	0.19		981.777	411.213
32	45	1.24230	0.19		67.101	410.955
33	45	1.24827	0.04		255.138	424.555
34	45	1.25024	0.09		318.226	429.211
35	45	1.25891	0.05		602.661	450.785
36	44	1.27528	0.15		212.858	493.076
37	44	1.27644	0.21		248.913	495.771
38	44	1.27825	0.24		305.516	500.033
39	44	1.28070	0.23		382.831	505.917
40	44	1.28346	0.08		470.942	512.710
41	44	1.29057	0.57		703.238	531.068
42	44	1.29212	0.17		754.974	535.245
43	44	1.29431	0.09		828.781	541.259
44	44	1.29857	0.15		974.897	553.358
45	43	1.29857	0.15		22.286	553.660
46	43	1.30216	0.32		129.153	561.623
47	43	1.30528	0.21		223.240	568.749
48	43	1.30852	0.39		322.202	576.363
49	43	1.31278	0.18		454.390	586.720
50	43	1.31567	0.19		545.500	593.984
51	43	1.32110	0.10		720.049	608.187
52	43	1.32366	0.27		803.977	615.149
53	43	1.33019	0.01		1023.281	633.750
54	42	1.33019	0.01		42.578	633.254
55	42	1.33247	0.04		108.868	638.307
56	42	1.34208	0.06		394.781	660.736
57	41	1.36749	0.01		181.054	725.970
58	41	1.36772	0.01		187.675	726.496
59	41	1.36921	0.01		230.698	729.928
60	41	1.37168	0.01		302.574	735.714
61	41	1.38237	0.01		622.205	762.253
62	48	1.19100	2.67e-6	6D(9/2)-4D(5/2)	999.334	281.500
63	47	1.19100	2.67e-6	6D(9/2)-4D(5/2)	118.091	280.606
64	47	1.20500	1.14e-6	6D(7/2)-4D(3/2)	590.806	314.435
65	45	1.24800	8.51e-5	6D(5/2)-4D(3.2)	246.534	423.924

Table 1.2: List of spectral lines displayed on J -band (Figures 1.3 and 1.4).

66	45	1.24900	3.19e-4	6D(7/2)-4D(5/2)	278.450	426.270
67	45	1.25200	6.48e-4	6D(3/2)-4D(1/2)	375.048	433.445
68	45	1.25700	4.83e-3	6D(9/2)-4D(7/2)	538.999	445.873
69	45	1.27000	2.91e-3	6D(1/2)-4D(1/2)	985.094	481.290
70	44	1.27000	2.91e-3	6D(1/2)-4D(1/2)	50.865	481.161
71	44	1.27900	2.25e-3	6D(3/2)-4D(3/2)	329.100	501.820
72	44	1.29400	1.94e-3	6D(5/2)-4D(5/2)	818.285	540.400
73	44	1.29800	1.00e-3	6D(1/2)-4D(3/2)	955.143	551.708
74	43	1.29800	1.00e-3	6D(1/2)-4D(3/2)	5.445	552.418
75	43	1.32100	1.33e-3	6D(7/2)-4D(7/2)	716.794	607.918
76	43	1.32800	1.21e-3	6D(3/2)-4D(5/2)	948.854	627.371
77	41	1.37200	9.03e-4	6D(5/2)-4D(7/2)	311.940	736.473
78	44	1.28220	0.1620	Pa β (5-3)	430.582	509.587
79	49	1.16220	0.23	2-0	827.366	206.990
80	46	1.23830	0.043	2-0	838.159	399.804
81	46	1.23830	0.12	2-9	838.159	399.804
82	46	1.24190	0.045	2-0	967.264	410.049
83	45	1.24190	0.045	2-0	54.663	410.071
84	45	1.24730	0.24	2-0	224.270	422.294
85	45	1.25450	0.056	2-0	456.550	439.584
86	45	1.26360	0.17	2-0	761.619	463.255
87	44	1.29320	0.024	2-0	791.267	538.194
88	42	1.33540	0.094	2-0	194.897	644.947
89	41	1.38170	0.03	2-0	601.738	760.513
90	49	1.16280	0	HEII	850.053	208.669
91	48	1.16280	0	HEII	5.721	210.178
92	48	1.16770	0	HEII	168.795	221.136
93	47	1.19720	0	HEI	323.659	295.008
94	46	1.22560	0	HEII	402.185	366.624
95	46	1.24180	0	HEII	963.641	409.759
96	45	1.24180	0	HEII	51.556	409.850
97	45	1.25310	0	HEI	410.796	436.128
98	44	1.27190	0	HEII	108.775	485.384
99	44	1.27590	0	HEI	232.109	494.513
100	44	1.27890	0	HEI	325.951	501.581
101	44	1.28170	0	HEII	414.634	508.358
102	44	1.28500	0	HEI	520.591	516.579
103	44	1.29140	0	HEII	730.892	533.296
104	44	1.29710	0	HEI	924.085	549.122
105	44	1.29760	0	HEI	941.321	550.556
106	44	1.29880	0	HEI	982.887	554.027
107	43	1.29880	0	HEI	29.090	554.163
108	44	1.29760	0	HEI	941.321	550.556
109	43	1.31500	0	HEII	524.271	592.283
110	42	1.34150	0	HEI	377.214	659.328
111	42	1.34420	0	HEII	459.392	665.947
(end)						

Table 1.3: List of spectral lines displayed on H -band (H-: Figures 1.5 and 1.6).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	38	1.46651	0.14		115.873	174.975
2	38	1.46984	0.35		203.256	181.073
3	38	1.47022	0.01		213.289	181.779
4	38	1.47133	0.01		242.673	183.852
5	38	1.47400	0.10		313.824	188.911
6	38	1.47556	0.05		355.709	191.916
7	38	1.47724	0.15		401.083	195.192
8	38	1.47837	0.15		431.763	197.421
9	38	1.47998	0.30		475.697	200.631
10	38	1.48057	0.26		491.868	201.817
11	38	1.48330	0.62		567.168	207.382
12	38	1.48644	0.20		654.801	213.938
13	38	1.48862	0.01		716.314	218.590
14	38	1.48877	0.78		720.567	218.913
15	38	1.49091	0.10		781.549	223.570
16	38	1.49319	0.26		847.156	228.625
17	37	1.50261	0.01		26.536	249.077
18	37	1.50528	0.01		93.915	253.823
19	37	1.50555	1.95		100.758	254.308
20	37	1.50640	0.01		122.346	255.841
21	37	1.50689	0.66		134.817	256.730
22	37	1.50882	0.23		184.126	260.259
23	37	1.51137	0.10		249.764	264.999
24	37	1.51870	0.38		441.678	279.143
25	37	1.52410	1.41		586.385	290.085
26	37	1.52878	0.58		714.300	299.956
27	37	1.53324	1.15		838.532	309.722
28	37	1.53953	0.40		1017.939	324.135
29	36	1.54621	0.10		72.164	336.961
30	36	1.54744	0.01		102.466	339.161
31	36	1.55008	0.20		167.893	343.949
32	36	1.55098	0.25		190.322	345.602
33	36	1.55179	0.20		210.565	347.099
34	36	1.55404	0.55		267.073	351.302
35	36	1.55462	0.01		281.705	352.397
36	36	1.55702	0.15		342.570	356.977
37	36	1.55977	0.70		412.928	362.326
38	36	1.56313	0.01		499.826	369.012
39	36	1.56316	0.35		500.606	369.072
40	36	1.56550	1.05		561.770	373.832
41	36	1.56570	0.01		567.023	374.243
42	36	1.57025	0.28		687.611	383.762
43	36	1.57603	0.10		844.004	396.362
44	36	1.57821	0.15		903.983	401.270
45	35	1.58973	0.10		56.465	425.193
46	35	1.59159	0.01		100.964	428.508
47	35	1.59726	0.50		238.181	438.880
48	35	1.60308	1.53		381.628	449.966
49	35	1.60798	0.65		504.615	459.668
50	35	1.61286	1.71		629.257	469.686
51	35	1.61947	0.63		801.828	483.866
52	35	1.62354	1.27		910.394	492.970
53	34	1.63418	0.12		3.173	515.656
54	34	1.63513	0.65		25.079	517.317
55	34	1.63604	0.10		46.116	518.917
56	34	1.63885	0.25		111.423	523.920
57	34	1.64147	0.20		172.798	528.669
58	34	1.64421	0.01		237.508	533.728
59	34	1.64476	0.70		250.566	534.755
60	34	1.64764	0.01		319.293	540.195
61	34	1.64790	0.50		325.529	540.691
62	34	1.65023	0.75		381.649	545.181
63	34	1.65539	0.30		507.480	555.391
64	34	1.65863	0.01		587.648	561.998
65	34	1.66110	0.10		649.393	567.141

Table 1.3: List of spectral lines displayed on H -band (H-: Figures 1.5 and 1.6).

66	34	1.66892	0.01	66	848.722	584.066
67	34	1.66921	2.30	67	856.233	584.714
68	34	1.67088	0.83	68	899.659	588.471
69	34	1.67325	0.30	69	961.797	593.887
70	33	1.68405	0.30	70	10.988	616.283
71	33	1.69037	1.45	71	153.613	627.535
72	33	1.69551	0.52	72	271.548	637.035
73	33	1.70088	1.80	73	396.753	647.315
74	33	1.70783	0.70	74	562.056	661.195
75	33	1.71236	1.20	75	671.940	670.615
76	33	1.72104	0.36	76	887.698	689.559
77	33	1.72486	0.70	77	984.999	698.296
78	32	1.73838	0.40	78	48.023	725.460
79	32	1.73867	0.40	79	54.342	725.971
80	32	1.74270	0.30	80	142.714	733.174
81	32	1.74499	0.72	81	193.372	737.349
82	32	1.75013	0.27	82	308.303	746.947
83	32	1.75060	0.08	83	318.899	747.841
84	32	1.75294	0.08	84	371.881	752.332
85	32	1.76532	2.00	85	658.881	777.301
86	32	1.76718	0.70	86	703.049	781.240
87	32	1.76984	0.18	87	766.725	786.964
88	31	1.79348	0.05	88	27.430	836.804
89	31	1.79940	1.42	89	153.056	847.353
90	31	1.80679	0.18	90	312.761	861.074
91	31	1.81185	0.50	91	424.096	870.845
92	31	1.82110	0.01	92	632.204	889.562
93	31	1.82542	0.05	93	731.594	898.709
94	31	1.83528	0.01	94	964.266	920.648
95	31	1.83646	0.01	95	992.689	923.378
96	37	1.53300	2.44e-3	4F(9/2)-4D(5/2)	831.785	309.187
97	35	1.59900	3.28e-3	4F(7/2)-4D(3/2)	280.783	442.147
98	34	1.64400	4.65e-3	4F(9/2)-4D(7/2)	232.536	533.337
99	34	1.66400	3.73e-3	4F(5/2)-4D(1/2)	722.614	573.301
100	33	1.71100	9.20e-4	4F(5/2)-4D(3/2)	638.764	667.754
101	32	1.74500	1.95e-3	4F(3/2)-4D(1/2)	193.597	737.368
102	32	1.74800	1.92e-3	4D(7/2)-4P(3/2)	260.468	742.931
103	31	1.80000	1.43e-3	4F(5/2)-4D(5/2)	165.902	848.444
104	31	1.80900	1.03e-3	4F(7/2)-4D(7/2)	361.183	865.303
105	31	1.81100	1.84e-3	4D(7/2)-4P(5/2)	405.275	869.182
106	31	1.81300	2.34e-3	4D(5/2)-4P(1/2)	449.639	873.111
107	37	1.51960	0.00116	Br(20-4)	465.595	280.935
108	37	1.52650	0.00133	Br(19-4)	651.685	295.101
109	37	1.53460	0.00156	Br(18-4)	876.890	312.773
110	36	1.54430	0.00184	Br(17-4)	25.337	333.581
111	36	1.55610	0.00220	Br(16-4)	319.183	355.212
112	36	1.57050	0.00266	Br(15-4)	694.302	384.296
113	35	1.58850	0.00327	Br(14-4)	27.172	423.024
114	35	1.61140	0.00409	Br(13-4)	591.733	466.650
115	34	1.64120	0.00521	Br(12-4)	166.456	528.176
116	32	1.73670	0.00909	Br(10-4)	11.498	722.516
117	31	1.81810	0.0126	Br(9-4)	564.031	883.366
118	34	1.65040	0.037	1-0	385.759	545.512
119	34	1.66650	0.034	1-0	786.387	578.721
120	33	1.68770	0.22	1-0	93.055	622.726
121	33	1.71470	0.14	1-0	729.410	675.603
122	32	1.74800	0.65	1-0	260.468	742.931
123	31	1.83580	1.21	1-0	976.776	921.848
124	38	1.47650	0	HeII	381.064	193.744
125	38	1.48820	0	HeII	704.420	217.687
126	37	1.50880	0	HeI	183.615	260.222
127	36	1.57190	0	HeII	731.881	387.300
128	35	1.62410	0	HeII	925.478	494.246
129	34	1.64000	0	HeII	138.305	525.994
130	34	1.65840	0	HeII	581.929	561.524
131	33	1.69260	0	HeII	204.562	631.617
132	33	1.70070	0	HeI	392.520	646.965

Table 1.3: List of spectral lines displayed on H -band (H-: Figures 1.5 and 1.6).

133	33	1.70530	0	HEII	501.433	656.064
134	32	1.77170	0	HEII	811.621	791.032
135	31	1.81670	0	HEII	532.445	880.516
136	32	1.77170	0	HEII	811.621	791.032
137	31	1.81670	0	HEII	532.445	880.516
138	36	1.55820	0	12C16O	372.680	359.259
139	36	1.57800	0	12C16O	898.184	400.794
140	35	1.59820	0	12C16O	261.167	440.640
141	35	1.61870	0	12C16O	781.493	482.176
142	34	1.63970	0	12C16O	131.286	525.452
143	34	1.66100	0	12C16O	646.884	566.931
						(end)

Table 1.4: List of spectral lines displayed on H -band (H+: Figures 1.7 and 1.8).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	38	1.47400	0.10	1	48.034	177.101
2	38	1.47556	0.05	2	89.340	179.873
3	38	1.47724	0.15	3	134.069	182.897
4	38	1.47837	0.15	4	164.303	184.953
5	38	1.47998	0.30	5	207.585	187.915
6	38	1.48057	0.26	6	223.511	189.010
7	38	1.48330	0.62	7	297.641	194.144
8	38	1.48644	0.20	8	383.849	200.192
9	38	1.48862	0.01	9	444.317	204.484
10	38	1.48877	0.78	10	448.497	204.782
11	38	1.49091	0.10	11	508.406	209.077
12	38	1.49319	0.26	12	572.819	213.740
13	38	1.50067	0.01	13	788.630	229.701
14	38	1.50261	0.01	14	845.809	234.017
15	38	1.50528	0.01	15	925.376	240.083
16	38	1.50555	1.95	16	933.479	240.705
17	38	1.50640	0.01	17	959.063	242.673
18	38	1.50689	0.66	18	973.860	243.815
19	37	1.51870	0.38	19	174.073	266.661
20	37	1.52410	1.41	20	316.552	276.757
21	37	1.52878	0.58	21	442.338	285.863
22	37	1.53324	1.15	22	564.353	294.870
23	37	1.53953	0.40	23	740.288	308.158
24	37	1.54321	1.08	24	845.489	316.274
25	37	1.54621	0.10	25	932.587	323.088
26	37	1.54744	0.01	26	968.660	325.936
27	36	1.55404	0.55	27	1.912	339.886
28	36	1.55462	0.01	28	16.349	340.896
29	36	1.55702	0.15	29	76.384	345.121
30	36	1.55977	0.70	30	145.743	350.056
31	36	1.56313	0.01	31	231.347	356.225
32	36	1.56316	0.35	32	232.116	356.281
33	36	1.56550	1.05	33	292.329	360.672
34	36	1.56570	0.01	34	297.499	361.051
35	36	1.57025	0.28	35	416.106	369.834
36	36	1.57603	0.10	36	569.725	381.455
37	36	1.57821	0.15	37	628.576	385.981
38	36	1.58303	0.01	38	760.605	396.283
39	36	1.58332	2.30	39	768.637	396.916
40	36	1.58481	0.90	40	810.055	400.194
41	36	1.58693	0.25	41	869.464	404.931
42	36	1.58973	0.10	42	948.818	411.323
43	36	1.59159	0.01	43	1002.109	415.657
44	35	1.60308	1.53	44	114.892	437.934
45	35	1.60798	0.65	45	236.063	446.885
46	35	1.61286	1.71	46	358.728	456.128
47	35	1.61947	0.63	47	528.320	469.207
48	35	1.62354	1.27	48	634.864	477.602
49	35	1.63172	0.28	49	854.401	495.334
50	35	1.63418	0.12	50	921.951	500.908
51	35	1.63513	0.65	51	948.239	503.092
52	35	1.63604	0.10	52	973.525	505.200
53	34	1.64764	0.01	53	53.428	528.602
54	34	1.64790	0.50	54	59.578	529.060
55	34	1.65023	0.75	55	114.913	533.203
56	34	1.65539	0.30	56	238.884	542.622
57	34	1.65863	0.01	57	317.794	548.718
58	34	1.66110	0.10	58	378.530	553.463
59	34	1.66892	0.01	59	574.355	569.073
60	34	1.66921	2.30	60	581.726	569.670
61	34	1.67088	0.83	61	624.335	573.134
62	34	1.67325	0.30	62	685.268	578.127
63	34	1.67636	0.15	63	766.111	584.823
64	34	1.68405	0.30	64	970.585	602.122

Table 1.4: List of spectral lines displayed on H -band (H+: Figures 1.7 and 1.8).

65	33	1.69551	0.52	65	6.327	625.810
66	33	1.70088	1.80	66	129.801	635.295
67	33	1.70783	0.70	67	292.610	648.100
68	33	1.71236	1.20	68	400.700	656.790
69	33	1.72104	0.36	69	612.601	674.260
70	33	1.72486	0.70	70	708.010	682.315
71	33	1.72829	0.18	71	794.898	689.752
72	33	1.73309	0.32	72	918.537	700.502
73	33	1.73511	0.20	73	971.320	705.151
74	33	1.73597	0.20	74	993.933	707.154
75	32	1.75013	0.27	75	42.588	735.561
76	32	1.75060	0.08	76	53.040	736.385
77	32	1.75294	0.08	77	105.284	740.528
78	32	1.76532	2.00	78	387.860	763.563
79	32	1.76718	0.70	79	431.281	767.196
80	32	1.76984	0.18	80	493.846	772.476
81	32	1.78114	0.08	81	766.298	796.071
82	32	1.78803	1.20	82	938.274	811.471
83	31	1.80679	0.18	83	46.985	849.730
84	31	1.81185	0.50	84	156.748	858.744
85	31	1.82110	0.01	85	361.626	876.011
86	31	1.82542	0.05	86	459.332	884.447
87	31	1.83528	0.01	87	687.689	904.676
88	31	1.83646	0.01	88	715.547	907.192
89	31	1.84004	0.01	89	800.829	914.962
90	31	1.84017	0.01	90	803.942	915.248
91	31	1.84023	0.01	91	805.387	915.381
92	31	1.84335	0.01	92	880.715	922.331
93	31	1.84595	0.01	93	944.200	928.249
94	37	1.53300	2.44e-3	4F(9/2)-4D(5/2)	557.731	294.377
95	35	1.59900	3.28e-3	4F(7/2)-4D(3/2)	15.439	430.719
96	34	1.66400	3.73e-3	4F(5/2)-4D(1/2)	450.509	559.145
97	34	1.67700	1.94e-3	4F(7/2)-4D(5/2)	782.877	586.222
98	33	1.71100	9.20e-4	4F(5/2)-4D(3/2)	368.077	654.151
99	31	1.80900	1.03e-3	4F(7/2)-4D(7/2)	94.737	853.631
100	31	1.81100	1.84e-3	4D(7/2)-4P(5/2)	138.201	857.210
101	31	1.81300	2.34e-3	4D(5/2)-4P(1/2)	181.916	860.834
102	37	1.51960	0.00116	Br(20-4)	197.634	268.314
103	37	1.52650	0.00133	Br(19-4)	380.784	281.384
104	37	1.53460	0.00156	Br(18-4)	601.997	297.684
105	37	1.54430	0.00184	Br(17-4)	876.992	318.728
106	36	1.55610	0.00220	Br(16-4)	53.319	343.493
107	36	1.57050	0.00266	Br(15-4)	422.683	370.326
108	36	1.58850	0.00327	Br(14-4)	913.834	408.496
109	35	1.61140	0.00409	Br(13-4)	321.814	453.327
110	34	1.68110	0.00679	Br(11-4)	891.344	595.356
111	33	1.73670	0.00909	Br(10-4)	1013.204	708.865
112	31	1.81810	0.0126	Br(9-4)	294.554	870.295
113	34	1.65040	0.037	1-0	118.964	533.508
114	34	1.66650	0.034	1-0	513.157	564.143
115	33	1.71470	0.14	1-0	457.187	661.391
116	32	1.78800	0.31	1-0	937.514	811.402
117	31	1.83580	1.21	1-0	699.952	905.782
118	38	1.47650	0	HeII	114.336	181.560
119	38	1.48820	0	HeII	432.628	203.651
120	36	1.57190	0	HeII	459.614	373.097
121	35	1.62410	0	HeII	649.658	478.779
122	34	1.65840	0	HeII	312.167	548.281
123	34	1.67990	0	HeII	859.402	592.651
124	33	1.70070	0	HeI	125.629	634.971
125	33	1.70530	0	HeII	232.930	643.367
126	33	1.73550	0	HeII	981.568	706.058
127	32	1.77170	0	HeII	537.936	776.227
128	31	1.81670	0	HeII	263.463	867.666
129	32	1.77170	0	HeII	537.936	776.227
130	31	1.81670	0	HeII	263.463	867.666

Table 1.4: List of spectral lines displayed on H -band (H+: Figures 1.7 and 1.8).

131	31	1.84500	0	HEII	920.928	926.074
132	36	1.55820	0	12C16O	106.072	347.227
133	36	1.57800	0	12C16O	622.888	385.542
134	35	1.61870	0	12C16O	508.351	467.649
135	34	1.66100	0	12C16O	376.063	553.269
						(end)

Table 1.5: List of spectral lines displayed on K -band (K-: Figures 1.9 and 1.10).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	29	1.89901	0.01		22.764	110.530
2	29	1.90484	0.01		135.377	118.401
3	29	1.91141	0.01		264.158	127.571
4	29	1.91932	0.01		422.051	139.060
5	29	1.92503	0.32		538.118	147.677
6	29	1.93501	0.25		745.564	163.444
7	29	1.93992	0.01		849.951	171.553
8	28	1.96990	0.15		79.795	217.967
9	28	1.97029	0.35		87.072	218.493
10	28	1.97362	0.05		149.469	223.029
11	28	1.97515	0.20		178.300	225.140
12	28	1.97718	0.52		216.708	227.966
13	28	1.98397	0.22		346.537	237.642
14	28	2.00082	1.05		678.716	263.259
15	28	2.00332	0.35		729.341	267.272
16	27	2.04127	1.28		51.262	326.762
17	27	2.04993	0.27		207.955	338.574
18	27	2.05636	1.05		326.293	347.684
19	27	2.06729	0.03		531.731	363.886
20	27	2.07290	0.77		639.447	372.577
21	27	2.08603	0.20		898.252	394.010
22	27	2.09096	0.33		998.081	402.485
23	26	2.11766	0.38		14.740	443.124
24	26	2.12325	0.15		111.362	450.598
25	26	2.12497	0.41		141.315	452.938
26	26	2.12791	0.05		192.778	456.983
27	26	2.13180	0.01		261.371	462.425
28	26	2.13260	0.16		275.551	463.557
29	26	2.15050	0.01		599.931	490.115
30	26	2.15073	1.20		604.195	490.472
31	26	2.15121	0.01		613.101	491.220
32	26	2.15376	0.30		660.587	495.222
33	26	2.15807	0.15		741.586	502.111
34	26	2.17111	0.25		992.745	523.975
35	25	2.21255	0.80		184.739	585.260
36	25	2.22479	0.28		393.921	602.658
37	25	2.23127	0.50		507.009	612.292
38	25	2.24603	0.10		771.414	635.444
39	25	2.25180	0.25		877.582	644.987
40	29	1.91400	7.81e-4	4D(3/2)-4P(1/2)	315.509	131.278
41	28	1.96700	8.83e-4	4D(5/2)-4P(5/2)	25.882	214.087
42	28	1.97700	1.13e-4	4D(1/2)-4P(1/2)	213.295	227.714
43	28	2.00200	5.79e-4	4D(3/2)-4P(3/2)	702.568	265.146
44	27	2.07100	5.12e-4	4D(1/2)-4P(3/2)	602.787	369.604
45	27	2.08500	2.76e-4	4D(3/2)-4P(5/2)	877.585	392.270
46	26	2.16000	2.89e-5	4D(1/2)-4P(5/2)	778.172	505.249
47	29	1.94510	0.0181	Br δ (8-4)	961.890	180.381
48	26	2.16610	0.0275	Br γ (7-4)	895.120	515.387
49	23	2.40350	0.000489	Pf(22-5)	162.341	874.216
50	23	2.41640	0.000558	Pf(21-5)	364.492	892.386
51	23	2.43140	0.000643	Pf(20-5)	606.493	914.874
52	23	2.44900	0.000747	Pf(19-5)	901.370	943.357
53	29	1.94490	0.28	2-1	957.535	180.035
54	28	1.96920	0.038	3-2	66.753	217.025
55	28	2.00410	0.15	2-1	745.214	268.536
56	28	2.01300	0.021	3-2	928.984	283.377
57	27	2.06560	0.088	3-2	499.596	361.320
58	27	2.07350	0.47	2-1	651.062	373.522
59	26	2.12180	1	1-0	86.195	448.640
60	26	2.12800	0.036	3-2	194.360	457.108
61	26	2.15420	0.14	2-1	668.813	495.918
62	25	2.22350	0.19	1-0	371.605	600.775
63	25	2.24770	0.33	2-1	801.968	638.176
64	25	2.25100	0	5-4	862.765	643.647

Table 1.5: List of spectral lines displayed on *K*-band (K-: Figures 1.9 and 1.10).

65	24	2.34460	0	4-3	859.363	785.174
66	23	2.40660	0.57	1-0	210.453	878.490
67	23	2.41340	0.21	1-0	317.014	888.069
68	23	2.42370	0.7	1-0	481.278	903.139
69	23	2.43750	0.24	1-0	707.267	924.474
70	23	2.45480	0.7	1-0	1001.469	953.296
71	29	1.90680	0	HEI	173.582	121.103
72	29	1.90940	0	HEI	224.542	124.731
73	27	2.04300	0	HEI	82.332	329.082
74	27	2.05870	0	HEI	369.812	351.076
75	27	2.05870	0	HEI	369.812	351.076
76	26	2.11950	0	HEII	46.421	445.562
77	26	2.14690	0	HEII	533.546	484.576
78	26	2.15000	0	HEI	590.681	489.340
79	26	2.16140	0	HEI	804.832	507.545
80	26	2.16170	0	HeI	810.557	508.040
81	26	2.16230	0	HEI	822.032	509.032
82	26	2.16530	0	HEII	879.664	514.037
83	26	2.16600	0	HeI	893.183	515.217
84	25	2.21550	0	HEII	234.651	589.361
85	25	2.22900	0	HEI	467.203	608.882
86	24	2.30690	0	HEI	219.800	727.731
87	24	2.31400	0	HEII	336.106	737.779
88	24	2.34800	0	HEII	920.014	790.899
89	24	2.29350	0	12C16O	4.728	709.616
90	24	2.32270	0	12C16O	481.069	750.550
91	24	2.35350	0	12C16O	1019.340	800.379
92	23	2.41420	0	12C16O	329.651	889.215
93	23	2.44610	0	12C16O	851.892	938.495
94	24	2.34480	0	13C16O	862.914	785.508
95	23	2.40370	0	13C16O	165.437	874.490
96	23	2.43410	0	13C16O	650.918	919.089
(end)						

Table 1.6: List of spectral lines displayed on K -band (K+: Figures 1.11 and 1.12).

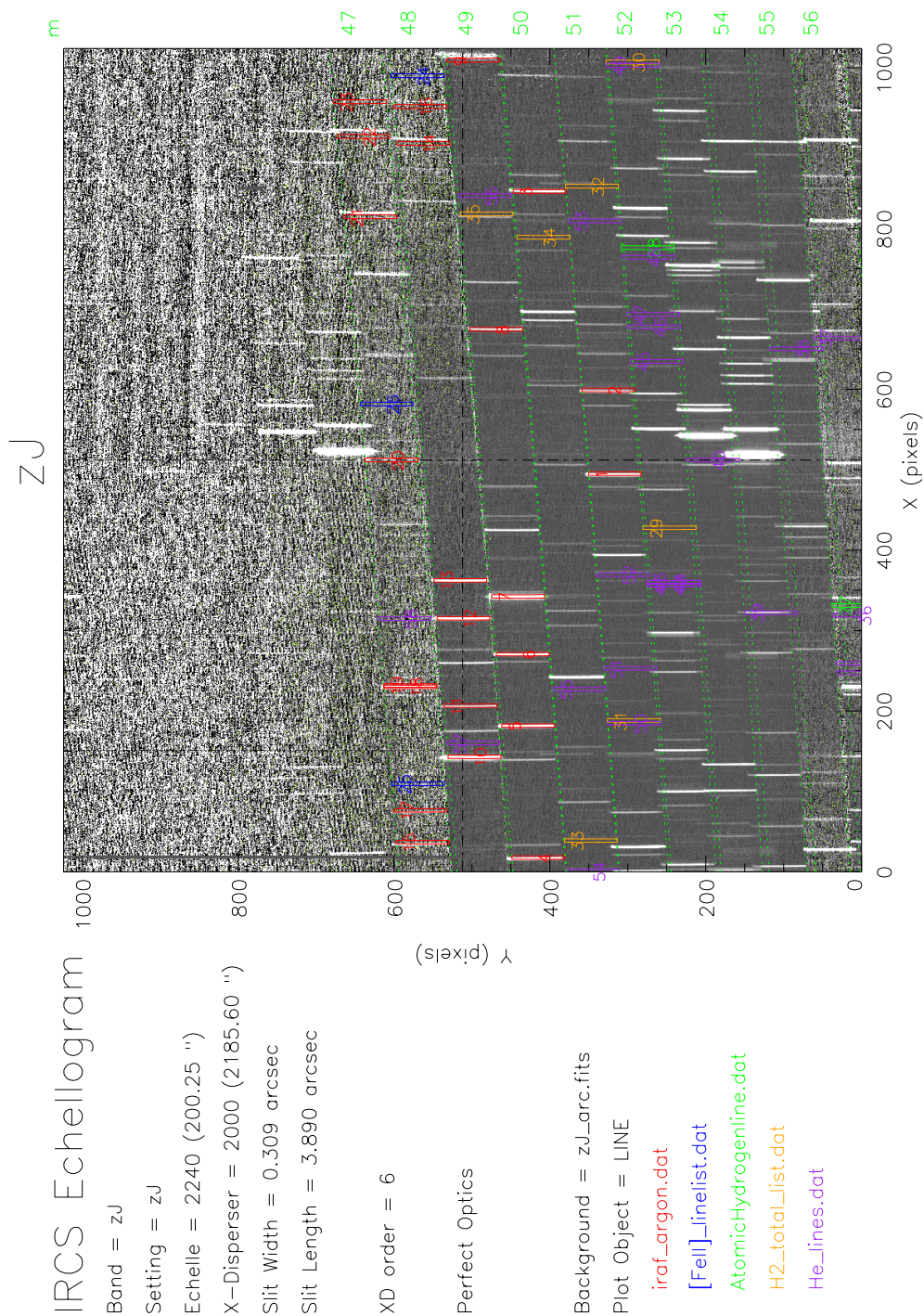
Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	29	1.95181	0.15		1	241.189
2	29	1.95611	0.12		2	332.302
3	29	1.95932	0.05		3	401.097
4	29	1.96425	0.30		4	508.118
5	29	1.96990	0.15		5	632.909
6	29	1.97029	0.35		6	641.612
7	29	1.97362	0.05		7	716.406
8	29	1.97515	0.20		8	751.076
9	29	1.97718	0.52		9	797.371
10	29	1.98397	0.22		10	954.824
11	28	2.01933	0.15		11	196.858
12	28	2.02759	1.00		12	365.722
13	28	2.03395	0.55		13	498.580
14	28	2.04127	1.28		14	654.832
15	28	2.04993	0.27		15	844.773
16	28	2.05636	1.05		16	989.731
17	27	2.08603	0.20		17	40.868
18	27	2.09096	0.33		18	135.539
19	27	2.10680	0.22		19	448.287
20	27	2.10966	0.01		20	506.283
21	27	2.11057	0.01		21	524.840
22	27	2.11159	0.24		22	545.704
23	27	2.11561	0.12		23	628.582
24	27	2.11766	0.38		24	671.255
25	27	2.12325	0.15		25	789.108
26	27	2.12497	0.41		26	825.824
27	27	2.12791	0.05		27	889.108
28	27	2.13180	0.01		28	973.874
29	27	2.13260	0.16		29	991.459
30	26	2.17111	0.25		30	130.485
31	26	2.18022	0.70		31	301.872
32	26	2.18735	0.35		32	438.947
33	26	2.19556	0.90		33	600.277
34	26	2.21255	0.80		34	947.677
35	25	2.25180	0.25		35	21.231
36	25	2.27420	0.15		36	426.934
37	29	1.95400	1.13e-4	4F(5/2)-4D(7/2)	287.448	117.966
38	29	1.96700	8.83e-4	4D(5/2)-4P(5/2)	568.560	137.253
39	29	1.97700	1.13e-4	4D(1/2)-4P(1/2)	793.253	153.296
40	27	2.08500	2.76e-4	4D(3/2)-4P(5/2)	21.234	319.300
41	29	1.94510	0.0181	Br δ (8-4)	101.250	105.673
42	26	2.16610	0.0275	Br γ (7-4)	37.893	442.180
43	25	2.27900	0.000	Pf(n-4)	516.989	610.405
44	24	2.37440	0.000343	Pf(25-5)	524.998	754.601
45	24	2.38280	0.000383	Pf(24-5)	679.297	767.653
46	24	2.39250	0.000431	Pf(23-5)	862.264	783.540
47	23	2.44900	0.000747	Pf(19-5)	43.828	870.192
48	23	2.47000	0.000877	Pf(18-5)	393.471	899.170
49	23	2.49530	0.00104	Pf(17-5)	839.891	938.640
50	29	1.94490	0.28		2-1	97.121
51	29	1.95760	1.45		1-0	364.153
52	29	1.96920	0.038		3-2	617.321
53	28	2.01300	0.021		3-2	70.041
54	28	2.03380	0.44		1-0	495.412
55	27	2.12180	1		1-0	758.327
56	27	2.12800	0.036		3-2	891.058
57	26	2.20100	0		4-3	709.415
58	26	2.20140	0.12		3-2	717.521
59	25	2.25100	0		5-4	7.148
60	25	2.26680	0		4-3	290.375
61	25	2.28700	0.037		3-2	669.848
62	24	2.34460	0		4-3	3.913
63	24	2.35550	0		5-4	190.191
64	24	2.35560	0.063		2-1	191.924

Table 1.6: List of spectral lines displayed on *K*-band (K+: Figures 1.11 and 1.12).

65	24	2.38640	0.087	3-2	746.571	773.442
66	23	2.45480	0.7	1-0	138.747	877.891
67	23	2.47560	0.21	1-0	489.697	907.443
68	23	2.50010	0.53	1-0	928.284	946.783
69	23	2.50140	0.016	3-2	952.458	949.029
70	29	1.95480	0	HeI	304.428	119.106
71	28	2.03790	0	HeII	582.433	245.092
72	28	2.04300	0	HeI	692.321	253.148
73	27	2.11260	0	HeI	566.433	358.461
74	27	2.11320	0	HeI	578.771	359.388
75	27	2.11380	0	HeI	591.140	360.319
76	27	2.11950	0	HeII	709.804	369.343
77	26	2.16530	0	HeII	23.209	441.134
78	26	2.16600	0	HeI	36.053	442.049
79	26	2.17860	0	HeII	271.106	459.148
80	26	2.18470	0	HeI	387.689	467.881
81	26	2.18910	0	HeII	473.012	474.378
82	26	2.21550	0	HeII	1010.085	517.329
83	25	2.26010	0	HeII	168.952	583.269
84	25	2.27780	0	HeII	494.363	608.594
85	24	2.34800	0	HeII	61.529	717.305
86	24	2.37880	0	HeII	605.361	761.359
87	23	2.46060	0	HeII	234.884	885.816
88	23	2.47340	0	HeI	451.732	904.164
89	25	2.29350	0	12C16O	796.803	633.345
90	24	2.35350	0	12C16O	155.664	724.649
91	24	2.38290	0	12C16O	681.153	767.812
92	23	2.47870	0	12C16O	543.559	912.130
93	24	2.34480	0	13C16O	7.289	713.127
94	24	2.37390	0	13C16O	515.928	753.844
95	23	2.46520	0	13C16O	312.048	892.270
96	23	2.49710	0	13C16O	872.890	941.667
						(end)

Chapter 2

zJ - to K -bands : Ar lines and other infrared lines



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Figure 2.1: Echellogram of the zJ -band when $ESP = 2240$ and $XSP = 2000$. The background image shows the emission lines of a Th-Ar lamp.

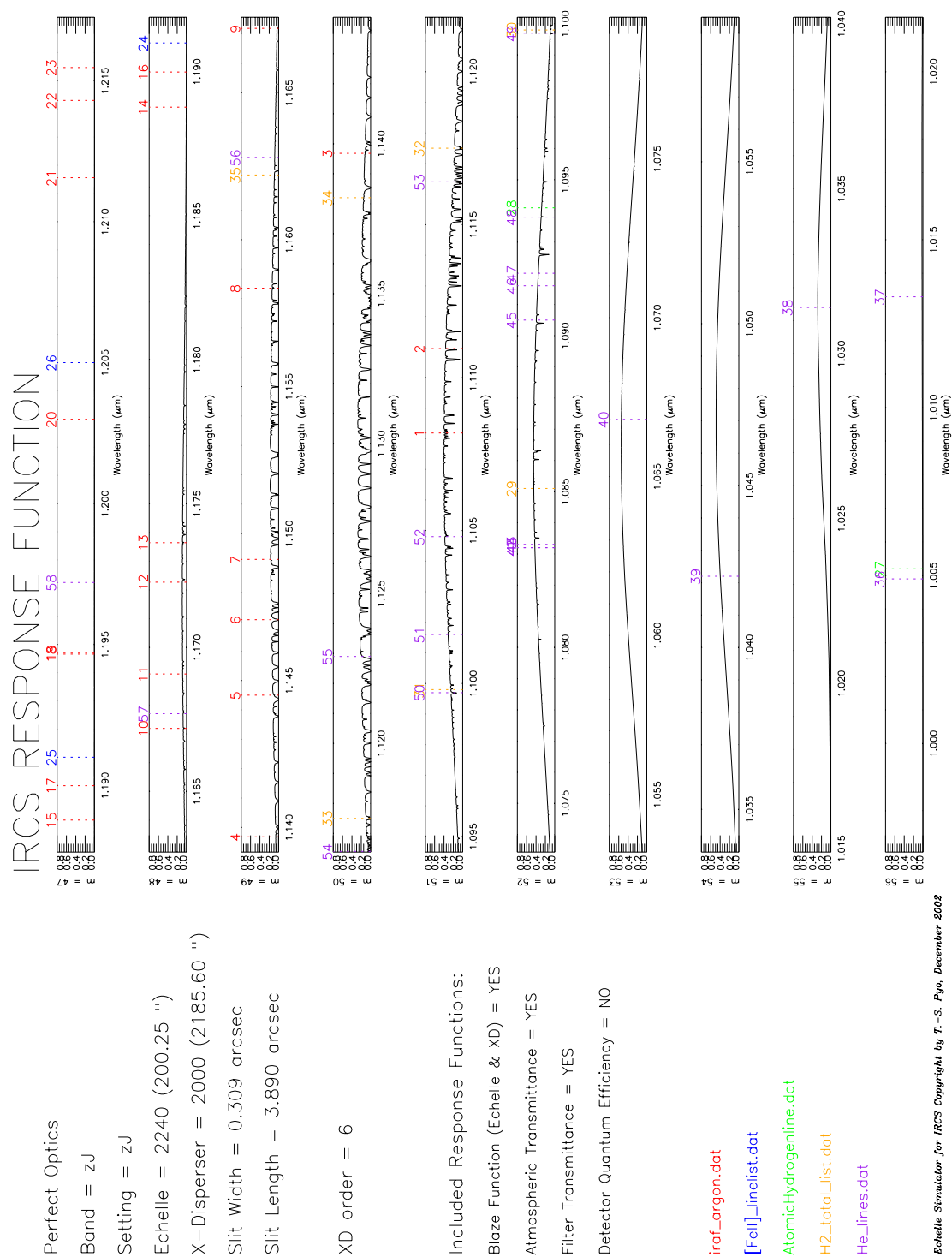
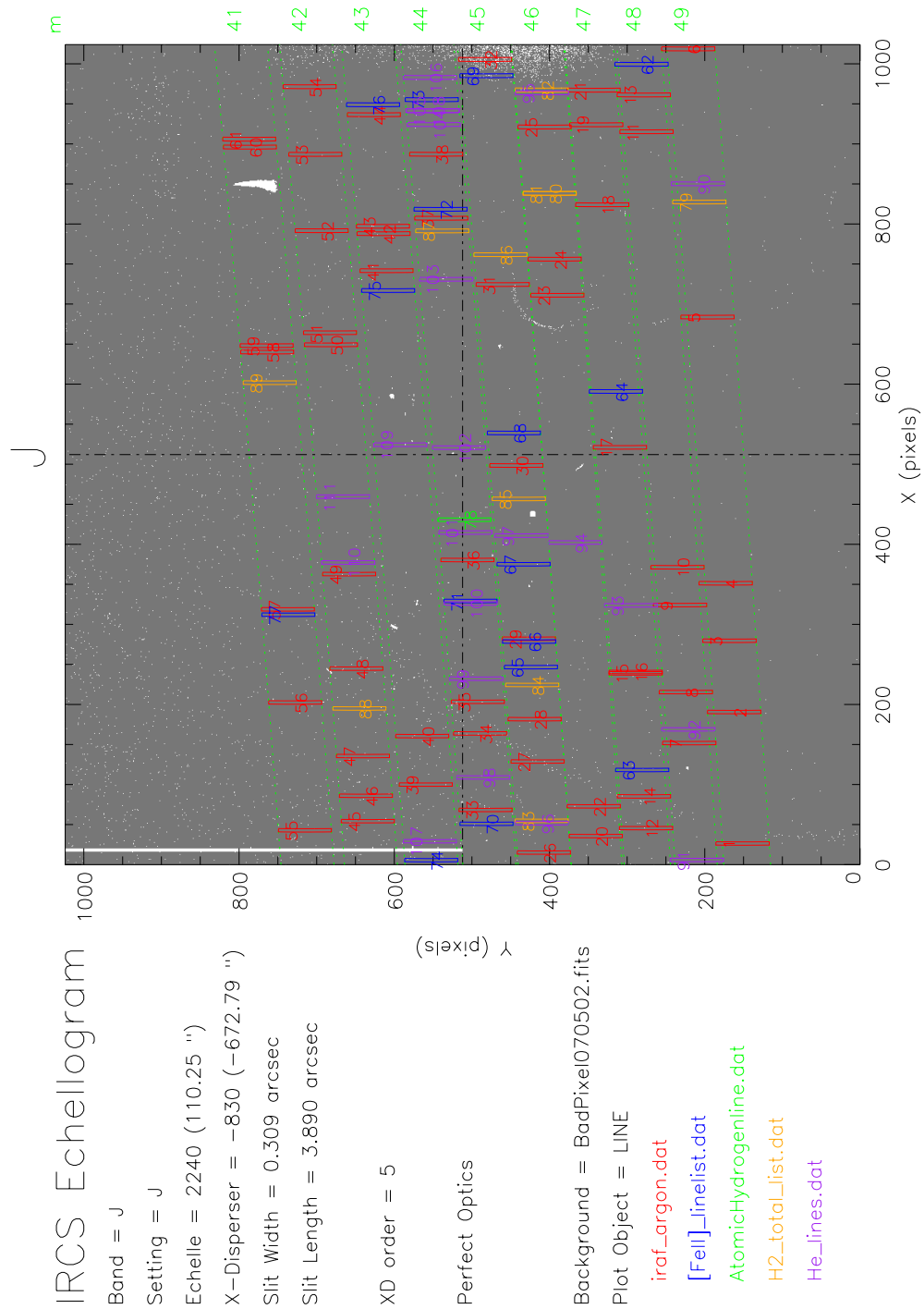


Figure 2.2: Response function of the zJ -band when ESP = 2240 and XSP = 2000.



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Figure 2.3: Echellogram of the J -band when $\text{ESP} = 2240$ and $\text{XSP} = -830$. The background is the bad pixel image.

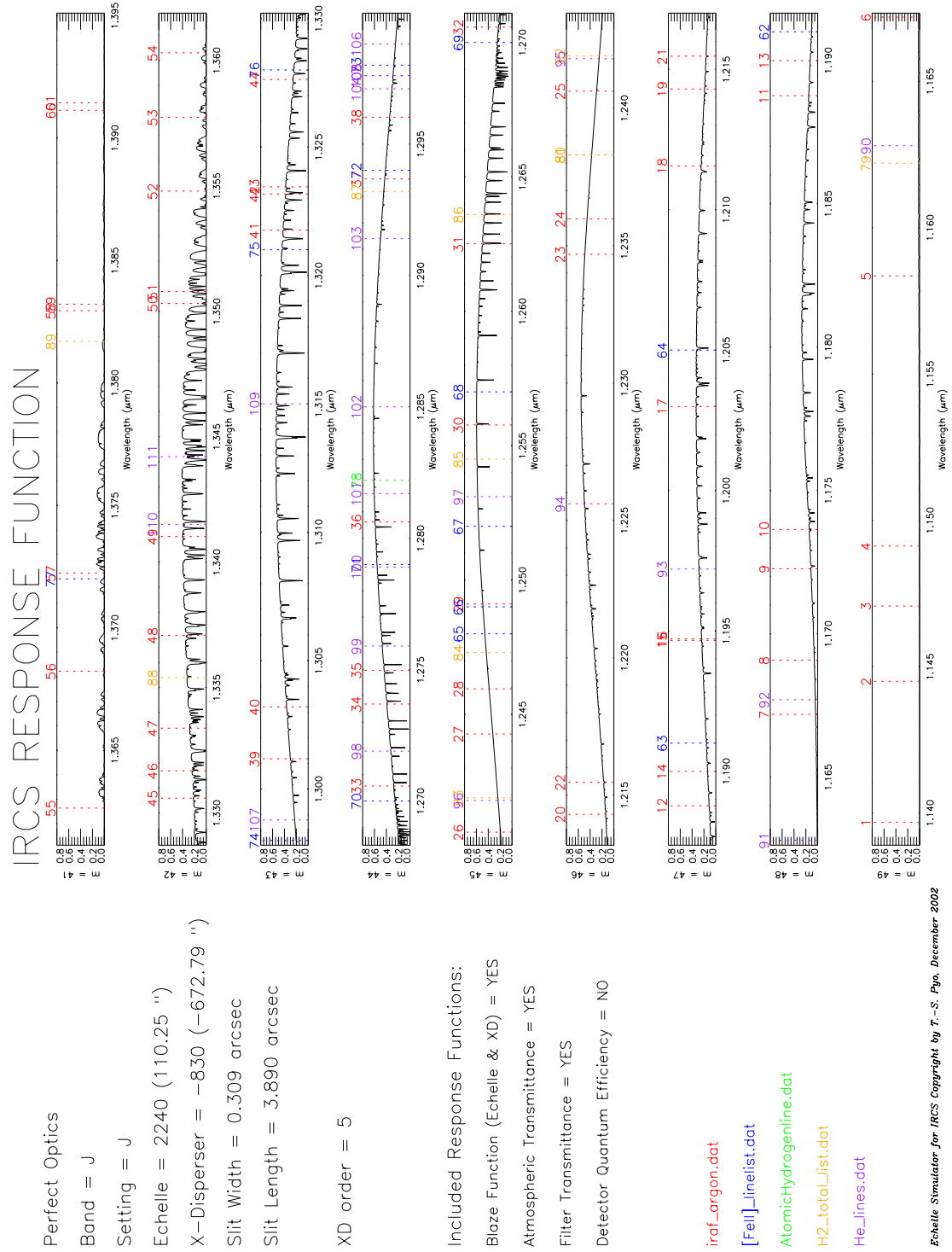
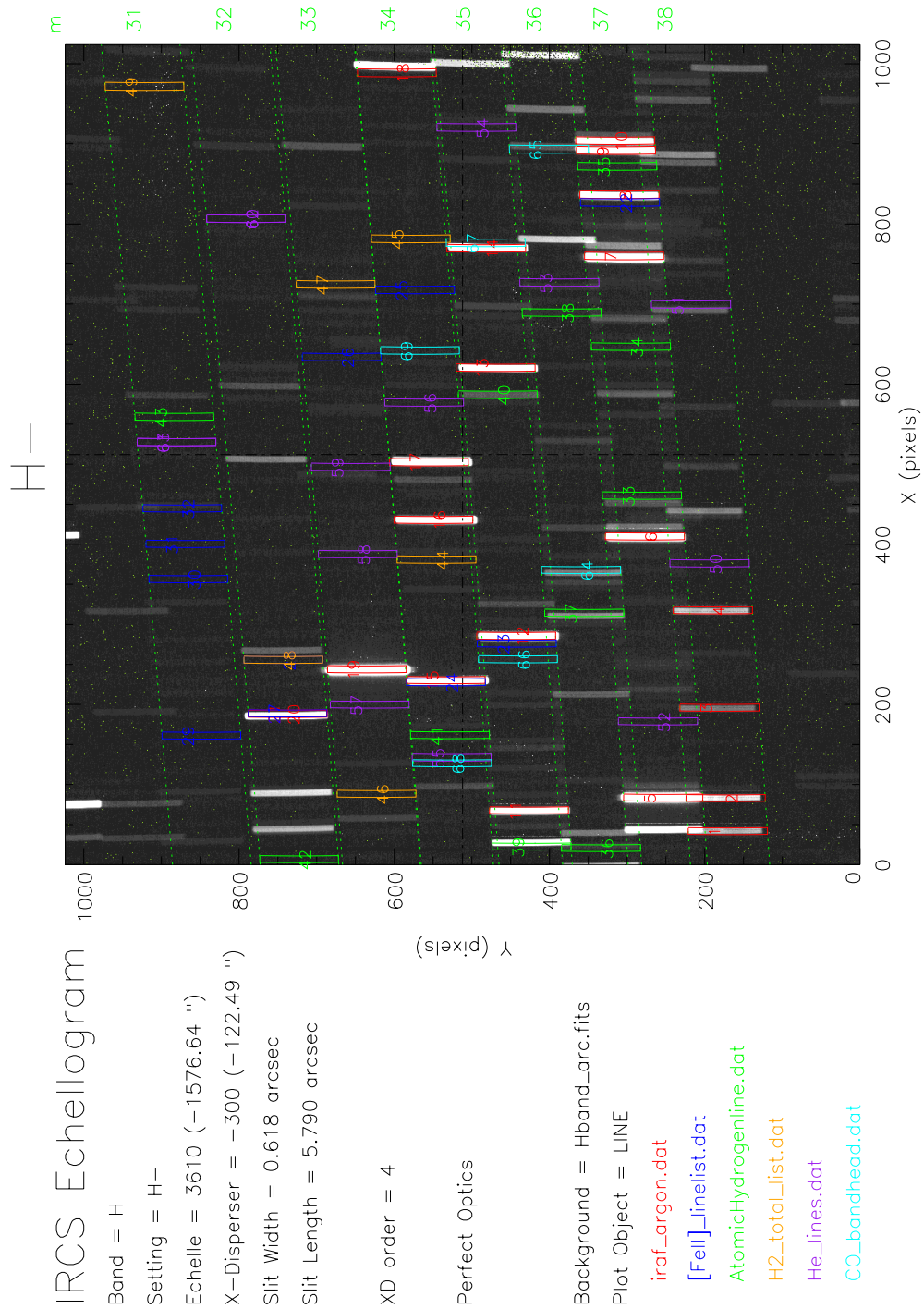


Figure 2.4: Response function of the J -band when $\text{ESP} = 2240$ and $\text{XSP} = -830$.



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Figure 2.5: Echellogram for part of the H -band when $ESP = 3610$ and $XSP = -300$. The background image shows the emission lines of a Th-Ar lamp.

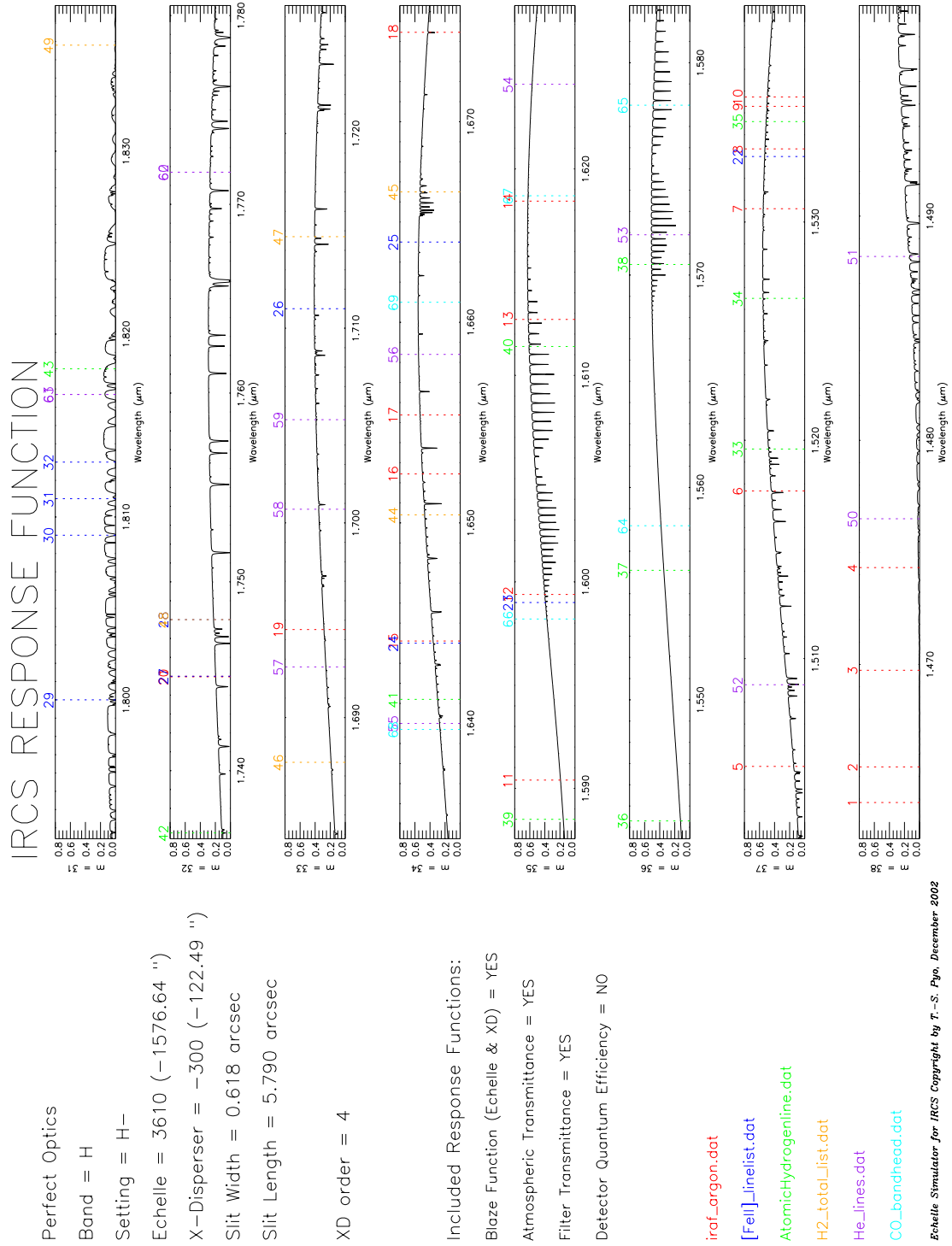
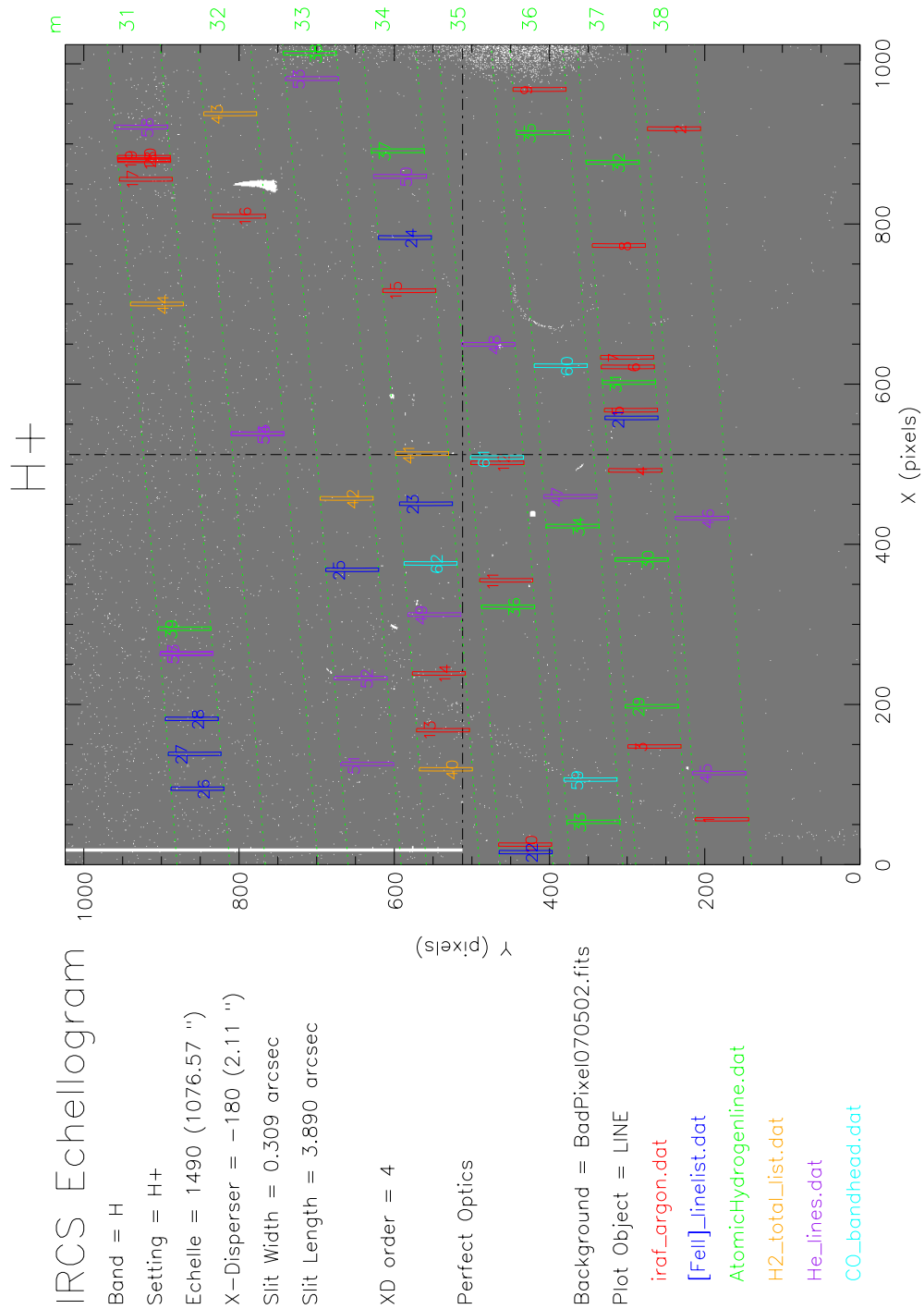


Figure 2.6: Response function for a part of the H -band when $ESP = 3610$ and $XSP = -300$.



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Figure 2.7: Echellogram for part of the H -band when $ESP = 1490$ and $XSP = -180$. The background is the bad pixel image.

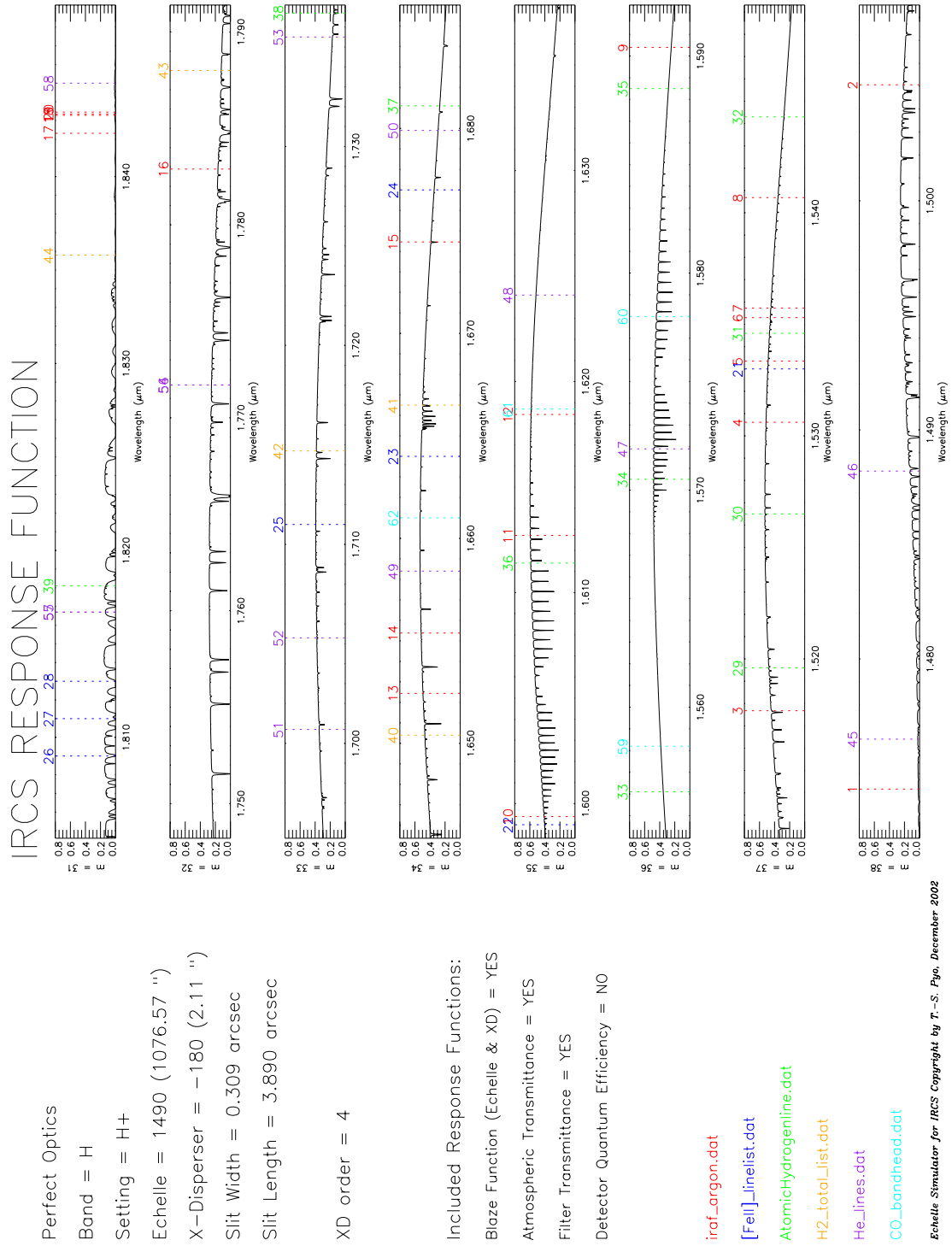
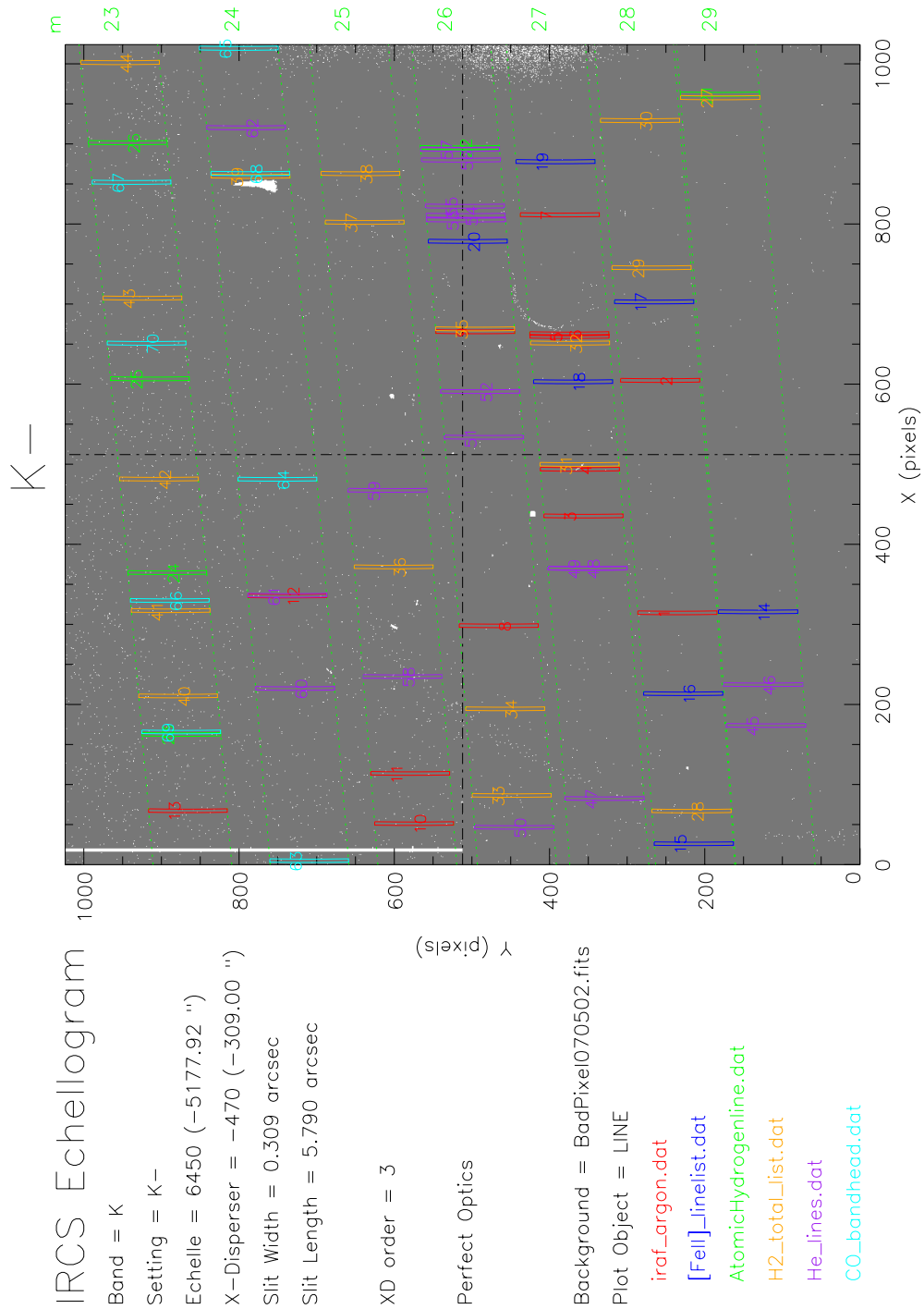


Figure 2.8: Response function for part of the H -band when $ESP = 1490$ and $XSP = -180$.



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Figure 2.9: Echellogram for part of the K -band when $ESP = 6450$ and $XSP = -470$. The background image is the bad pixel image.

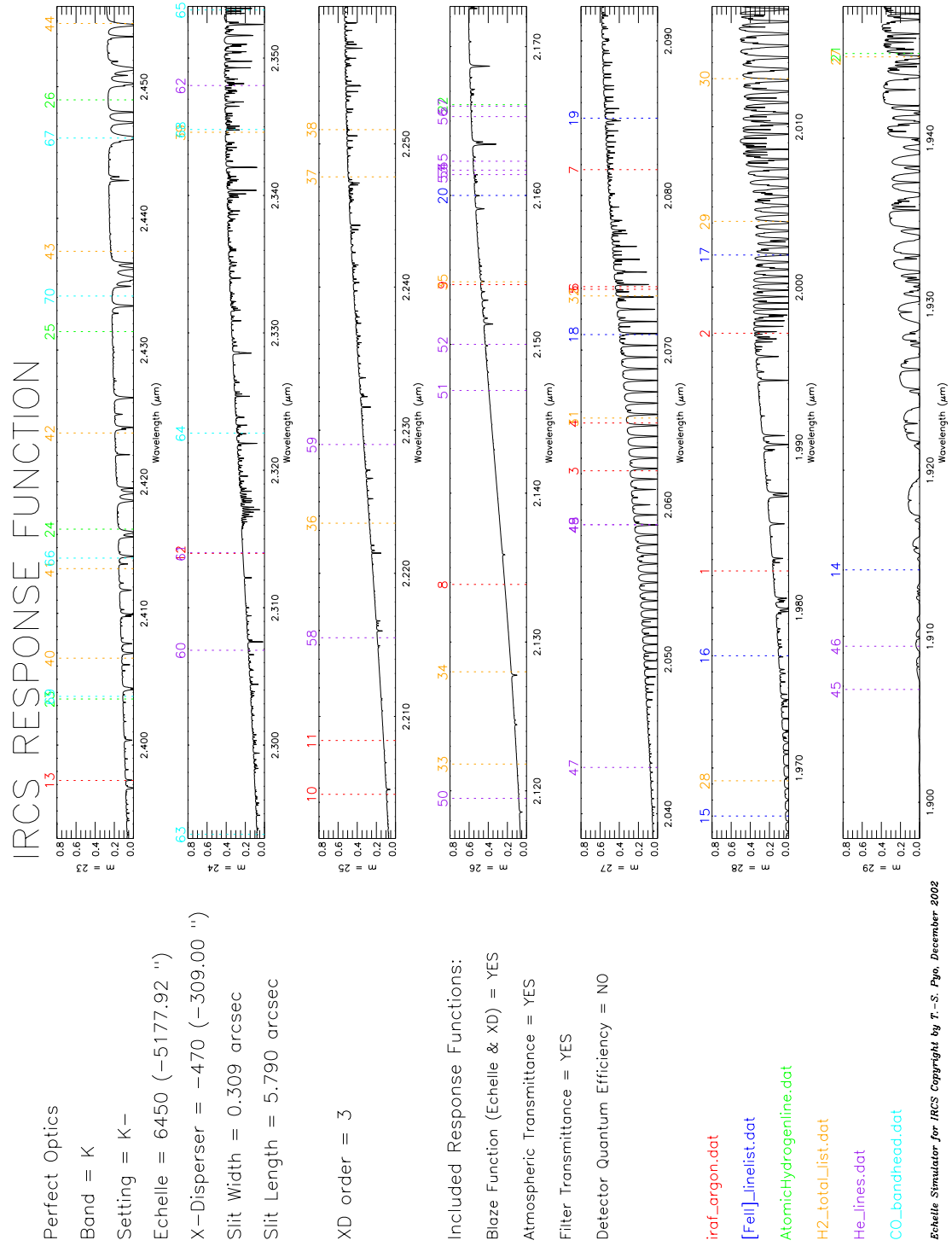
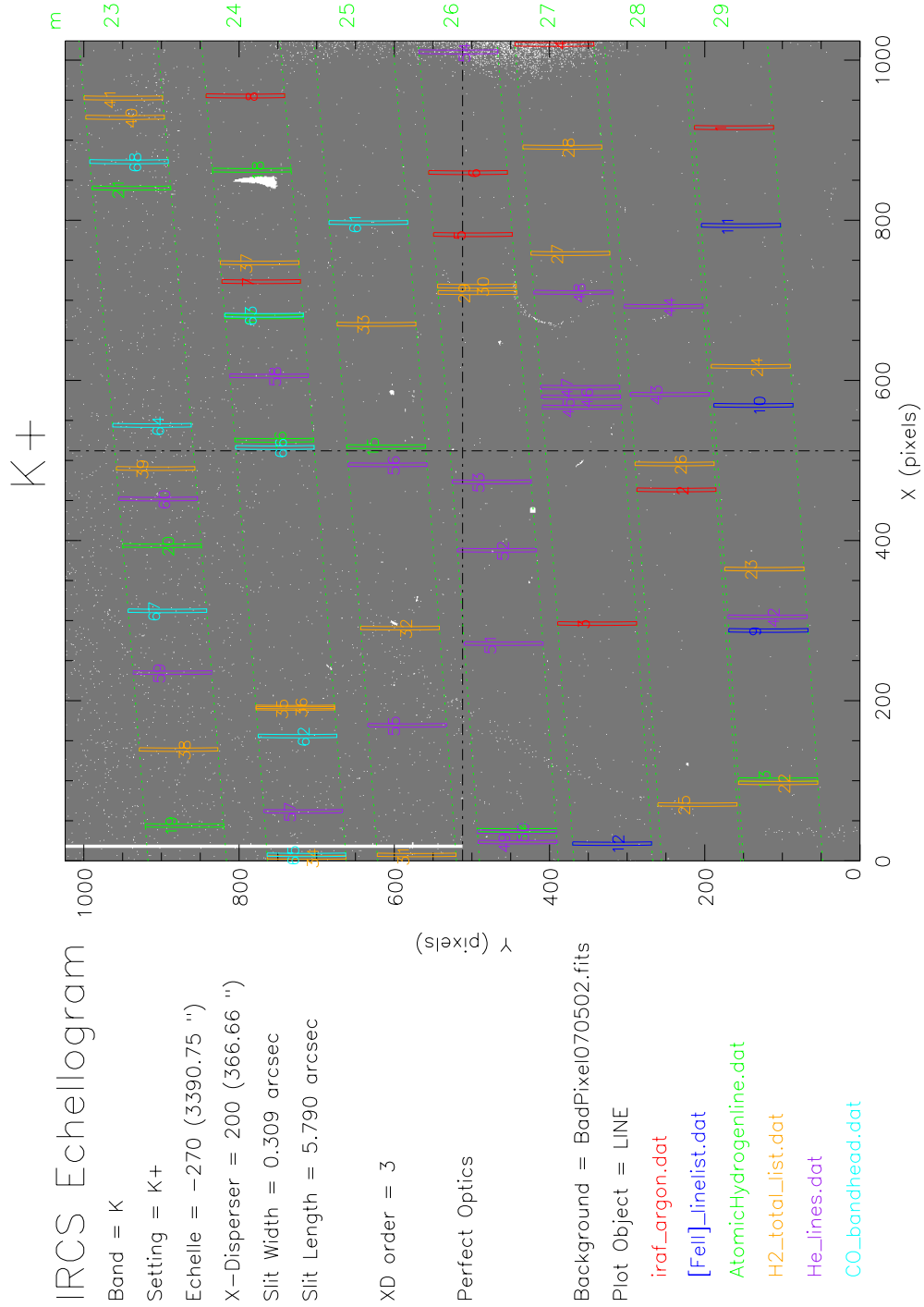


Figure 2.10: Response function for part of the *K*-band when ESP = 6450 and XSP = -470.



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Figure 2.11: Echellogram for part of the K -band when $\text{ESP} = -270$ and $\text{XSP} = 200$. The background is the bad pixel image.

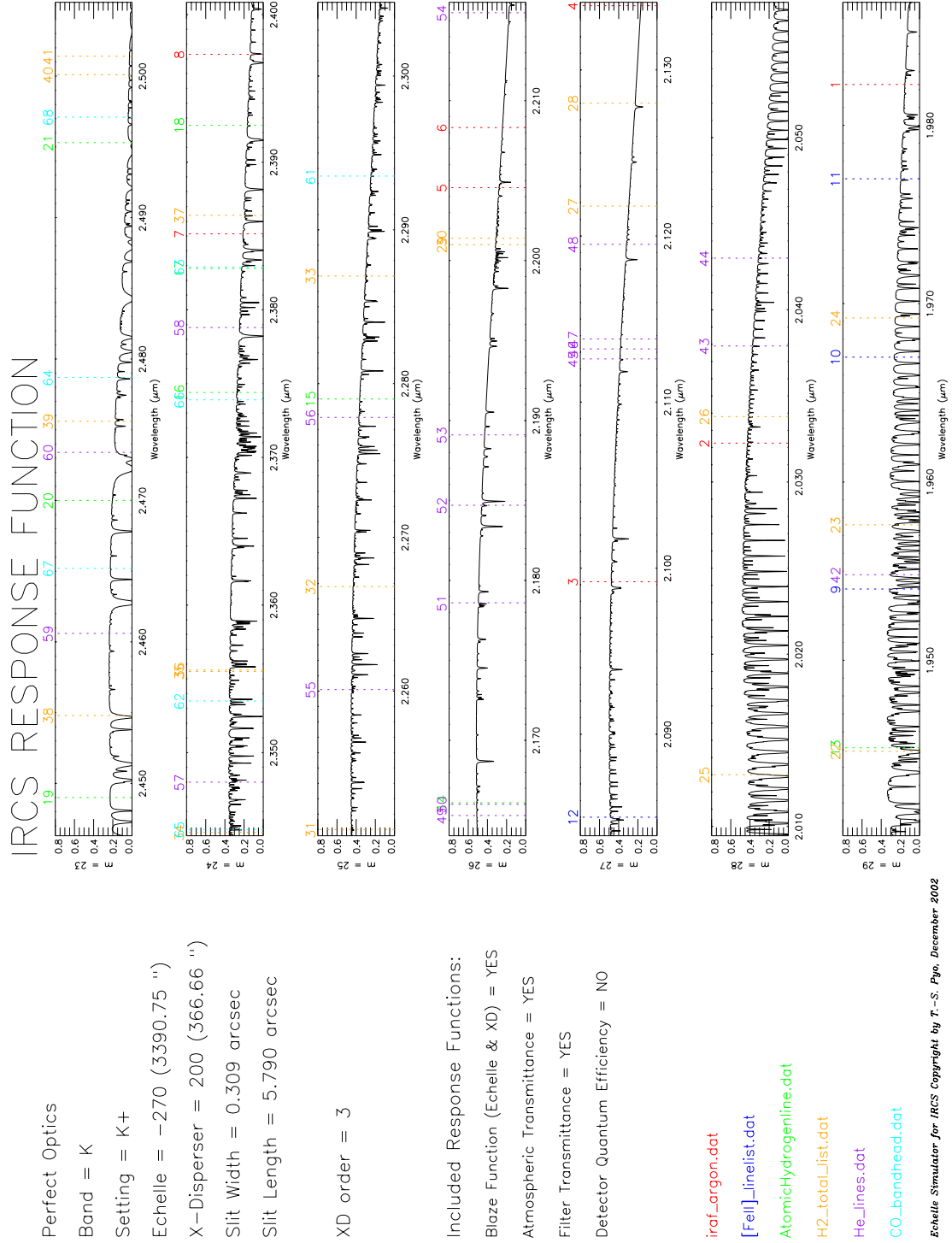


Figure 2.12: Response function for part of the K -band when $ESP = -270$ and $XSP = 200$.

Table 2.1: List of spectral lines displayed on zJ -band (Figures 2.1 and 2.2).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	51	1.10819	10		495.201	316.360
2	51	1.11095	3		599.184	324.815
3	50	1.13968	8		846.095	413.142
4	49	1.13968	8		17.508	414.794
5	49	1.14450	12		181.623	427.709
6	49	1.14707	6		270.586	434.855
7	49	1.14912	120		342.313	440.691
8	49	1.15835	1		674.568	468.594
9	49	1.16719	200		1009.286	498.149
10	48	1.16719	200		142.832	496.737
11	48	1.16908	1		206.486	501.909
12	48	1.17227	10		315.150	510.863
13	48	1.17364	9		362.314	514.797
14	48	1.18877	4		905.884	562.265
15	47	1.18877	4		36.697	563.181
16	48	1.18999	1		951.770	566.451
17	47	1.18999	1		76.326	566.404
18	47	1.19466	12		229.895	579.094
19	47	1.19471	B		231.559	579.234
20	47	1.20299	2		511.970	603.233
21	47	1.21156	150		814.717	630.335
22	47	1.21430	30		914.586	639.546
23	47	1.21547	2		957.724	643.567
24	48	1.19100	2.67e-6	6D(9/2)-4D(5/2)	990.014	569.960
25	47	1.19100	2.67e-6	6D(9/2)-4D(5/2)	109.279	569.100
26	47	1.20500	1.14e-6	6D(7/2)-4D(3/2)	581.753	609.370
27	56	1.00520	0.0000	Pa δ (7-3)	331.070	3.703
28	52	1.09410	0.0901	Pa γ (6-3)	776.276	274.466
29	52	1.08510	0.44	2-0	427.721	246.409
30	52	1.09980	0.15	2-0	1007.134	293.864
31	51	1.09980	0.15	2-0	188.158	292.179
32	51	1.11750	0.43	2-0	852.668	345.990
33	50	1.11750	0.43	2-0	38.634	347.307
34	50	1.13820	0.12	2-0	789.135	408.227
35	49	1.16220	0.23	2-0	818.166	481.096
36	56	1.00490	0	HEII	319.040	2.838
37	56	1.01330	0	HEII	663.774	28.282
38	55	1.03140	0	HEI	650.409	83.357
39	54	1.04220	0	HEII	322.190	116.409
40	53	1.06680	0	HEI	511.874	190.766
41	52	1.08320	0	HEI	356.331	240.846
42	52	1.08320	0	HEI	356.331	240.846
43	52	1.08330	0	HEI	360.073	241.136
44	52	1.08330	0	HEI	360.073	241.136
45	52	1.09050	0	HEI	634.676	262.889
46	52	1.09160	0	HEI	677.618	266.374
47	52	1.09200	0	HEI	693.305	267.653
48	52	1.09380	0	HEII	764.354	273.482
49	52	1.09970	0	HEI	1003.007	293.512
50	51	1.09970	0	HEI	184.575	291.903
51	51	1.10160	0	HEI	252.963	297.185
52	51	1.10480	0	HEI	369.571	306.324
53	51	1.11640	0	HEII	809.397	342.318
54	50	1.11640	0	HEII	0.798	344.425
55	50	1.12290	0	HEI	227.057	361.930
56	49	1.16280	0	HEII	840.837	483.094
57	48	1.16770	0	HEII	159.960	498.123
58	47	1.19720	0	HEI	314.751	586.243
(end)						

Table 2.2: List of spectral lines displayed on J -band (Figures 2.3 and 2.4).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	49	1.13968	8		1	26.281
2	49	1.14450	12		2	190.468
3	49	1.14707	6		3	279.472
4	49	1.14912	120		4	351.235
5	49	1.15835	1		5	683.677
6	49	1.16719	200		6	1018.621
7	48	1.16719	200		7	151.659
8	48	1.16908	1		8	215.342
9	48	1.17227	10		9	324.059
10	48	1.17364	9		10	371.247
11	48	1.18877	4		11	915.145
12	47	1.18877	4		12	45.478
13	48	1.18999	1		13	961.063
14	47	1.18999	1		14	85.124
15	47	1.19466	12		15	238.762
16	47	1.19471	B		16	240.427
17	47	1.20299	2		17	520.983
18	47	1.21156	150		18	823.915
19	47	1.21430	30		19	923.852
20	46	1.21430	30		20	35.562
21	47	1.21547	2		21	967.021
22	46	1.21547	2		22	72.719
23	46	1.23468	30		23	710.946
24	46	1.23597	10		24	755.996
25	46	1.24062	100		25	921.052
26	45	1.24062	100		26	14.991
27	45	1.24427	300		27	128.644
28	45	1.24595	100		28	181.516
29	45	1.24911	200		29	281.970
30	45	1.25577	2		30	498.307
31	45	1.26251	2		31	724.329
32	45	1.27057	100		32	1005.395
33	44	1.27057	100		33	68.191
34	44	1.27369	30		34	163.720
35	44	1.27497	12		35	203.254
36	44	1.28062	200		36	380.296
37	44	1.29367	40		37	807.125
38	44	1.29602	500		38	887.021
39	43	1.30118	200		39	99.835
40	43	1.30320	2		40	160.388
41	43	1.32176	200		41	741.582
42	43	1.32317	200		42	787.827
43	43	1.32345	200		43	797.051
44	43	1.32763	500		44	936.373
45	42	1.33059	4		45	54.169
46	42	1.33168	800		46	85.834
47	42	1.33338	6		47	135.486
48	42	1.33708	1000		48	244.665
49	42	1.34102	100		49	362.699
50	42	1.35031	30		50	649.015
51	42	1.35079	1000		51	664.140
52	42	1.35479	8		52	791.558
53	42	1.35773	12		53	886.850
54	42	1.36030	40		54	971.363
55	41	1.36264	400		55	42.755
56	41	1.36823	200		56	202.373
57	41	1.37223	1000		57	318.676
58	41	1.38295	B		58	639.976
59	41	1.38321	9		59	647.957
60	41	1.39113	8		60	895.933
61	41	1.39144	50		61	905.839
62	48	1.19100	2.67e-6	6D(9/2)-4D(5/2)	999.334	281.500
63	47	1.19100	2.67e-6	6D(9/2)-4D(5/2)	118.091	280.606
64	47	1.20500	1.14e-6	6D(7/2)-4D(3/2)	590.806	314.435
65	45	1.24800	8.51e-5	6D(5/2)-4D(3.2)	246.534	423.924

Table 2.2: List of spectral lines displayed on J -band (Figures 2.3 and 2.4).

66	45	1.24900	3.19e-4	6D(7/2)-4D(5/2)	278.450	426.270
67	45	1.25200	6.48e-4	6D(3/2)-4D(1/2)	375.048	433.445
68	45	1.25700	4.83e-3	6D(9/2)-4D(7/2)	538.999	445.873
69	45	1.27000	2.91e-3	6D(1/2)-4D(1/2)	985.094	481.290
70	44	1.27000	2.91e-3	6D(1/2)-4D(1/2)	50.865	481.161
71	44	1.27900	2.25e-3	6D(3/2)-4D(3/2)	329.100	501.820
72	44	1.29400	1.94e-3	6D(5/2)-4D(5/2)	818.285	540.400
73	44	1.29800	1.00e-3	6D(1/2)-4D(3/2)	955.143	551.708
74	43	1.29800	1.00e-3	6D(1/2)-4D(3/2)	5.445	552.418
75	43	1.32100	1.33e-3	6D(7/2)-4D(7/2)	716.794	607.918
76	43	1.32800	1.21e-3	6D(3/2)-4D(5/2)	948.854	627.371
77	41	1.37200	9.03e-4	6D(5/2)-4D(7/2)	311.940	736.473
78	44	1.28220	0.1620	Pa β (5-3)	430.582	509.587
79	49	1.16220	0.23	2-0	827.366	206.990
80	46	1.23830	0.043	2-0	838.159	399.804
81	46	1.23830	0.12	2-9	838.159	399.804
82	46	1.24190	0.045	2-0	967.264	410.049
83	45	1.24190	0.045	2-0	54.663	410.071
84	45	1.24730	0.24	2-0	224.270	422.294
85	45	1.25450	0.056	2-0	456.550	439.584
86	45	1.26360	0.17	2-0	761.619	463.255
87	44	1.29320	0.024	2-0	791.267	538.194
88	42	1.33540	0.094	2-0	194.897	644.947
89	41	1.38170	0.03	2-0	601.738	760.513
90	49	1.16280	0	HEII	850.053	208.669
91	48	1.16280	0	HEII	5.721	210.178
92	48	1.16770	0	HEII	168.795	221.136
93	47	1.19720	0	HEI	323.659	295.008
94	46	1.22560	0	HEII	402.185	366.624
95	46	1.24180	0	HEII	963.641	409.759
96	45	1.24180	0	HEII	51.556	409.850
97	45	1.25310	0	HEI	410.796	436.128
98	44	1.27190	0	HEII	108.775	485.384
99	44	1.27590	0	HEI	232.109	494.513
100	44	1.27890	0	HEI	325.951	501.581
101	44	1.28170	0	HEII	414.634	508.358
102	44	1.28500	0	HEI	520.591	516.579
103	44	1.29140	0	HEII	730.892	533.296
104	44	1.29710	0	HEI	924.085	549.122
105	44	1.29760	0	HEI	941.321	550.556
106	44	1.29880	0	HEI	982.887	554.027
107	43	1.29880	0	HEI	29.090	554.163
108	44	1.29760	0	HEI	941.321	550.556
109	43	1.31500	0	HEII	524.271	592.283
110	42	1.34150	0	HEI	377.214	659.328
111	42	1.34420	0	HEII	459.392	665.947
(end)						

Table 2.3: List of spectral lines displayed on H -band (H-: Figures 2.5 and 2.6).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	38	1.46384	30		41.603	170.243
2	38	1.46543	30		82.835	173.075
3	38	1.46974	4		195.687	180.921
4	38	1.47432	5		317.436	189.545
5	37	1.50506	100		83.436	253.475
6	37	1.51768	25		409.682	277.138
7	37	1.53061	40		759.888	303.891
8	37	1.53335	9		836.496	309.930
9	37	1.53530	7		891.578	314.313
10	37	1.53573	3		903.786	315.289
11	35	1.59040	10		67.565	426.432
12	35	1.59939	25		285.410	442.910
13	35	1.61271	1		620.340	469.360
14	35	1.61844	4		769.533	481.577
15	34	1.64411	13		230.199	533.574
16	34	1.65244	30		430.276	549.518
17	34	1.65538	8		502.218	555.372
18	34	1.67446	9		988.579	596.631
19	33	1.69452	500		243.746	635.212
20	32	1.74497	11		187.999	737.352
21	32	1.74500	B		188.666	737.408
22	37	1.53300	2.44e-3	4F(9/2)-4D(5/2)	826.660	309.151
23	35	1.59900	3.28e-3	4F(7/2)-4D(3/2)	275.831	442.174
24	34	1.64400	4.65e-3	4F(9/2)-4D(7/2)	227.597	533.370
25	34	1.66400	3.73e-3	4F(5/2)-4D(1/2)	717.528	573.276
26	33	1.71100	9.20e-4	4F(5/2)-4D(3/2)	633.706	667.739
27	32	1.74500	1.95e-3	4F(3/2)-4D(1/2)	188.668	737.408
28	32	1.74800	1.92e-3	4D(7/2)-4P(3/2)	255.522	742.963
29	31	1.80000	1.43e-3	4F(5/2)-4D(5/2)	160.980	848.489
30	31	1.80900	1.03e-3	4F(7/2)-4D(7/2)	356.209	865.323
31	31	1.81100	1.84e-3	4D(7/2)-4P(5/2)	400.289	869.196
32	31	1.81300	2.34e-3	4D(5/2)-4P(1/2)	444.640	873.119
33	37	1.51960	0.00116	Br(20-4)	460.592	280.940
34	37	1.52650	0.00133	Br(19-4)	646.623	295.085
35	37	1.53460	0.00156	Br(18-4)	871.749	312.731
36	36	1.54430	0.00184	Br(17-4)	20.449	333.635
37	36	1.55610	0.00220	Br(16-4)	314.221	355.234
38	36	1.57050	0.00266	Br(15-4)	689.225	384.275
39	35	1.58850	0.00327	Br(14-4)	22.283	423.079
40	35	1.61140	0.00409	Br(13-4)	586.691	466.641
41	34	1.64120	0.00521	Br(12-4)	161.534	528.217
42	32	1.73670	0.00909	Br(10-4)	6.613	722.578
43	31	1.81810	0.0126	Br(9-4)	558.997	883.359
44	34	1.65040	0.037	1-0	380.778	545.527
45	34	1.66650	0.034	1-0	781.278	578.687
46	33	1.68770	0.22	1-0	88.151	622.776
47	33	1.71470	0.14	1-0	724.322	675.575
48	32	1.74800	0.65	1-0	255.522	742.963
49	31	1.83580	1.21	1-0	971.597	921.785
50	38	1.47650	0	HEII	376.084	193.758
51	38	1.48820	0	HEII	699.340	217.666
52	37	1.50880	0	HEI	178.688	260.258
53	36	1.57190	0	HEII	726.791	387.275
54	35	1.62410	0	HEII	920.318	494.196
55	34	1.64000	0	HEII	133.390	526.039
56	34	1.65840	0	HEII	576.890	561.516
57	33	1.69260	0	HEII	199.631	631.655
58	33	1.70070	0	HEI	387.538	646.980
59	33	1.70530	0	HEII	496.419	656.066
60	32	1.77170	0	HEII	806.504	790.993
61	31	1.81670	0	HEII	527.420	880.514
62	32	1.77170	0	HEII	806.504	790.993
63	31	1.81670	0	HEII	527.420	880.514
64	36	1.55820	0	12C16O	367.703	359.275
65	36	1.57800	0	12C16O	893.035	400.749

Table 2.3: List of spectral lines displayed on H -band (H-: Figures 2.5 and 2.6).

66	35	1.59820	0	12C16O	256.220	440.669
67	35	1.61870	0	12C16O	776.386	482.144
68	34	1.63970	0	12C16O	126.373	525.497
69	34	1.66100	0	12C16O	641.823	566.915
						(end)

Table 2.4: List of spectral lines displayed on *H*-band (H+: Figures 2.7 and 2.8).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	38	1.47432	5		56.491	177.667
2	38	1.50506	100		918.781	239.578
3	37	1.51768	25		147.460	264.801
4	37	1.53061	40		492.140	289.519
5	37	1.53335	9		567.389	295.096
6	37	1.53530	7		621.458	299.144
7	37	1.53573	3		633.438	300.046
8	37	1.54068	6		772.977	310.666
9	36	1.59040	10		967.958	412.876
10	35	1.59939	25		24.891	431.400
11	35	1.61271	1		354.927	455.839
12	35	1.61844	4		501.618	467.125
13	34	1.65244	30		167.760	537.195
14	34	1.65538	8		238.643	542.604
15	34	1.67446	9		716.602	580.713
16	32	1.78289	5		809.530	799.905
17	31	1.84232	2		855.744	920.019
18	31	1.84328	10		879.014	922.174
19	31	1.84334	B		880.473	922.309
20	31	1.84345	B		883.145	922.557
21	37	1.53300	2.44e-3	4F(9/2)-4D(5/2)	557.731	294.377
22	35	1.59900	3.28e-3	4F(7/2)-4D(3/2)	15.439	430.719
23	34	1.66400	3.73e-3	4F(5/2)-4D(1/2)	450.509	559.145
24	34	1.67700	1.94e-3	4F(7/2)-4D(5/2)	782.877	586.222
25	33	1.71100	9.20e-4	4F(5/2)-4D(3/2)	368.077	654.151
26	31	1.80900	1.03e-3	4F(7/2)-4D(7/2)	94.737	853.631
27	31	1.81100	1.84e-3	4D(7/2)-4P(5/2)	138.201	857.210
28	31	1.81300	2.34e-3	4D(5/2)-4P(1/2)	181.916	860.834
29	37	1.51960	0.00116	Br(20-4)	197.634	268.314
30	37	1.52650	0.00133	Br(19-4)	380.784	281.384
31	37	1.53460	0.00156	Br(18-4)	601.997	297.684
32	37	1.54430	0.00184	Br(17-4)	876.992	318.728
33	36	1.55610	0.00220	Br(16-4)	53.319	343.493
34	36	1.57050	0.00266	Br(15-4)	422.683	370.326
35	36	1.58850	0.00327	Br(14-4)	913.834	408.496
36	35	1.61140	0.00409	Br(13-4)	321.814	453.327
37	34	1.68110	0.00679	Br(11-4)	891.344	595.356
38	33	1.73670	0.00909	Br(10-4)	1013.204	708.865
39	31	1.81810	0.0126	Br(9-4)	294.554	870.295
40	34	1.65040	0.037	1-0	118.964	533.508
41	34	1.66650	0.034	1-0	513.157	564.143
42	33	1.71470	0.14	1-0	457.187	661.391
43	32	1.78800	0.31	1-0	937.514	811.402
44	31	1.83580	1.21	1-0	699.952	905.782
45	38	1.47650	0	HEII	114.336	181.560
46	38	1.48820	0	HEII	432.628	203.651
47	36	1.57190	0	HEII	459.614	373.097
48	35	1.62410	0	HEII	649.658	478.779
49	34	1.65840	0	HEII	312.167	548.281
50	34	1.67990	0	HEII	859.402	592.651
51	33	1.70070	0	HEI	125.629	634.971
52	33	1.70530	0	HEII	232.930	643.367
53	33	1.73550	0	HEII	981.568	706.058
54	32	1.77170	0	HEII	537.936	776.227
55	31	1.81670	0	HEII	263.463	867.666
56	32	1.77170	0	HEII	537.936	776.227
57	31	1.81670	0	HEII	263.463	867.666
58	31	1.84500	0	HEII	920.928	926.074
59	36	1.55820	0	12C16O	106.072	347.227
60	36	1.57800	0	12C16O	622.888	385.542
61	35	1.61870	0	12C16O	508.351	467.649
62	34	1.66100	0	12C16O	376.063	553.269
(end)						

Table 2.5: List of spectral lines displayed on *K*-band (K-: Figures 2.9 and 2.10).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	28	1.98229	5		314.216	235.215
2	28	1.99712	4		604.466	257.426
3	27	2.06219	50		435.175	356.210
4	27	2.06528	2		493.525	360.836
5	27	2.07393	2		659.401	374.202
6	27	2.07410	B		662.699	374.471
7	27	2.08167	2		811.208	386.715
8	26	2.13387	1		298.118	465.363
9	26	2.15401	8		665.255	495.617
10	25	2.20456	1		51.069	574.430
11	25	2.20832	8		113.702	579.476
12	24	2.31395	20		335.284	737.707
13	23	2.39731	20		67.102	865.848
14	29	1.91400	7.81e-4	4D(3/2)-4P(1/2)	315.509	131.278
15	28	1.96700	8.83e-4	4D(5/2)-4P(5/2)	25.882	214.087
16	28	1.97700	1.13e-4	4D(1/2)-4P(1/2)	213.295	227.714
17	28	2.00200	5.79e-4	4D(3/2)-4P(3/2)	702.568	265.146
18	27	2.07100	5.12e-4	4D(1/2)-4P(3/2)	602.787	369.604
19	27	2.08500	2.76e-4	4D(3/2)-4P(5/2)	877.585	392.270
20	26	2.16000	2.89e-5	4D(1/2)-4P(5/2)	778.172	505.249
21	29	1.94510	0.0181	Br δ (8-4)	961.890	180.381
22	26	2.16610	0.0275	Br γ (7-4)	895.120	515.387
23	23	2.40350	0.000489	Pf(22-5)	162.341	874.216
24	23	2.41640	0.000558	Pf(21-5)	364.492	892.386
25	23	2.43140	0.000643	Pf(20-5)	606.493	914.874
26	23	2.44900	0.000747	Pf(19-5)	901.370	943.357
27	29	1.94490	0.28	2-1	957.535	180.035
28	28	1.96920	0.038	3-2	66.753	217.025
29	28	2.00410	0.15	2-1	745.214	268.536
30	28	2.01300	0.021	3-2	928.984	283.377
31	27	2.06560	0.088	3-2	499.596	361.320
32	27	2.07350	0.47	2-1	651.062	373.522
33	26	2.12180	1	1-0	86.195	448.640
34	26	2.12800	0.036	3-2	194.360	457.108
35	26	2.15420	0.14	2-1	668.813	495.918
36	25	2.22350	0.19	1-0	371.605	600.775
37	25	2.24770	0.33	2-1	801.968	638.176
38	25	2.25100	0	5-4	862.765	643.647
39	24	2.34460	0	4-3	859.363	785.174
40	23	2.40660	0.57	1-0	210.453	878.490
41	23	2.41340	0.21	1-0	317.014	888.069
42	23	2.42370	0.7	1-0	481.278	903.139
43	23	2.43750	0.24	1-0	707.267	924.474
44	23	2.45480	0.7	1-0	1001.469	953.296
45	29	1.90680	0	HEI	173.582	121.103
46	29	1.90940	0	HEI	224.542	124.731
47	27	2.04300	0	HEI	82.332	329.082
48	27	2.05870	0	HEI	369.812	351.076
49	27	2.05870	0	HEI	369.812	351.076
50	26	2.11950	0	HEII	46.421	445.562
51	26	2.14690	0	HEII	533.546	484.576
52	26	2.15000	0	HEI	590.681	489.340
53	26	2.16140	0	HEI	804.832	507.545
54	26	2.16170	0	HeI	810.557	508.040
55	26	2.16230	0	HEI	822.032	509.032
56	26	2.16530	0	HEII	879.664	514.037
57	26	2.16600	0	HeI	893.183	515.217
58	25	2.21550	0	HEII	234.651	589.361
59	25	2.22900	0	HEI	467.203	608.882
60	24	2.30690	0	HEI	219.800	727.731
61	24	2.31400	0	HEII	336.106	737.779
62	24	2.34800	0	HEII	920.014	790.899
63	24	2.29350	0	12C16O	4.728	709.616
64	24	2.32270	0	12C16O	481.069	750.550

Table 2.5: List of spectral lines displayed on K -band (K-: Figures 2.9 and 2.10).

65	24	2.35350	0	12C16O	1019.340	800.379
66	23	2.41420	0	12C16O	329.651	889.215
67	23	2.44610	0	12C16O	851.892	938.495
68	24	2.34480	0	13C16O	862.914	785.508
69	23	2.40370	0	13C16O	165.437	874.490
70	23	2.43410	0	13C16O	650.918	919.089
						(end)

Table 2.6: List of spectral lines displayed on *K*-band (K+: Figures 2.11 and 2.12).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	29	1.98229	5		915.482	162.257
2	28	2.03226	2		463.021	236.494
3	27	2.09918	30		296.124	338.605
4	27	2.13387	1		1019.487	393.680
5	26	2.20456	1		781.870	498.646
6	26	2.20832	8		859.329	504.915
7	24	2.38515	1		723.129	771.418
8	24	2.39731	20		955.077	791.769
9	29	1.95400	1.13e-4	4F(5/2)-4D(7/2)	287.448	117.966
10	29	1.96700	8.83e-4	4D(5/2)-4P(5/2)	568.560	137.253
11	29	1.97700	1.13e-4	4D(1/2)-4P(1/2)	793.253	153.296
12	27	2.08500	2.76e-4	4D(3/2)-4P(5/2)	21.234	319.300
13	29	1.94510	0.0181	Br δ (8-4)	101.250	105.673
14	26	2.16610	0.0275	Br γ (7-4)	37.893	442.180
15	25	2.27900	0.000	Pf(n-4)	516.989	610.405
16	24	2.37440	0.000343	Pf(25-5)	524.998	754.601
17	24	2.38280	0.000383	Pf(24-5)	679.297	767.653
18	24	2.39250	0.000431	Pf(23-5)	862.264	783.540
19	23	2.44900	0.000747	Pf(19-5)	43.828	870.192
20	23	2.47000	0.000877	Pf(18-5)	393.471	899.170
21	23	2.49530	0.00104	Pf(17-5)	839.891	938.640
22	29	1.94490	0.28	2-1	97.121	105.404
23	29	1.95760	1.45	1-0	364.153	123.142
24	29	1.96920	0.038	3-2	617.321	140.687
25	28	2.01300	0.021	3-2	70.041	209.348
26	28	2.03380	0.44	1-0	495.412	238.810
27	27	2.12180	1	1-0	758.327	373.082
28	27	2.12800	0.036	3-2	891.058	383.449
29	26	2.20100	0	4-3	709.415	492.847
30	26	2.20140	0.12	3-2	717.521	493.493
31	25	2.25100	0	5-4	7.148	571.180
32	25	2.26680	0	4-3	290.375	592.560
33	25	2.28700	0.037	3-2	669.848	622.813
34	24	2.34460	0	4-3	3.913	712.868
35	24	2.35550	0	5-4	190.191	727.372
36	24	2.35560	0.063	2-1	191.924	727.509
37	24	2.38640	0.087	3-2	746.571	773.442
38	23	2.45480	0.7	1-0	138.747	877.891
39	23	2.47560	0.21	1-0	489.697	907.443
40	23	2.50010	0.53	1-0	928.284	946.783
41	23	2.50140	0.016	3-2	952.458	949.029
42	29	1.95480	0	HeI	304.428	119.106
43	28	2.03790	0	HeII	582.433	245.092
44	28	2.04300	0	HeI	692.321	253.148
45	27	2.11260	0	HeI	566.433	358.461
46	27	2.11320	0	HeI	578.771	359.388
47	27	2.11380	0	HeI	591.140	360.319
48	27	2.11950	0	HeII	709.804	369.343
49	26	2.16530	0	HeII	23.209	441.134
50	26	2.16600	0	HeI	36.053	442.049
51	26	2.17860	0	HeII	271.106	459.148
52	26	2.18470	0	HeI	387.689	467.881
53	26	2.18910	0	HeII	473.012	474.378
54	26	2.21550	0	HeII	1010.085	517.329
55	25	2.26010	0	HeII	168.952	583.269
56	25	2.27780	0	HeII	494.363	608.594
57	24	2.34800	0	HeII	61.529	717.305
58	24	2.37880	0	HeII	605.361	761.359
59	23	2.46060	0	HeII	234.884	885.816
60	23	2.47340	0	HeI	451.732	904.164
61	25	2.29350	0	12C16O	796.803	633.345
62	24	2.35350	0	12C16O	155.664	724.649
63	24	2.38290	0	12C16O	681.153	767.812
64	23	2.47870	0	12C16O	543.559	912.130

Table 2.6: List of spectral lines displayed on K -band (K+: Figures 2.11 and 2.12).

65	24	2.34480	0	$^{13}\text{C}^{16}\text{O}$	7.289	713.127
66	24	2.37390	0	$^{13}\text{C}^{16}\text{O}$	515.928	753.844
67	23	2.46520	0	$^{13}\text{C}^{16}\text{O}$	312.048	892.270
68	23	2.49710	0	$^{13}\text{C}^{16}\text{O}$	872.890	941.667
(end)						

Chapter 3

L- and *M*-bands

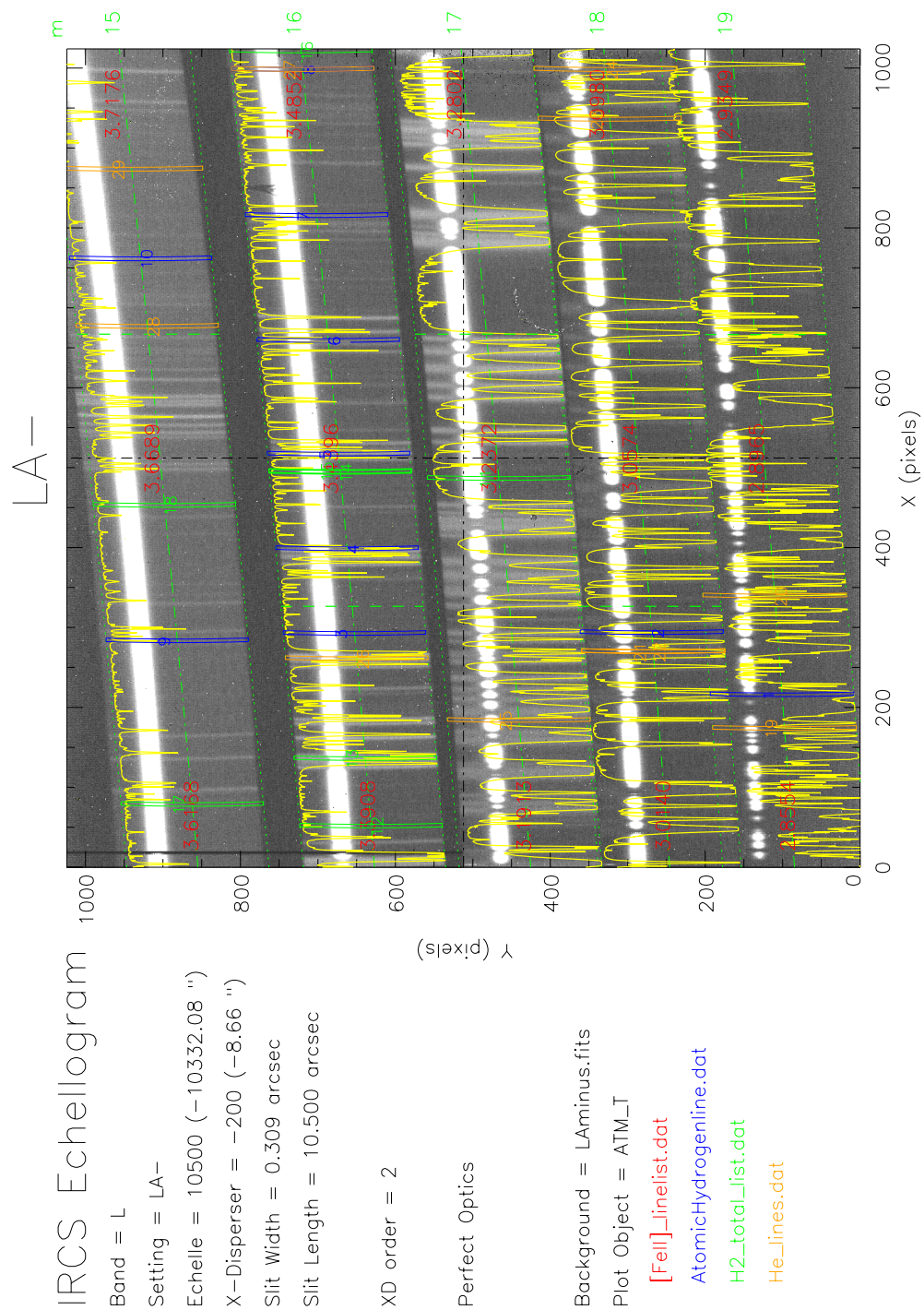


Figure 3.1: Echellogram for part of the L -band when $\text{ESP} = 10500$ and $\text{XSP} = -200$. The background image shows the spectra of a standard star and sky. Telluric lines are revealed as emission lines.

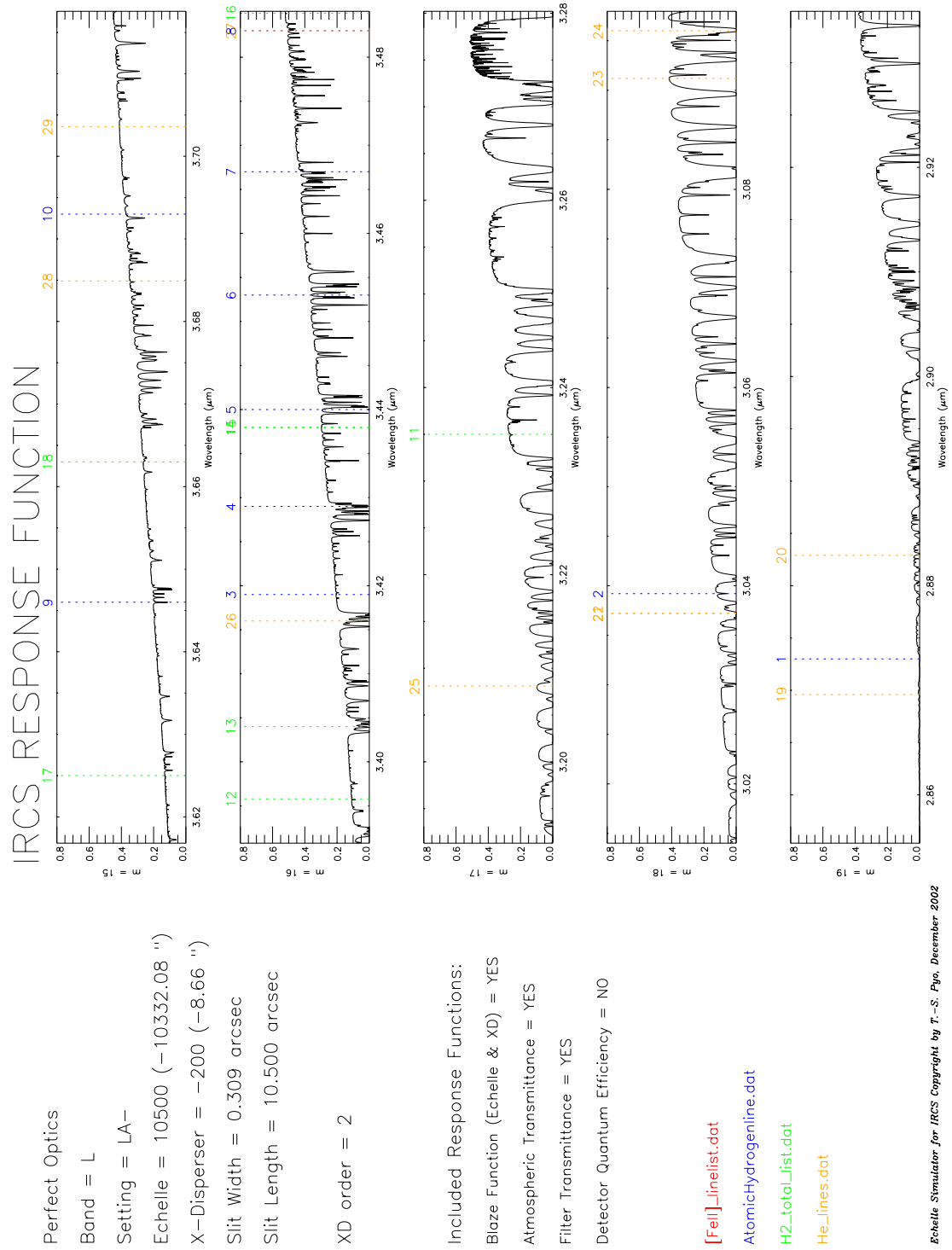


Figure 3.2: Response function for part of the L -band when $ESP = 10500$ and $XSP = -200$.

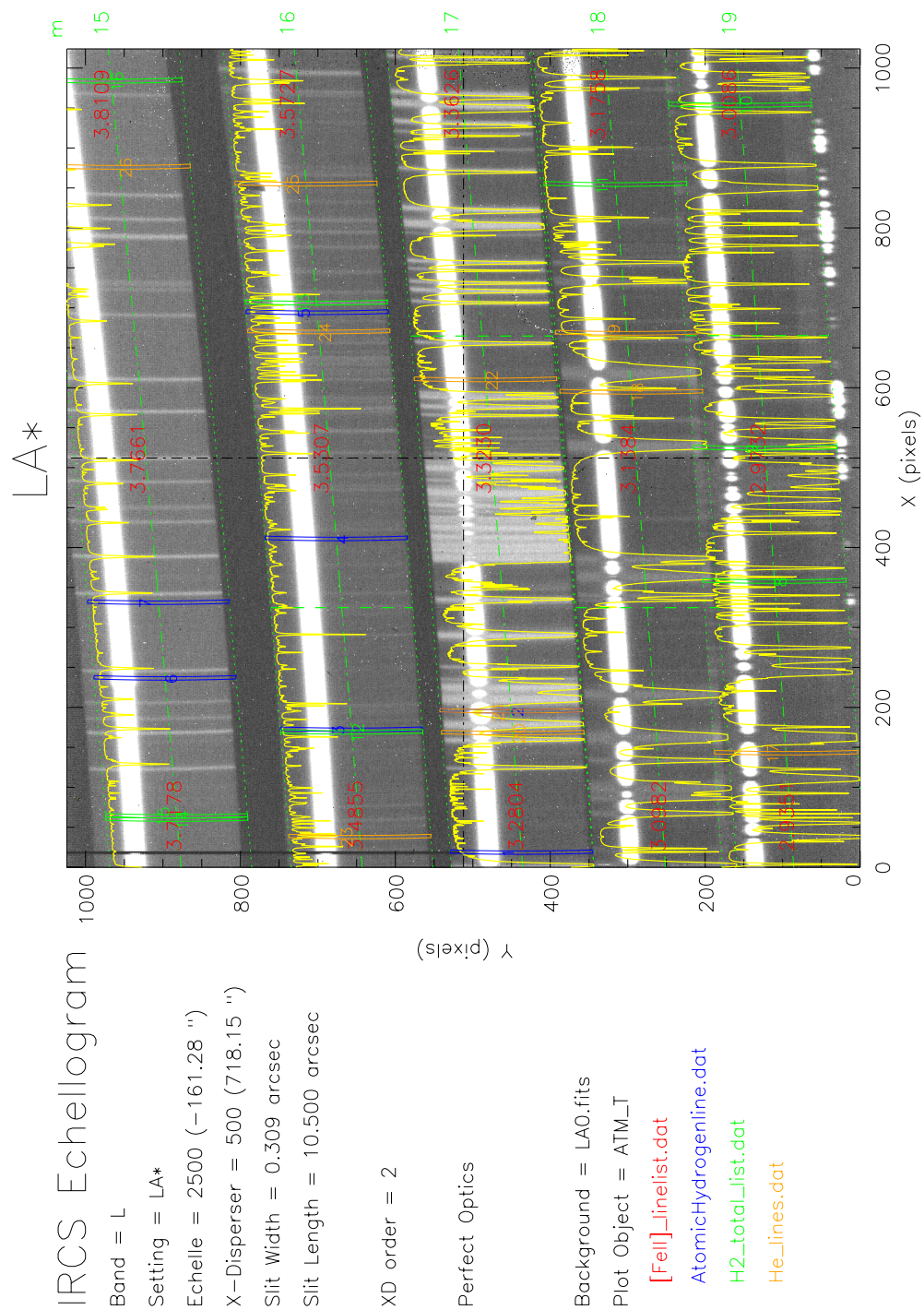


Figure 3.3: Echellogram for part of the L -band when $\text{ESP} = 2500$ and $\text{XSP} = 500$. The background image shows the spectra of a standard star and sky. Telluric lines are revealed as emission lines.

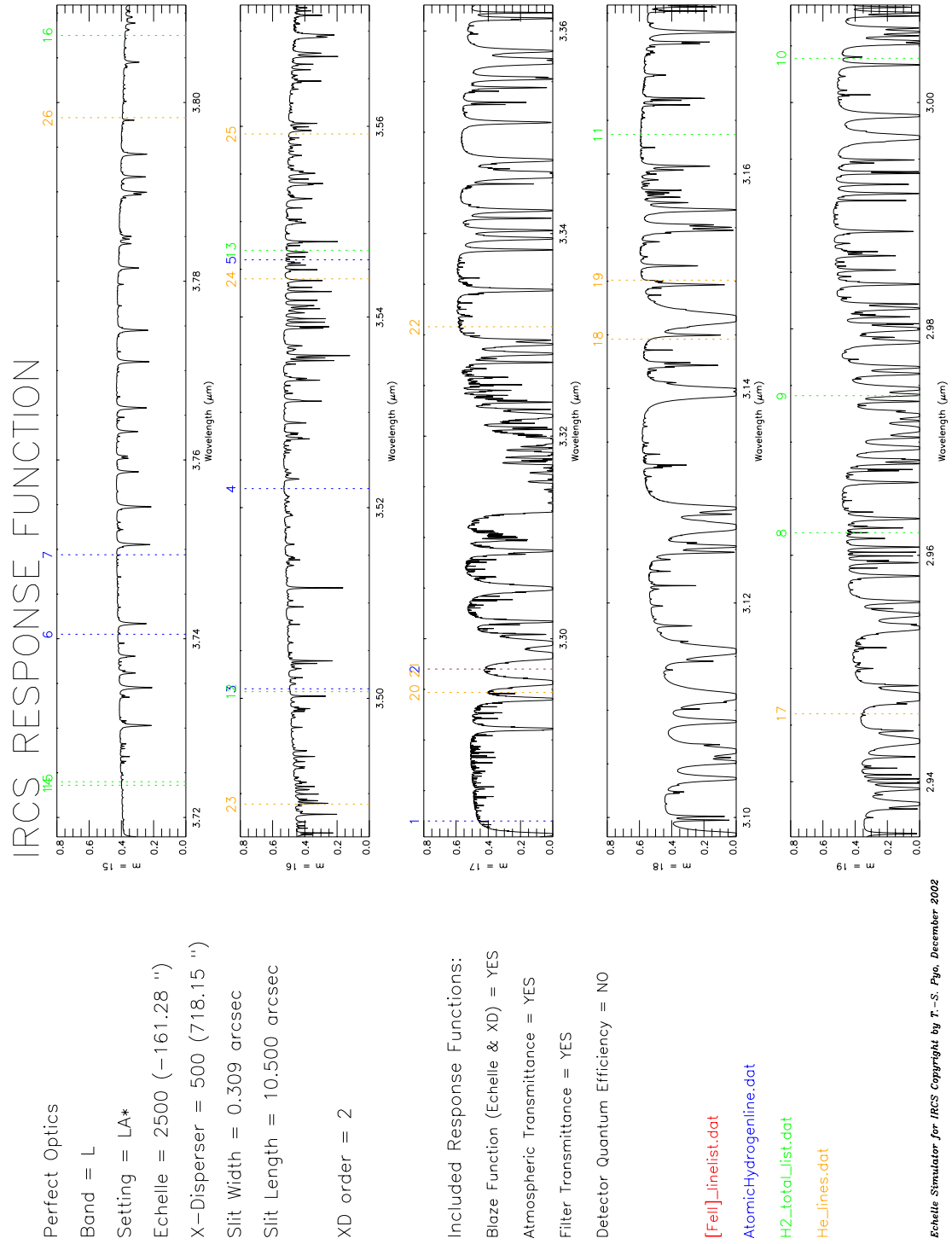
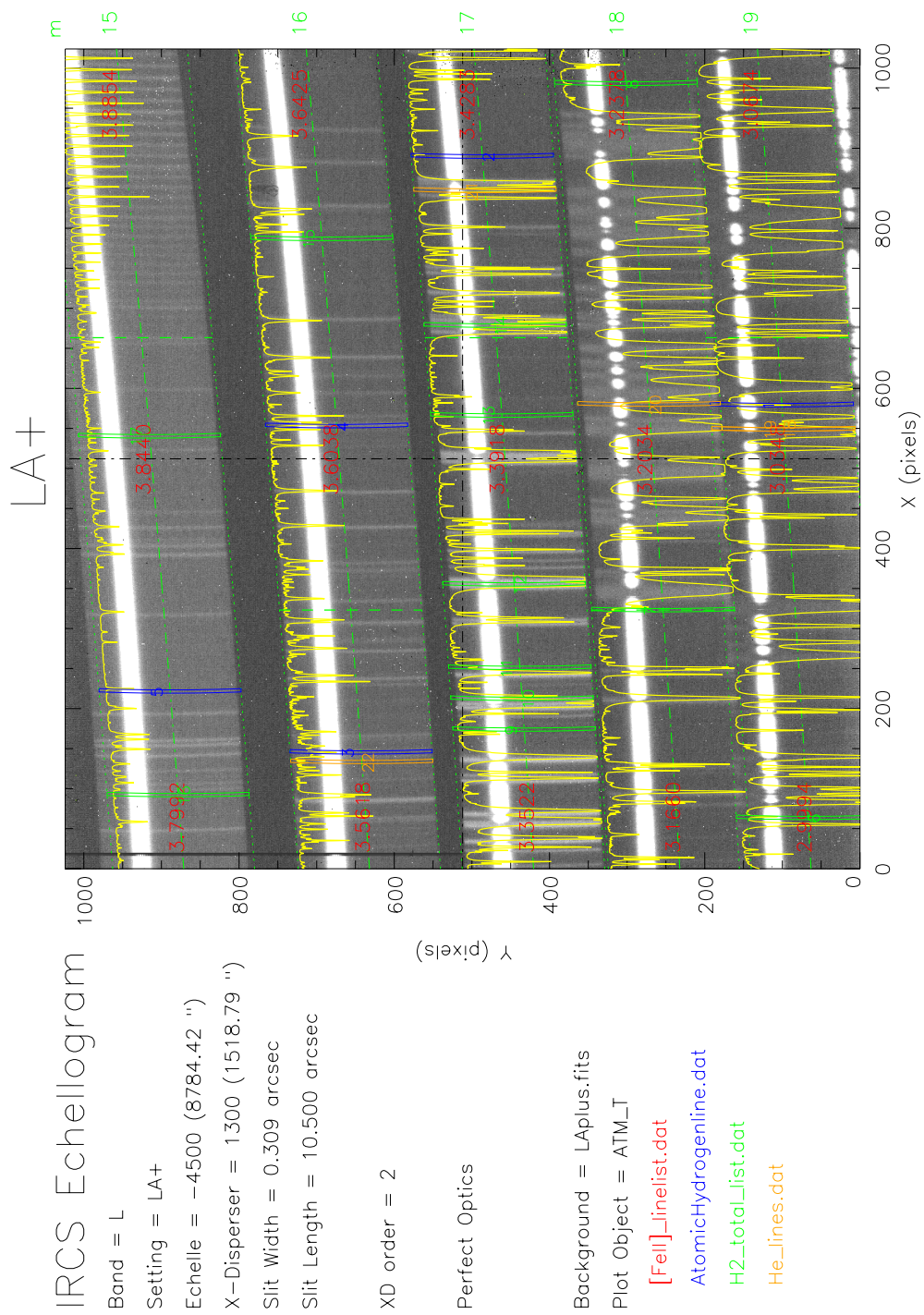


Figure 3.4: Response function for part of the L -band when $ESP = 2500$ and $XSP = 500$.



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Figure 3.5: Echellogram for part of the L -band when $ESP = -4500$ and $XSP = 1300$. The background image shows the spectra of a standard star and sky. Telluric lines are revealed as emission lines.

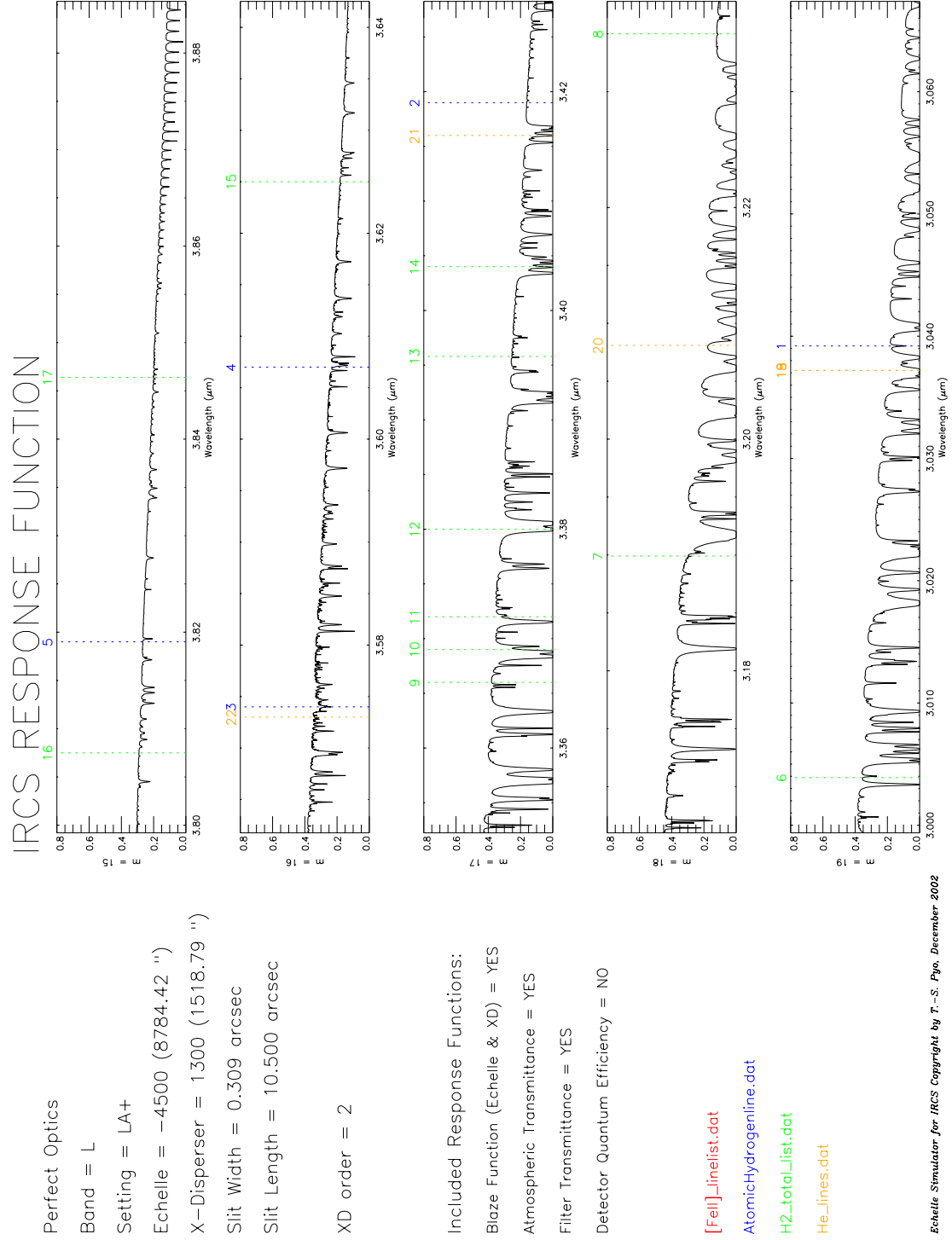
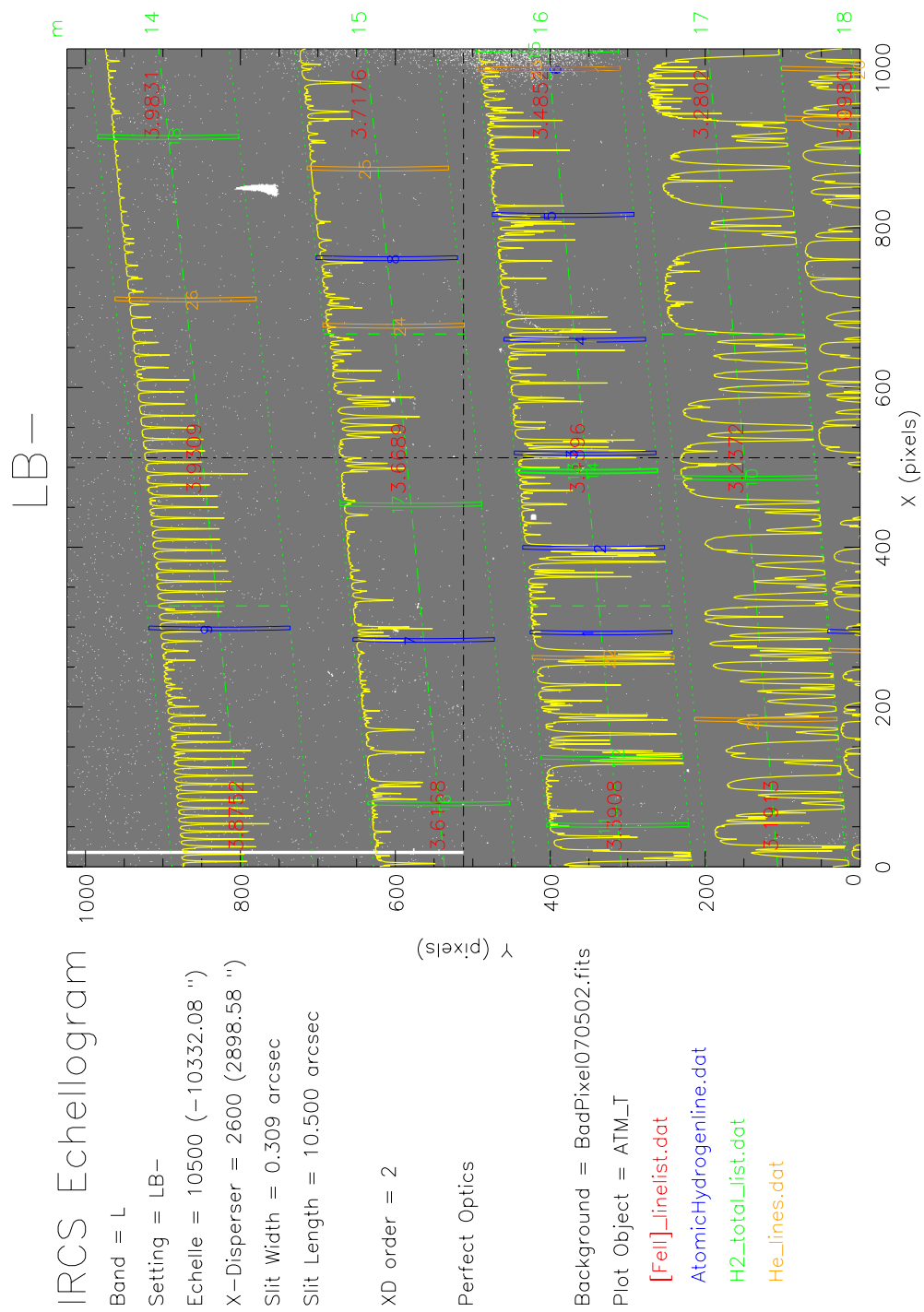


Figure 3.6: Response function for part of the L -band when $ESP = -4500$ and $XSP = 1300$.



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Figure 3.7: Echellogram for part of the L -band when $ESP = 10500$ and $XSP = 2600$. The background image shows the spectra of a standard star and sky. Telluric lines are revealed as emission lines.

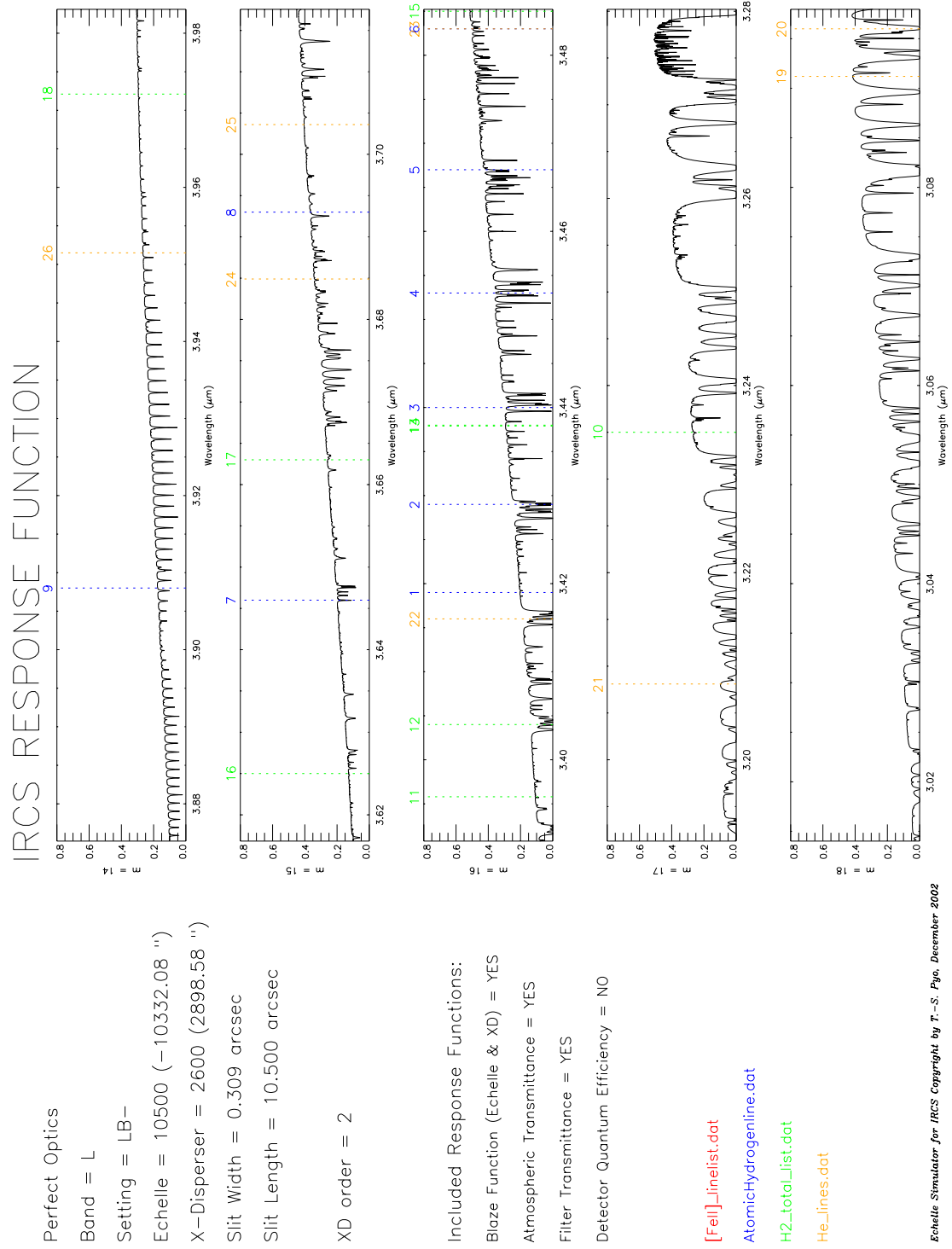
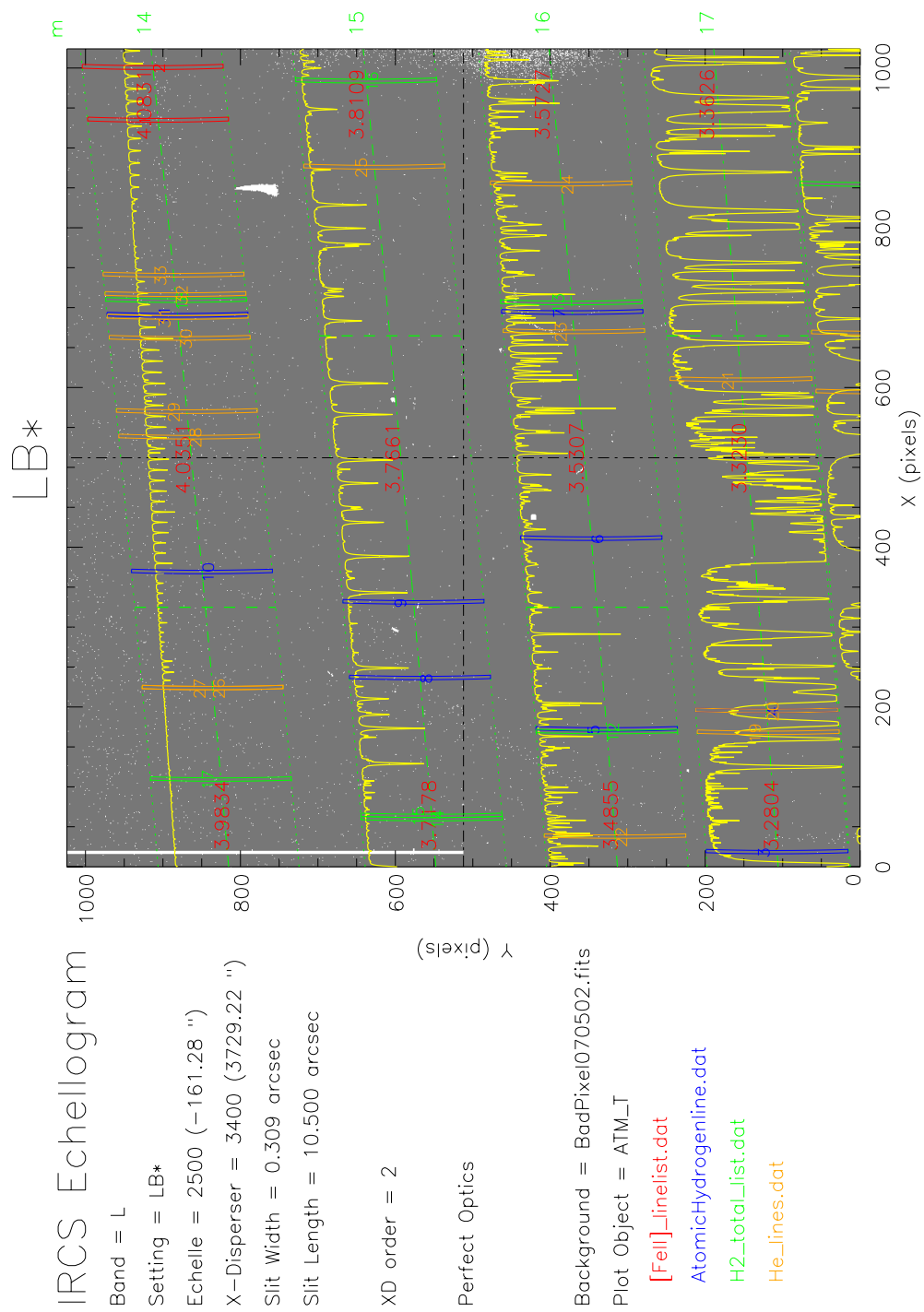


Figure 3.8: Response function for part of the L -band when $ESP = 10500$ and $XSP = 2600$.



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Figure 3.9: Echellogram for part of the L -band when $ESP = 2500$ and $XSP = 3400$. The background image shows the spectra of a standard star and sky. Telluric lines are revealed as emission lines.

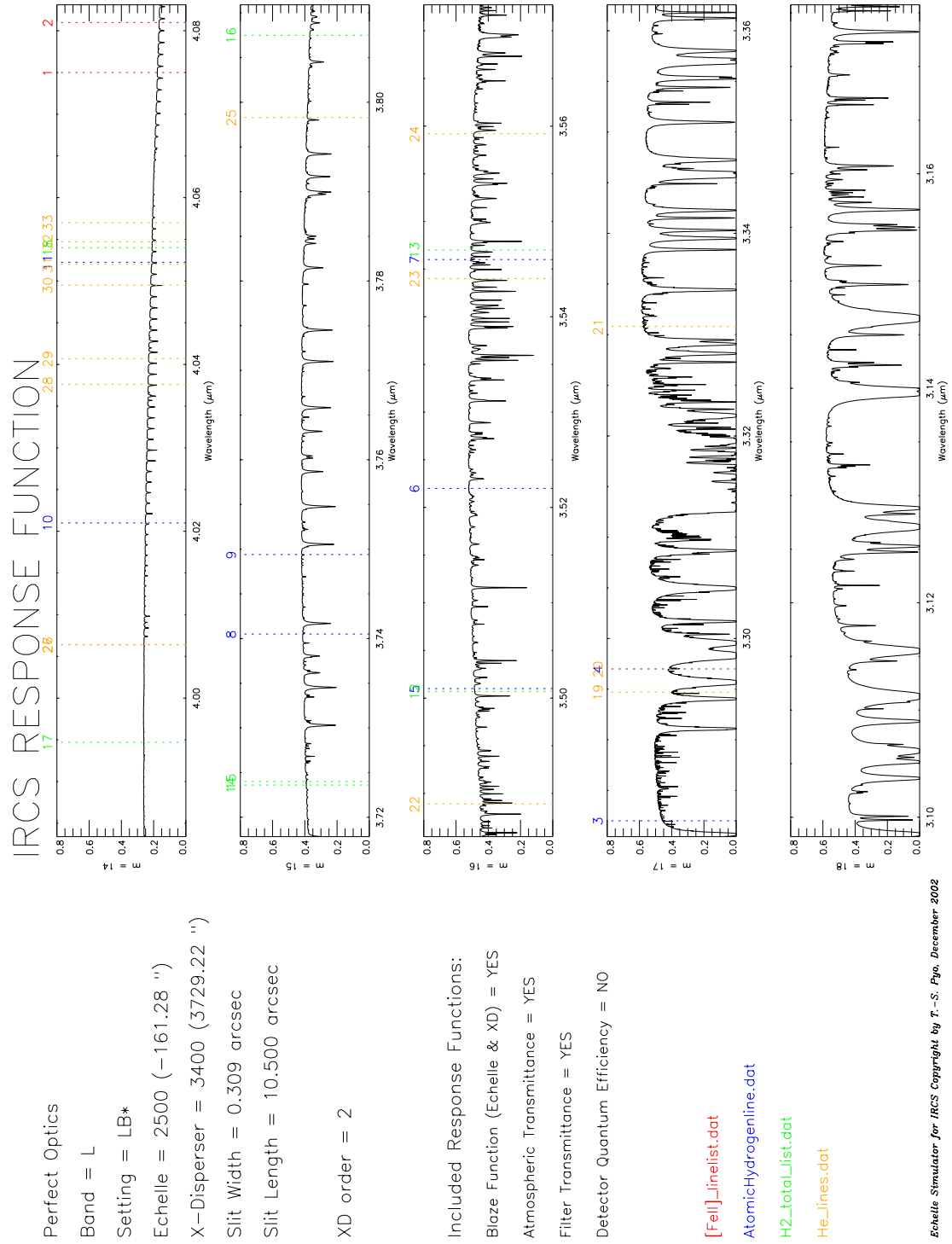
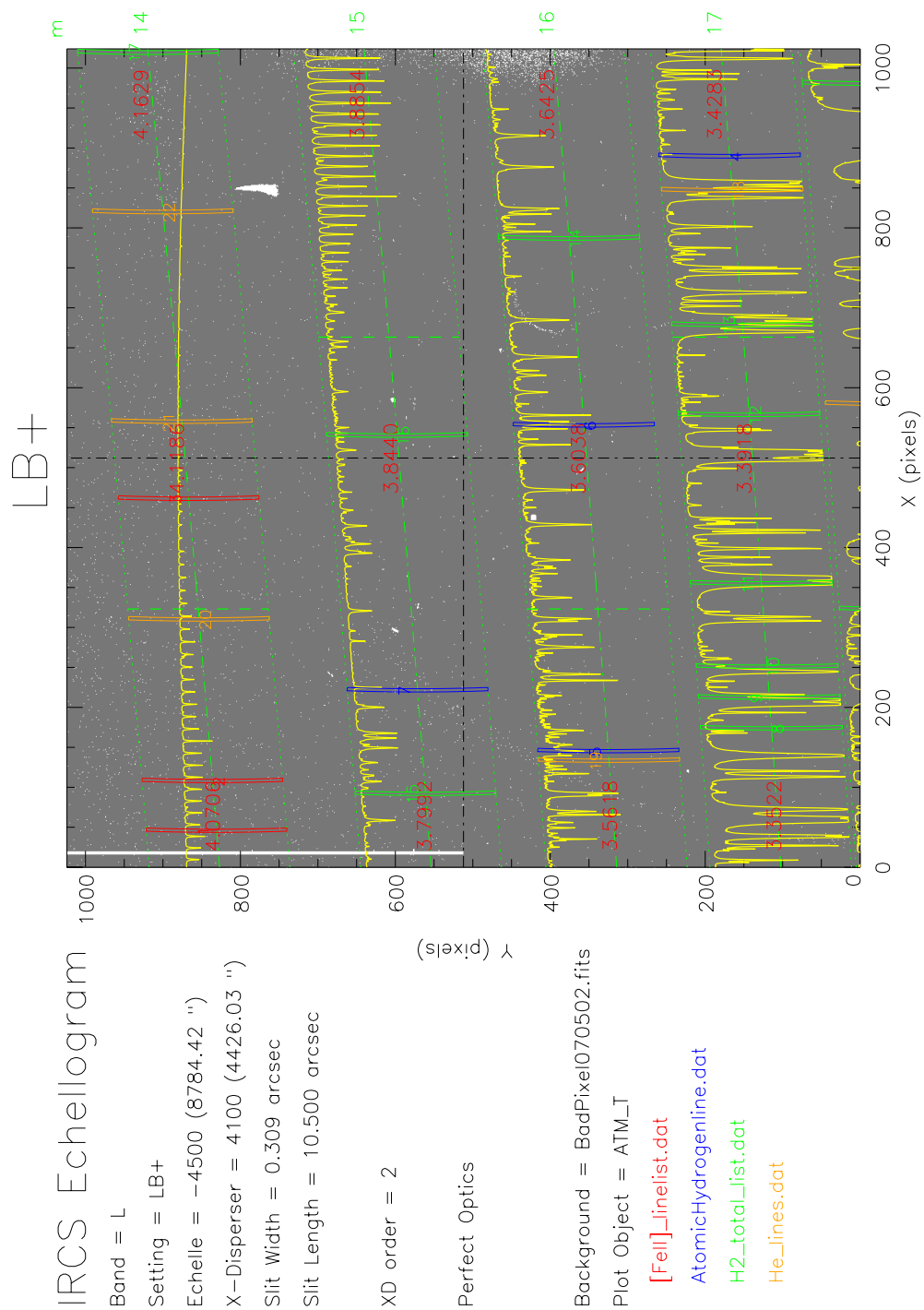


Figure 3.10: Response function for part of the L -band when $\text{ESP} = 2500$ and $\text{XSP} = 3400$.



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Figure 3.11: Echellogram for part of the L -band when $ESP = -4500$ and $XSP = 4100$. The background image shows the spectra of a standard star and sky. Telluric lines are revealed as emission lines.

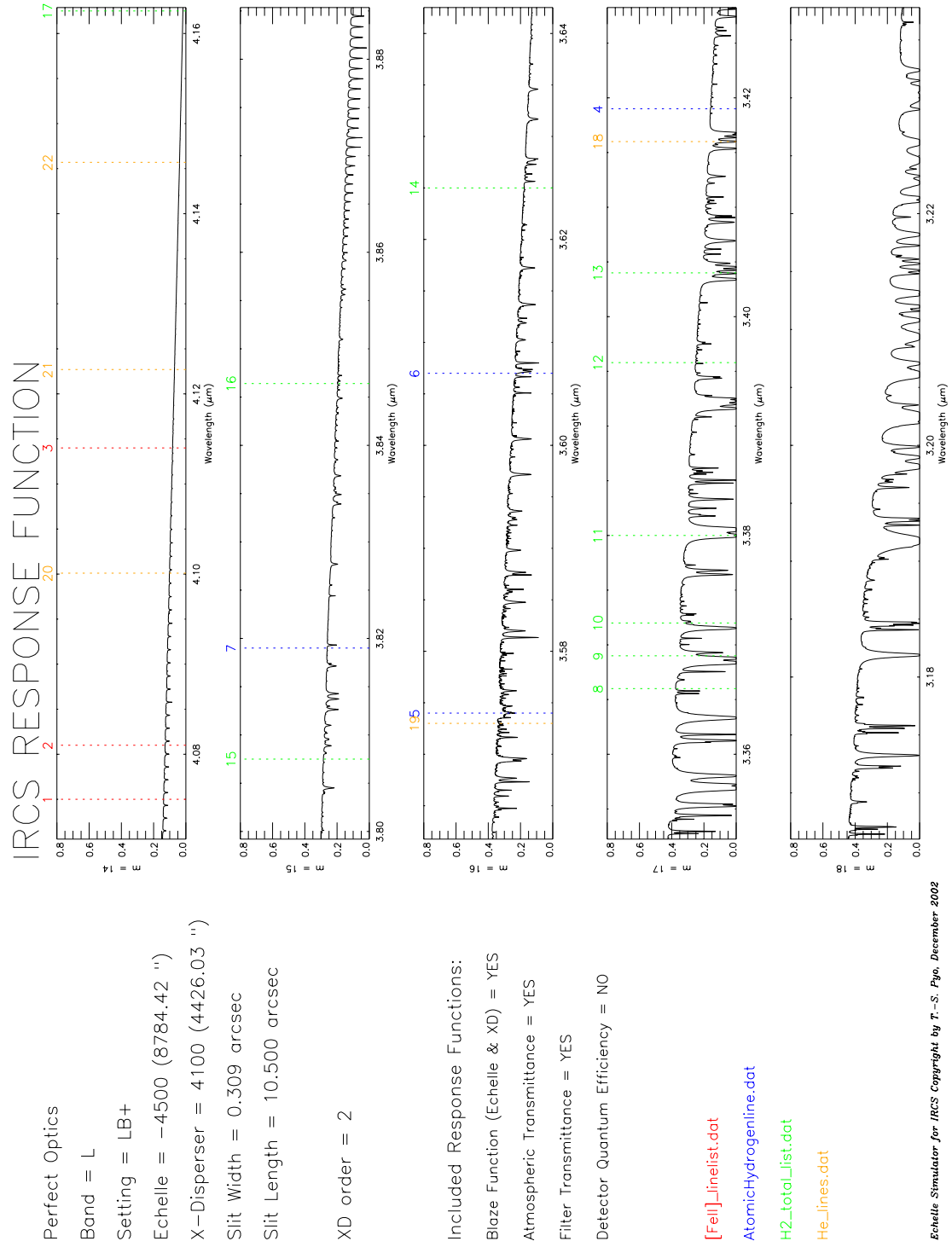
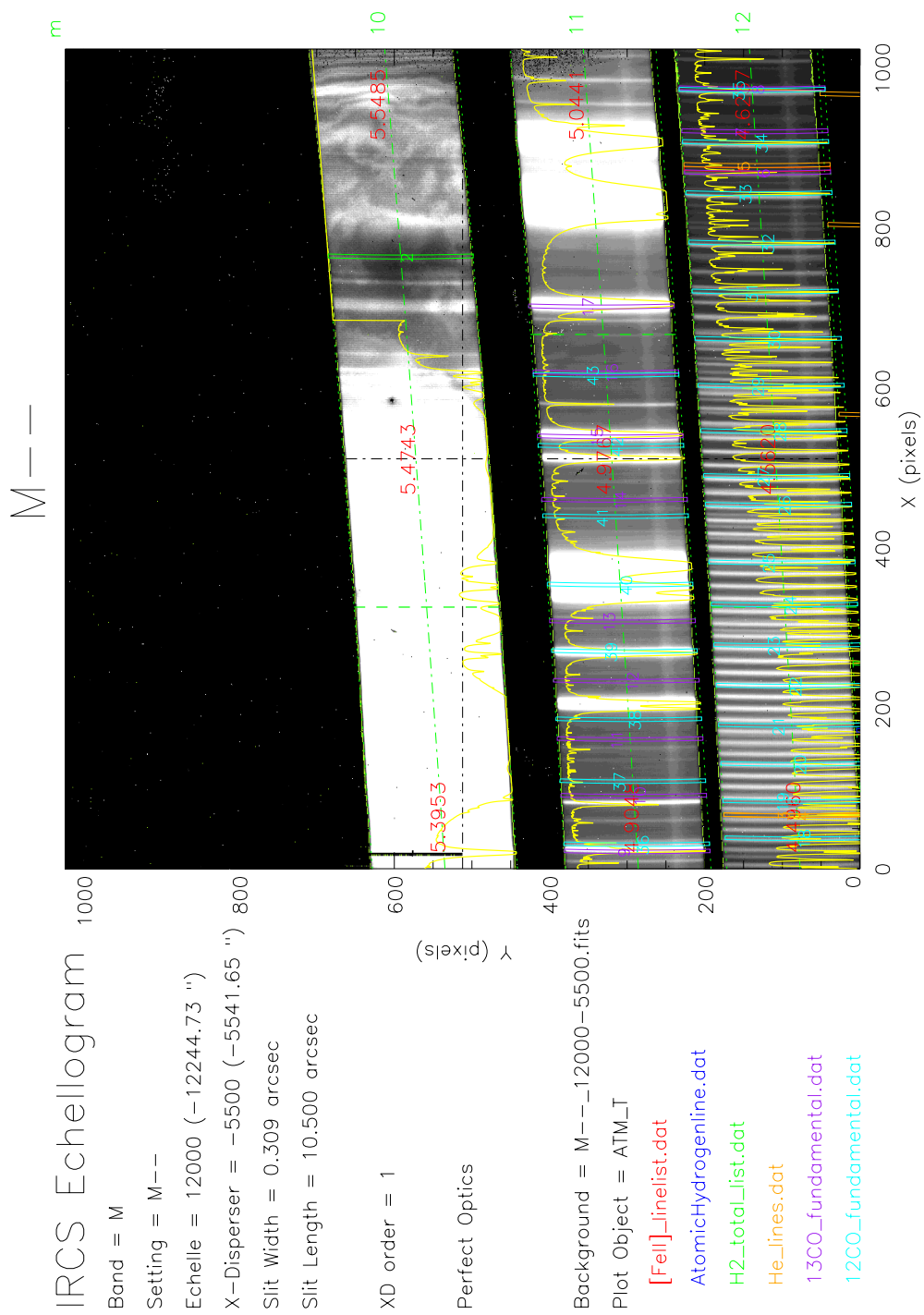


Figure 3.12: Response function for part of the L -band when $ESP = -4500$ and $XSP = 4100$.



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Figure 3.13: Echellogram for part of M -band when $ESP = 12000$ and $XSP = -5500$. The background image shows the spectra of a standard star and sky. Telluric lines are revealed as emission lines.

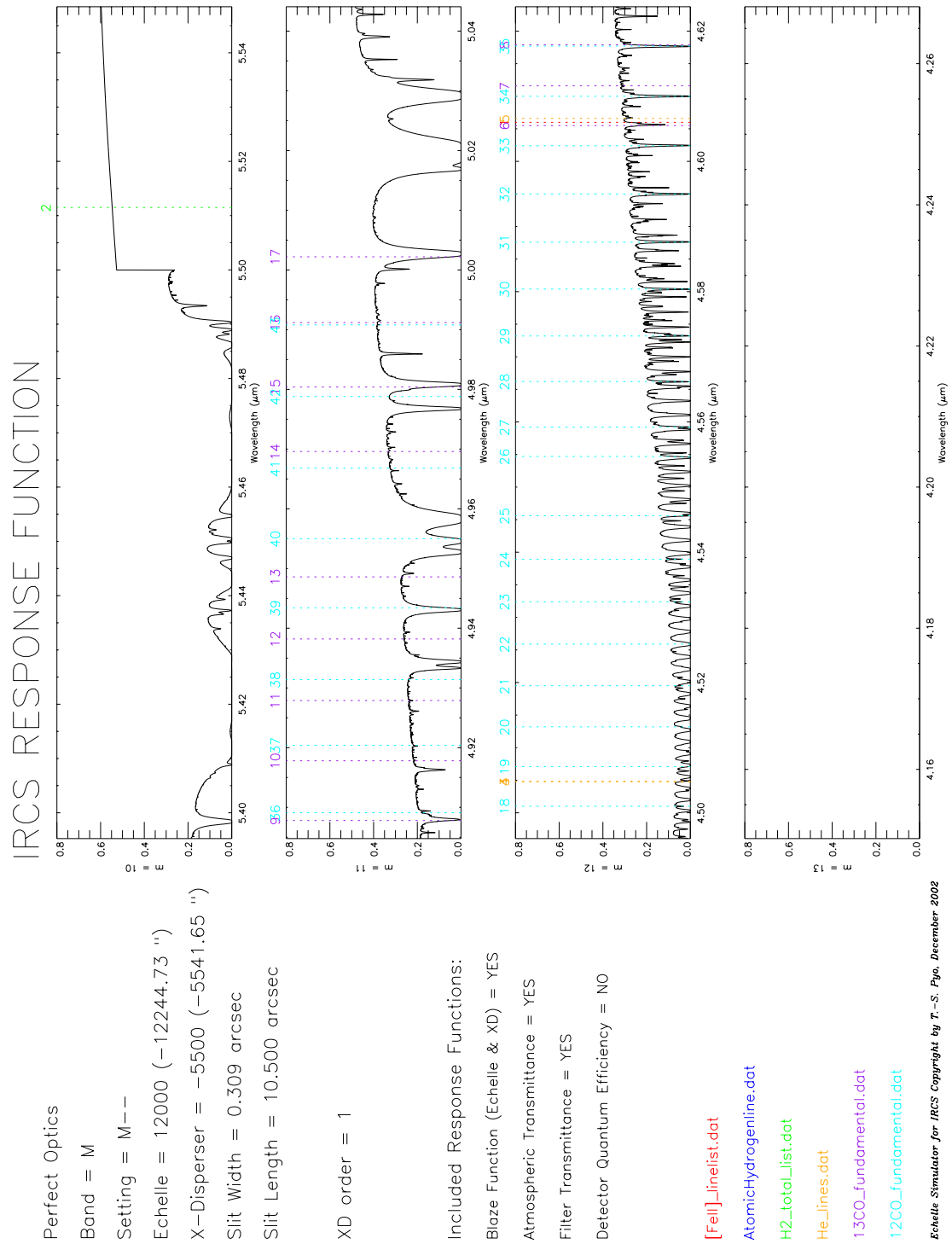
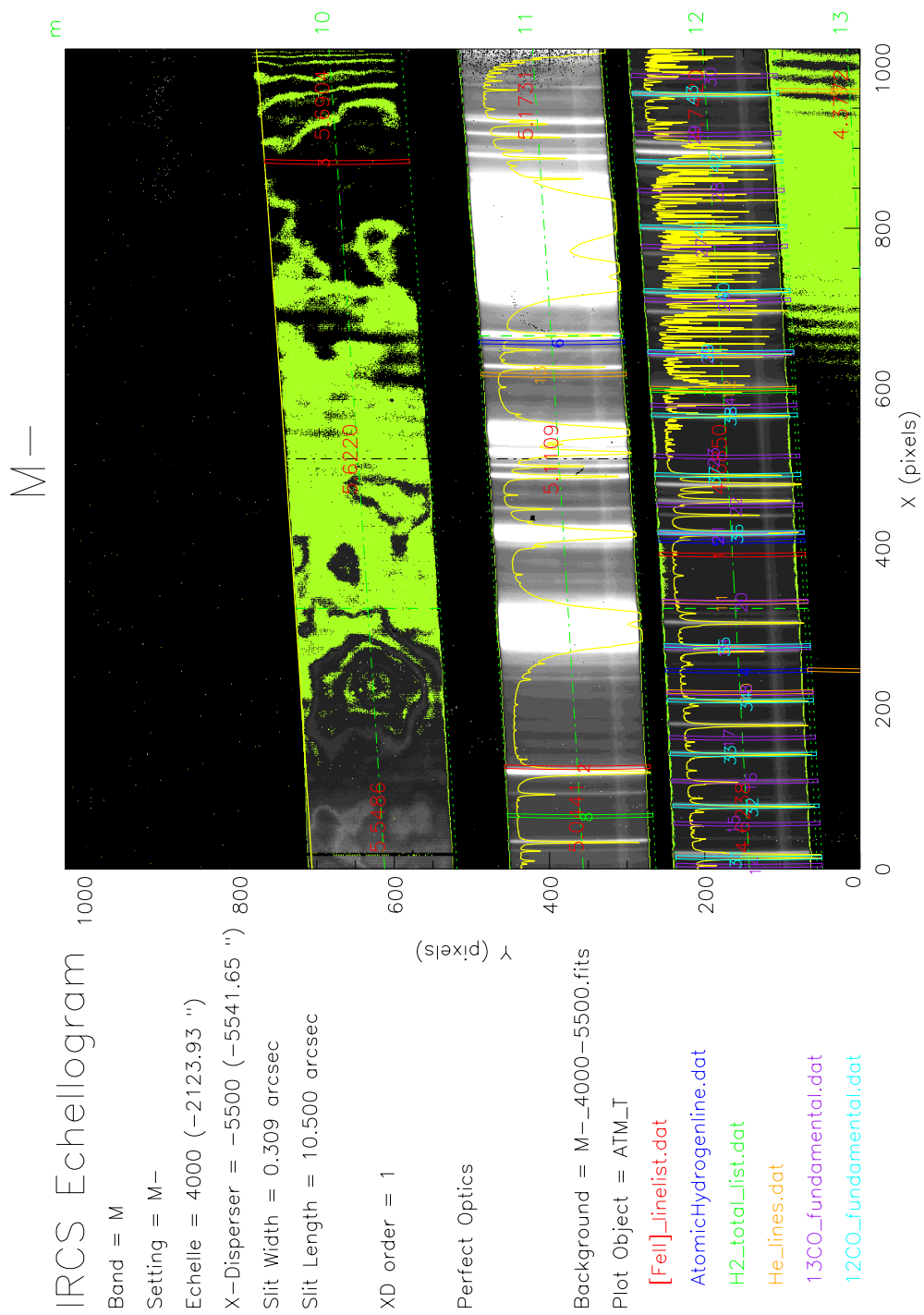


Figure 3.14: Response function for part of *M*-band when ESP = 12000 and XSP = -5500 .



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Figure 3.15: Echellogram for part of the M-band when ESP = 4000 and XSP = -5500. The background image shows the spectra of a standard star and sky. Telluric lines are revealed as emission lines.

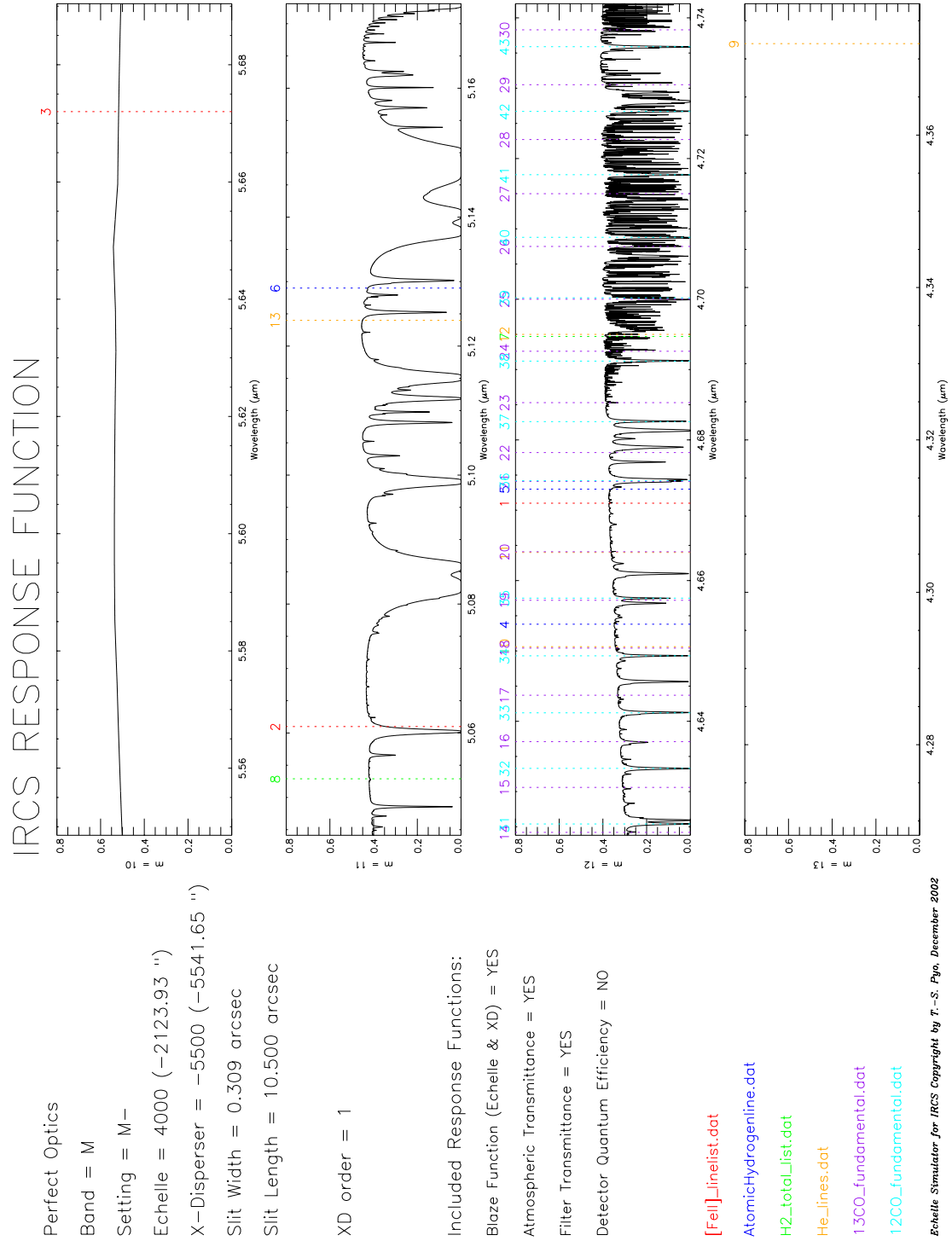
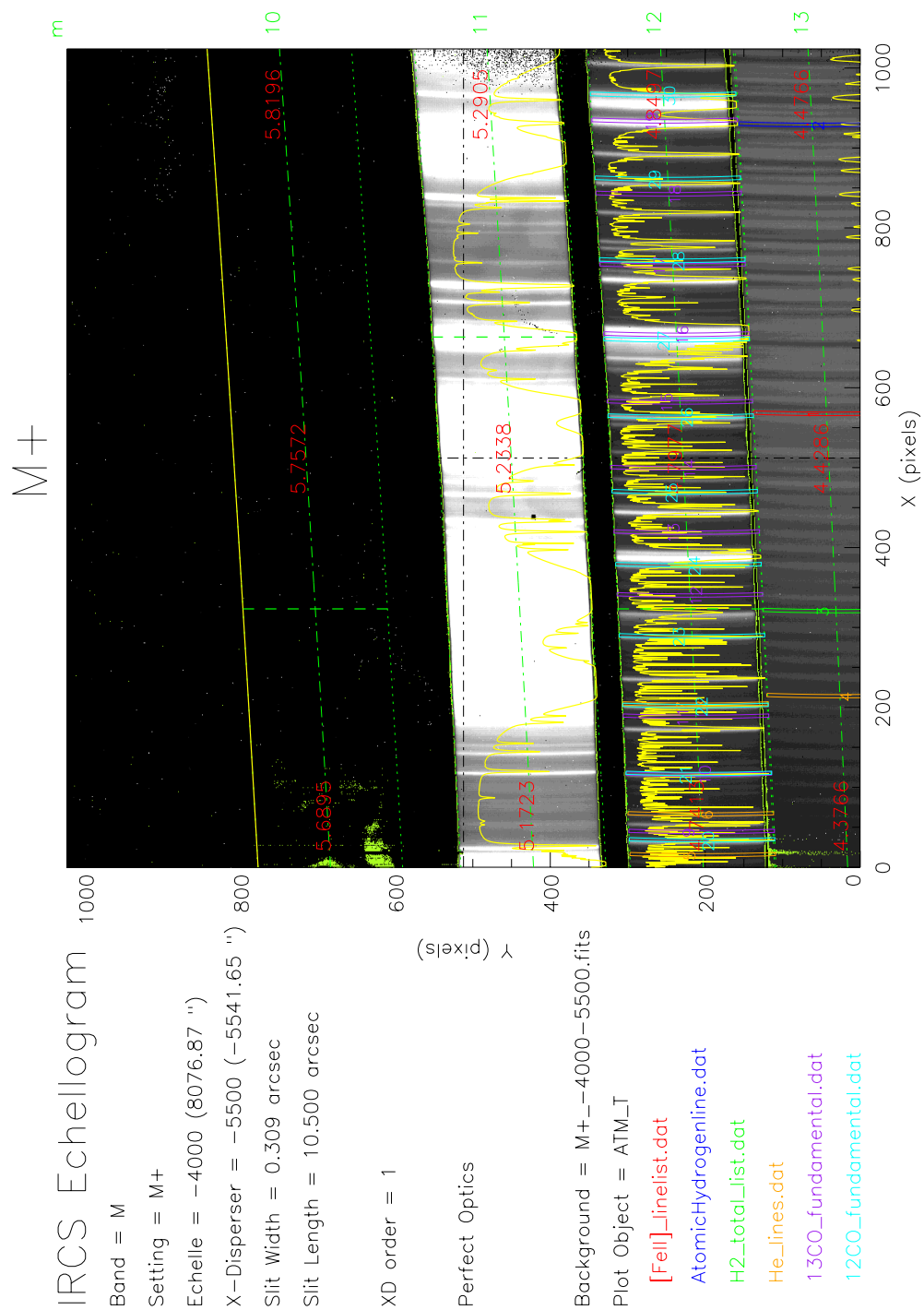


Figure 3.16: Response function for part of the *M*-band when $\text{ESP} = 4000$ and $\text{XSP} = -5500$.



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Figure 3.17: Echellogram for part of the M -band when $\text{ESP} = -4000$ and $\text{XSP} = -5500$. The background image shows the spectra of a standard star and sky. Telluric lines are revealed as emission lines.

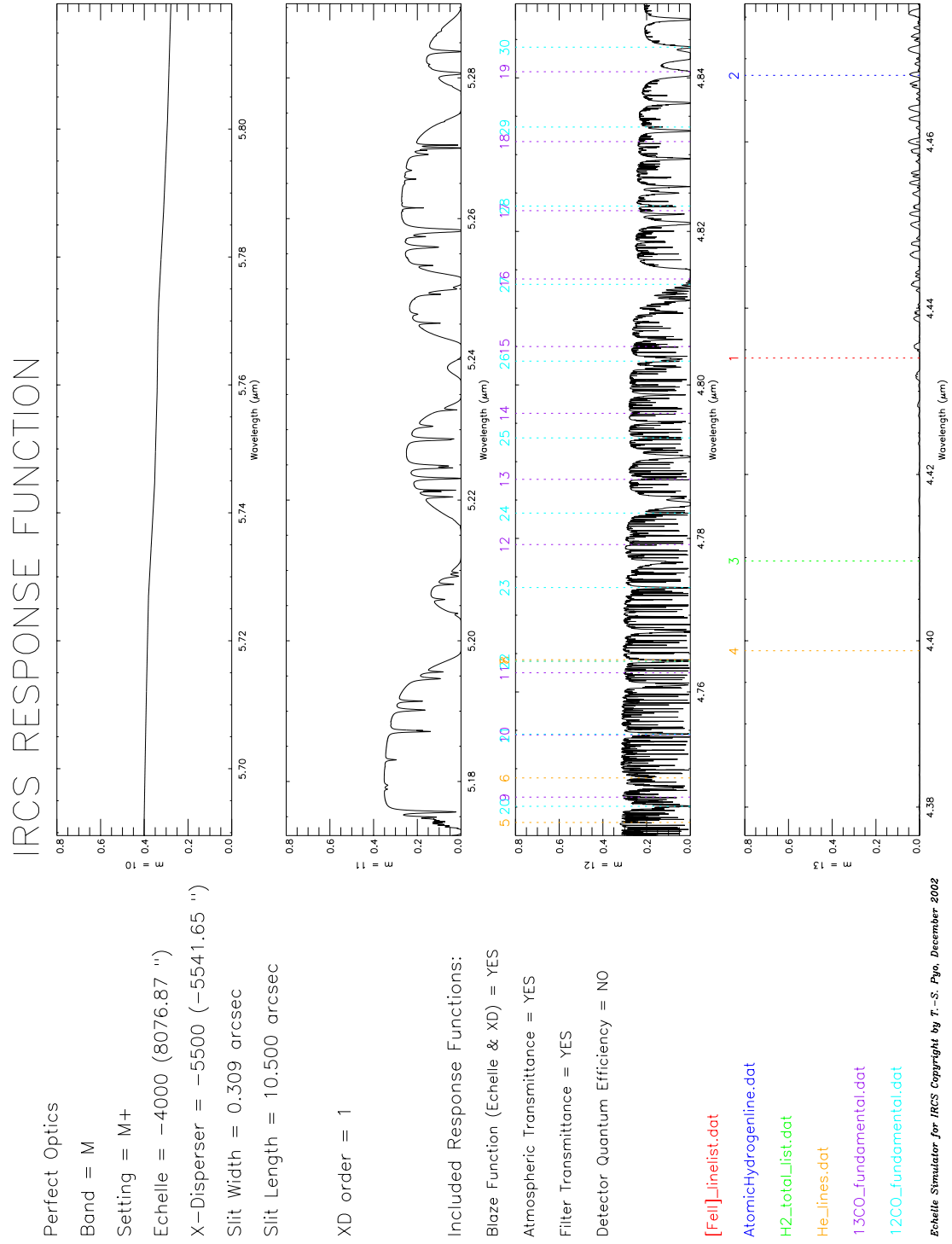
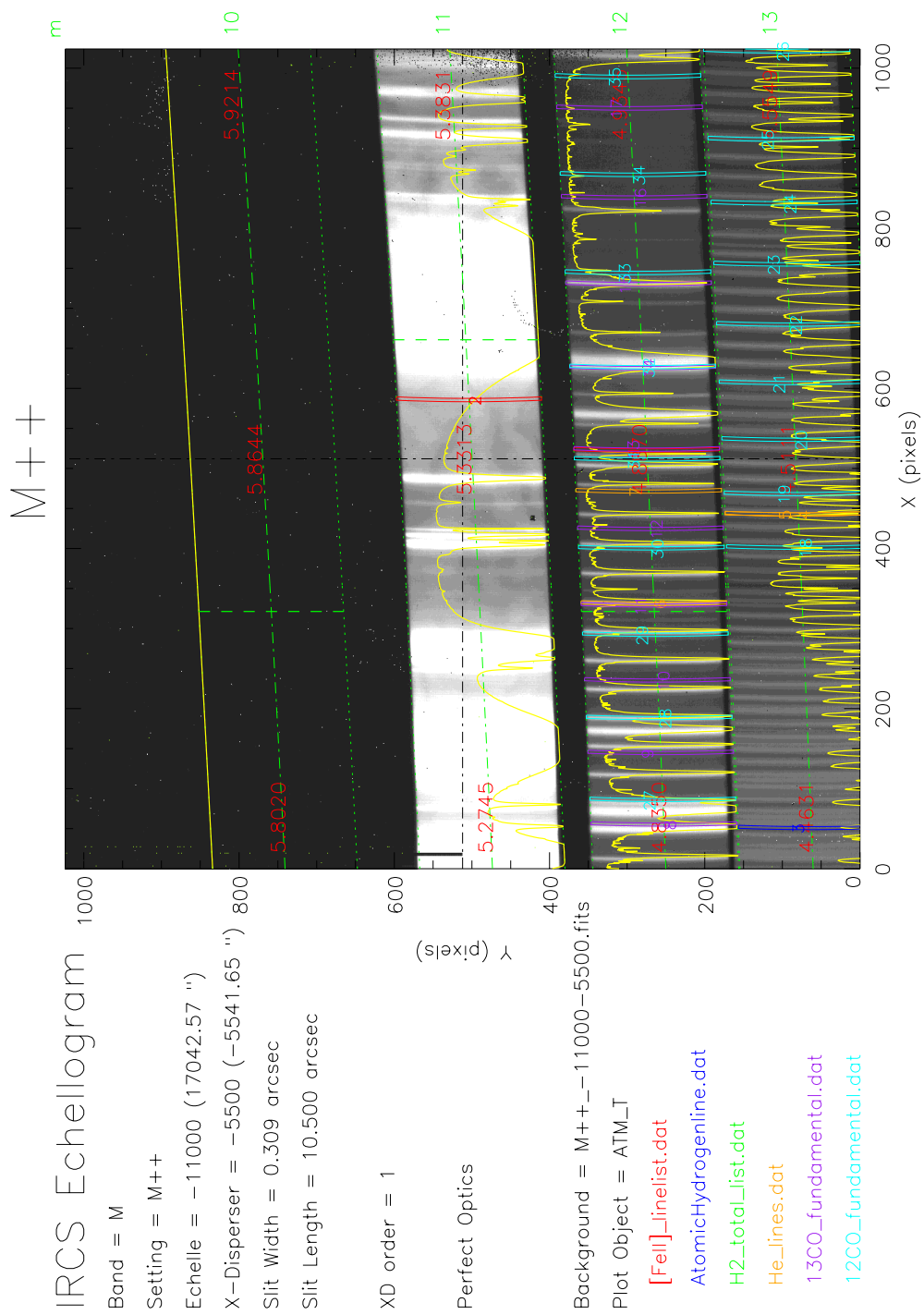


Figure 3.18: Response function for part of the *M*-band when ESP = -4000 and XSP = -5500.



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Figure 3.19: Echellogram for part of the *M*-band when ESP = -1100 and XSP = -5500. The background image shows the spectra of a standard star and sky. Telluric lines are revealed as emission lines.

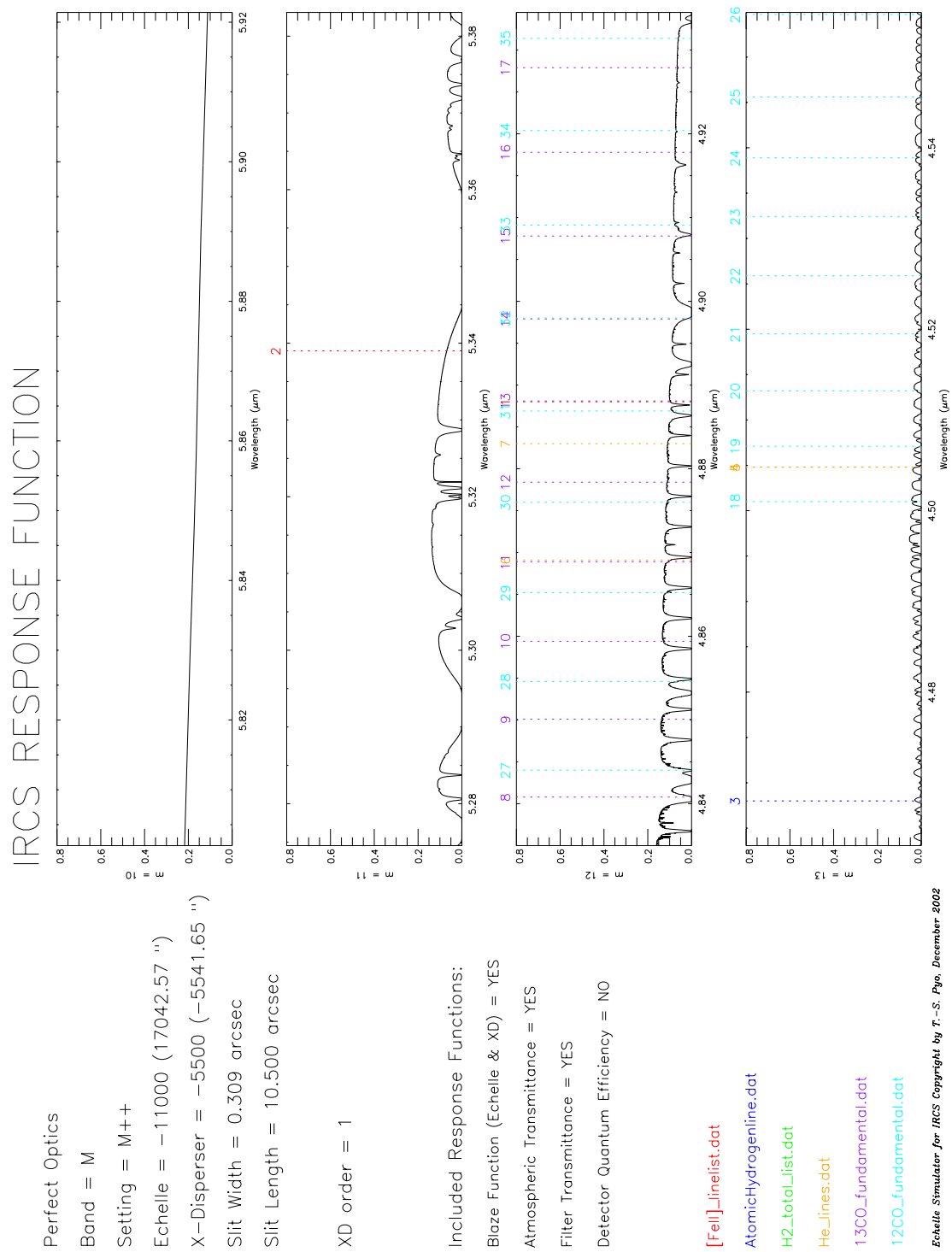


Figure 3.20: Response function for part of the *M*-band when ESP = -1100 and XSP = -5500.

Table 3.1: List of spectral lines displayed on *L*-band (LA-: Figures 3.1 and 3.2).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	19	2.87300	0.00391	Pf(11-5)	215.753	100.757
2	18	3.03920	0.00524	Pf(10-5)	293.524	268.931
3	16	3.41900	0.000124	30-6	292.467	652.649
4	16	3.42900	0.000137	29-6	398.541	662.291
5	16	3.44000	0.000150	28-6	516.869	673.218
6	16	3.45300	0.000166	27-6	659.090	686.591
7	16	3.46700	0.000185	26-6	815.362	701.587
8	16	3.48300	0.000207	25-6	998.287	719.541
9	15	3.64600	0.000463	19-6	283.250	881.410
10	15	3.69300	0.000546	18-6	761.263	928.868
11	17	3.23500	0.4	1-0	486.444	466.414
12	16	3.39580	0.015	3-2	51.417	631.278
13	16	3.40400	0.15	0-0	135.851	638.678
14	16	3.43790	0.14	2-1	494.142	671.105
15	16	3.43800	0.073	0-0	495.222	671.205
16	16	3.48500	0.31	0-0	1021.498	721.850
17	15	3.62500	0.55	0-0	78.484	862.046
18	15	3.66300	0.038	3-2	452.780	897.880
19	19	2.86960	0	HEII	173.696	97.583
20	19	2.88290	0	HEII	339.436	110.204
21	18	3.03720	0	HEII	269.839	267.025
22	18	3.03720	0	HEII	269.839	267.025
23	18	3.09120	0	HEII	936.009	323.068
24	18	3.09600	0	HEII	998.285	328.568
25	17	3.20810	0	HEII	183.641	440.494
26	16	3.41600	0	HEII	260.912	649.808
27	16	3.48300	0	HEII	998.287	719.541
28	15	3.68490	0	HEII	676.712	920.244
29	15	3.70360	0	HEI	873.430	940.462
						(end)

Table 3.2: List of spectral lines displayed on *L*-band (LA*: Figures 3.3 and 3.4).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	17	3.28200	0.000	limit 6	18.191	437.065
2	17	3.29700	0.00725	Pf(9-5)	195.059	450.504
3	16	3.50100	0.000232	24-6	171.941	656.518
4	16	3.52200	0.000262	23-6	410.707	676.338
5	16	3.54600	0.000299	22-6	693.751	700.809
6	15	3.74050	0.0104	Pf(8-5)	236.209	897.240
7	15	3.74940	0.000650	17-6	330.971	905.611
8	19	2.96200	0.011	3-2	357.449	110.491
9	19	2.97410	0.17	2-1	524.220	122.514
10	19	3.00390	0.16	1-0	953.423	154.884
11	18	3.16370	0.045	3-2	854.245	315.944
12	16	3.50070	0.096	1-0	168.586	656.245
13	16	3.54700	0.14	0-0	705.803	701.875
14	15	3.72360	0.034	2-1	59.452	881.965
15	15	3.72400	0.23	0-0	63.588	882.317
16	15	3.80750	0.19	1-0	983.606	966.706
17	19	2.94600	0	HEII	142.624	95.459
18	18	3.14460	0	HEII	594.233	295.348
19	18	3.15010	0	HEII	668.057	301.115
20	17	3.29470	0	HEII	167.675	448.398
21	17	3.29700	0	HeI	195.059	450.504
22	17	3.33080	0	HEI	609.680	483.535
23	16	3.48890	0	HEII	37.693	645.705
24	16	3.54400	0	HEII	669.705	698.689
25	16	3.55920	0	HeI	854.708	715.198
26	15	3.79830	0	HEII	875.812	956.201
						(end)

Table 3.3: List of spectral lines displayed on *L*-band (LA+: Figures 3.5 and 3.6).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	19	3.03920	0.00524	Pf(10-5)	579.026	100.622
2	17	3.41900	0.000124	30-6	889.646	486.477
3	16	3.57400	0.000343	21-6	145.203	642.688
4	16	3.60700	0.000397	20-6	552.831	674.202
5	15	3.81900	0.000782	16-6	221.277	888.729
6	19	3.00390	0.16	1-0	63.359	66.955
7	18	3.18990	0.056	2-1	322.910	253.678
8	18	3.23500	0.4	1-0	980.663	301.471
9	17	3.36600	0.015	0-0	173.728	432.626
10	17	3.36900	0.069	0-0	212.193	435.354
11	17	3.37200	0.034	0-0	250.875	438.117
12	17	3.38000	0.034	0-0	355.133	445.657
13	17	3.39580	0.015	3-2	566.074	461.335
14	17	3.40400	0.15	0-0	678.431	469.915
15	16	3.62500	0.55	0-0	786.804	693.299
16	15	3.80750	0.19	1-0	91.847	878.425
17	15	3.84640	0.83	0-0	540.093	915.136
18	19	3.03720	0	HEII	548.688	98.557
19	19	3.03720	0	HEII	548.688	98.557
20	18	3.20810	0	HEII	579.828	271.730
21	17	3.41600	0	HEII	846.782	483.070
22	16	3.57300	0	HEII	133.231	641.796
						(end)

Table 3.4: List of spectral lines displayed on *L*-band (LB-: Figures 3.7 and 3.8).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	16	3.41900	0.000124	30-6	292.467	334.303
2	16	3.42900	0.000137	29-6	398.541	343.961
3	16	3.44000	0.000150	28-6	516.869	354.905
4	16	3.45300	0.000166	27-6	659.090	368.299
5	16	3.46700	0.000185	26-6	815.362	383.317
6	16	3.48300	0.000207	25-6	998.287	401.295
7	15	3.64600	0.000463	19-6	283.250	563.299
8	15	3.69300	0.000546	18-6	761.263	610.769
9	14	3.90800	0.000953	15-6	297.737	826.909
10	17	3.23500	0.4	1-0	486.444	147.655
11	16	3.39580	0.015	3-2	51.417	312.895
12	16	3.40400	0.15	0-0	135.851	320.308
13	16	3.43790	0.14	2-1	494.142	352.789
14	16	3.43800	0.073	0-0	495.222	352.890
15	16	3.48500	0.31	0-0	1021.498	403.607
16	15	3.62500	0.55	0-0	78.484	543.927
17	15	3.66300	0.038	3-2	452.780	579.775
18	14	3.97210	0.01	3-2	912.939	893.031
19	18	3.09120	0	HEII	936.009	3.855
20	18	3.09600	0	HEII	998.285	9.374
21	17	3.20810	0	HEII	183.641	121.662
22	16	3.41600	0	HEII	260.912	331.458
23	16	3.48300	0	HEII	998.287	401.295
24	15	3.68490	0	HEII	676.712	602.143
25	15	3.70360	0	HEI	873.430	622.363
26	14	3.95150	0	HEII	709.649	870.563
						(end)

Table 3.5: List of spectral lines displayed on *L*-band (LB*: Figures 3.9 and 3.10).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	14	4.07500	1.10e-5	6D(7/2)-4F(5/2)	934.552	906.127
2	14	4.08100	6.14e-6	6D(5/2)-4F(3/2)	1000.574	913.051
3	17	3.28200	0.000	limit 6	18.191	107.173
4	17	3.29700	0.00725	Pf(9-5)	195.059	120.652
5	16	3.50100	0.000232	24-6	171.941	327.142
6	16	3.52200	0.000262	23-6	410.707	346.994
7	16	3.54600	0.000299	22-6	693.751	371.502
8	15	3.74050	0.0104	Pf(8-5)	236.209	568.101
9	15	3.74940	0.000650	17-6	330.971	576.474
10	14	4.02100	0.00118	14-6	368.933	849.508
11	14	4.05225	0.0777	Br α (5-4)	690.365	881.091
12	16	3.50070	0.096	1-0	168.586	326.868
13	16	3.54700	0.14	0-0	705.803	372.569
14	15	3.72360	0.034	2-1	59.452	552.820
15	15	3.72400	0.23	0-0	63.588	553.173
16	15	3.80750	0.19	1-0	983.606	637.572
17	14	3.99470	0.31	0-0	109.108	825.119
18	14	4.05400	0.068	2-1	708.821	882.952
19	17	3.29470	0	HeII	167.675	118.540
20	17	3.29700	0	HeI	195.059	120.652
21	17	3.33080	0	HeI	609.680	153.776
22	16	3.48890	0	HeII	37.693	316.310
23	16	3.54400	0	HeII	669.705	369.379
24	16	3.55920	0	HeI	854.708	385.911
25	15	3.79830	0	HeII	875.812	627.067
26	14	4.00640	0	HeI	223.593	835.740
27	14	4.00640	0	HeI	223.593	835.740
28	14	4.03760	0	HeI	537.810	865.907
29	14	4.04070	0	HeI	569.811	869.062
30	14	4.04950	0	HeII	661.460	878.187
31	14	4.05200	0	HeI	687.731	880.826
32	14	4.05470	0	HeI	716.220	883.699
33	14	4.05700	0	HeI	740.587	886.167
						(end)

Table 3.6: List of spectral lines displayed on *L*-band (LB+: Figures 3.11 and 3.12).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	14	4.07500	1.10e-5	6D(7/2)-4F(5/2)	45.533	830.714
2	14	4.08100	6.14e-6	6D(5/2)-4F(3/2)	107.851	835.947
3	14	4.11400	8.89e-6	6D(9/2)-4F(7/2)	461.063	866.737
4	17	3.41900	0.000124	30-6	889.646	168.441
5	16	3.57400	0.000343	21-6	145.203	324.977
6	16	3.60700	0.000397	20-6	552.831	356.539
7	15	3.81900	0.000782	16-6	221.277	571.247
8	17	3.36600	0.015	0-0	173.728	114.445
9	17	3.36900	0.069	0-0	212.193	117.181
10	17	3.37200	0.034	0-0	250.875	119.952
11	17	3.38000	0.034	0-0	355.133	127.513
12	17	3.39580	0.015	3-2	566.074	143.233
13	17	3.40400	0.15	0-0	678.431	151.837
14	16	3.62500	0.55	0-0	786.804	375.664
15	15	3.80750	0.19	1-0	91.847	560.940
16	15	3.84640	0.83	0-0	540.093	597.658
17	14	4.16250	0.038	1-0	1019.400	919.318
18	17	3.41600	0	HEII	846.782	165.026
19	16	3.57300	0	HEII	133.231	324.084
20	14	4.10010	0	HEII	310.010	853.335
21	14	4.12270	0	HEI	557.458	875.472
22	14	4.14570	0	HEII	819.878	899.978
						(end)

Table 3.7: List of spectral lines displayed on *M*-band (M-: Figures 3.13 and 3.14).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	12	4.60600	2.47e-5	6D(5/2)-4F(5/2)	873.254	132.222
2	10	5.51150	0.57	0-0	764.097	591.634
3	12	4.50480	0	HEII	66.313	81.121
4	12	4.50480	0	HEII	66.313	81.121
5	12	4.60660	0	HEI	878.298	132.559
6	12	4.60550	0	R(22)	869.057	131.941
7	12	4.61160	0	R(21)	920.489	135.387
8	12	4.61790	0	R(20)	974.010	138.997
9	11	4.90780	0	P(15)	20.954	286.963
10	11	4.91780	0	P(16)	90.541	291.480
11	11	4.92790	0	P(17)	161.375	296.124
12	11	4.93820	0	P(18)	234.204	300.948
13	11	4.94860	0	P(19)	308.370	305.912
14	11	4.96960	0	P(20)	460.171	316.233
15	11	4.98040	0	P(21)	539.359	321.703
16	11	4.99120	0	P(22)	619.357	327.289
17	11	5.00220	0	P(23)	701.705	333.102
18	12	4.50100	0	R(22)	37.479	79.399
19	12	4.50710	0	R(21)	83.813	82.170
20	12	4.51320	0	R(20)	130.381	84.973
21	12	4.51950	0	R(19)	178.738	87.903
22	12	4.52590	0	R(18)	228.137	90.918
23	12	4.53240	0	R(17)	278.603	94.019
24	12	4.53890	0	R(16)	329.364	97.161
25	12	4.54560	0	R(15)	382.013	100.443
26	12	4.55470	0	R(14)	454.068	104.974
27	12	4.55920	0	R(13)	489.939	107.247
28	12	4.56620	0	R(12)	546.060	110.824
29	12	4.57320	0	R(11)	602.591	114.455
30	12	4.58040	0	R(10)	661.168	118.246
31	12	4.58760	0	R(9)	720.207	122.098
32	12	4.59500	0	R(8)	781.367	126.119
33	12	4.60240	0	R(7)	843.053	130.208
34	12	4.61000	0	R(6)	906.961	134.478
35	12	4.61770	0	R(5)	972.306	138.881
36	11	4.90910	0	P(25)	29.972	287.546
37	11	4.92040	0	P(26)	108.724	292.667
38	11	4.93140	0	P(27)	186.055	297.753
39	11	4.94340	0	P(28)	271.207	303.418
40	11	4.95500	0	P(29)	354.337	309.015
41	11	4.96680	0	P(30)	439.767	314.833
42	11	4.97880	0	P(31)	527.578	320.886
43	11	4.99080	0	P(32)	616.379	327.080
						(end)

Table 3.8: List of spectral lines displayed on *M*-band (M-: Figures 3.15 and 3.16).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	12	4.67100	2.71e-6	6D(1/2)-4F(3/2)	391.579	164.380
2	11	5.06100	5.73e-6	6D(3/2)-4F(5/2)	126.078	364.015
3	10	5.67200	5.80e-6	6D(5/2)-4F(7/2)	882.121	673.610
4	12	4.65380	0.0158	Pf(7-5)	246.608	156.091
5	12	4.67300	0.00246	11-6	408.614	165.367
6	11	5.12900	0.00303	10-6	656.715	397.351
7	12	4.69470	0.92	0-0	596.153	176.394
8	11	5.05290	0.25	0-0	65.267	360.368
9	13	4.37200	0	HEII	971.131	13.313
10	12	4.65060	0	HEII	219.939	154.587
11	12	4.66400	0	HEII	332.238	160.965
12	12	4.69500	0	HEI	598.791	176.551
13	11	5.12400	0	HEII	616.333	394.719
14	12	4.62420	0	R(19)	3.292	142.596
15	12	4.63060	0	R(18)	55.281	145.436
16	12	4.63710	0	R(17)	108.425	148.363
17	12	4.64370	0	R(16)	162.747	151.381
18	12	4.65040	0	R(15)	218.276	154.493
19	12	4.65720	0	R(14)	275.044	157.702
20	12	4.66410	0	R(13)	333.082	161.013
21	12	4.67410	0	R(12)	418.008	165.911
22	12	4.67820	0	R(11)	453.110	167.955
23	12	4.68530	0	R(10)	514.310	171.543
24	12	4.69260	0	R(9)	577.789	175.300
25	12	4.70000	0	R(8)	642.734	179.181
26	12	4.70750	0	R(7)	709.195	183.190
27	12	4.71500	0	R(6)	776.319	187.280
28	12	4.72270	0	R(5)	845.956	191.564
29	12	4.73050	0	R(4)	917.269	195.996
30	12	4.73830	0	R(3)	989.395	200.524
31	12	4.62540	0	R(4)	13.014	143.126
32	12	4.63330	0	R(3)	77.312	146.646
33	12	4.64120	0	R(2)	142.127	150.232
34	12	4.64930	0	R(1)	209.131	153.979
35	12	4.65750	0	R(0)	277.557	157.845
36	12	4.67420	0	P(1)	418.865	165.961
37	12	4.68260	0	P(2)	490.974	170.171
38	12	4.69120	0	P(3)	565.567	174.574
39	12	4.70020	0	P(4)	644.497	179.287
40	12	4.70880	0	P(5)	720.777	183.893
41	12	4.71770	0	P(6)	800.651	188.772
42	12	4.72670	0	P(7)	882.422	193.825
43	12	4.73590	0	P(8)	967.113	199.121
						(end)

Table 3.9: List of spectral lines displayed on *M*-band (M+: Figures 3.17 and 3.18).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	13	4.43400	1.09e-6	6D(3/2)-4F(3/2)	567.284	43.335
2	13	4.46800	0.000	limit 7	928.720	62.109
3	13	4.40960	0.33	0-0	320.389	31.138
4	13	4.39880	0	HeII	213.985	26.038
5	12	4.74300	0	HeII	14.984	203.086
6	12	4.74880	0	HeII	66.060	205.623
7	12	4.76400	0	HeII	201.665	212.472
8	12	4.76420	0	HeII	203.471	212.564
9	12	4.74630	0	R(2)	44.006	204.525
10	12	4.75440	0	R(1)	115.719	208.112
11	12	4.76250	0	R(0)	188.166	211.783
12	12	4.77920	0	P(1)	339.975	219.628
13	12	4.78770	0	P(2)	418.579	223.772
14	12	4.79630	0	P(3)	499.087	228.075
15	12	4.80500	0	P(4)	581.583	232.544
16	12	4.81380	0	P(5)	666.166	237.190
17	12	4.82270	0	P(6)	752.927	242.022
18	12	4.83170	0	P(7)	841.981	247.053
19	12	4.84080	0	P(8)	933.446	252.295
20	12	4.74510	0	P(9)	33.440	204.000
21	12	4.75450	0	P(10)	116.608	208.157
22	12	4.76400	0	P(11)	201.665	212.472
23	12	4.77360	0	P(12)	288.694	216.955
24	12	4.78330	0	P(13)	377.770	221.614
25	12	4.79310	0	P(14)	469.012	226.461
26	12	4.80310	0	P(15)	563.474	231.558
27	12	4.81310	0	P(16)	659.395	236.815
28	12	4.82330	0	P(17)	758.820	242.353
29	12	4.83360	0	P(18)	860.960	248.135
30	12	4.84400	0	P(19)	965.968	254.176
						(end)

Table 3.10: List of spectral lines displayed on *M*-band (M++: Figures 3.19 and 3.20).

Line Number	Order	Wavelength (μm)	Intensity	Label	X(pixels)	Y(pixels)
1	12	4.88800	3.71e-5	6D(7/2)-4F(7/2)	522.408	274.728
2	11	5.33900	4.17e-5	6D(9/2)-4F(9/2)	585.418	503.693
3	13	4.46800	0.000	limit 7	50.663	62.431
4	13	4.50480	0	HeII	442.616	79.515
5	13	4.50480	0	HeII	442.616	79.515
6	12	4.86910	0	HeII	330.937	265.407
7	12	4.88300	0	HeI	471.131	272.199
8	12	4.84080	0	P(8)	55.112	252.571
9	12	4.85010	0	P(9)	144.427	256.651
10	12	4.85940	0	P(10)	235.013	260.864
11	12	4.86890	0	P(11)	328.939	265.312
12	12	4.87840	0	P(12)	424.361	269.913
13	12	4.88810	0	P(13)	523.437	274.779
14	12	4.89790	0	P(14)	625.321	279.877
15	12	4.90780	0	P(15)	730.200	285.224
16	12	4.91780	0	P(16)	838.272	290.839
17	12	4.92790	0	P(17)	949.787	296.744
18	13	4.50100	0	R(22)	400.951	77.637
19	13	4.50710	0	R(21)	467.988	80.665
20	13	4.51320	0	R(20)	535.806	83.768
21	13	4.51950	0	R(19)	606.721	87.054
22	13	4.52590	0	R(18)	679.707	90.481
23	13	4.53240	0	R(17)	754.863	94.057
24	13	4.53890	0	R(16)	831.093	97.733
25	13	4.54560	0	R(15)	910.864	101.632
26	13	4.55470	0	R(14)	1021.278	107.118
27	12	4.84400	0	P(19)	85.704	253.960
28	12	4.85460	0	P(20)	188.097	258.673
29	12	4.86520	0	P(21)	292.188	263.562
30	12	4.87600	0	P(22)	400.112	268.736
31	12	4.88690	0	P(23)	511.083	274.168
32	12	4.89800	0	P(24)	626.363	279.930
33	12	4.90910	0	P(25)	744.127	285.941
34	12	4.92040	0	P(26)	866.748	292.336
35	12	4.93140	0	P(27)	989.012	298.849
						(end)