ING Technical Note 116

Atlas of Thorium Argon lines and the Solar spectrum obtained with the ESA-MUSICOS spectrograph at the Isaac Newton Telescope

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June 1998

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This ThAr atlas was made from the median of a few arc exposures. The source was one of the standard ThAr lamps that fit on the INT Cass A&G box, mounted in a tube that replaces the Cassegrain integrating sphere. The MUSICOS spectrograph was set up manually; we used the red crossdispersing prism and the new single blue Polymicro F-UV050P fiber. The detector we used was SITe1 which has 2048x2048 24μm pixels. This instrument setup allows to sample the full length of the orders, except in the blue end where camera vignetting occurs. For this setup, the unvignetted wavelength region is approximately 4850–9100Å.

The solar spectrum was taken using the same setup.

The orders were traced using the solar spectrum. The arc lines were identified using the IRAF task 'ecidentify'. All lines were carefully identified, with the IRAF line lists and the UES ThAr Atlas (ING technical note 91, 1993, by Lipman, Pettini, Wall & Walton) as a reference. With the help of the UES atlas we identified only those lines that seemed free from blending.

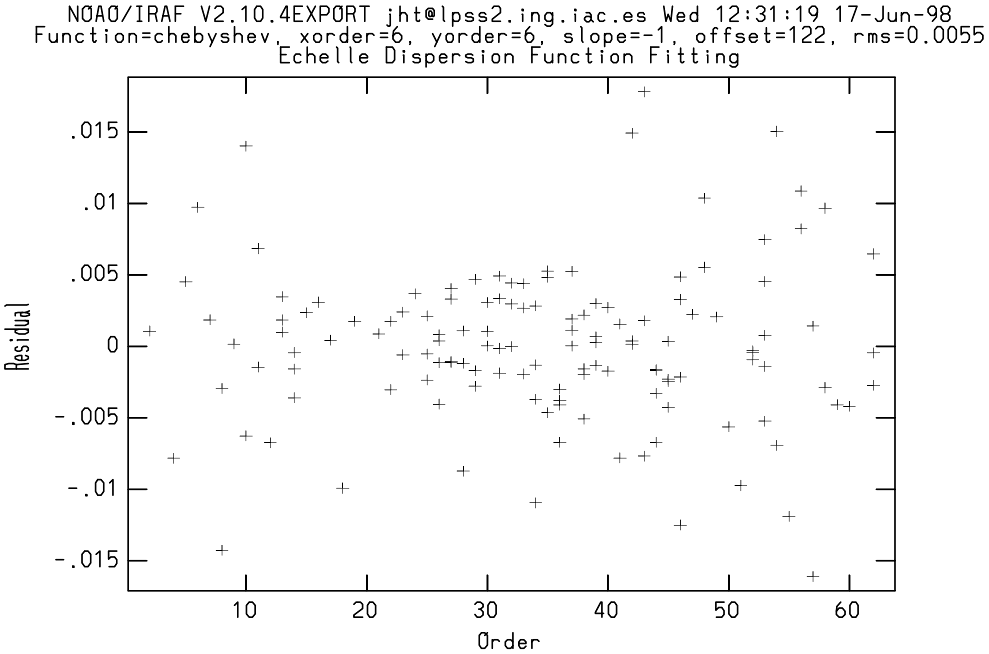
Parameters found and used ('ecidentify'):
RMS = 0.00573 Angstrom
function chebyshev
xorder 6
yorder 6
slope -1
shift 0.
See the help on the 'ecidentify' package for a detailed description of these parameters.

The results of the transformation fit are summarised in the first two figures. The residuals between measured and laboratory wavelength add up to give a total RMS=0.00573 Angstrom.

A list of the identified lines is given in the following table. In the figures of the atlas the identified lines are marked by a vertical dash and the corresponding wavelength. The vertical axis gives a measure of the strength of the ThAr lines. We only plot the orders that are not affected by camera vignetting.

The solar spectrum is overplotted in the figures; all orders were normalized to unity. The spectral orders have not been flatfielded; fringing was not corrected for.

In the Appendix (page 35) we show the ThAr lines of the spectral regions that are not sampled by the above instrument setup. The data that result in these figures were taken with a 1024x1024 TEK chip with 24μm pixels, with the blue crossdispersing prism and with fibers that have been replaced in March 1998.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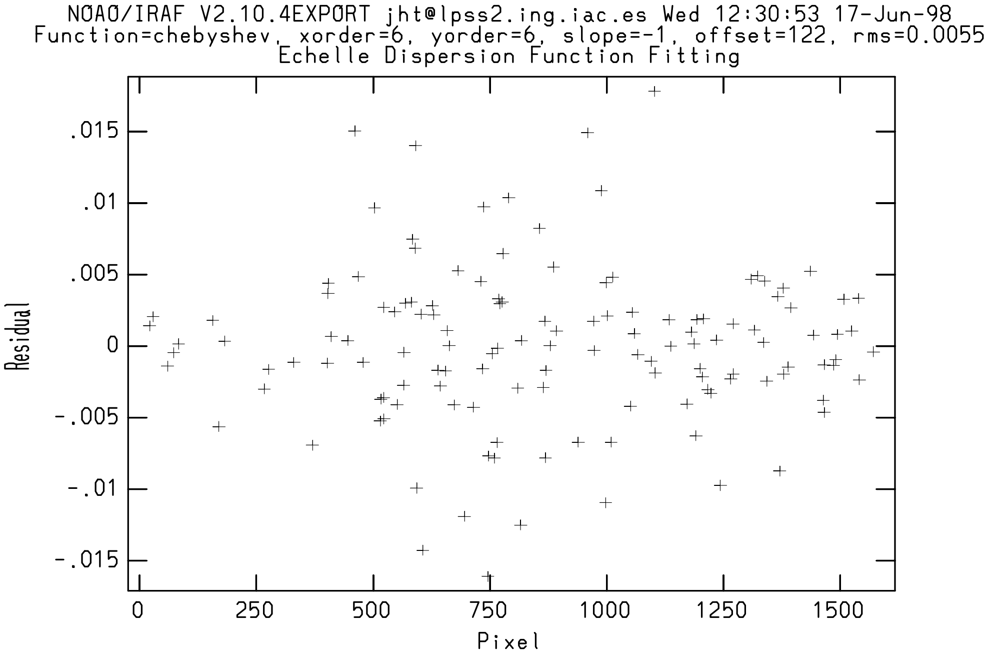
Echelle Dispersion Function Fitting
Residual
Order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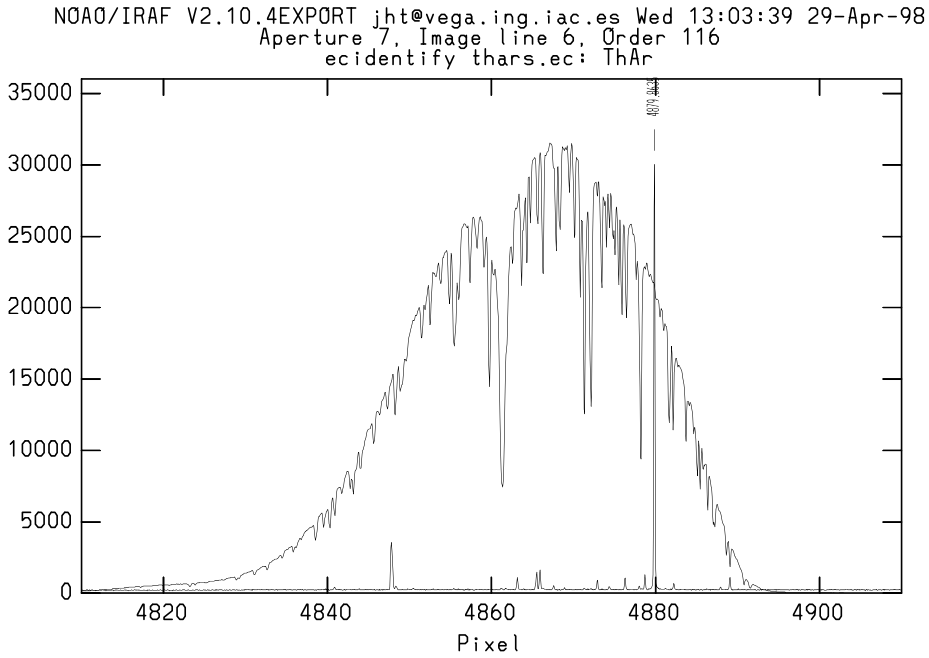
Echelle Dispersion Function Fitting
Residual
Pixel

Order	Pixel	Fit	Laboratory	Residual
116	1193.59	4879.8603	4879.8635	-0.0032188
115	606.27	4879.8763	4879.8635	0.01282128
115	810.00	4894.9615	4894.9551	0.00640335
114	1187.35	4965.0801	4965.0795	5.71954E-4
113	590.86	4965.066	4965.0795	-0.0134766
113	1191.62	5009.3416	5009.3344	0.00716278
112	589.95	5009.3289	5009.3344	-0.005538
112	1389.15	5067.9755	5067.9737	0.00184563
111	765.22	5067.9817	5067.9737	0.00800489
110	1133.63	5141.7823	5141.7827	-3.8787E-4
110	1181.87	5145.3082	5145.3083	-1.2835E-4
110	1367.00	5158.6	5158.6041	-0.0040995
109	522.05	5141.7858	5141.7827	0.00311051
109	566.07	5145.3099	5145.3083	0.00158973
109	734.64	5158.6058	5158.6041	0.00165056
108	1055.49	5231.1576	5231.1597	-0.0021001
107	776.38	5258.3553	5258.3602	-0.0048605
106	1235.56	5343.5801	5343.5812	-0.0011262
105	593.23	5343.5906	5343.5812	0.00941874
104	867.88	5417.4812	5417.4858	-0.004642
102	1059.33	5539.2595	5539.2618	-0.0022994
101	972.15	5587.0226	5587.0263	-0.0036591
101	1217.21	5606.7351	5606.733	0.00207658
100	546.23	5606.7291	5606.733	-0.0038921
100	1067.13	5650.7038	5650.7043	-4.9707E-4
99	403.15	5650.7004	5650.7043	-0.0039307
98	755.18	5739.5182	5739.5196	-0.0013685
98	1001.40	5760.5479	5760.5508	-0.0028728
98	1541.31	5804.144	5804.1412	0.00282259
97	329.97	5760.5527	5760.5508	0.00189443
97	817.50	5804.1397	5804.1412	-0.001528
97	1172.18	5834.2672	5834.2633	0.00385255
97	1494.40	5860.3092	5860.3103	-0.0011331
96	479.00	5834.2635	5834.2633	2.22340E-4
96	768.69	5860.3062	5860.3103	-0.004104
96	1095.37	5888.5853	5888.5841	0.00124134
96	1378.86	5912.0807	5912.0853	-0.0045532
95	402.28	5888.585	5888.5841	9.44263E-4
95	658.40	5912.0835	5912.0853	-0.0017971
95	1370.94	5973.6733	5973.6649	0.0084365
94	643.98	5973.6674	5973.6649	0.00248386
94	870.32	5994.1311	5994.1287	0.00242921
94	1309.62	6032.1228	6032.1274	-0.0045745
93	581.72	6032.1242	6032.1274	-0.0032245
93	878.99	6059.3737	6059.3725	0.0011939
93	1525.15	6114.9223	6114.9234	-0.0010999
92	766.36	6114.9248	6114.9234	0.00144206
92	1104.42	6145.4442	6145.4411	0.00314826
92	1323.69	6164.4751	6164.4796	-0.0045322
92	1539.96	6182.6183	6182.6217	-0.0034136

Order	Pixel	Fit	Laboratory	Residual
91	771.61	6182.6204	6182.6217	-0.001256
91	998.74	6203.4899	6203.4925	-0.002641
91	1137.64	6215.9396	6215.9383	0.00128591
90	403.86	6215.9337	6215.9383	-0.0045667
90	1271.14	6296.8749	6296.8722	0.00270139
90	1394.87	6307.6546	6307.657	-0.0023651
89	516.30	6296.8765	6296.8722	0.00434561
89	626.83	6307.6557	6307.657	-0.001329
89	998.34	6342.8724	6342.8595	0.01287785
89	1466.17	6384.7183	6384.7169	0.00137028
88	681.78	6384.7136	6384.7169	-0.0032981
88	1012.74	6416.3041	6416.3071	-0.0030256
88	1466.27	6457.2871	6457.2824	0.00465966
87	266.70	6416.3097	6416.3071	0.00264083
87	673.44	6457.2884	6457.2824	0.00604895
87	939.32	6483.0911	6483.0825	0.0086093
87	1464.35	6531.3456	6531.3418	0.00376255
86	663.03	6531.3436	6531.3418	0.00177702
86	1207.62	6583.9047	6583.906	-0.0012803
86	1316.47	6593.9384	6593.9391	-7.3345E-4
86	1436.97	6604.8482	6604.8534	-0.0051967
85	523.13	6593.9451	6593.9391	0.00600353
85	630.04	6604.8527	6604.8534	-6.9951E-4
85	1200.28	6660.678	6660.6761	0.0019482
85	1379.10	6677.2838	6677.2817	0.0020946
84	410.32	6660.6755	6660.6761	-6.4456E-4
84	569.71	6677.2797	6677.2817	-0.0019924
84	1336.64	6752.8333	6752.8335	-2.3267E-4
84	1486.14	6766.6127	6766.6117	9.59818E-4
83	522.88	6752.8313	6752.8335	-0.0021813
83	655.00	6766.6143	6766.6117	0.00257554
82	869.07	6871.2968	6871.2891	0.0076775
82	1270.81	6911.2244	6911.2264	-0.0020079
81	83.33	6871.2891	6871.2891	1.25766E-5
81	445.48	6911.2258	6911.2264	-6.1793E-4
81	959.36	6965.4148	6965.4307	-0.0158688
80	156.22	6965.4287	6965.4307	-0.0019769
80	747.35	7030.2579	7030.2514	0.00654867
80	1102.96	7067.1989	7067.2181	-0.0192171
79	276.03	7067.2195	7067.2181	0.0013978
79	638.56	7107.478	7107.4778	2.26676E-4
79	1009.92	7147.0463	7147.0416	0.00474011
79	1223.13	7168.8972	7168.8952	0.00204764
78	182.04	7147.0416	7147.0416	-4.8635E-5
78	714.77	7206.9824	7206.9804	0.00195459
78	1265.95	7265.1736	7265.1724	0.00121545
78	1342.86	7272.9378	7272.9359	0.00185019
77	468.54	7272.9296	7272.9359	-0.0063285
77	815.90	7311.7254	7311.7159	0.00950449
77	1205.58	7353.2937	7353.293	7.02868E-4
77	1508.12	7383.9779	7383.9805	-0.0025797
76	602.49	7383.9755	7383.9805	-0.0050367

Order	Pixel	Fit	Laboratory	Residual
75	790.42	7503.8552	7503.8691	-0.0138724
75	886.72	7514.6431	7514.6518	-0.008722
74	28.40	7514.6496	7514.6518	-0.0021886
73	169.56	7635.1129	7635.106	0.00694836
72	1243.88	7868.2052	7868.1946	0.01063127
71	973.44	7948.1765	7948.1764	8.82915E-5
71	1490.96	8006.158	8006.1567	0.00128563
71	1571.60	8014.7855	8014.7857	-2.1541E-4
70	59.59	7948.177	7948.1764	6.46802E-4
70	515.35	8006.1607	8006.1567	0.00404596
70	584.81	8014.7769	8014.7857	-0.0088364
70	1338.56	8103.6902	8103.6931	-0.0029047
70	1443.30	8115.3102	8115.311	-7.7989E-4
69	369.90	8103.6998	8103.6931	0.00666388
69	460.79	8115.2956	8115.311	-0.0154158
68	695.59	8264.5358	8264.5225	0.01326532
67	856.42	8408.2049	8408.2096	-0.0046671
67	989.00	8424.6406	8424.6475	-0.0068957
66	21.11	8424.6464	8424.6475	-0.0011189
66	745.68	8521.4626	8521.4422	0.02043416
65	503.11	8620.4528	8620.4602	-0.007433
65	864.30	8667.9518	8667.9442	0.00759293
64	551.14	8761.6938	8761.6862	0.00762201
63	1051.02	8967.6409	8967.6403	6.02400E-4
61	72.69	9122.9678	9122.9674	4.05532E-4
61	565.12	9194.6382	9194.6385	-2.8995E-4
61	778.00	9224.488	9224.4992	-0.0112248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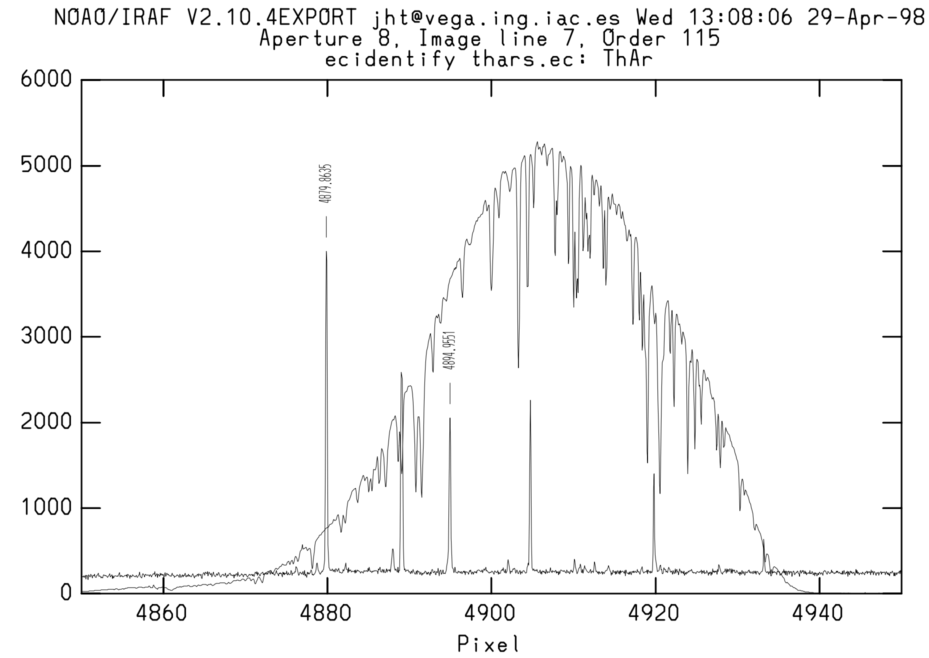
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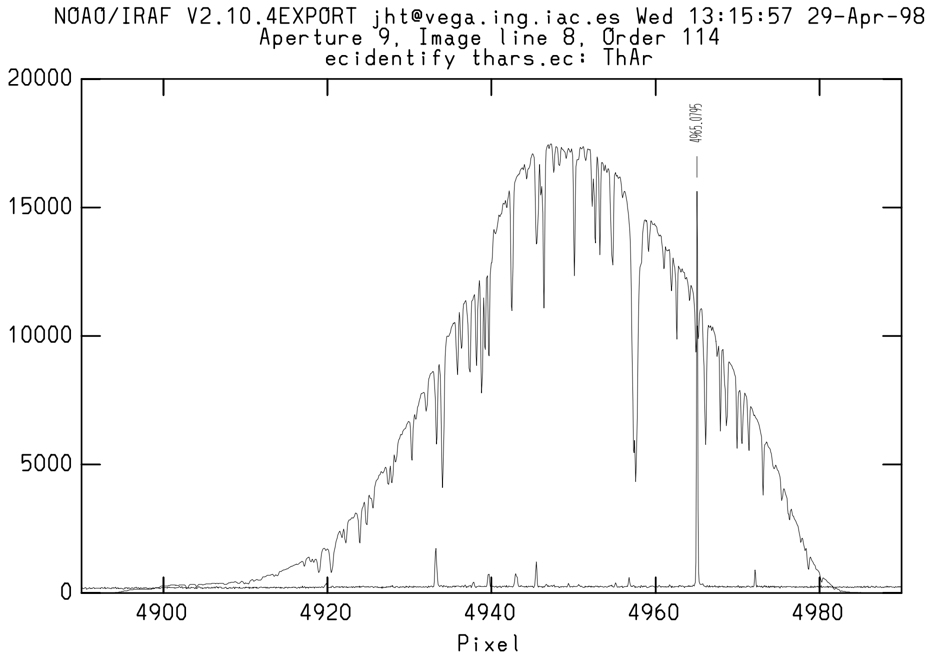
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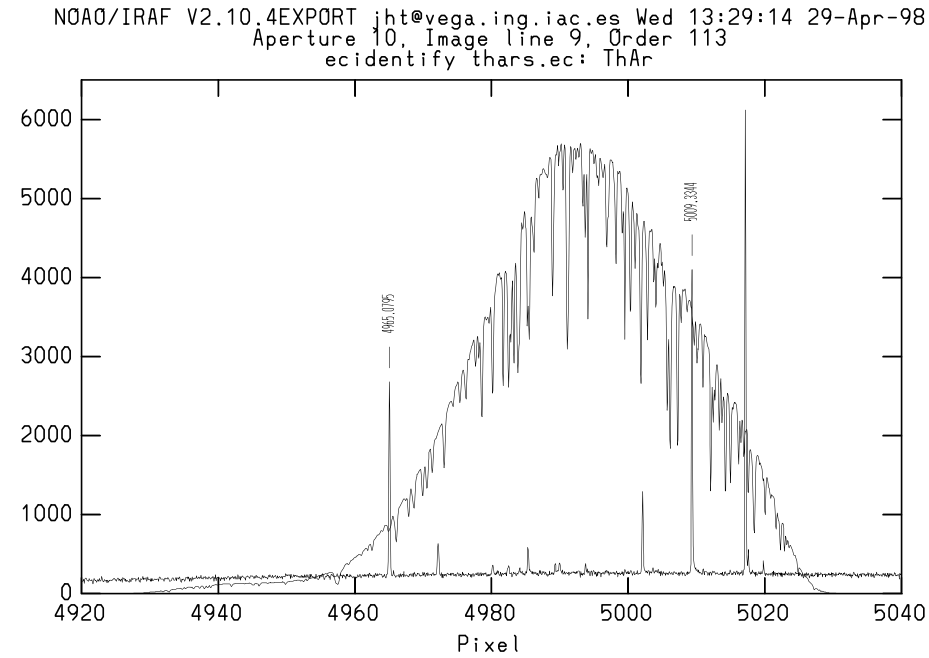
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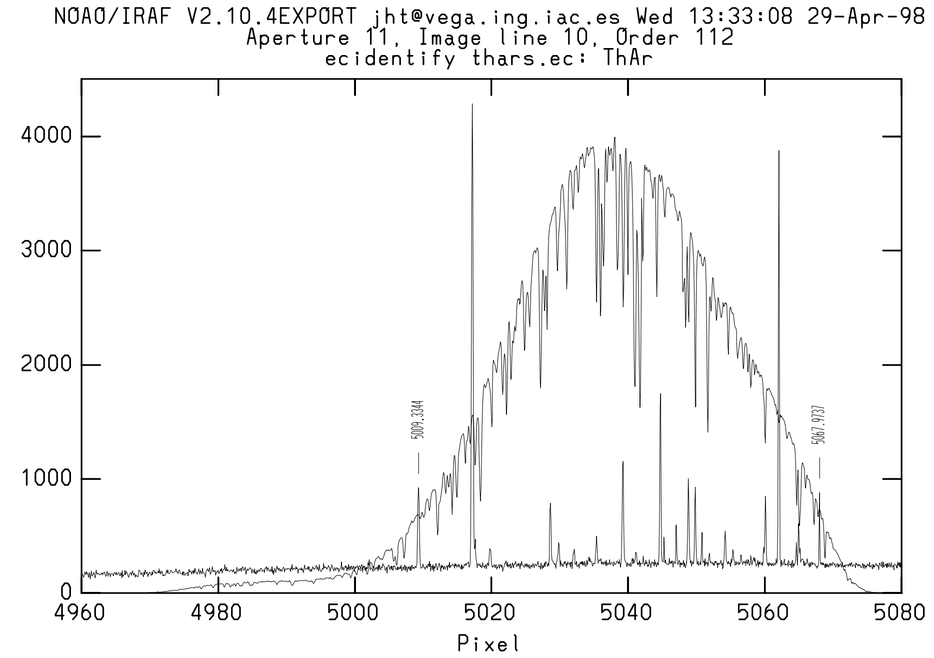
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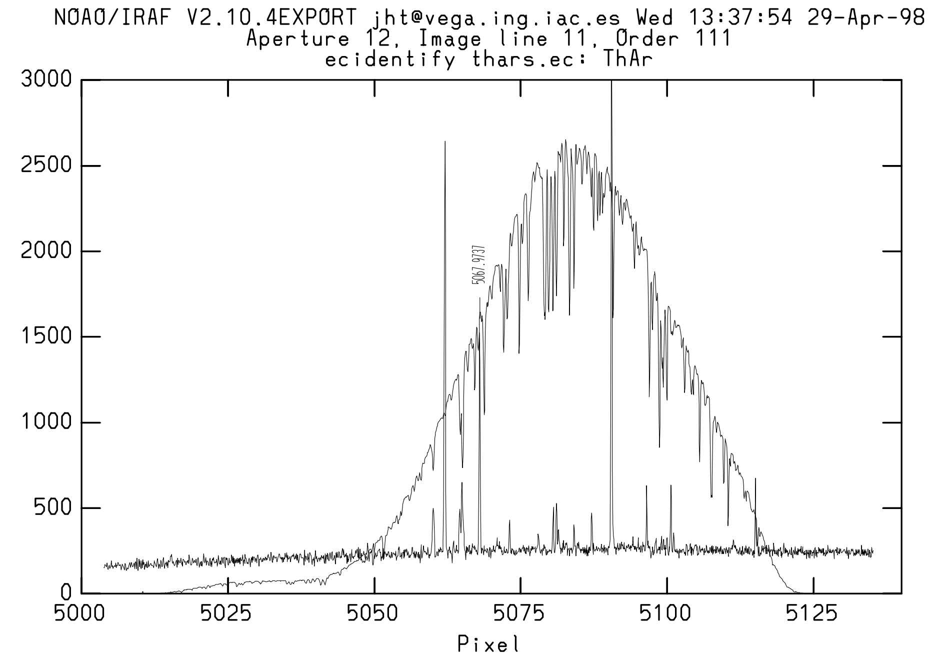
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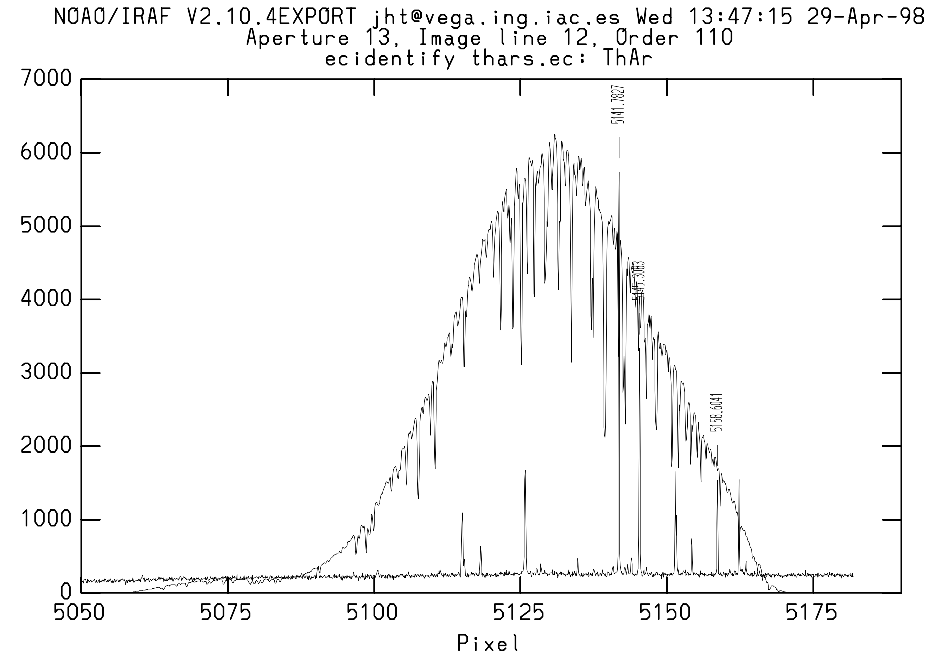
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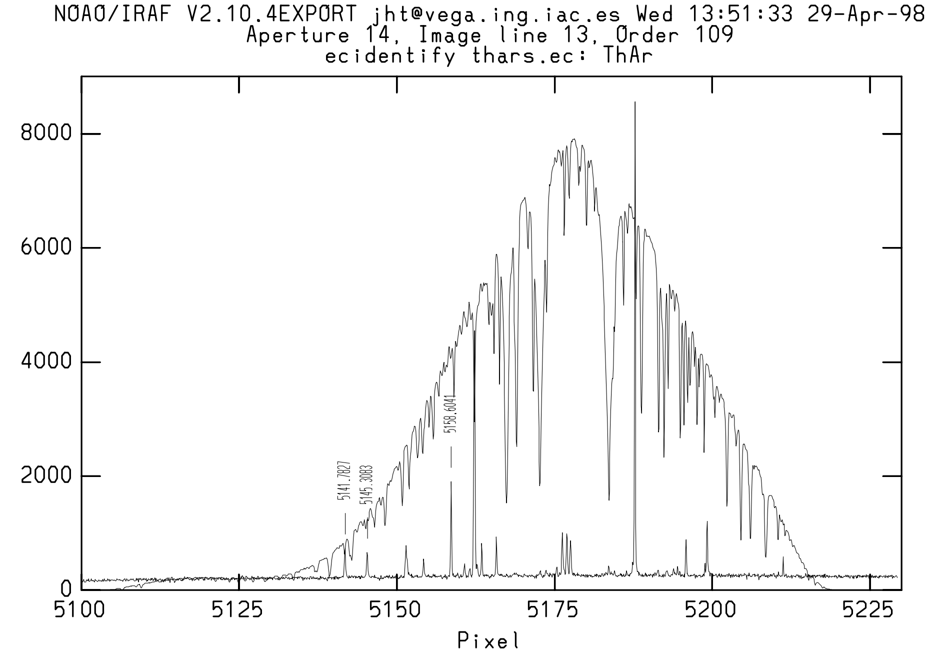
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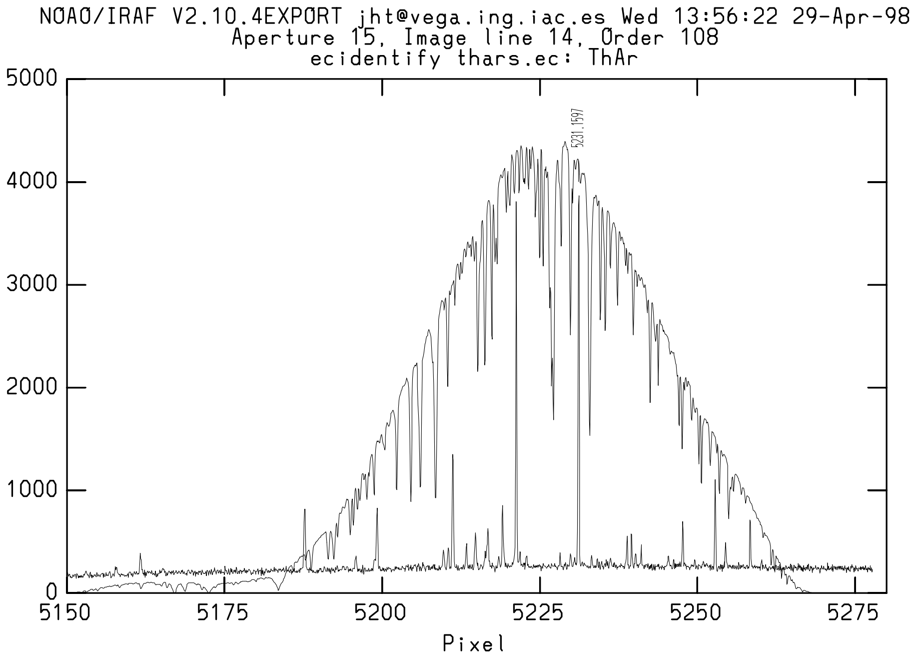
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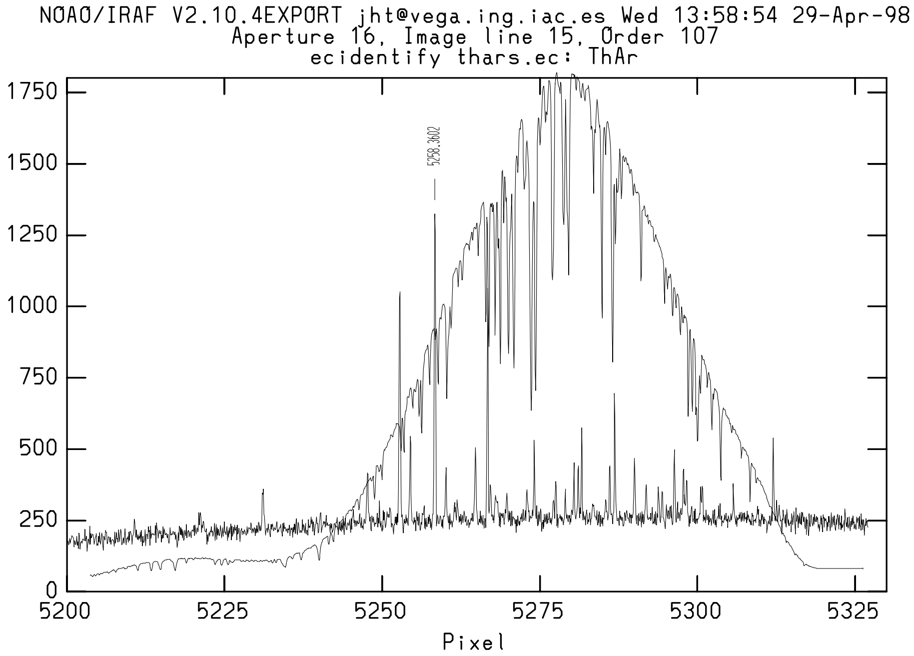
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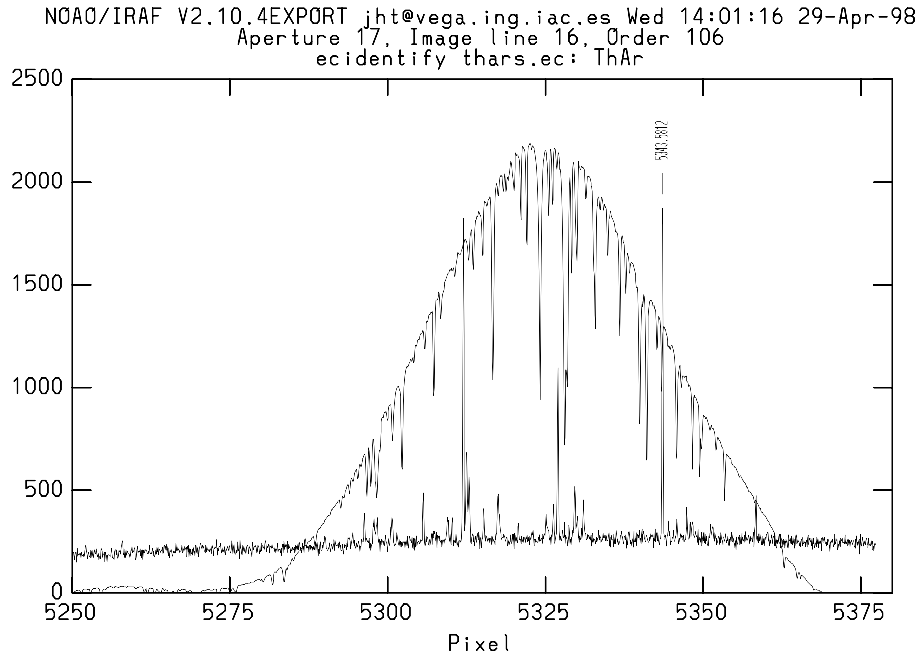
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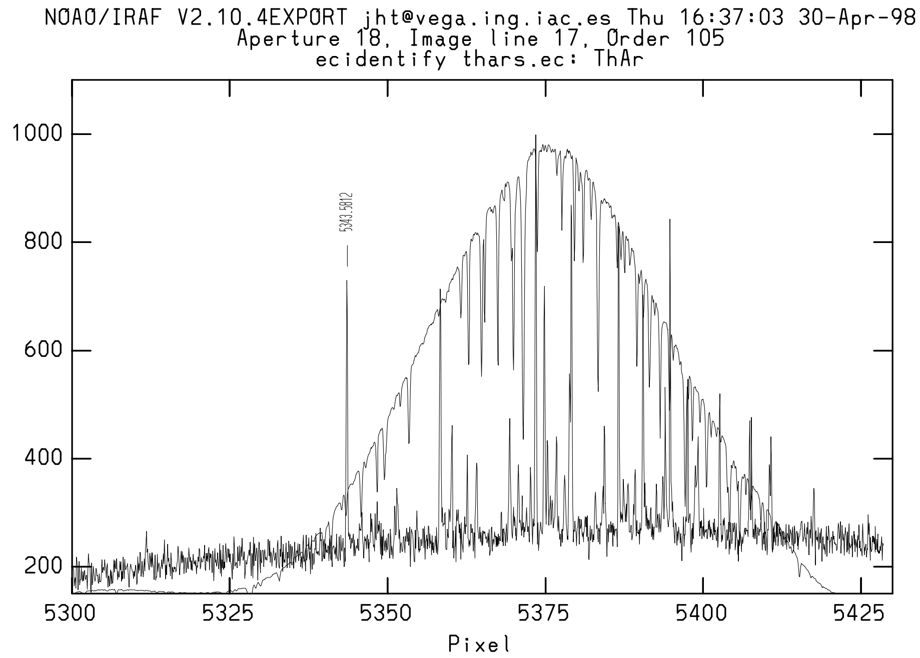
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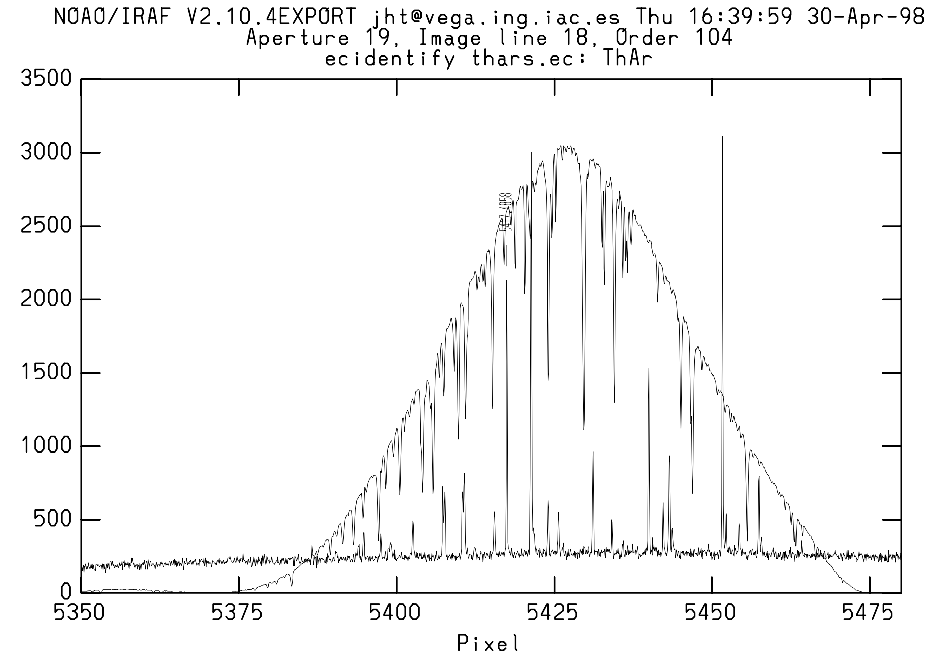
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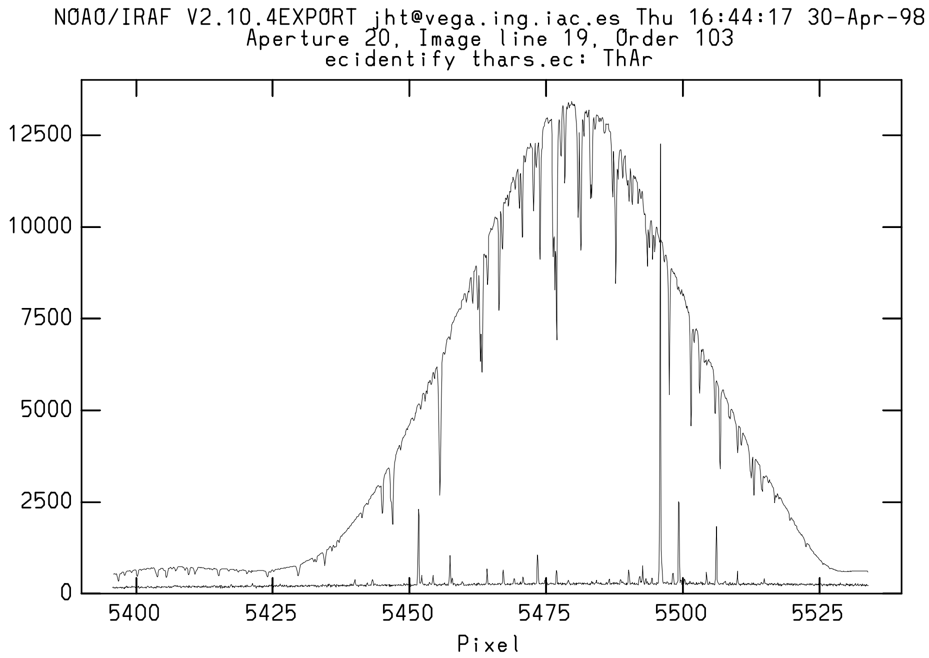
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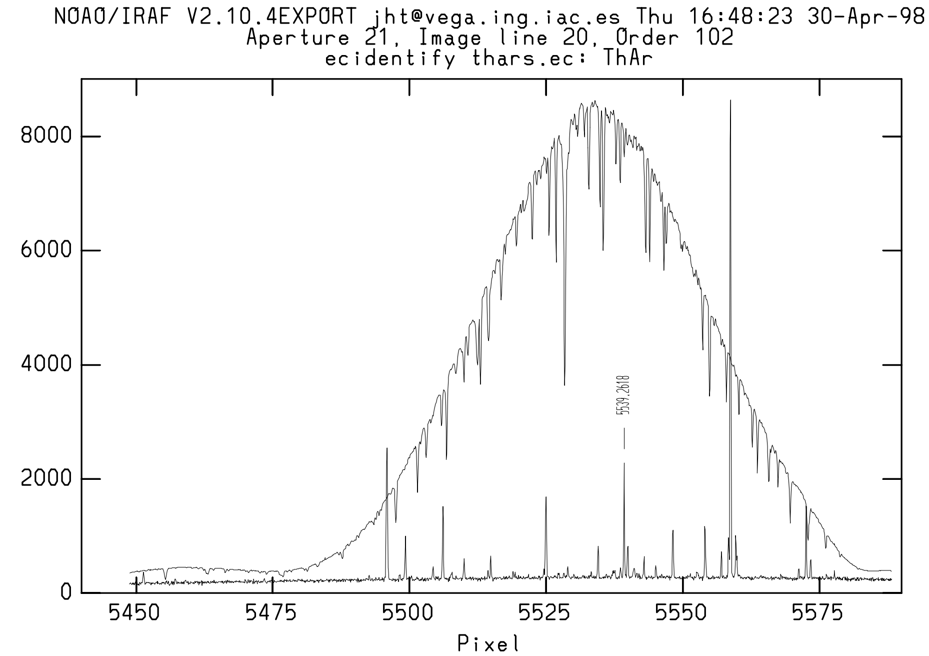
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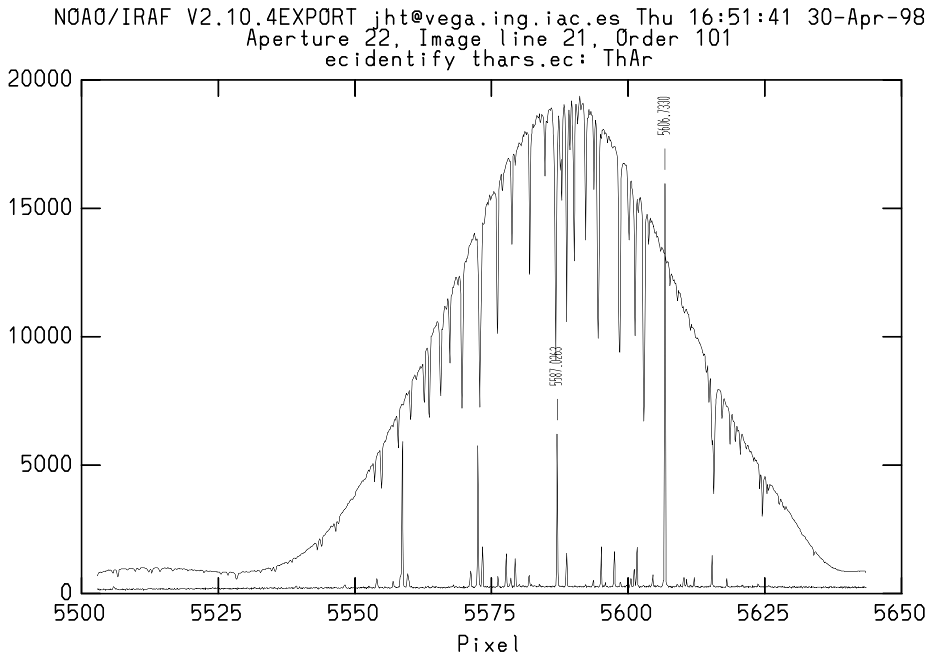
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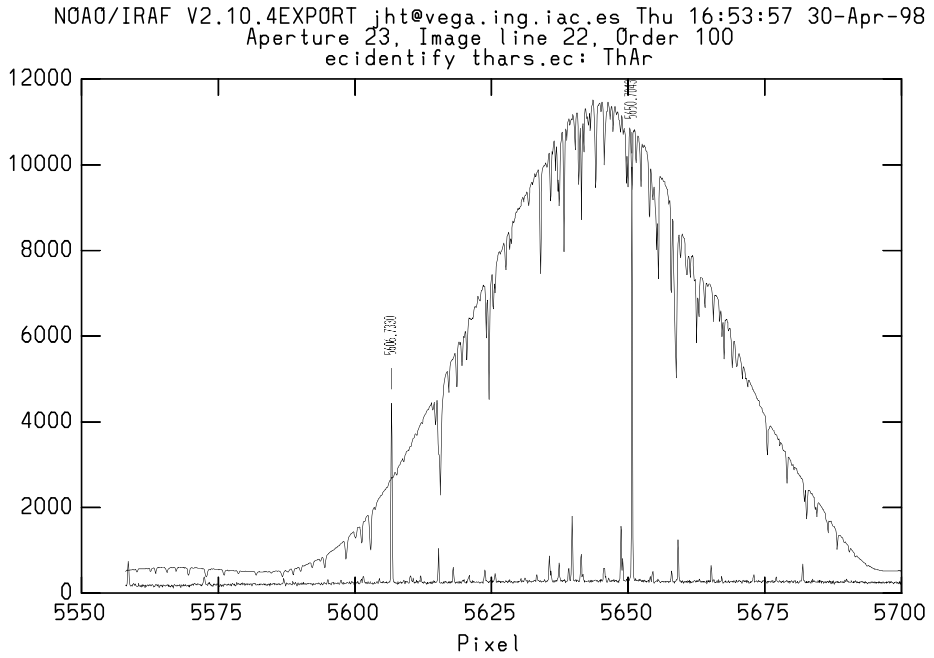
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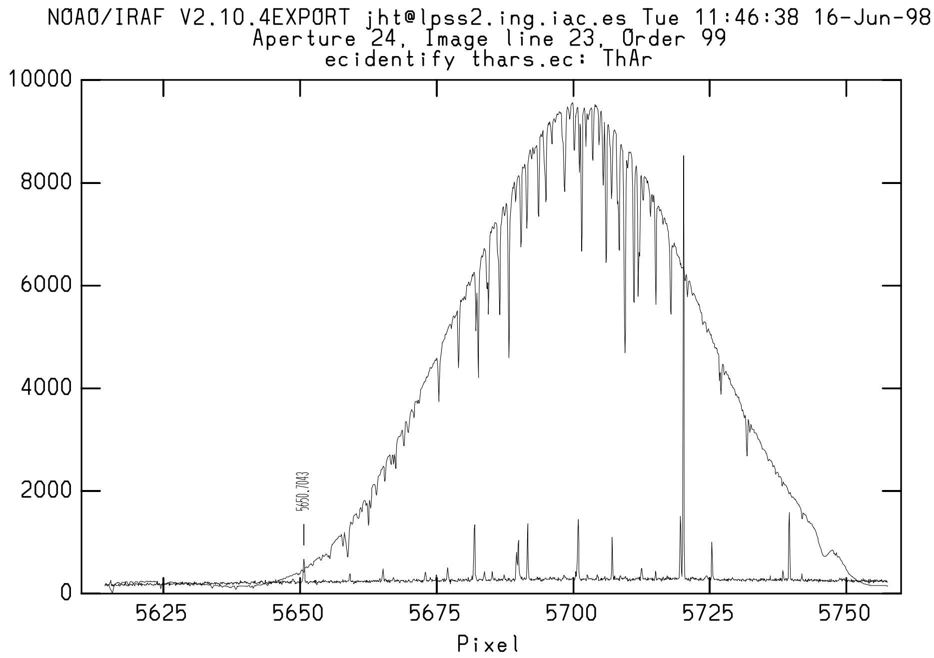
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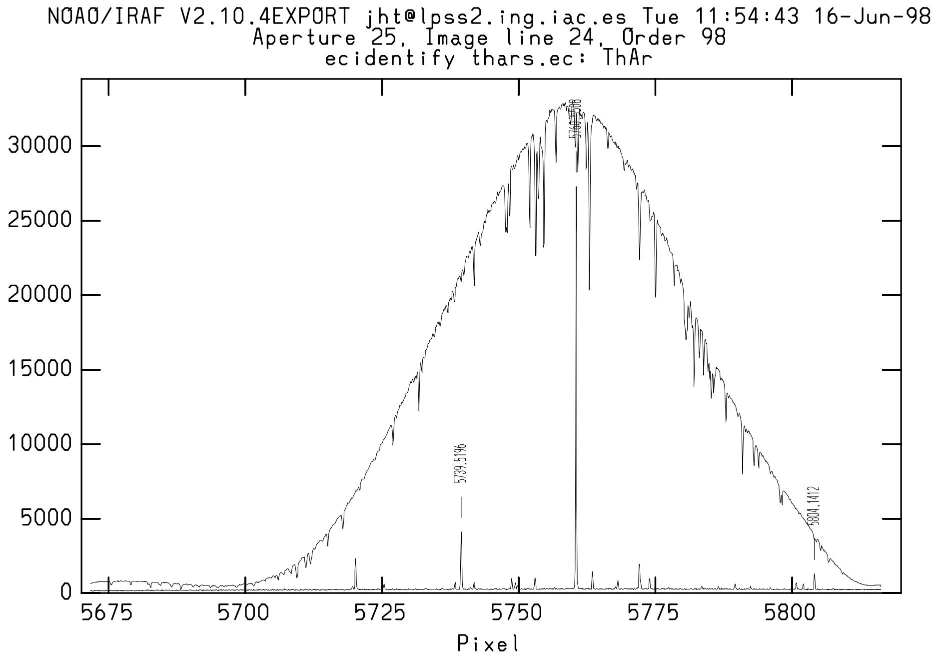
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5000
0
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5775
5800
Pixel
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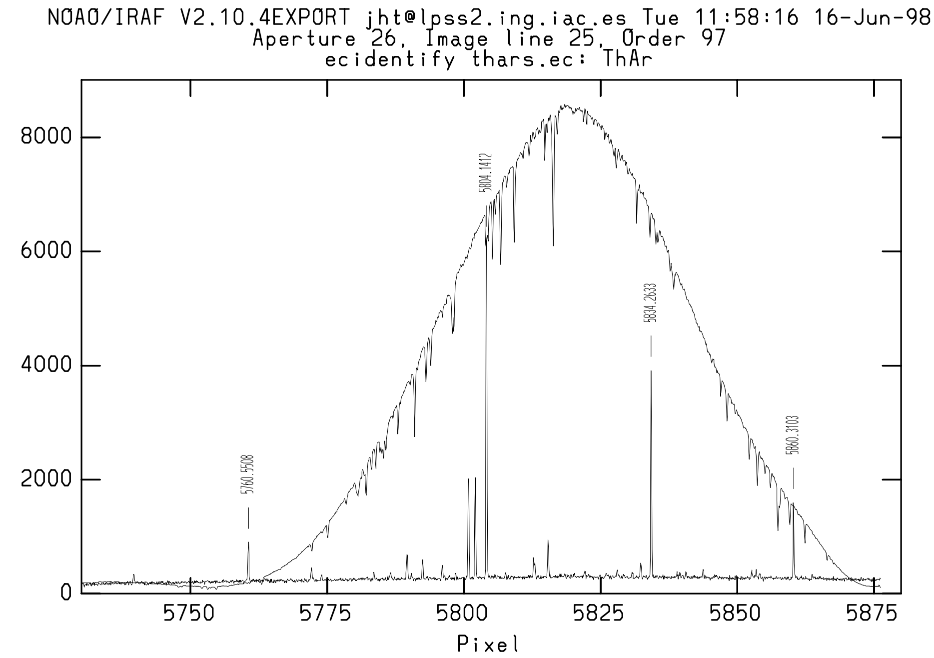
5804.1412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Aperture 26, Image line 25, Order 97
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8000
6000
4000
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5800
5825
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5875
Pixel
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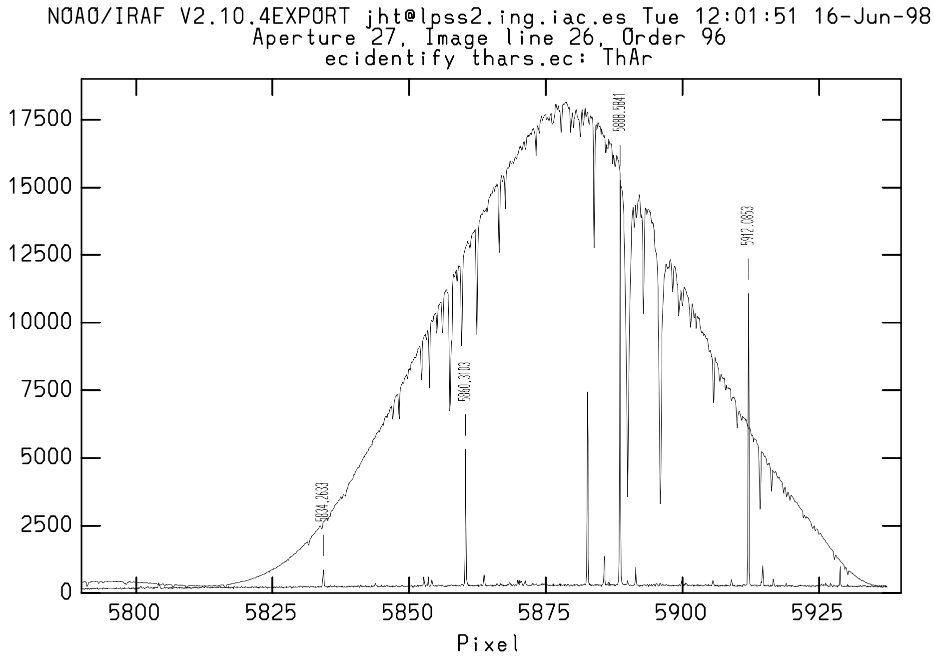
5804.1412
5834.2633
5860.3103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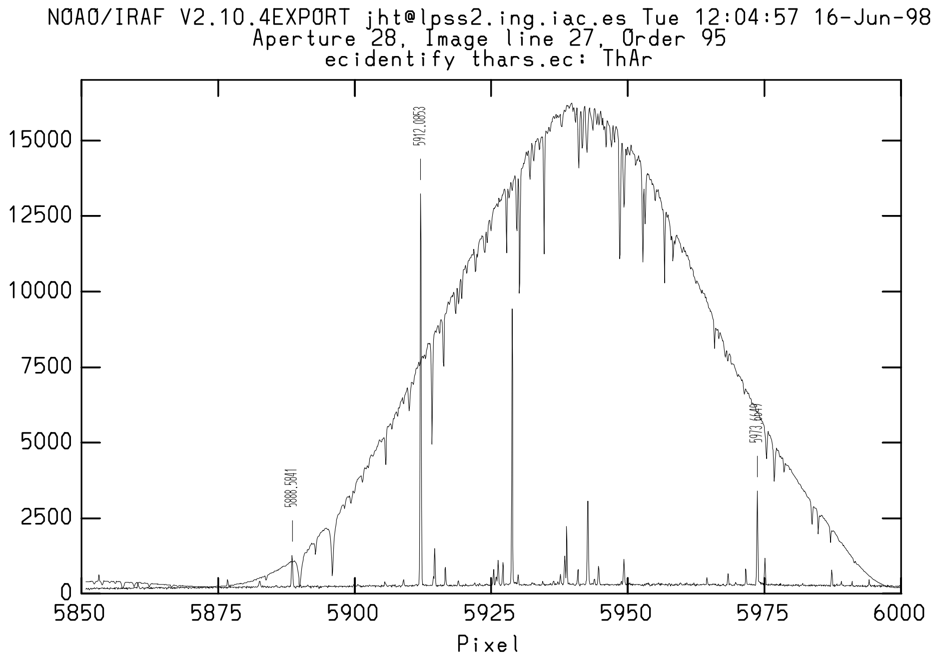
5860.3103
5888.5841
5912.0853
Pixel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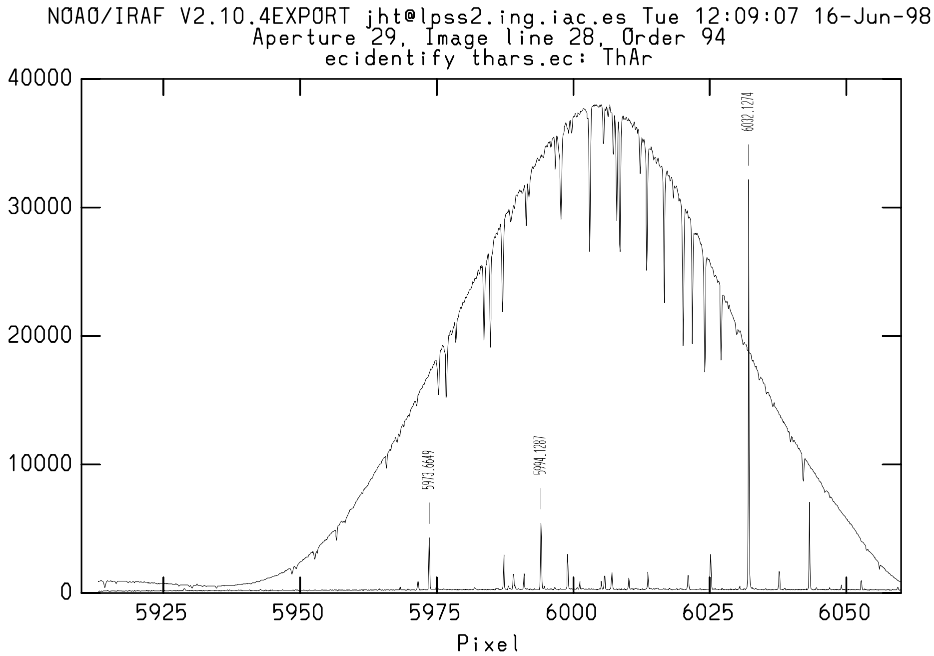
5912.0853
Pixel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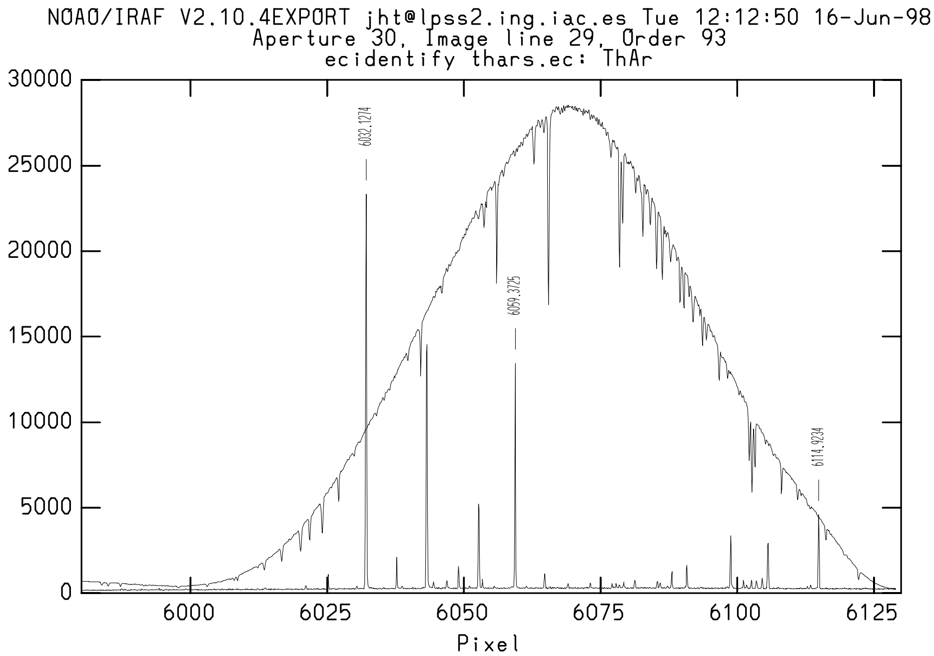
6032.1274
5973.6649
5994.1287
0
10000
20000
30000
40000
5925
5950
5975
6000
6025
6050
Pixel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Aperture 30, Image line 29, Order 93
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6032.1274
6059.3725
6114.9234
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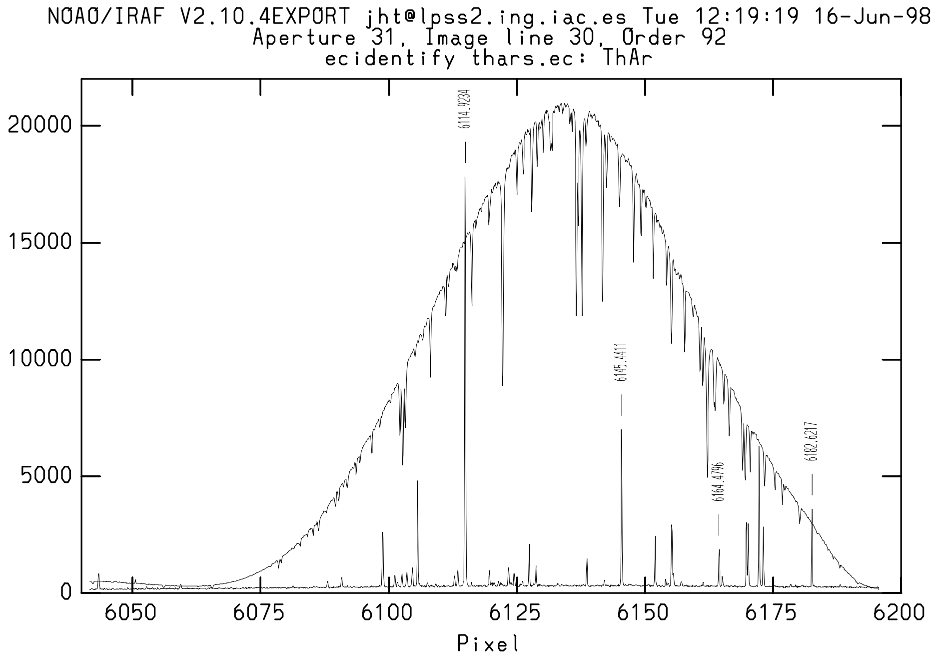
5000
10000
15000
20000
25000
30000
6000
6025
6050
6075
6100
6125
Pixel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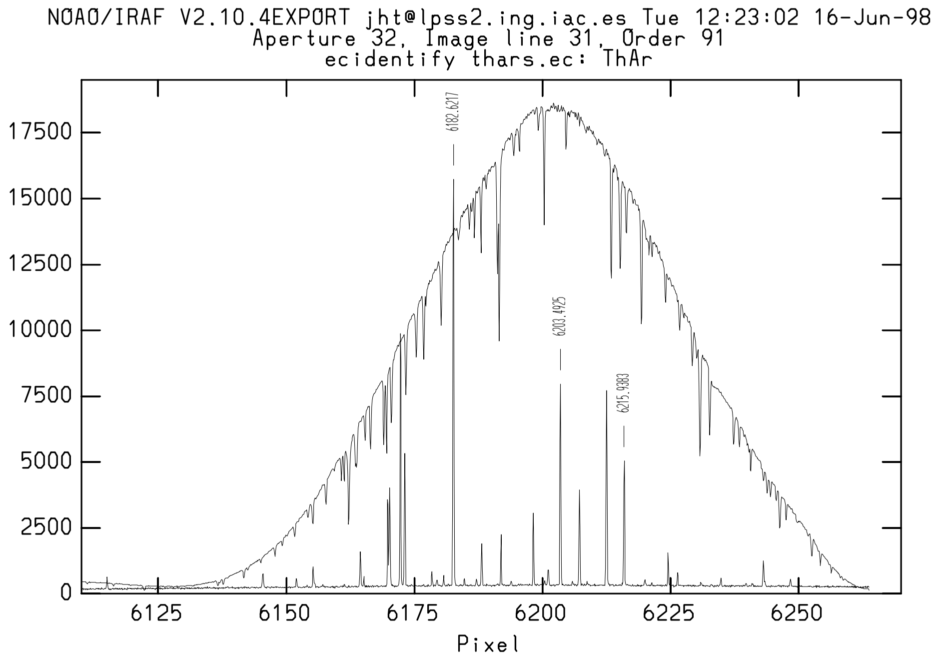
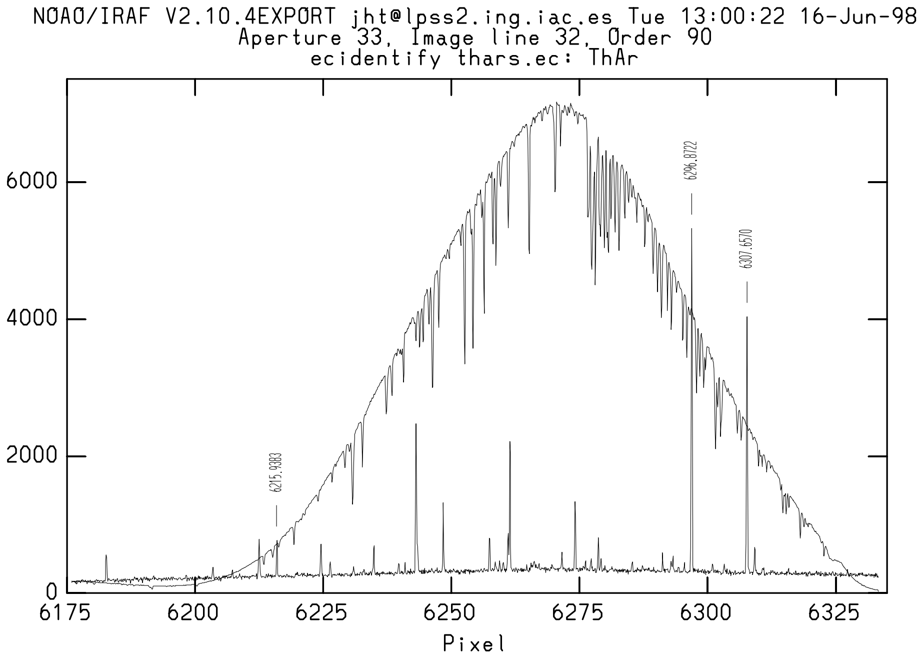
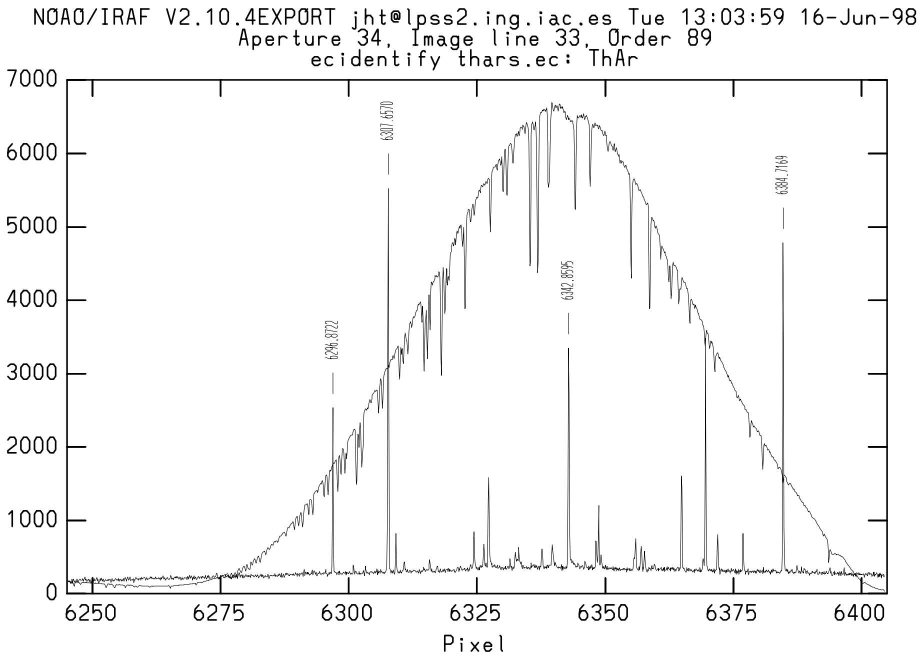
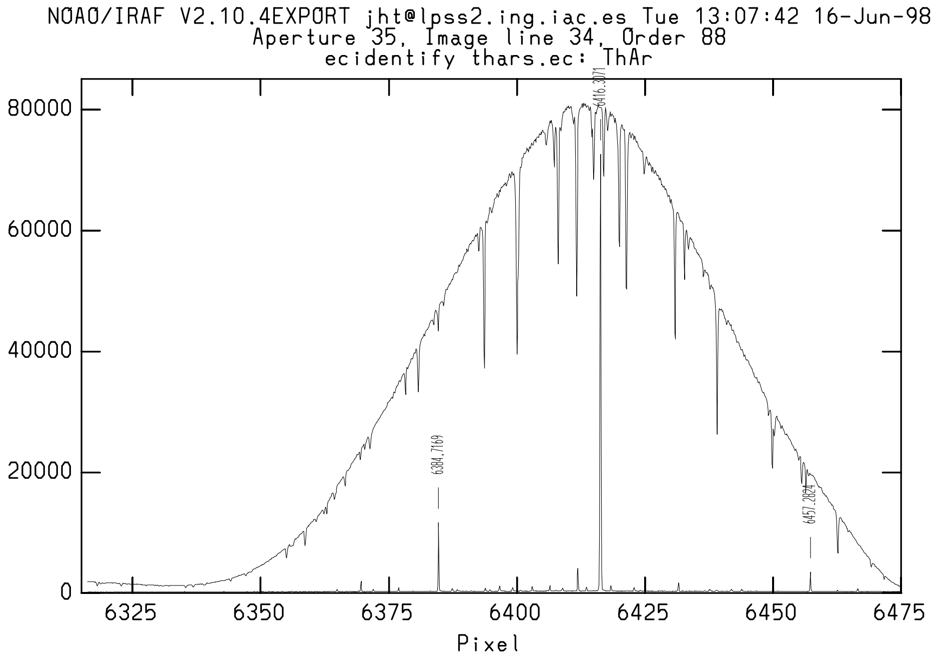
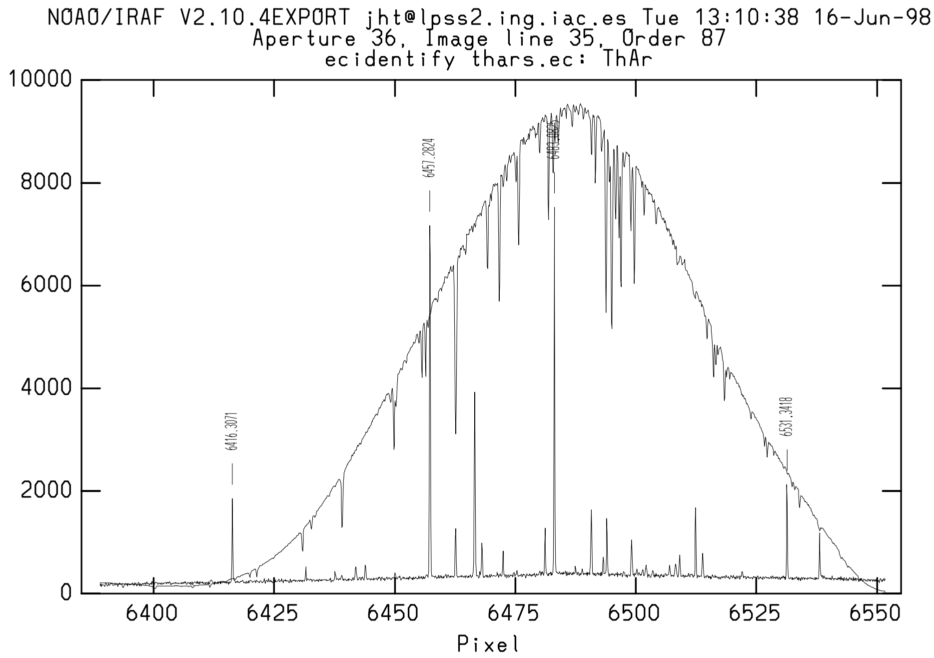
ecidentify thars.ec: ThAr
6114.9234
6145.4411
6164.4796
6182.6217
20000
15000
10000
5000
0
6050
6075
6100
6125
6150
6175
6200
Pixel

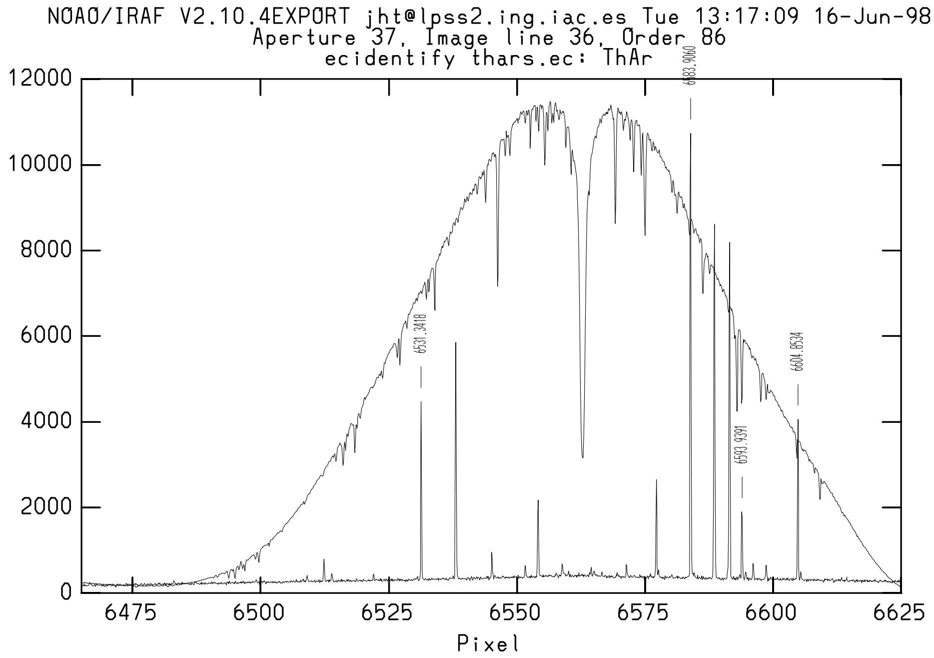

NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 12:23:02 16-Jun-98
Aperture 32, Image line 31, Order 91
ecidentify thars.ec: ThAr
6182.6217
6203.4925
6215.9383
17500
15000
12500
10000
7500
5000
2500
0
6125
6150
6175
6200
6225
6250
Pixel

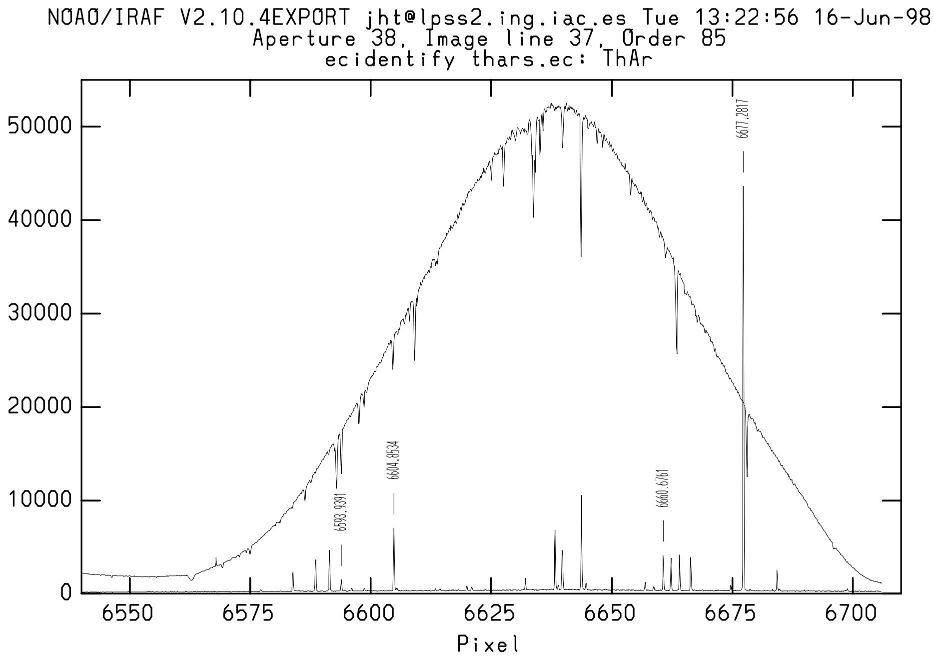

NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 13:00:22 16-Jun-98
Aperture 33, Image line 32, Order 90
ecidentify thars.ec: ThAr
6215.9383
6296.8722
6307.6570
0
2000
4000
6000
6175
6200
6225
6250
6275
6300
6325
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 13:03:59 16-Jun-98
Aperture 34, Image line 33, Order 89
ecidentify thars.ec: ThAr
6296.8722
6307.6570
6342.8595
6384.7169
0
1000
2000
3000
4000
5000
6000
7000
6250
6275
6300
6325
6350
6375
6400
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 13:07:42 16-Jun-98
Aperture 35, Image line 34, Order 88
ecidentify thars.ec: ThAr
6416.3071
6384.7169
6457.2824
80000
60000
40000
20000
0
6325
6350
6375
6400
6425
6450
6475
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 13:10:38 16-Jun-98
Aperture 36, Image line 35, Order 87
ecidentify thars.ec: ThAr
6457.2824
6416.3071
6531.3418
10000
8000
6000
4000
2000
0
6400
6425
6450
6475
6500
6525
6550
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 13:17:09 16-Jun-98
Aperture 37, Image line 36, Order 86
ecidentify thars.ec: ThAr
6583.9060
6531.3418
6604.8534
6593.9391
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 13:22:56 16-Jun-98
Aperture 38, Image line 37, Order 85
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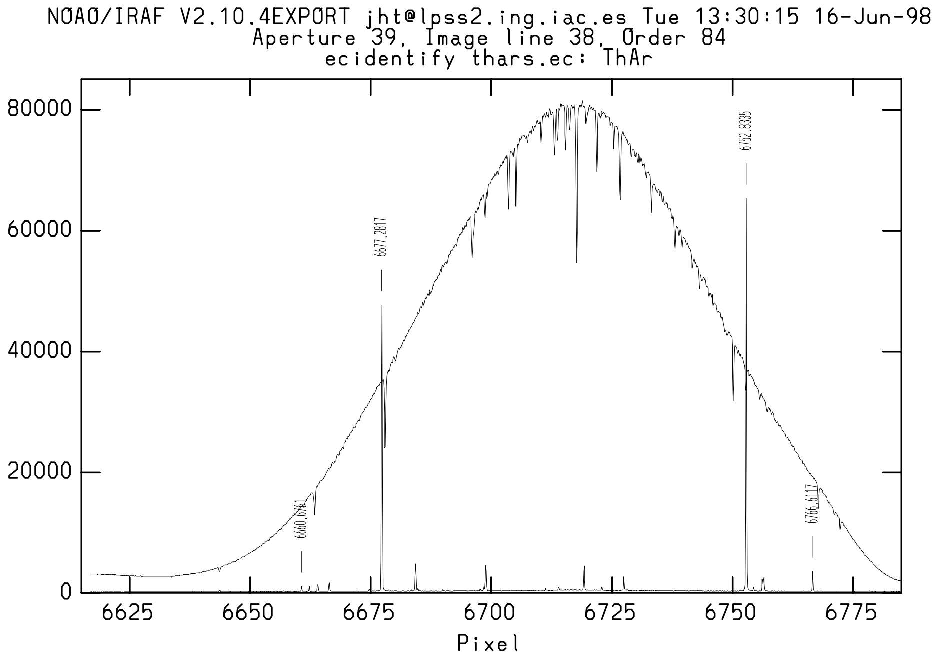
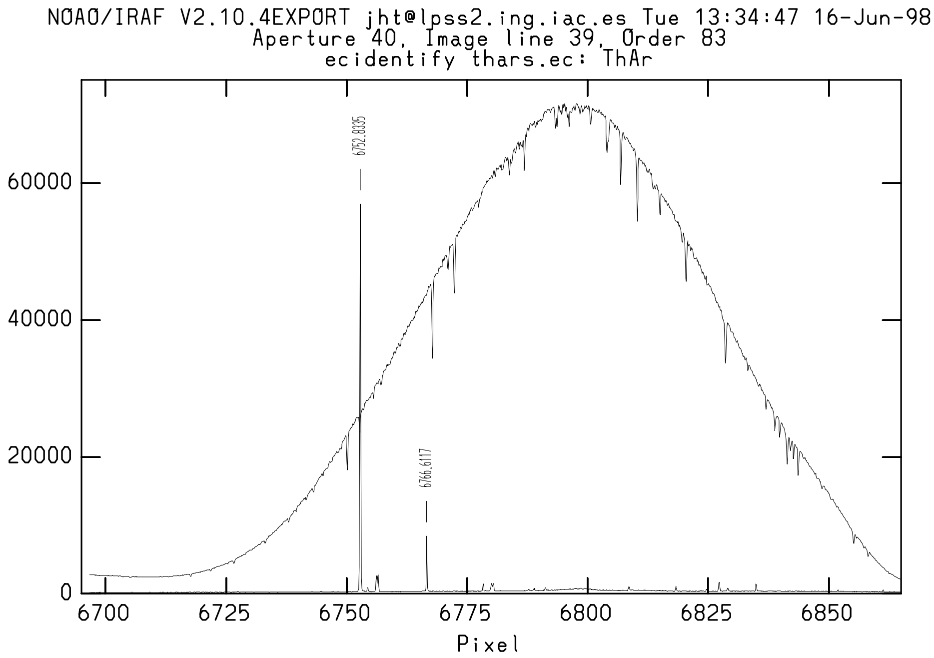
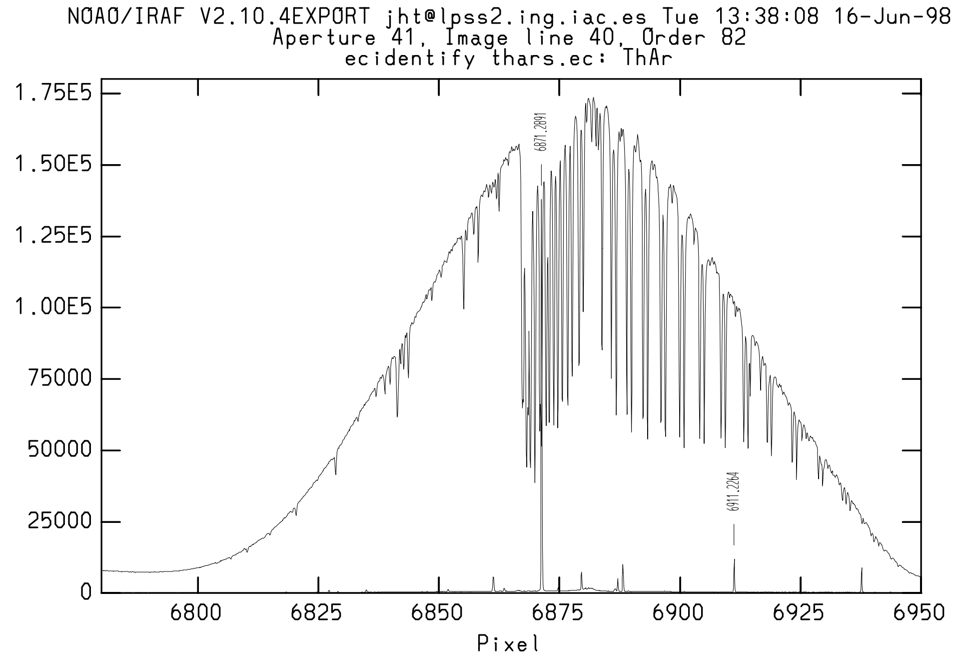
6604.8534
6593.9391
6660.6761
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 13:30:15 16-Jun-98
Aperture 39, Image line 38, Order 84
ecidentify thars.ec: ThAr
6677.2817
6752.8335
6766.6117
80000
60000
40000
20000
0
6625
6650
6675
6700
6725
6750
6775
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 13:34:47 16-Jun-98
Aperture 40, Image line 39, Order 83
ecidentify thars.ec: ThAr
6752.8335
6766.6117
60000
40000
20000
0
6700
6725
6750
6775
6800
6825
6850
Pixel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Aperture 41, Image line 40, Order 82
ecidentify thars.ec: ThAr
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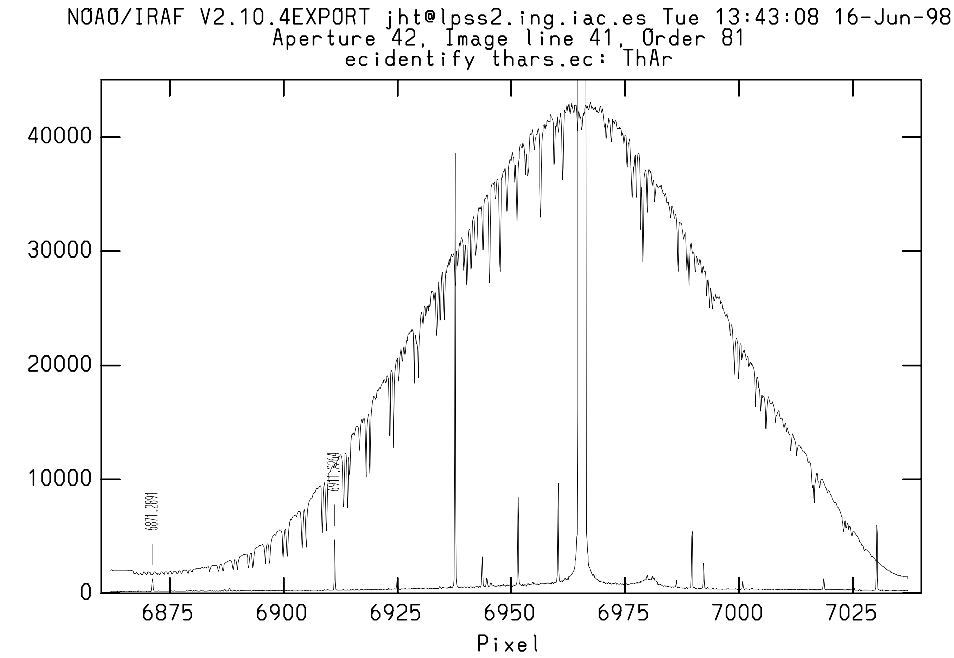
6911.2264
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 13:43:08 16-Jun-98
Aperture 42, Image line 41, Order 81
ecidentify thars.ec: ThAr
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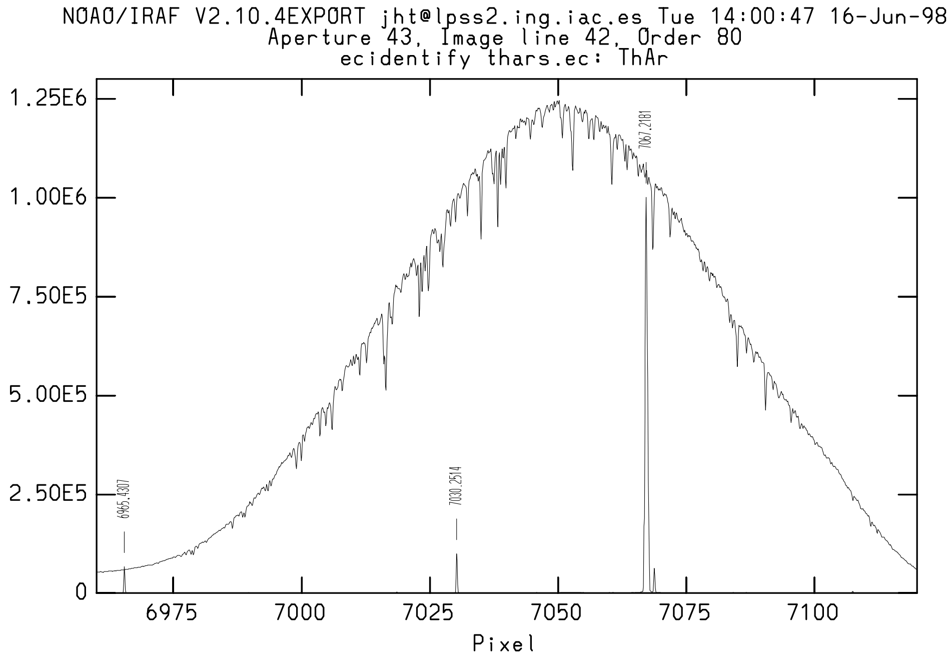
6911.2264
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 14:00:47 16-Jun-98
Aperture 43, Image line 42, Order 80
ecidentify thars.ec: ThAr
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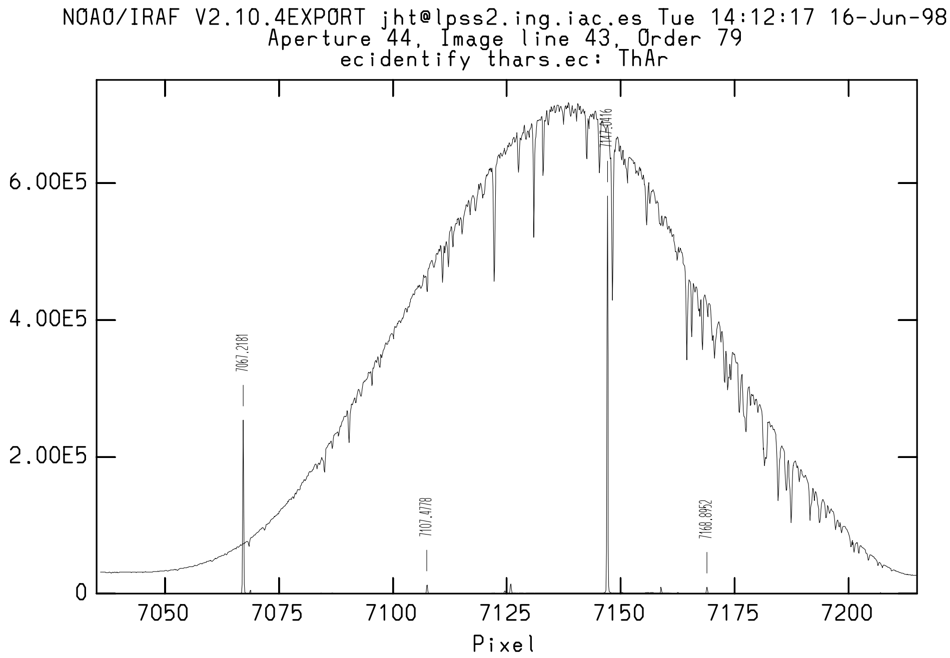
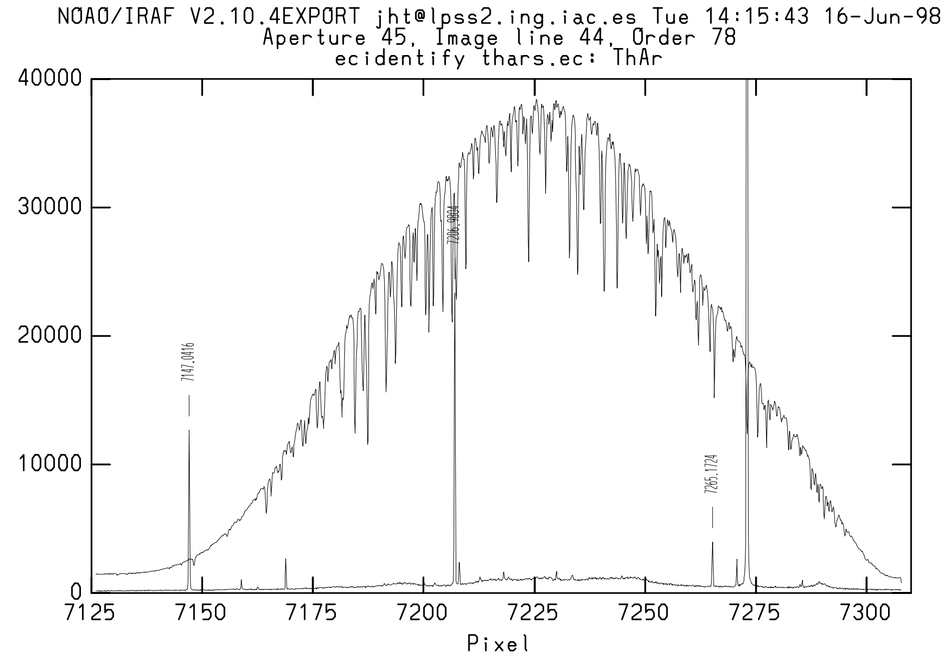
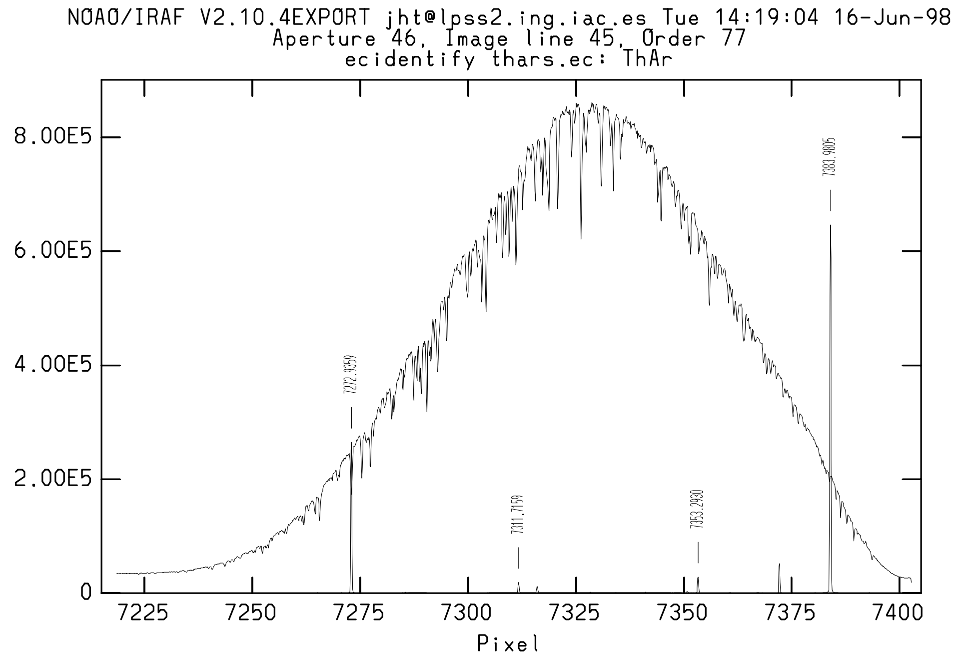
1.00E6
7.50E5
5.00E5
2.50E5
0
6975
7000
7025
7050
7075
7100
Pixel
6965.4307
7030.2514
7067.2181

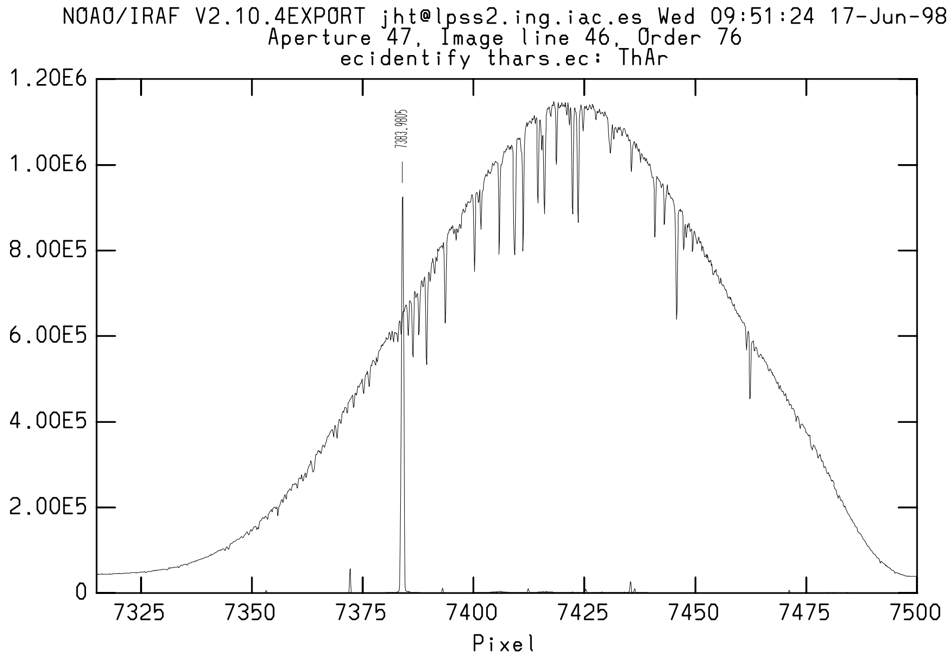

NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 14:12:17 16-Jun-98
Aperture 44, Image line 43, Order 79
ecidentify thars.ec: ThAr
6.00E5
4.00E5
2.00E5
0
7050
7075
7100
7125
7150
7175
7200
Pixel
7067.2181
7107.4778
7168.8952



NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 14:15:43 16-Jun-98
Aperture 45, Image line 44, Order 78
ecidentify thars.ec: ThAr
40000
30000
20000
10000
0
7125
7150
7175
7200
7225
7250
7275
7300
Pixel
7147.0416
7265.1724



NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Tue 14:19:04 16-Jun-98
Aperture 46, Image line 45, Order 77
ecidentify thars.ec: ThAr
8.00E5
6.00E5
4.00E5
2.00E5
0
7225
7250
7275
7300
7325
7350
7375
7400
Pixel
7272.9359
7311.7159
7353.2930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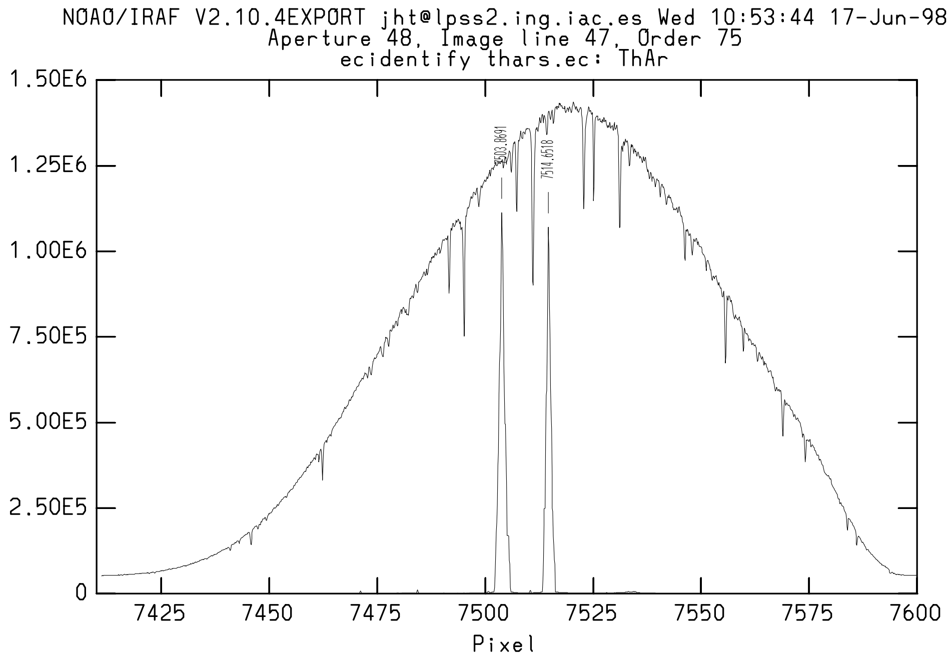
Pixel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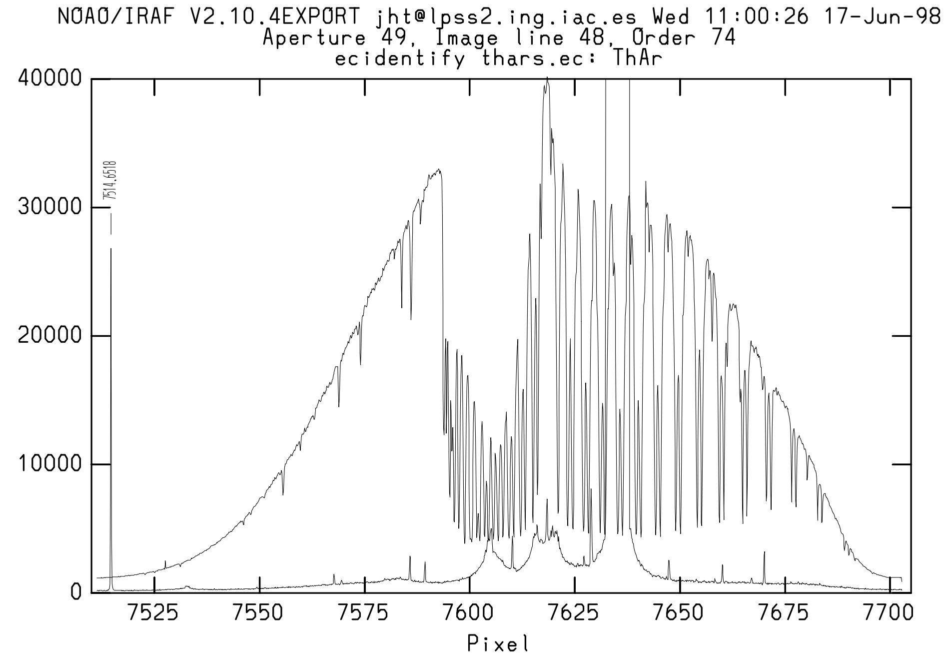
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Wed 11:00:26 17-Jun-98
Aperture 49, Image line 48, Order 74
ecidentify thars.ec: ThAr
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30000
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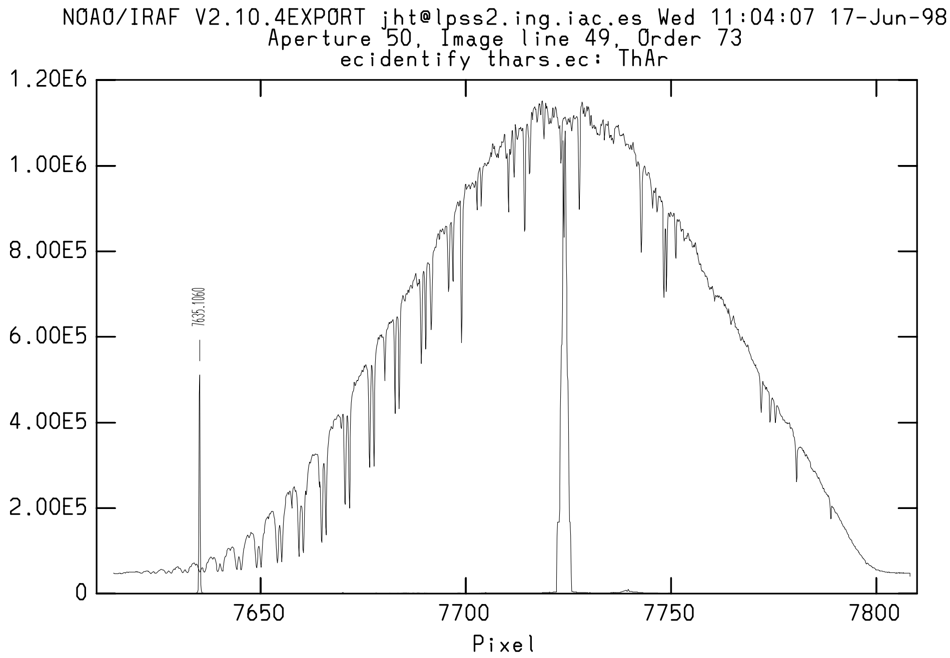
10000
0
7525
7550
7575
7600
7625
7650
7675
7700
Pixel
7514.6518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Aperture 50, Image line 49, Order 73
ecidentify thars.ec: ThAr
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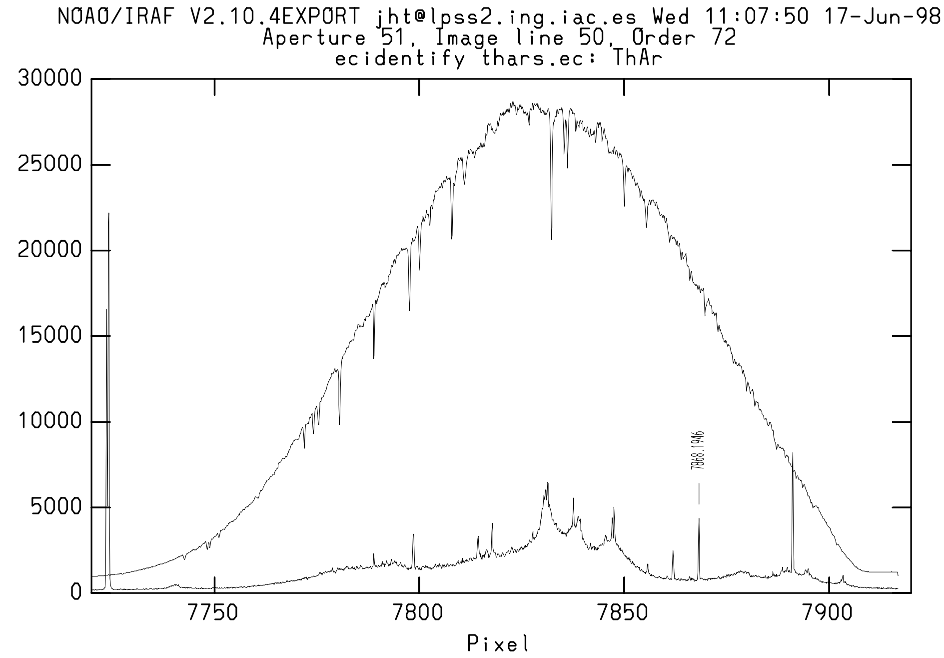
1.00E6
8.00E5
6.00E5
4.00E5
2.00E5
0
7650
7700
7750
7800
Pixel
7635.1060


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Wed 11:07:50 17-Jun-98
Aperture 51, Image line 50, Order 72
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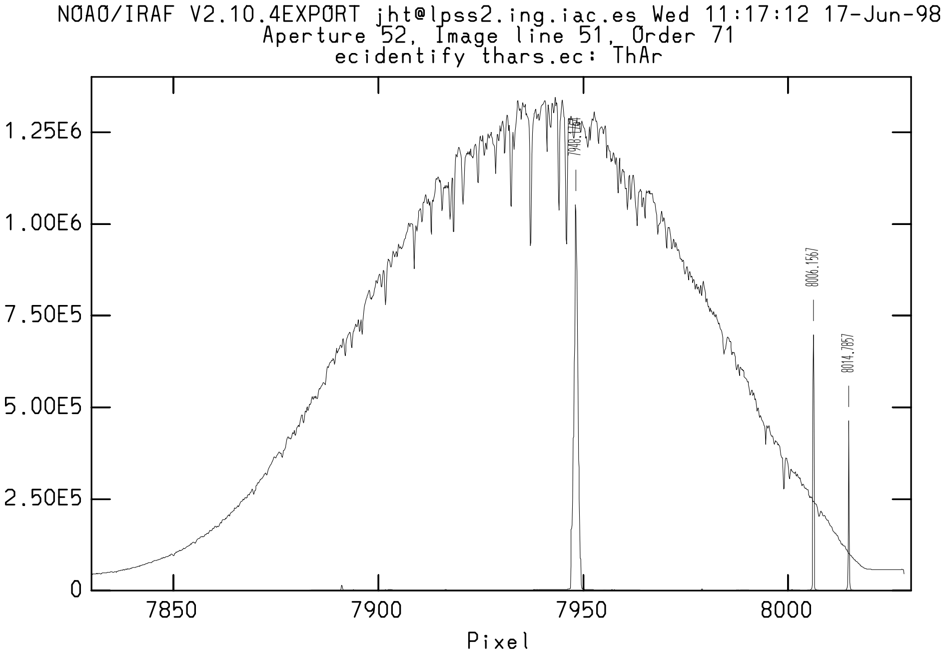
20000
15000
10000
5000
0
7750
7800
7850
7900
Pixel
7868.1946


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Wed 11:17:12 17-Jun-98
Aperture 52, Image line 51, Order 71
ecidentify thars.ec: ThAr
1.25E6
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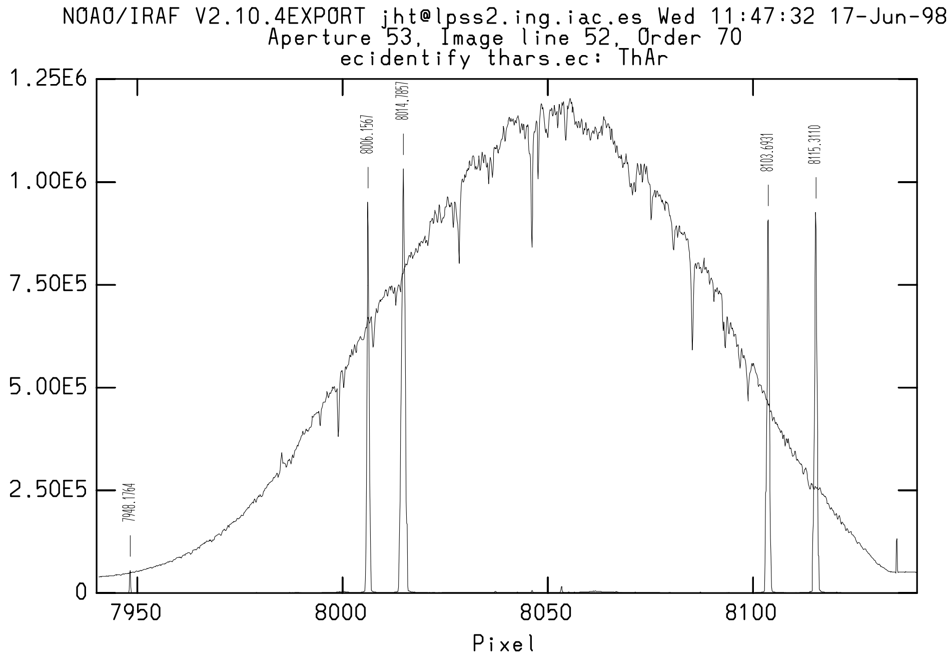
7.50E5
5.00E5
2.50E5
0
7850
7900
7950
8000
Pixel
8006.1567
8014.7857


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Wed 11:47:32 17-Jun-98
Aperture 53, Image line 52, Order 70
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1.00E6
7.50E5
5.00E5
2.50E5
0
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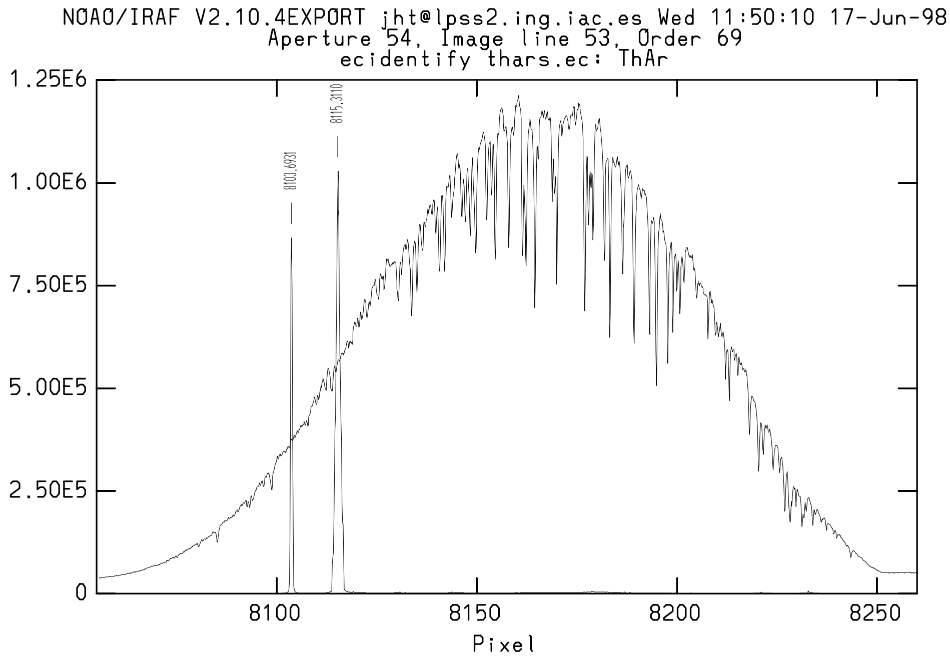
8006.1567
8014.7857
8103.6931
8115.3110
7950
8000
8050
8100
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Wed 11:50:10 17-Jun-98
Aperture 54, Image line 53, Order 69
ecidentify thars.ec: ThAr
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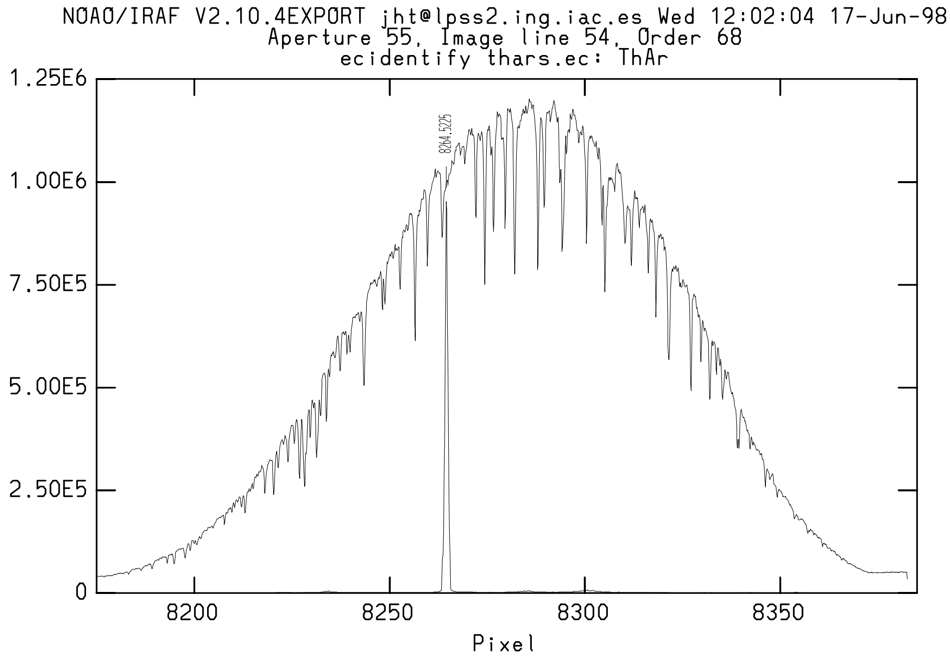
1.00E6
7.50E5
5.00E5
2.50E5
0
8103.6931
8115.3110
8100
8150
8200
8250
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Wed 12:02:04 17-Jun-98
Aperture 55, Image line 54, Order 68
ecidentify thars.ec: ThAr
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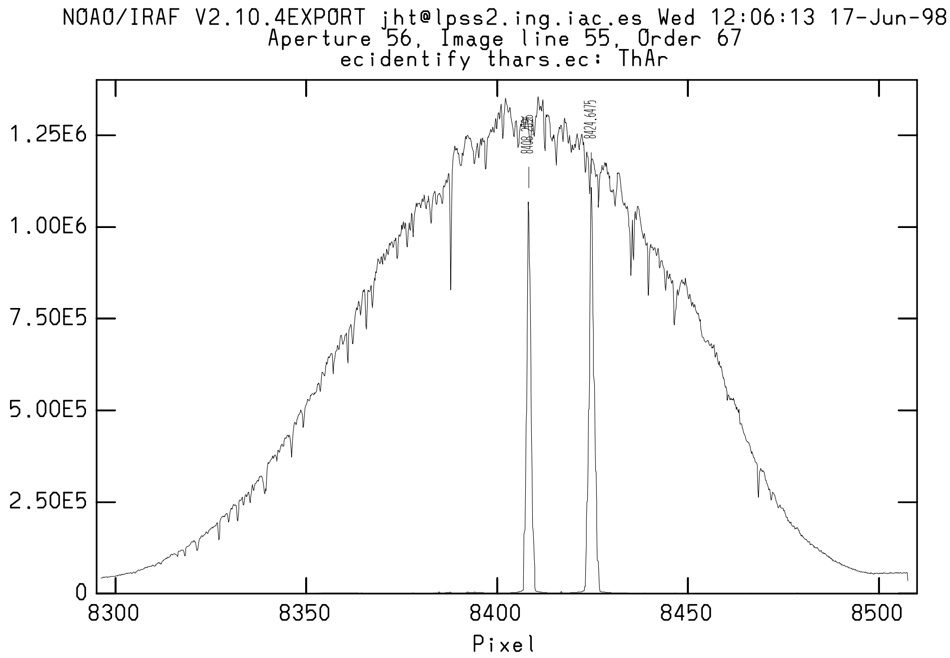
7.50E5
5.00E5
2.50E5
0
8200
8250
8300
8350
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Wed 12:06:13 17-Jun-98
Aperture 56, Image line 55, Order 67
ecidentify thars.ec: ThAr
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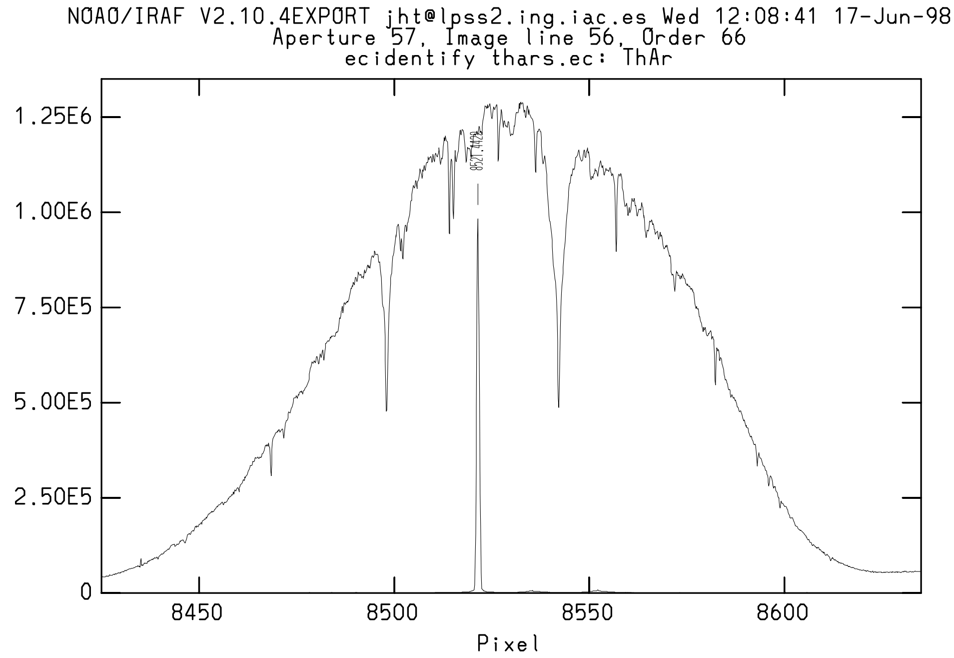
1.00E6
7.50E5
5.00E5
2.50E5
0
8300
8350
8400
8450
8500
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Wed 12:08:41 17-Jun-98
Aperture 57, Image line 56, Order 66
ecidentify thars.ec: ThAr
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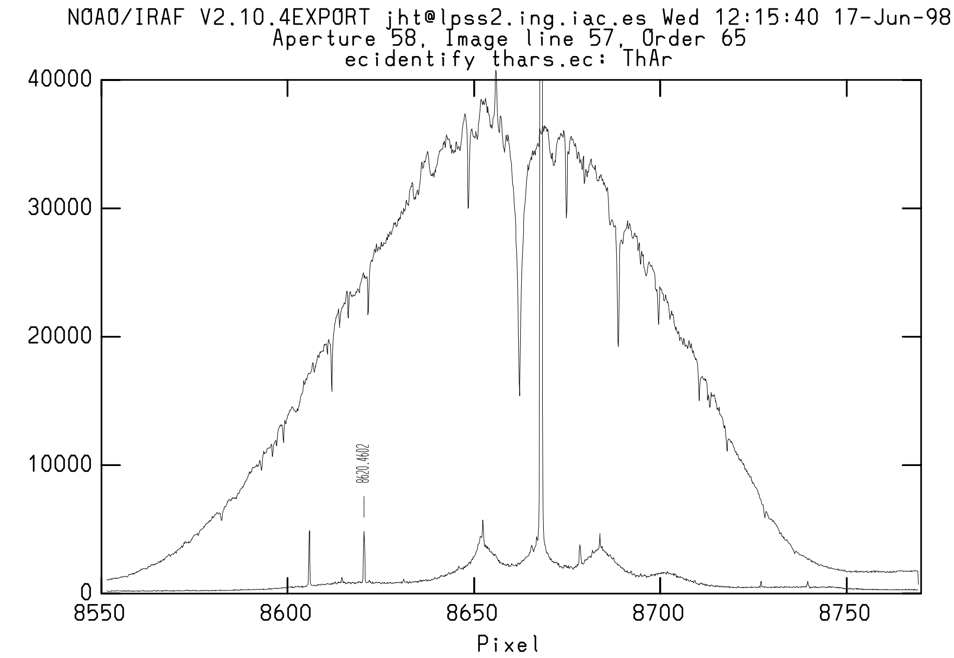
1.00E6
7.50E5
5.00E5
2.50E5
0
8450
8500
8550
8600
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Wed 12:15:40 17-Jun-98
Aperture 58, Image line 57, Order 65
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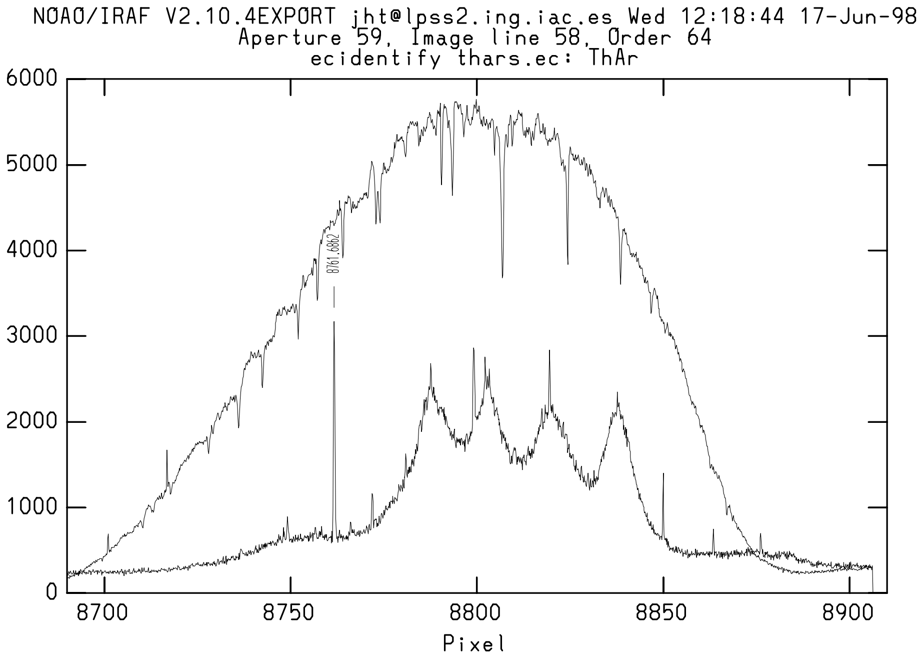
30000
20000
10000
0
8620.4602
8550
8600
8650
8700
8750
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Wed 12:18:44 17-Jun-98
Aperture 59, Image line 58, Order 64
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0
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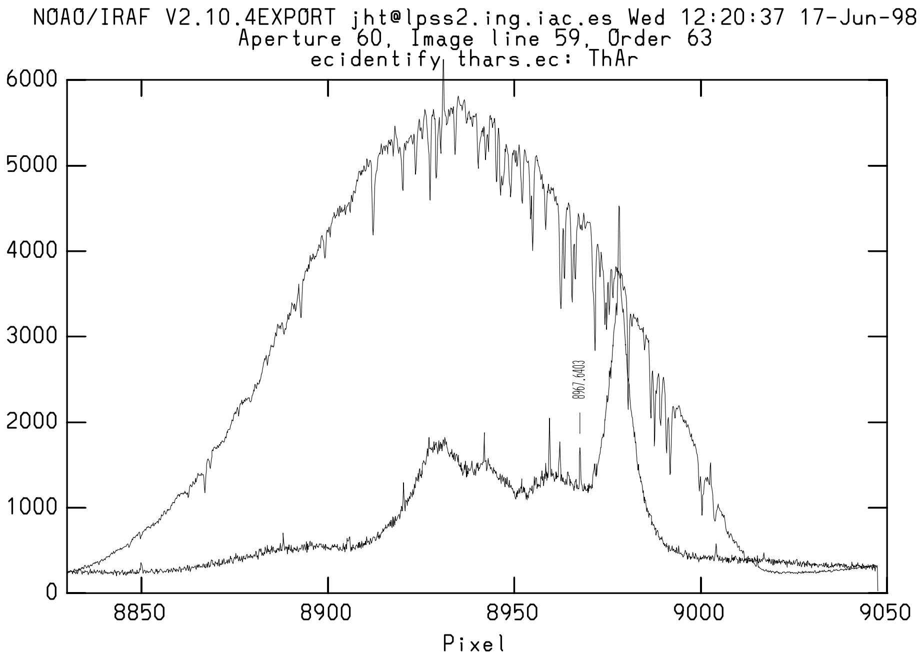
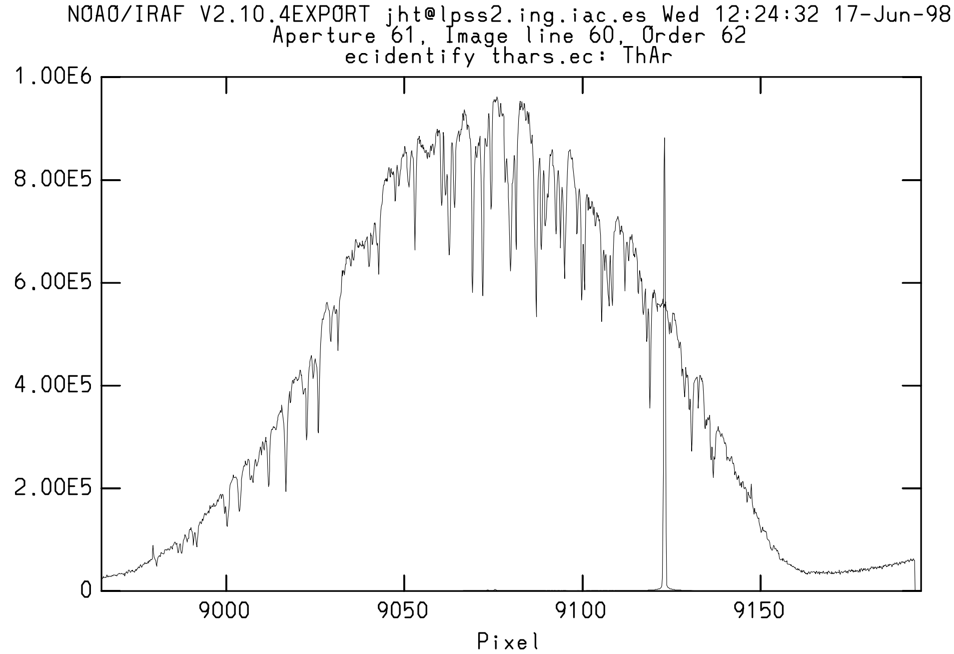
2000
3000
4000
5000
6000
8700
8750
8800
8850
8900
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Wed 12:20:37 17-Jun-98
Aperture 60, Image line 59, Order 63
ecidentify thars.ec: ThAr
8967.6403
0
1000
2000
3000
4000
5000
6000
8850
8900
8950
9000
9050
Pixel


NOAO/IRAF V2.10.4EXPORT jht@lpss2.ing.iac.es Wed 12:24:32 17-Jun-98
Aperture 61, Image line 60, Order 62
ecidentify thars.ec: ThAr
1.00E6
8.00E5
6.00E5
4.00E5
2.00E5
0
9000
9050
9100
9150
Pixel

APPENDIX:

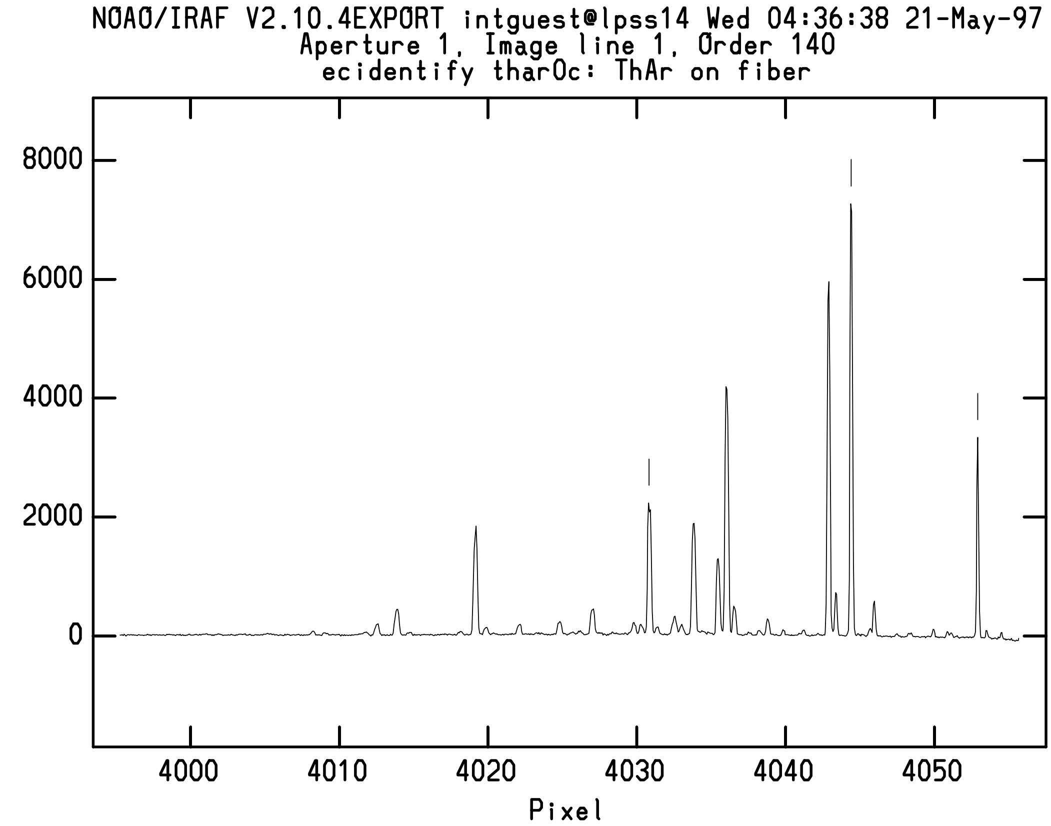
The blue (4050–4950Å) and the red (8800–10600Å)

Here we show the ThAr lines of the spectral regions that are not sampled by the main atlas. The data shown in the following figures were taken with a 1024x1024 TEK chip with 24μm pixels. We used two different wavelength settings with the blue crossdispersing prism, and with fibers that have been replaced in March 1998. The pixel-wavelength solution gave a very similar accuracy as that of the main atlas.

A list of the identified lines is given in the following tables. In the figures the identified lines are marked by a vertical dash.

Order	Pixel	Fit	User	Residual
64	850.05	8761.6813	8761.6862	-0.0049117
63	349.35	8967.6303	8967.6403	-0.0099997
62	267.41	9122.9586	9122.9674	-0.0087726
61	622.10	9224.5019	9224.4992	0.00265467
61	835.16	9194.6392	9194.6385	7.32561E-4
60	472.45	9399.0866	9399.0891	-0.0024919
60	791.00	9354.2175	9354.2198	-0.0022541
58	29.67	9784.5017	9784.5028	-0.0010772
58	917.71	9657.7877	9657.7863	0.0014004
56	595.19	10052.065	10052.063	0.00173852
54	295.96	10470.053	10470.053	1.64402E-5
53	256.65	10673.563	10673.55	0.01262318

Order	Pixel	Fit	User	Residual
140	54.17	4052.9186	4052.9208	-0.0022438
140	205.52	4044.4157	4044.4179	-0.0022421
140	440.42	4030.8348	4030.8424	-0.0076008
139	231.53	4072.0039	4071.9967	0.00715571
139	555.81	4052.9355	4052.9208	0.01469159
139	915.41	4030.8511	4030.8424	0.00865295
138	34.14	4112.755	4112.7545	4.51230E-4
138	347.17	4094.741	4094.747	-0.0060124
137	226.26	4131.7242	4131.7235	7.10595E-4
136	285.56	4158.5893	4158.5905	-0.0011738
136	725.81	4131.722	4131.7235	-0.0015216
135	93.62	4200.674	4200.6745	-4.5958E-4
135	784.43	4158.5862	4158.5905	-0.0043368
134	609.93	4200.6728	4200.6745	-0.0017279
134	647.39	4198.3146	4198.317	-0.0023543
133	168.67	4259.3653	4259.3619	0.00343854
133	530.72	4237.2243	4237.2198	0.00448052
132	25.76	4300.1011	4300.1008	3.35769E-4
132	399.36	4277.5295	4277.5282	0.00131898
132	686.68	4259.3583	4259.3619	-0.0036105
131	54.58	4331.2021	4331.1995	0.00256451
131	354.02	4312.9911	4312.9975	-0.0064156
131	904.78	4277.5207	4277.5282	-0.0074522
131	985.02	4272.1627	4272.1689	-0.0061691
130	323.40	4348.0638	4348.064	-1.8924E-4
129	25.09	4400.0961	4400.0968	-6.8634E-4
129	356.49	4379.6665	4379.6668	-3.4672E-4
129	841.39	4348.0583	4348.064	-0.0057084
128	35.34	4433.8343	4433.838	-0.0037059
128	163.11	4426.0049	4426.0011	0.00375883
128	434.33	4408.8818	4408.8828	-0.0010017
128	1006.37	4370.7574	4370.7532	0.00421521
127	700.63	4426.0037	4426.0011	0.00256378
127	952.41	4408.878	4408.8828	-0.0047513
126	208.91	4493.3339	4493.3337	2.08512E-4
126	496.25	4474.7599	4474.7594	5.46522E-4
125	493.36	4510.7304	4510.7332	-0.0028018
125	751.03	4493.3305	4493.3337	-0.0031501
124	523.66	4545.0539	4545.0519	0.00201751
123	104.83	4609.5715	4609.5673	0.00418809
123	562.43	4579.3503	4579.3495	7.98534E-4
122	667.93	4609.5692	4609.5673	0.001883
122	946.16	4589.9042	4589.8978	0.00640987
121	520.47	4657.901	4657.9012	-2.3082E-4
120	72.47	4726.8689	4726.8683	5.55207E-4
119	98.40	4764.8655	4764.8646	8.51551E-4
119	651.71	4726.8709	4726.8683	0.0025963
118	86.43	4806.0225	4806.0205	0.00195821
118	680.09	4764.8662	4764.8646	0.00156426
117	673.86	4806.0239	4806.0205	0.00342176
116	218.16	4879.8609	4879.8635	-0.0025915
115	58.90	4933.2115	4933.2091	0.00239376
115	600.63	4894.9565	4894.9551	0.00137066
115	804.11	4879.8653	4879.8635	0.00180877
114	223.24	4965.0776	4965.0795	-0.0018669


NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:36:38 21-May-97
Aperture 1, Image line 1, Order 140
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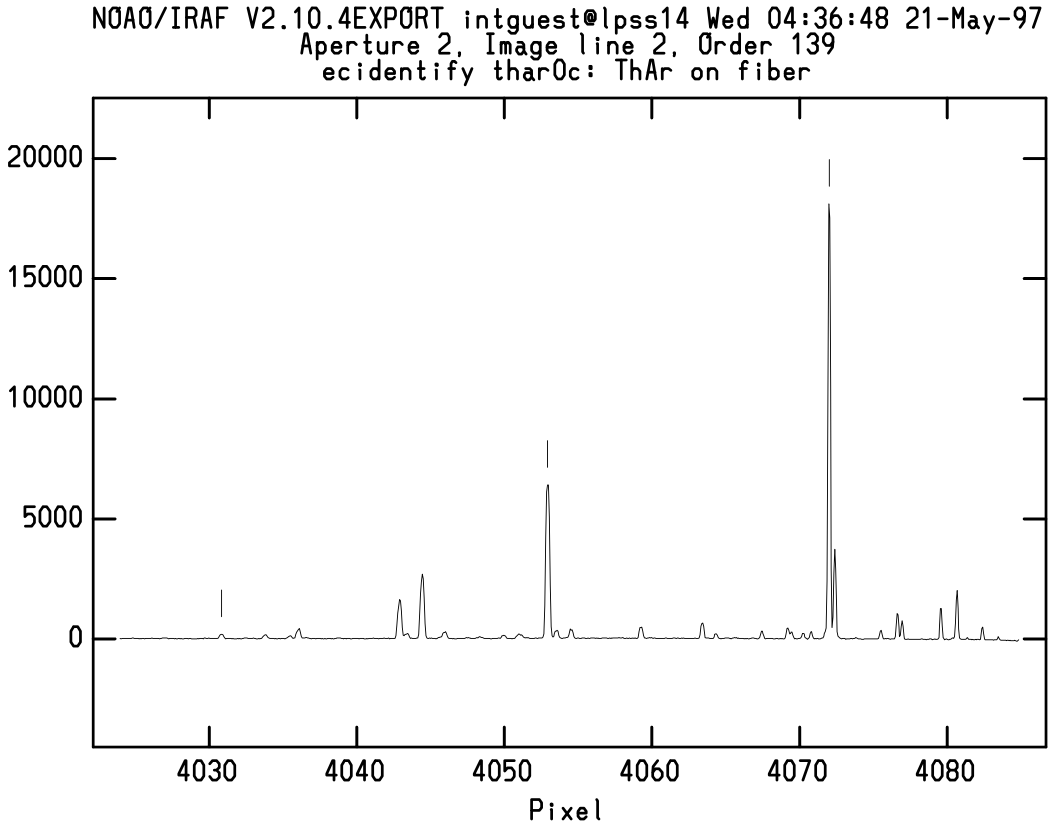
8000
6000
4000
2000
0
4000
4010
4020
4030
4040
4050
Pixel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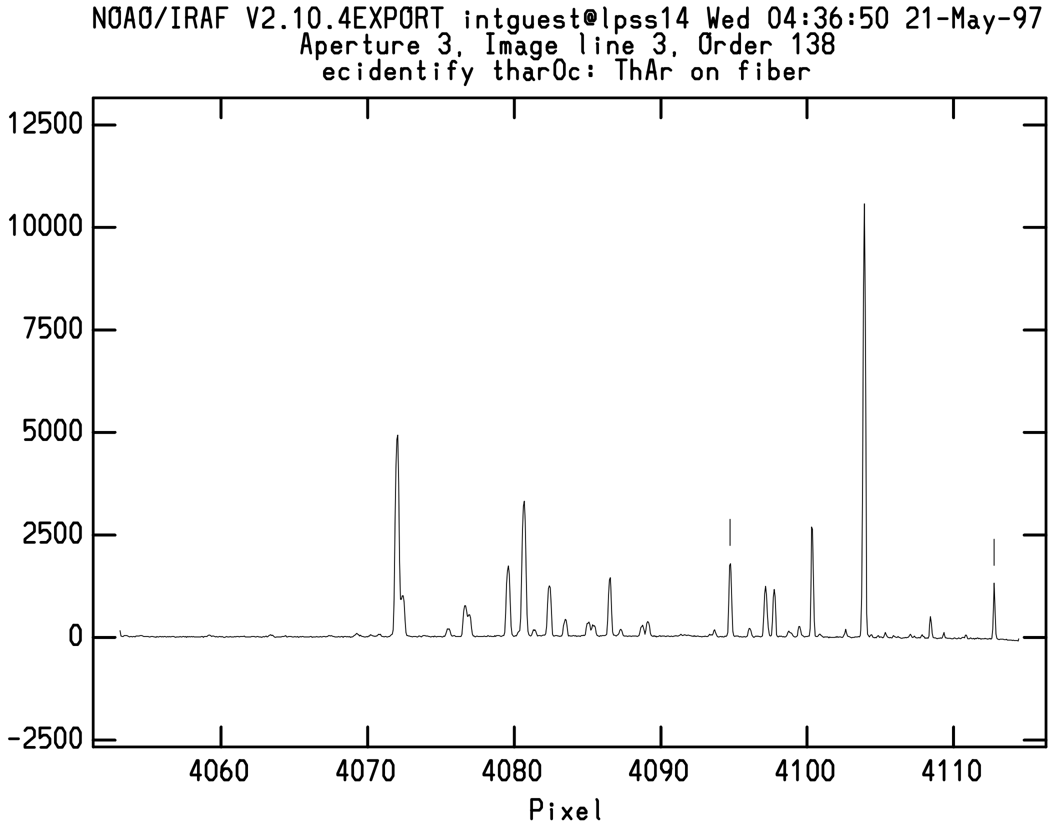
Aperture 2, Image line 2, Order 139
ecidentify thar0c: ThAr on fiber
20000
15000
10000
5000
0
4030
4040
4050
4060
4070
4080
Pixel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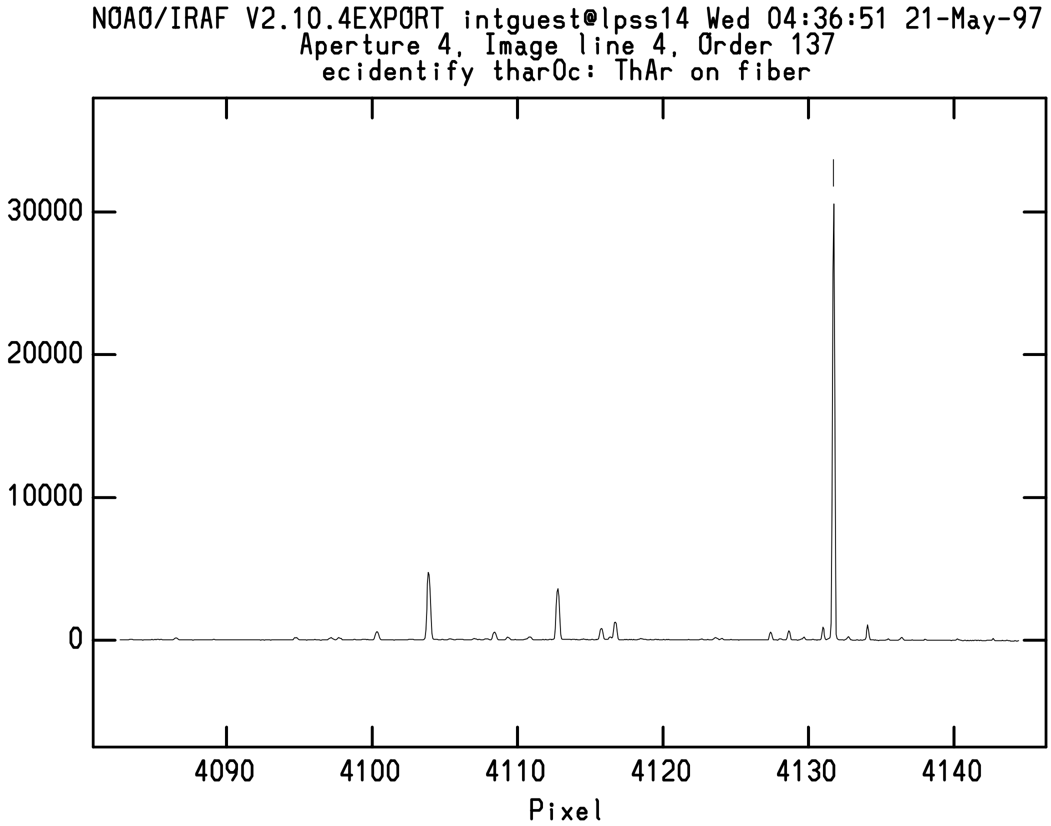
Aperture 3, Image line 3, Order 138
ecidentify thar0c: ThAr on fiber
12500
10000
7500
5000
2500
0
-2500
4060
4070
4080
4090
4100
4110
Pixel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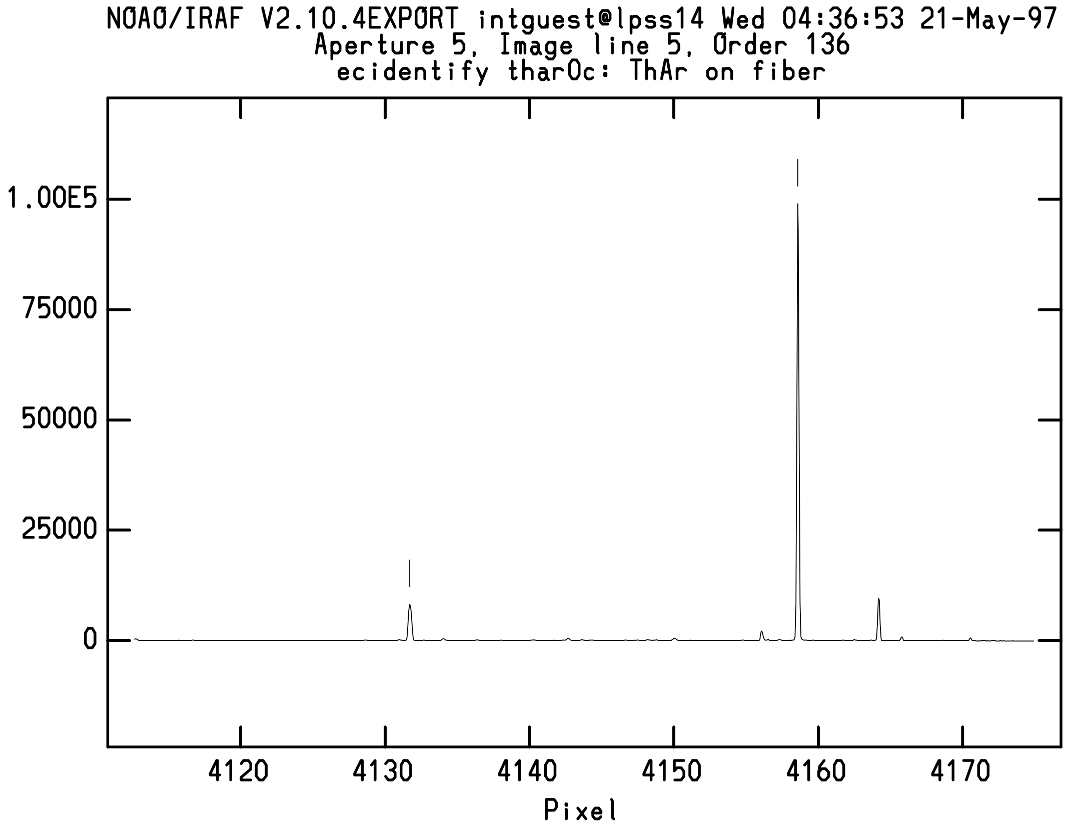
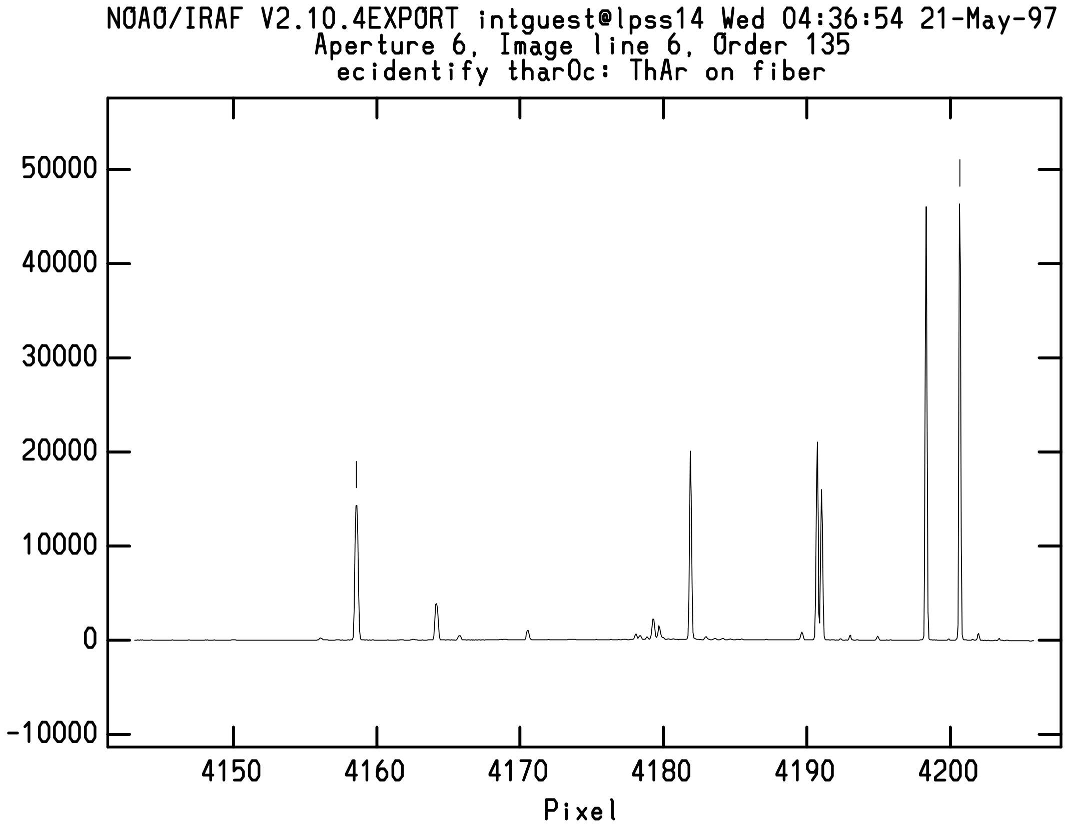
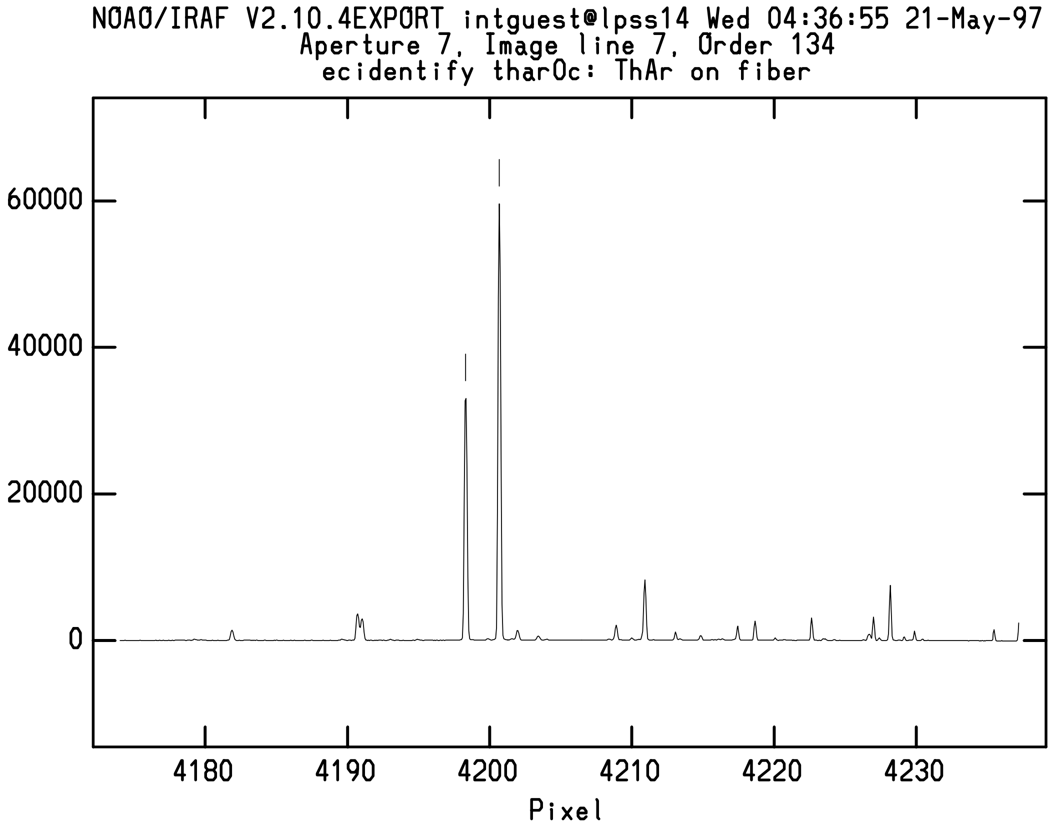
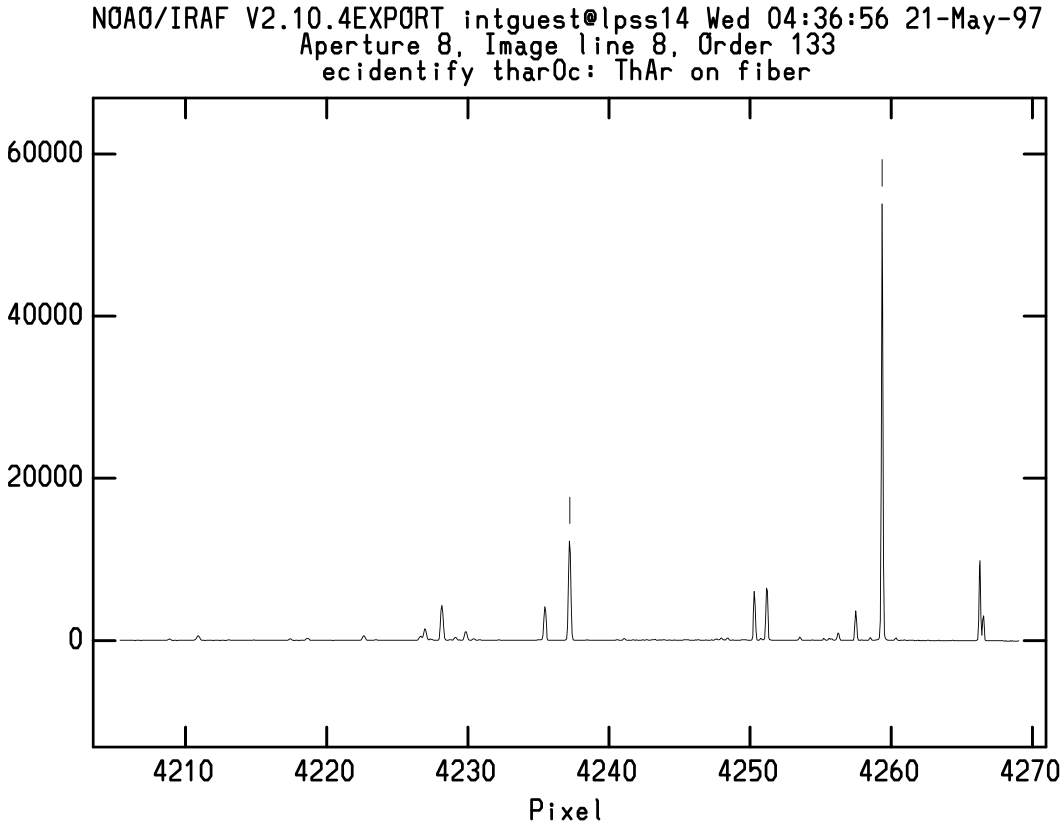
Aperture 4, Image line 4, Order 137
ecidentify thar0c: ThAr on fiber
30000
20000
10000
0
4090
4100
4110
4120
4130
4140
Pixel


NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:36:53 21-May-97
Aperture 5, Image line 5, Order 136
ecidentify tharOc: ThAr on fiber
1.00E5
75000
50000
25000
0
4120
4130
4140
4150
4160
4170
Pixel


NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:36:54 21-May-97
Aperture 6, Image line 6, Order 135
ecidentify tharOc: ThAr on fiber
50000
40000
30000
20000
10000
0
-10000
4150
4160
4170
4180
4190
4200
Pixel


NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:36:55 21-May-97
Aperture 7, Image line 7, Order 134
ecidentify tharOc: ThAr on fiber
60000
40000
20000
0
4180
4190
4200
4210
4220
4230
Pixel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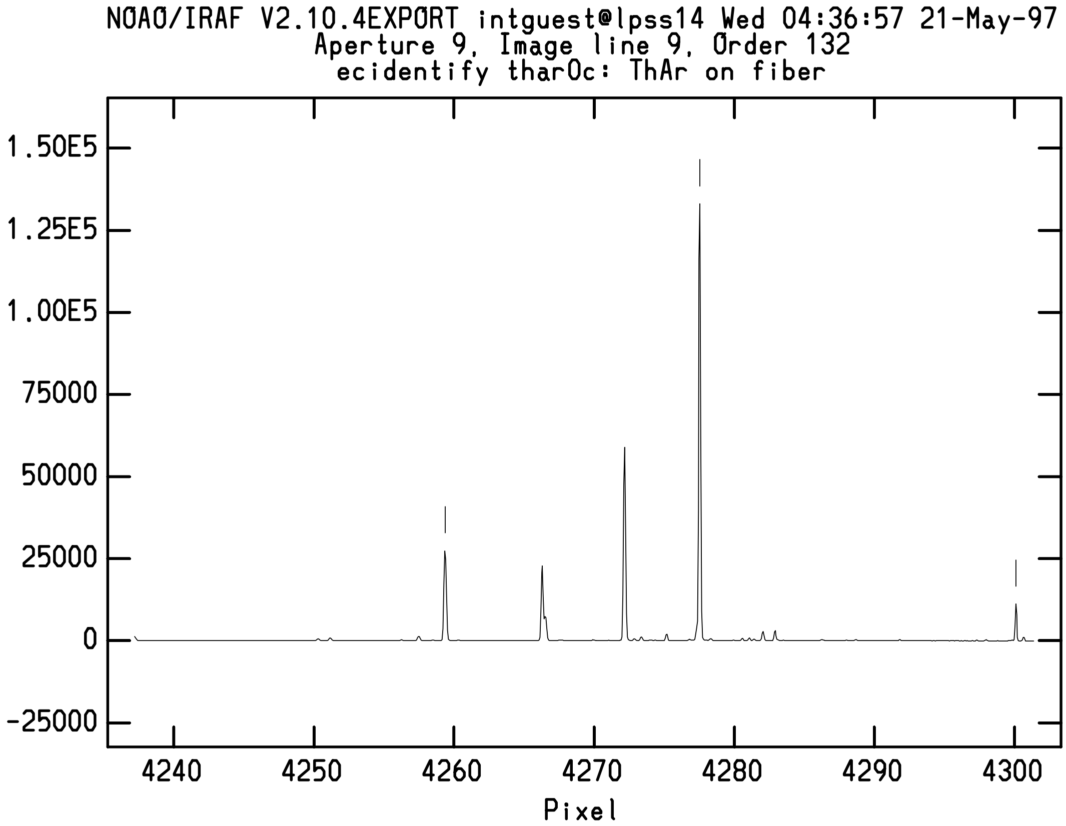
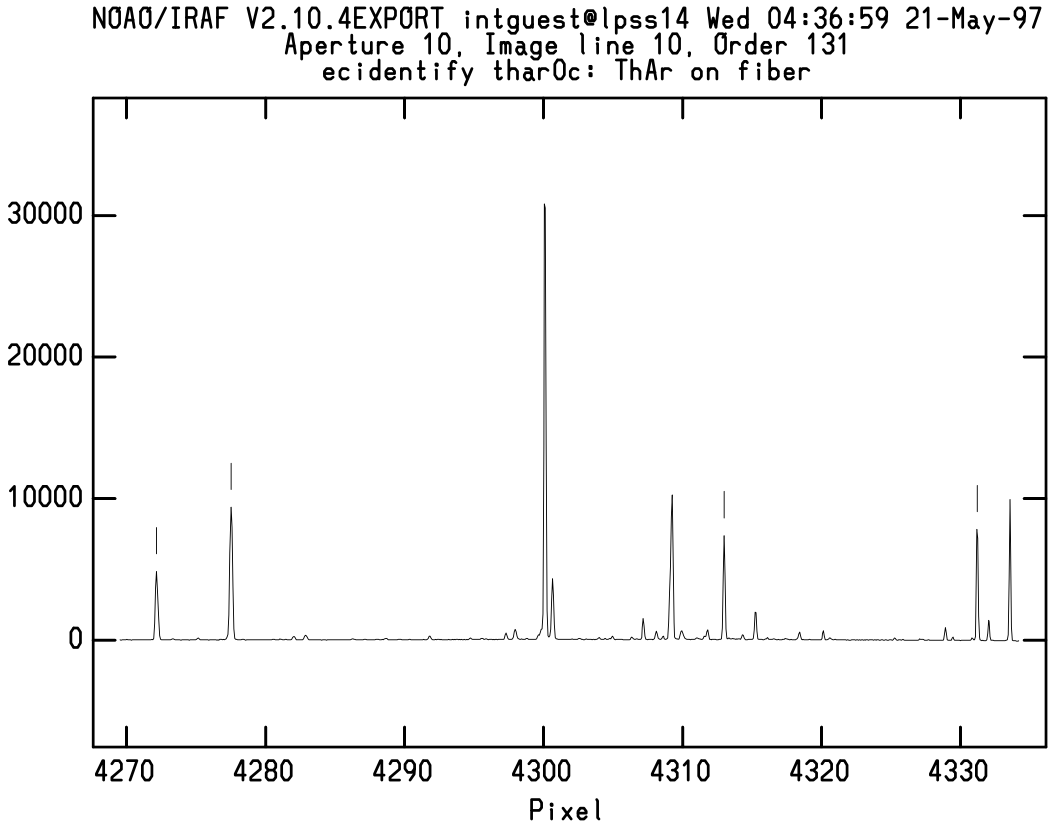
Aperture 8, Image line 8, Order 133
ecidentify tharOc: ThAr on fiber
60000
40000
20000
0
4210
4220
4230
4240
4250
4260
4270
Pixel


NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:36:57 21-May-97
Aperture 9, Image line 9, Order 132
ecidentify tharOc: ThAr on fiber
1.50E5
1.25E5
1.00E5
75000
50000
25000
0
-25000
4240
4250
4260
4270
4280
4290
4300
Pixel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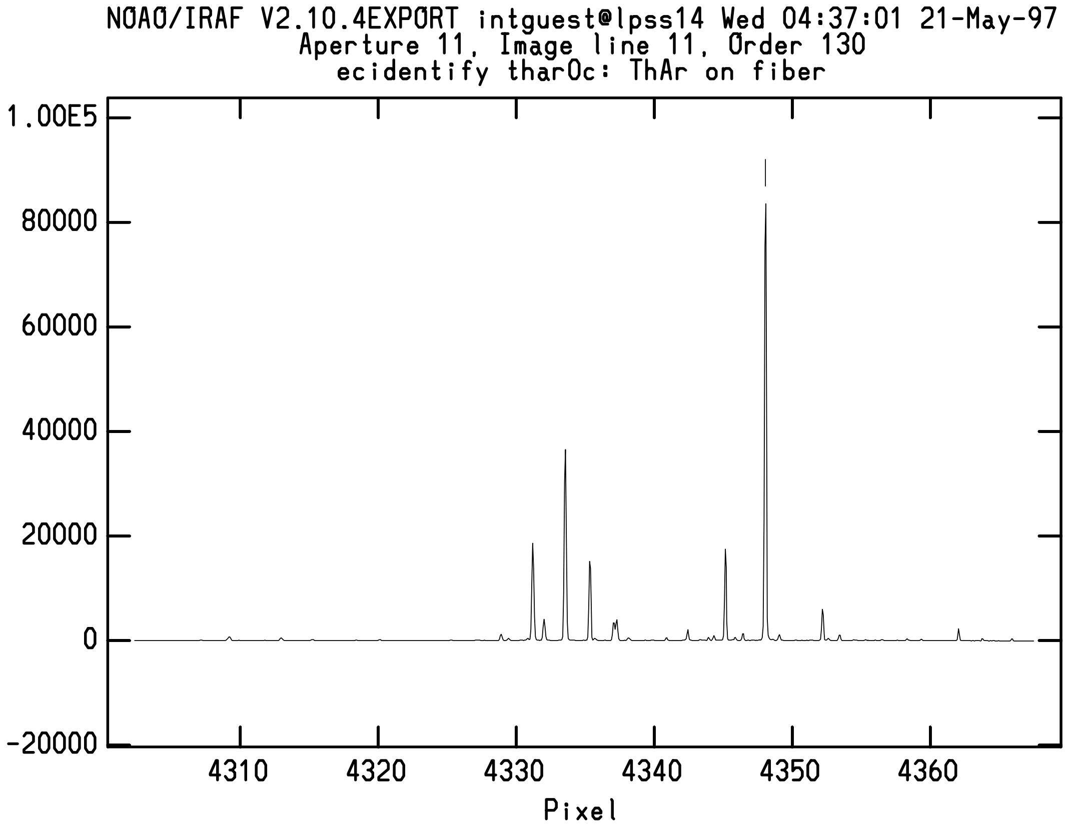
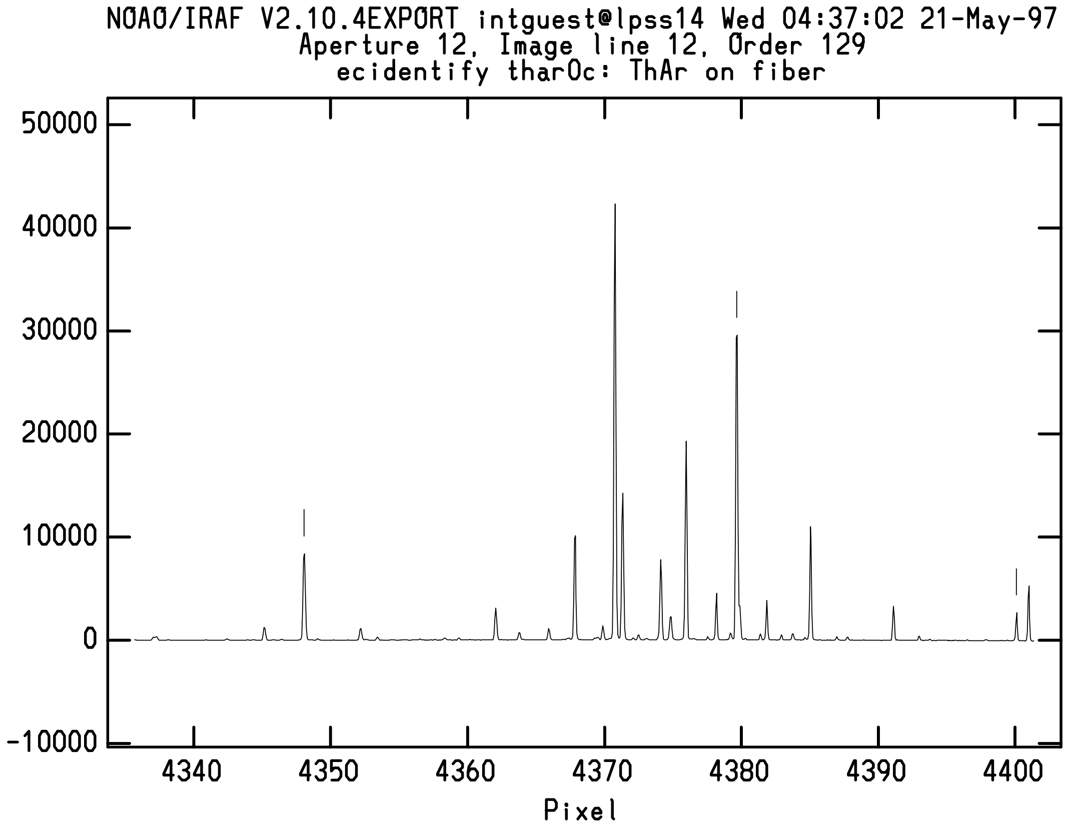
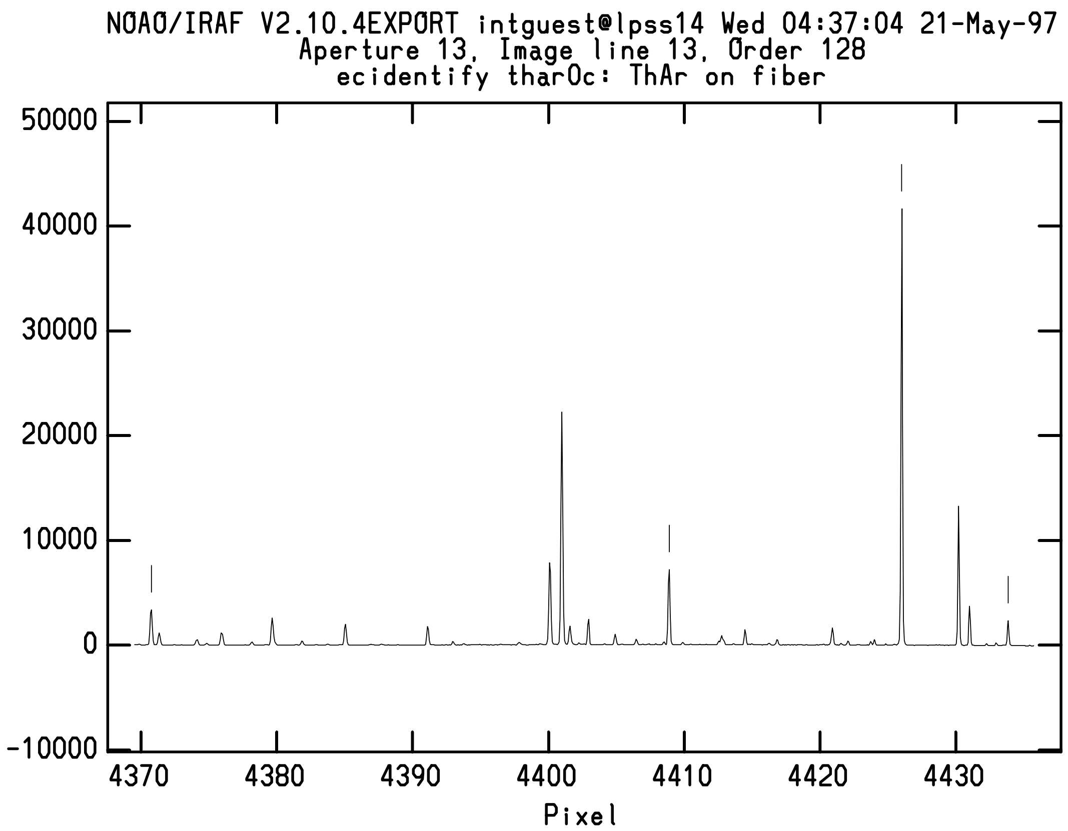
Aperture 10, Image line 10, Order 131
ecidentify tharOc: ThAr on fiber
30000
20000
10000
0
4270
4280
4290
4300
4310
4320
4330
Pixel


NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:01 21-May-97
Aperture 11, Image line 11, Order 130
ecidentify thar0c: ThAr on fiber
1.00E5
80000
60000
40000
20000
0
-20000
4310
4320
4330
4340
4350
4360
Pixel


NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:02 21-May-97
Aperture 12, Image line 12, Order 129
ecidentify thar0c: ThAr on fiber
50000
40000
30000
20000
10000
0
-10000
4340
4350
4360
4370
4380
4390
4400
Pixel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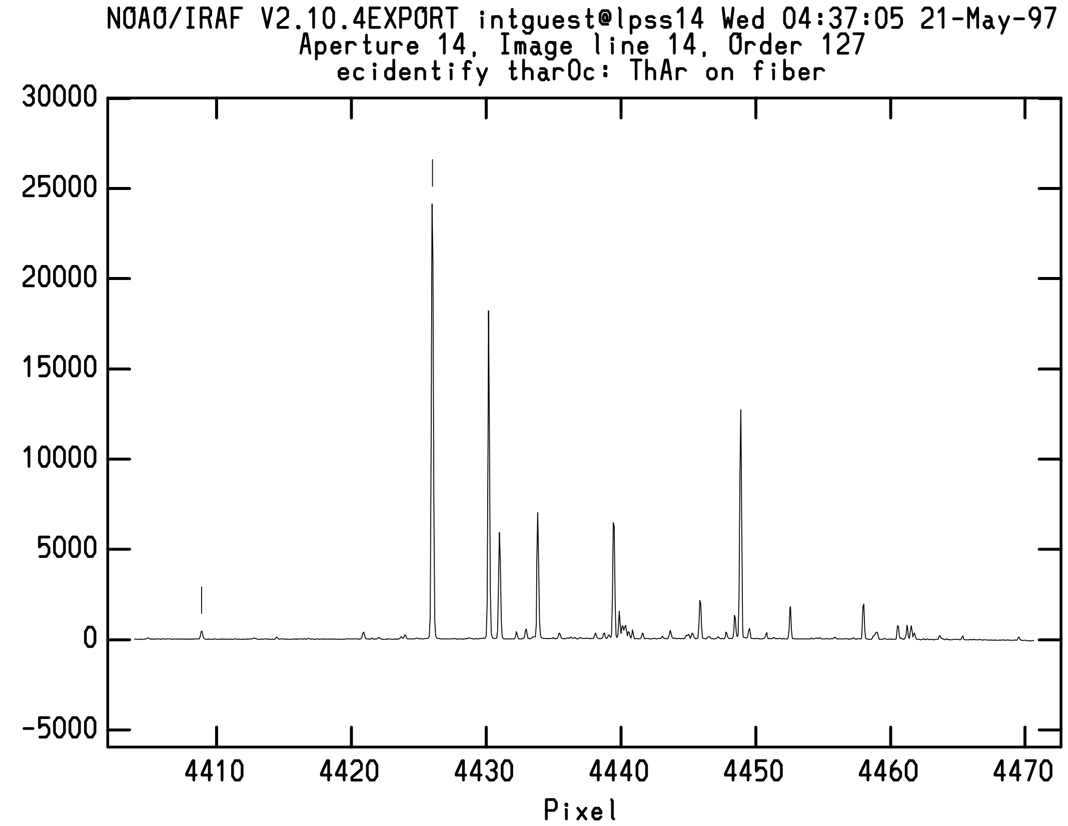
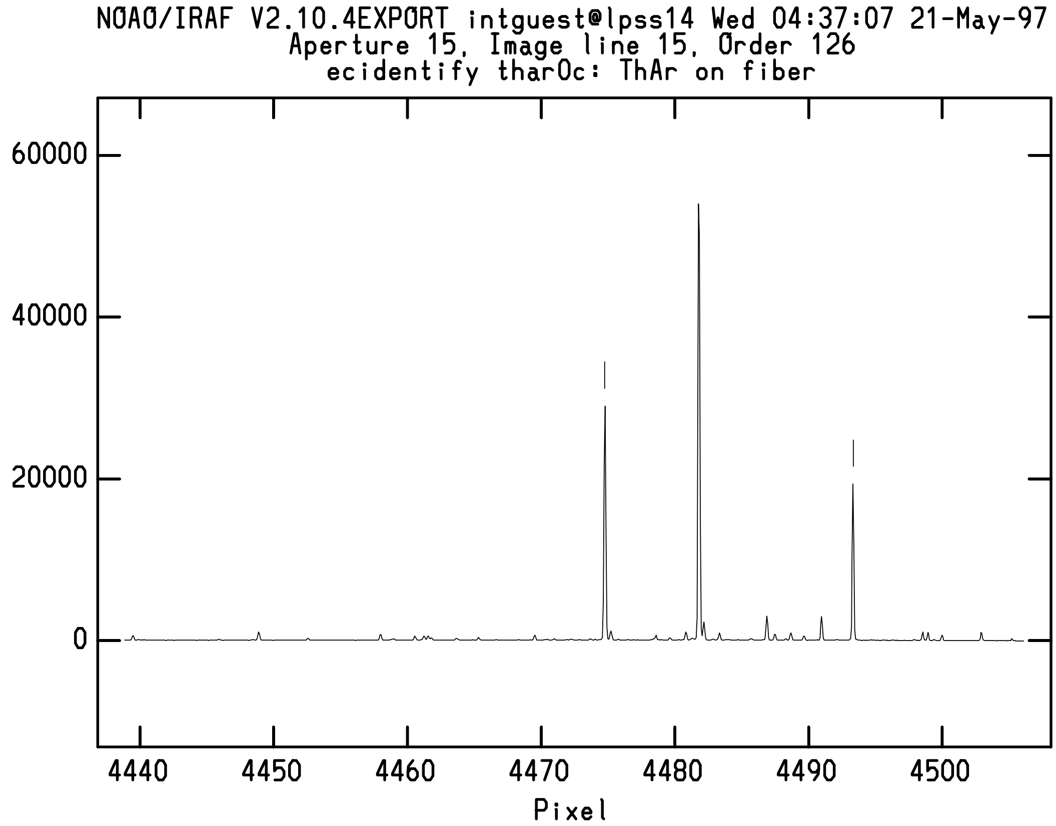
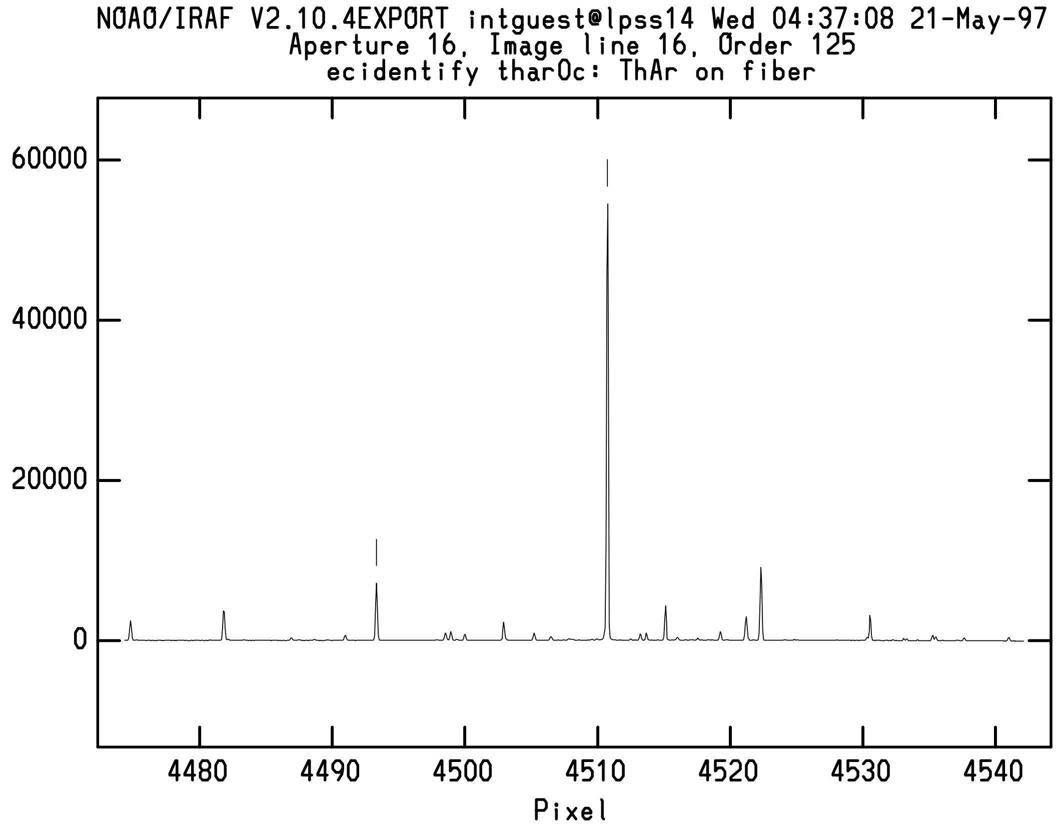
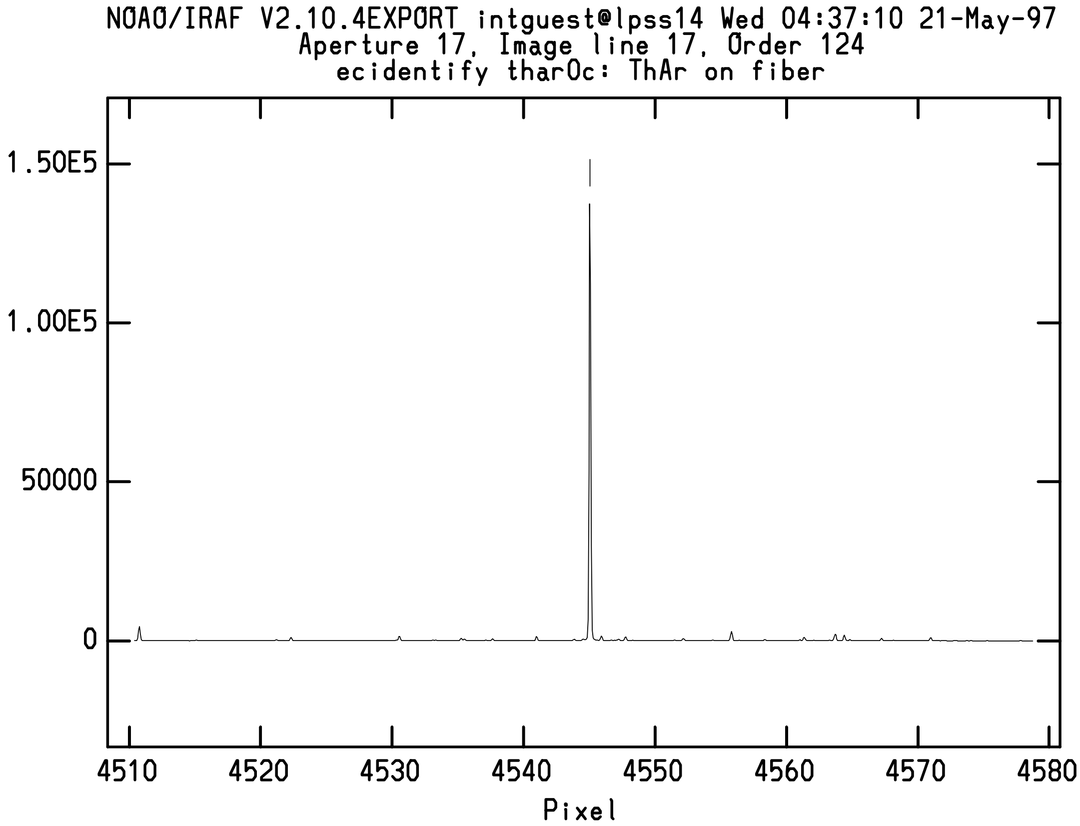
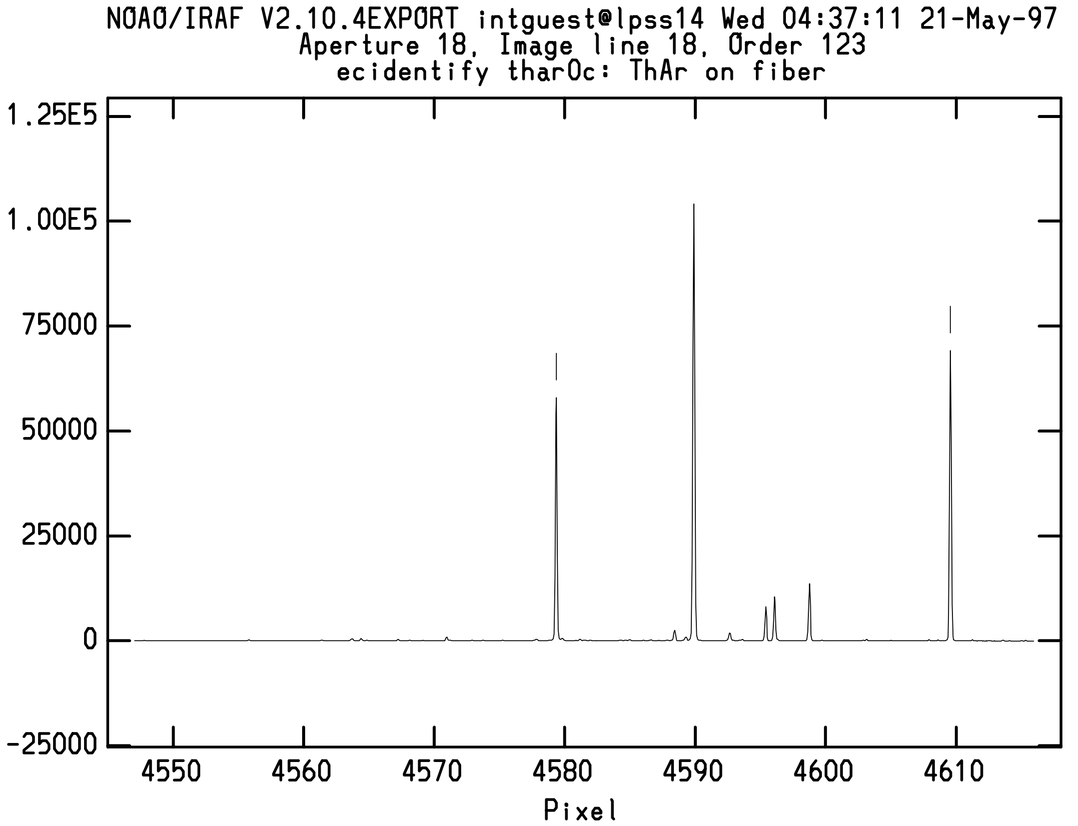
Aperture 13, Image line 13, Order 128
ecidentify tharOc: ThAr on fiber
Pixel

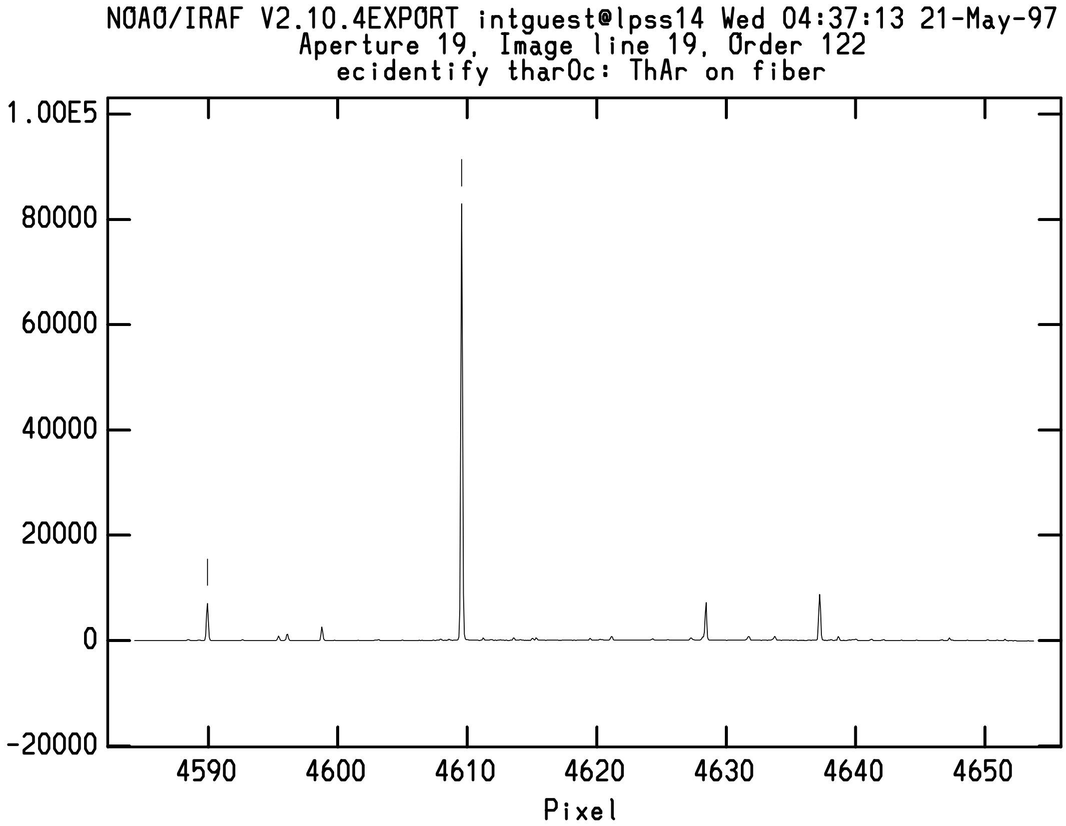

NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:05 21-May-97
Aperture 14, Image line 14, Order 127
ecidentify tharOc: ThAr on fiber
Pixel

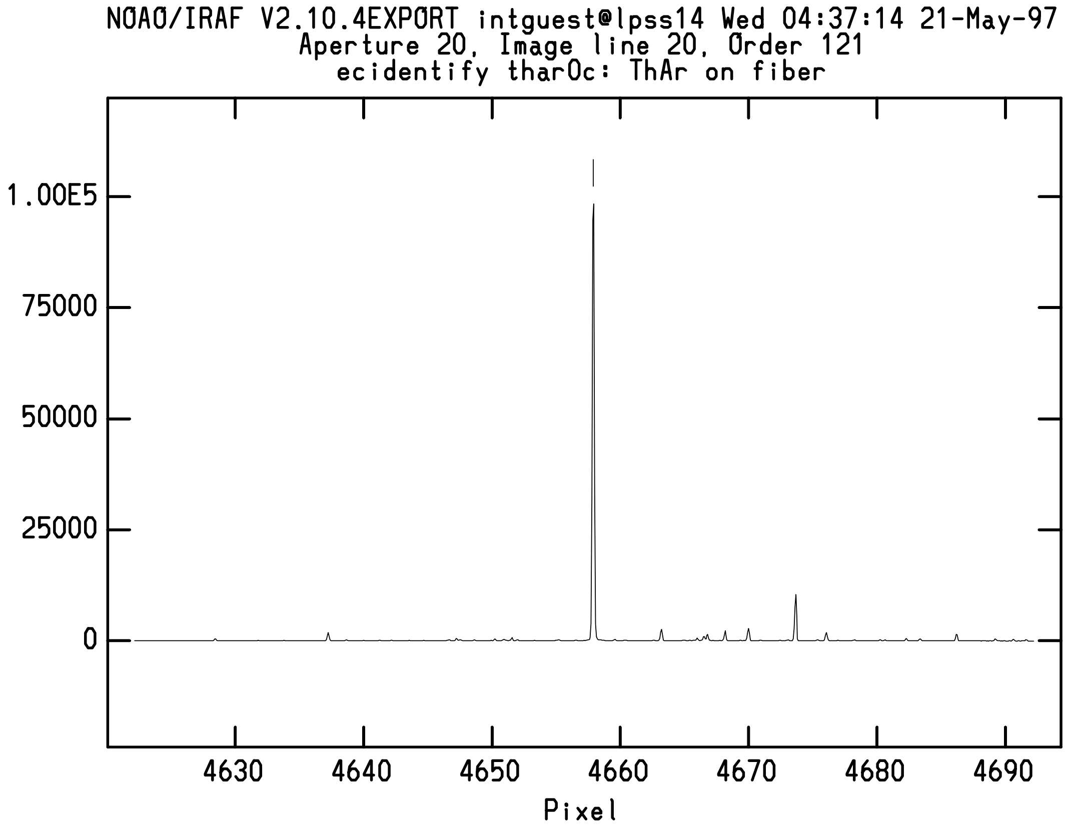

NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:07 21-May-97
Aperture 15, Image line 15, Order 126
ecidentify thar0c: ThAr on fiber
60000
40000
20000
0
4440
4450
4460
4470
4480
4490
4500
Pixel

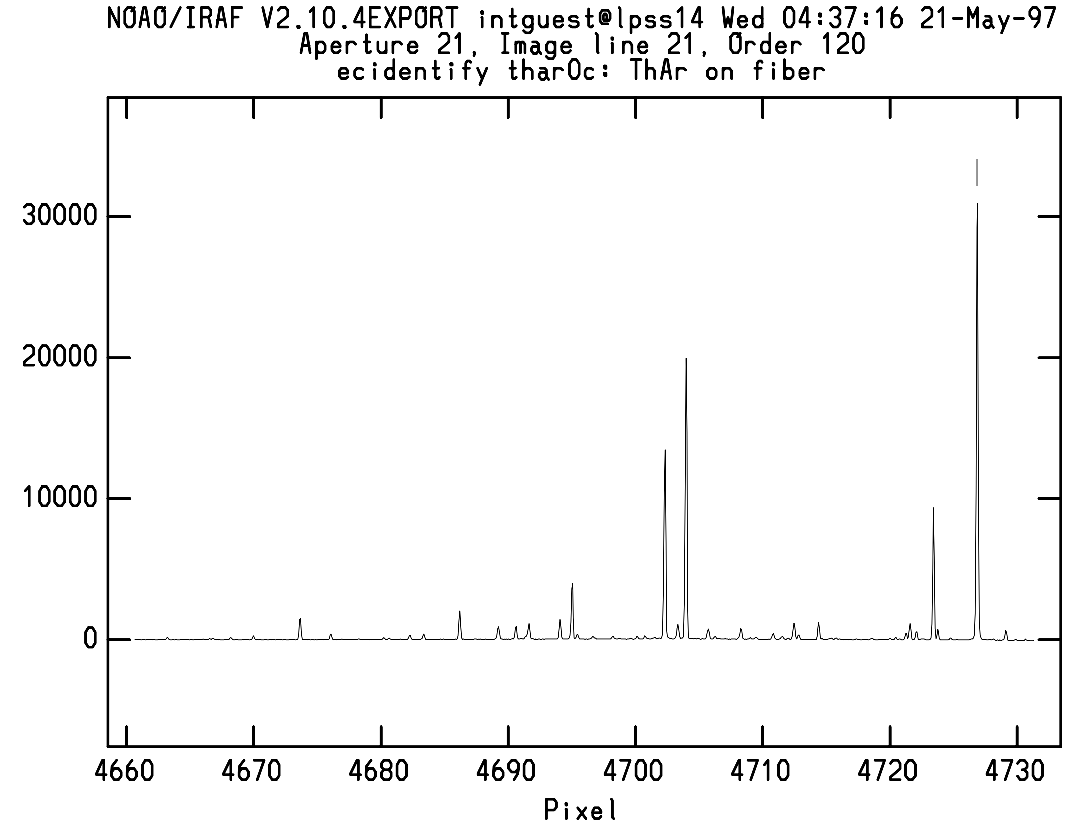

NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:08 21-May-97
Aperture 16, Image line 16, Order 125
ecidentify thar0c: ThAr on fiber
60000
40000
20000
0
4480
4490
4500
4510
4520
4530
4540
Pixel


NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:10 21-May-97
Aperture 17, Image line 17, Order 124
ecidentify tharOc: ThAr on fiber
1.50E5
1.00E5
50000
0
4510
4520
4530
4540
4550
4560
4570
4580
Pixel


NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:11 21-May-97
Aperture 18, Image line 18, Order 123
ecidentify tharOc: ThAr on fiber
1.25E5
1.00E5
75000
50000
25000
0
-25000
4550
4560
4570
4580
4590
4600
4610
Pixel


NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:13 21-May-97
Aperture 19, Image line 19, Order 122
ecidentify thar0c: ThAr on fiber
1.00E5
80000
60000
40000
20000
0
-20000
4590
4600
4610
4620
4630
4640
4650
Pixel


NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:14 21-May-97
Aperture 20, Image line 20, Order 121
ecidentify thar0c: ThAr on fiber
1.00E5
75000
50000
25000
0
4630
4640
4650
4660
4670
4680
4690
Pixel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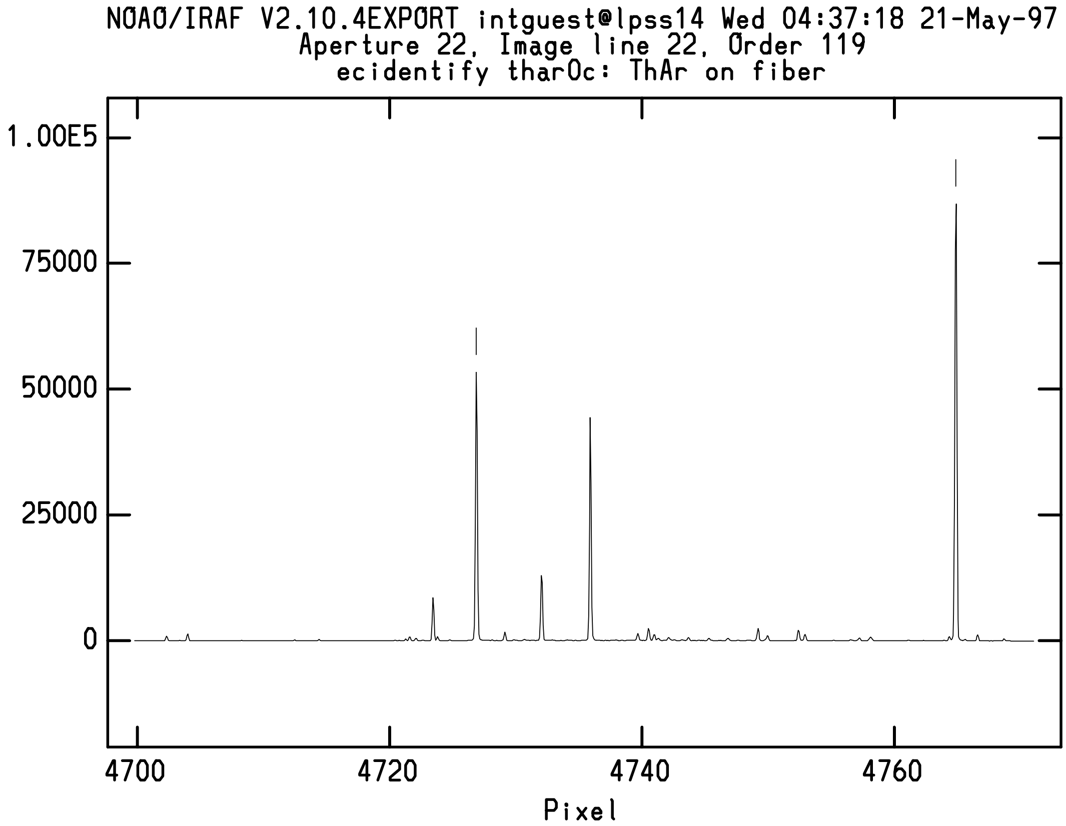
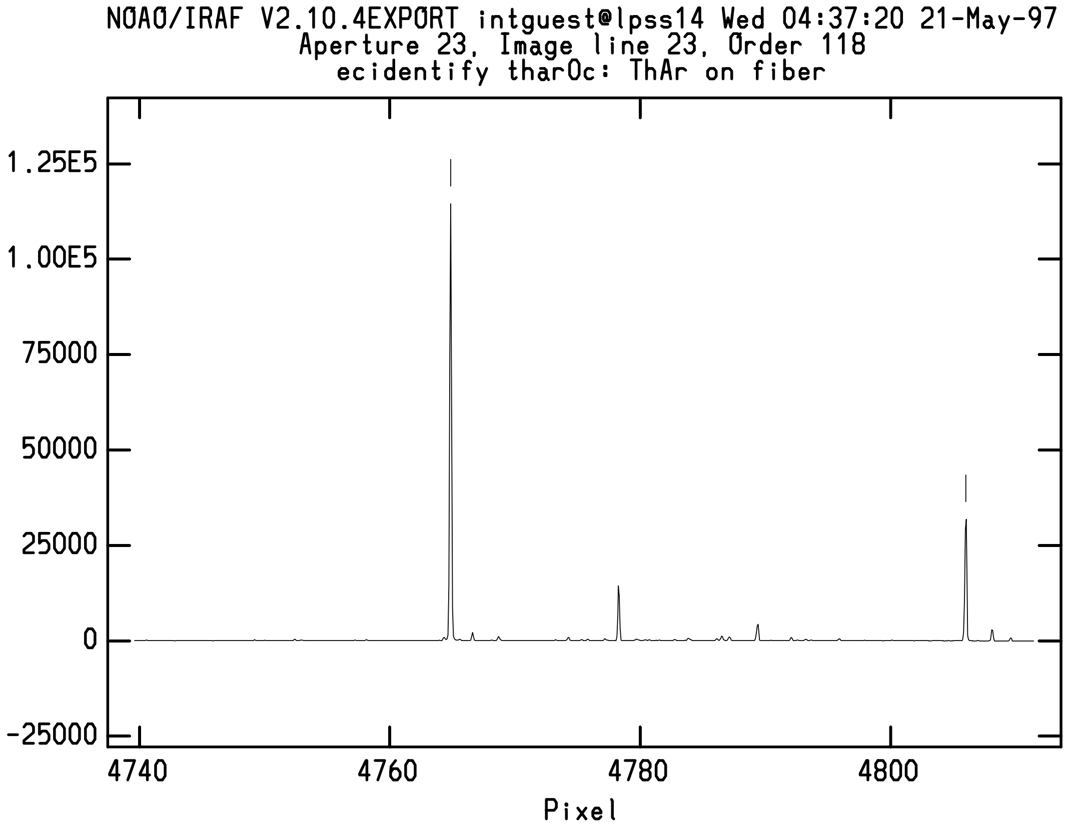
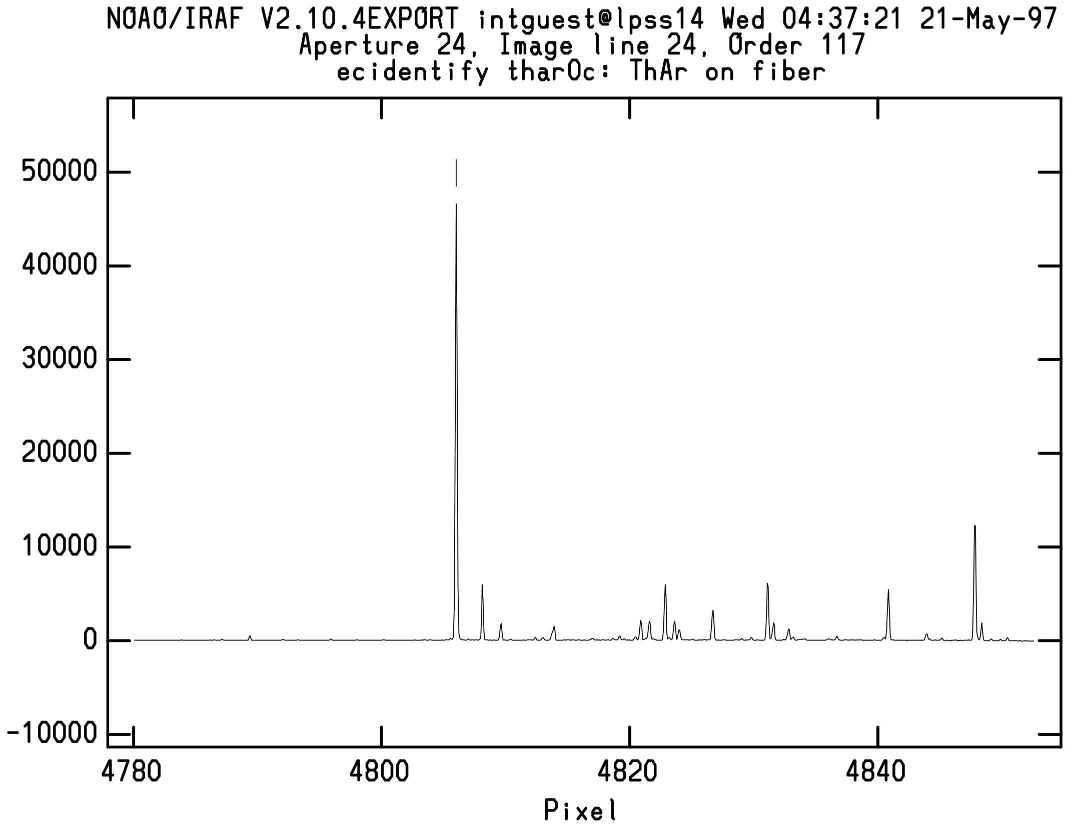
Aperture 21, Image line 21, Order 120
ecidentify tharOc: ThAr on fiber
30000
20000
10000
0
4660
4670
4680
4690
4700
4710
4720
4730
Pixel


NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:18 21-May-97
Aperture 22, Image line 22, Order 119
ecidentify tharOc: ThAr on fiber
1.00E5
75000
50000
25000
0
4700
4720
4740
4760
Pixel


NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:20 21-May-97
Aperture 23, Image line 23, Order 118
ecidentify tharOc: ThAr on fiber
1.25E5
1.00E5
75000
50000
25000
0
-25000
4740
4760
4780
4800
Pixel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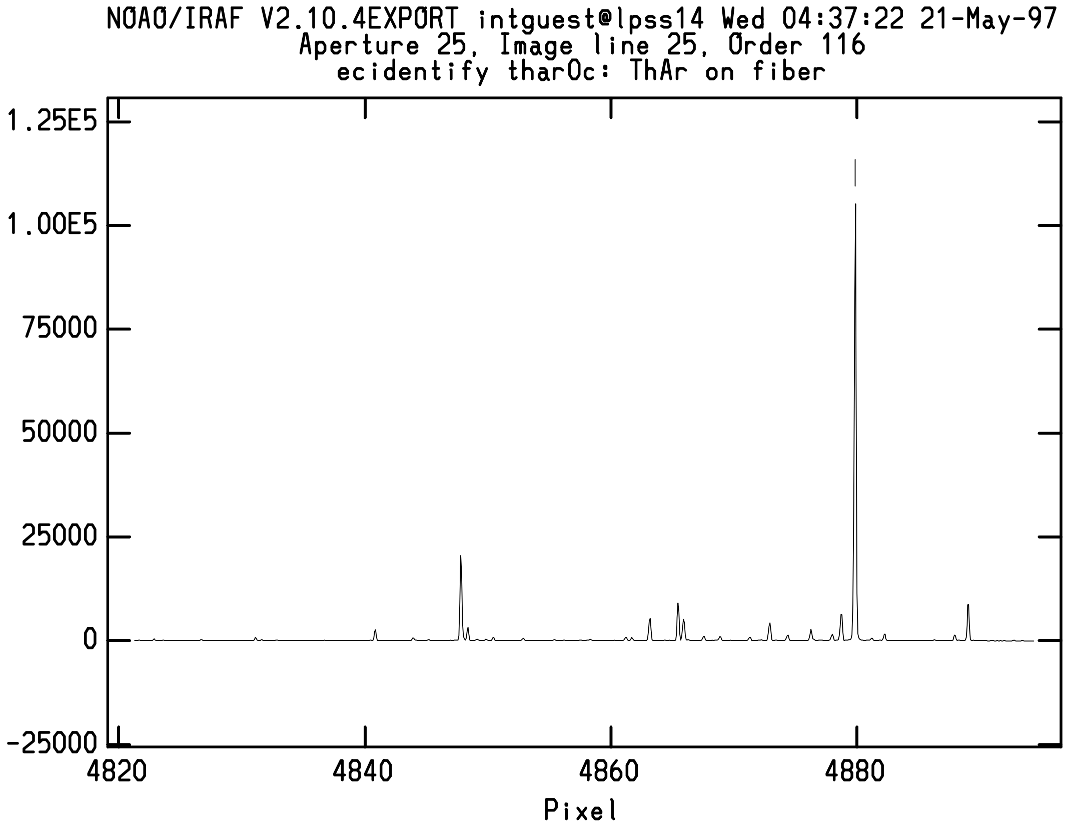
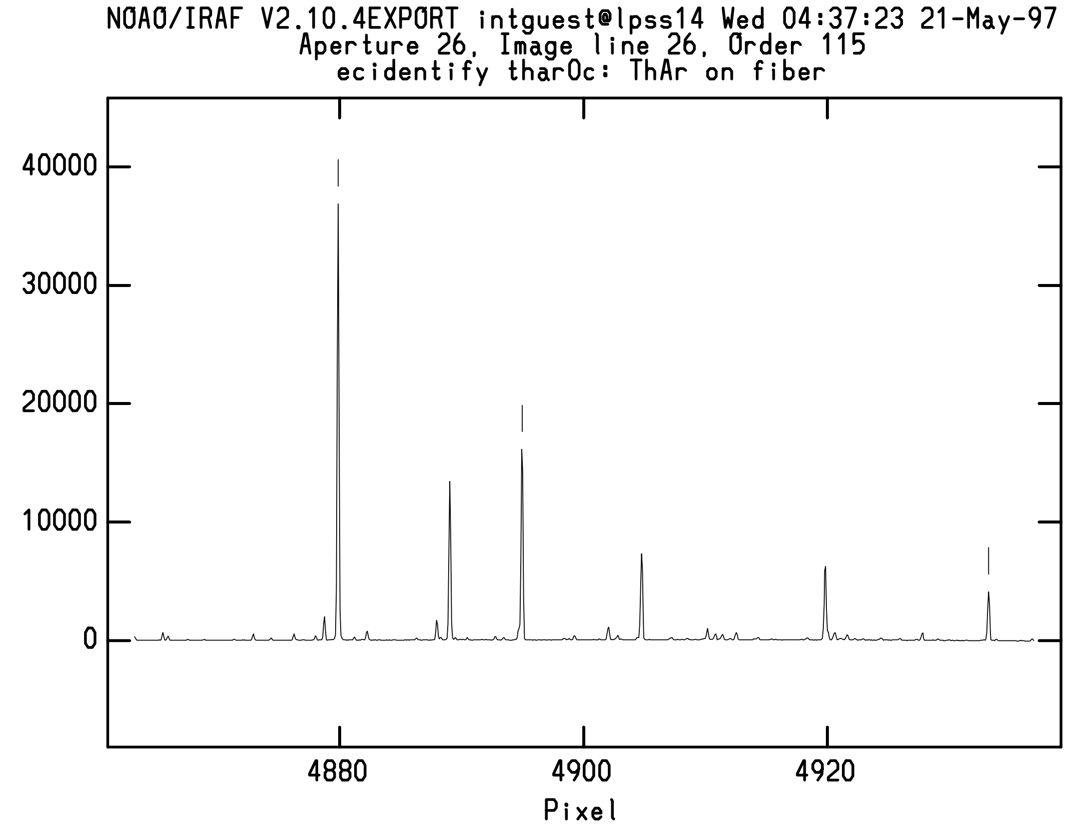
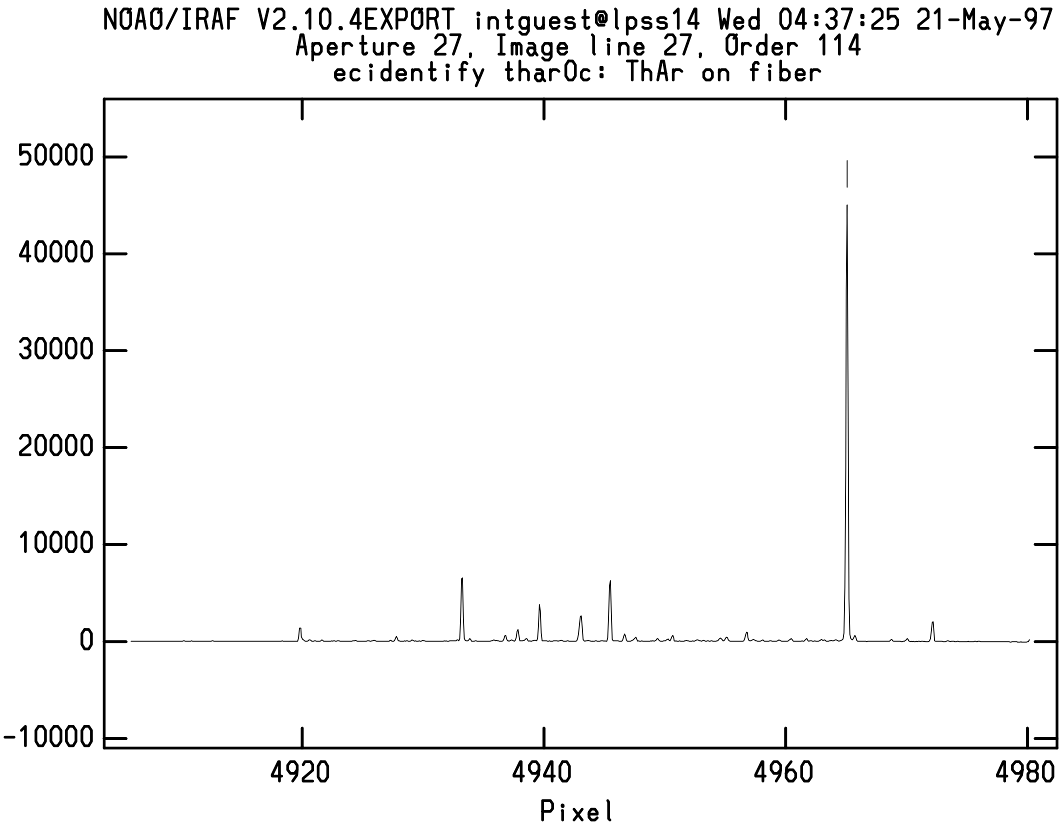
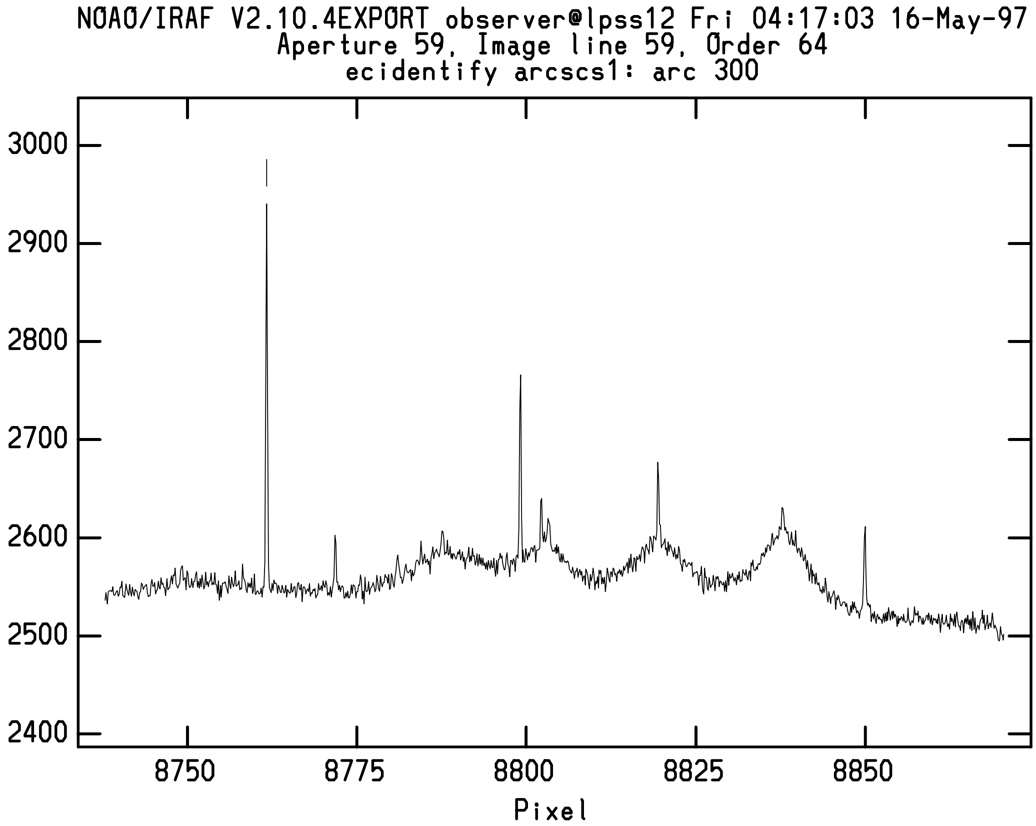
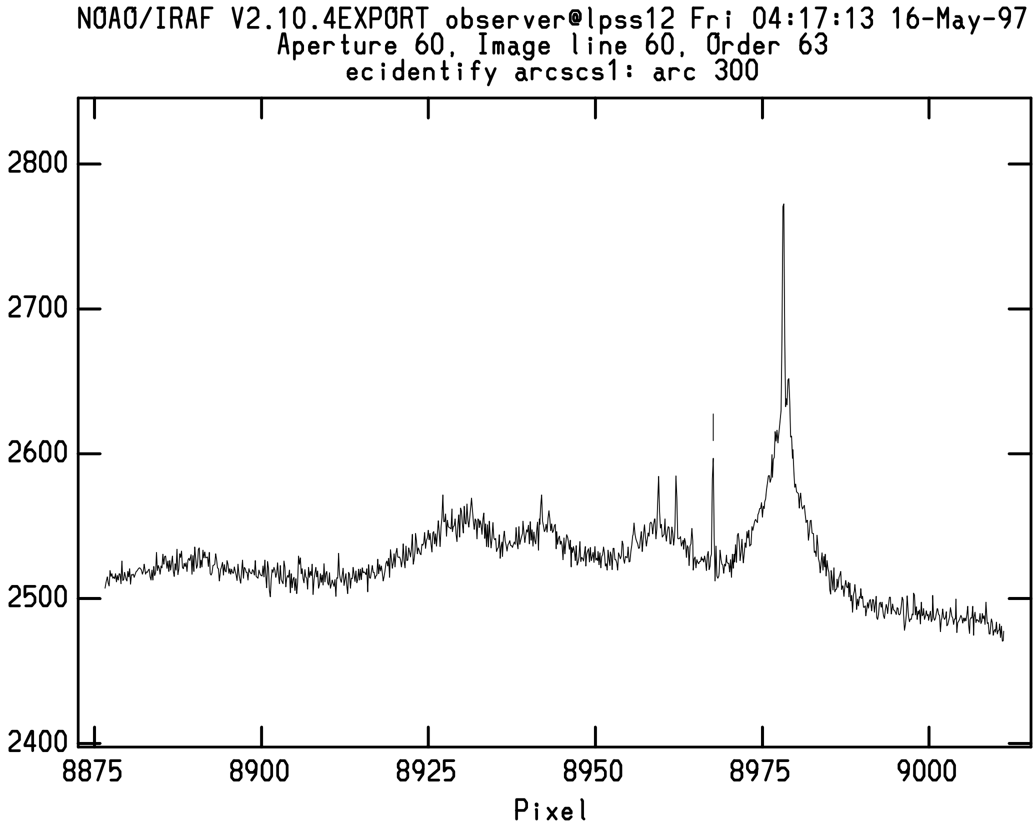
Aperture 24, Image line 24, Order 117
ecidentify tharOc: ThAr on fiber
50000
40000
30000
20000
10000
0
-10000
4780
4800
4820
4840
Pixel

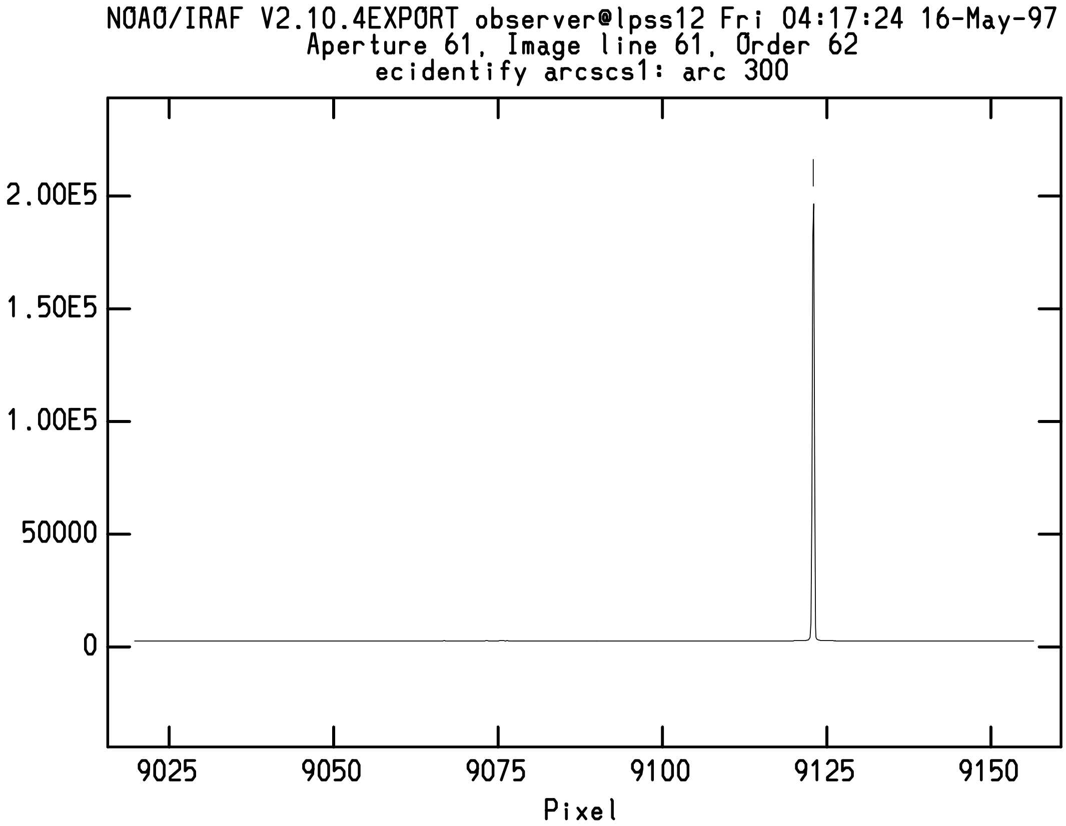

NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:22 21-May-97
Aperture 25, Image line 25, Order 116
ecidentify tharOc: ThAr on fiber
1.25E5
1.00E5
75000
50000
25000
0
-25000
4820
4840
4860
4880
Pixel

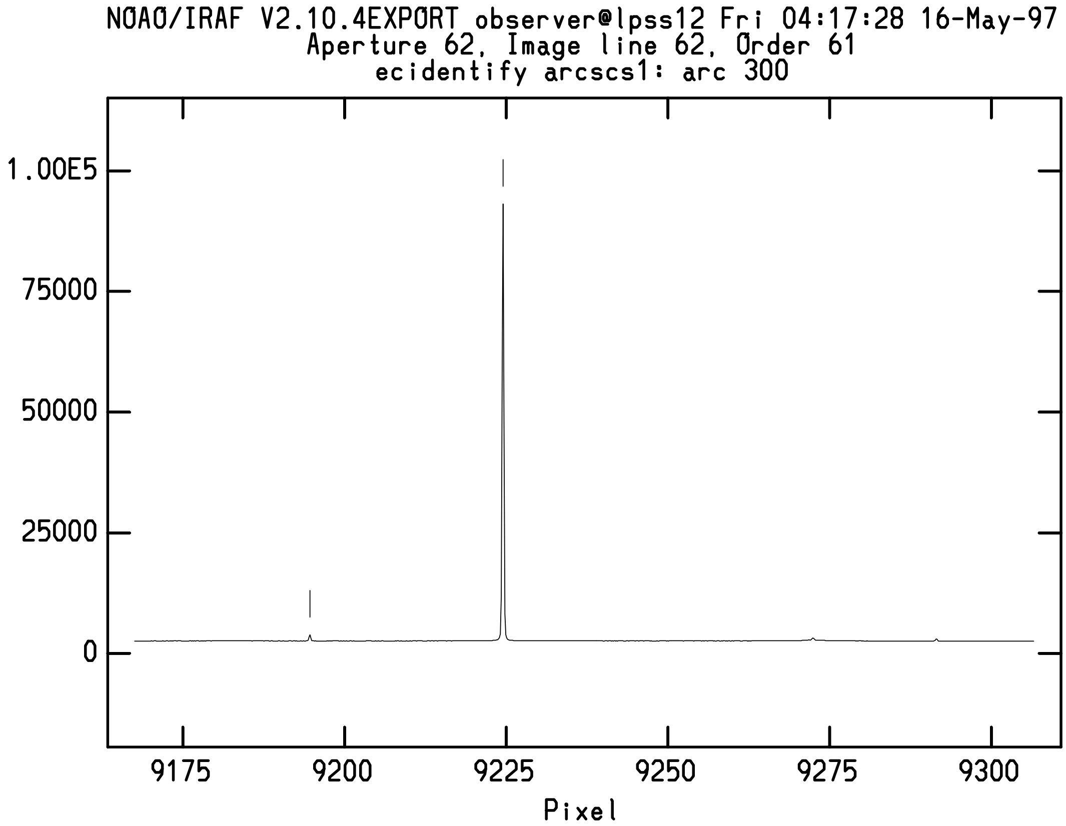

NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:23 21-May-97
Aperture 26, Image line 26, Order 115
ecidentify tharOc: ThAr on fiber
40000
30000
20000
10000
0
4880
4900
4920
Pixel

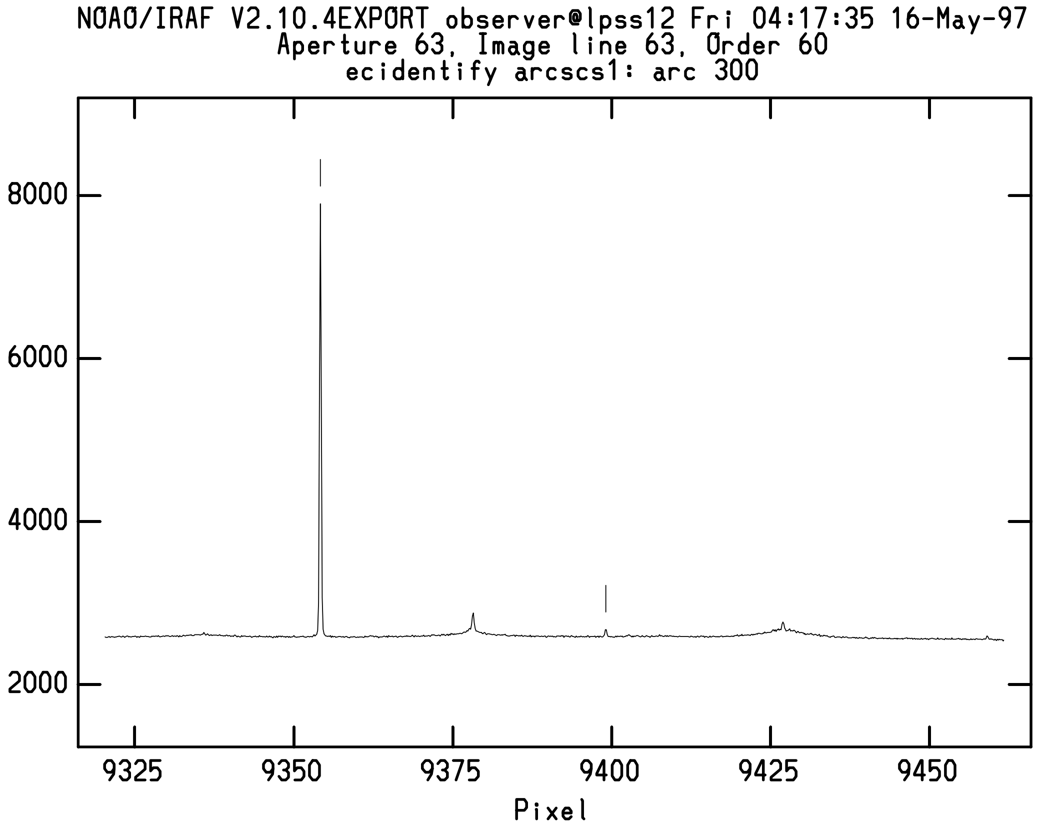

NOAO/IRAF V2.10.4EXPORT intguest@lpss14 Wed 04:37:25 21-May-97
Aperture 27, Image line 27, Order 114
ecidentify thar0c: ThAr on fiber
50000
40000
30000
20000
10000
0
-10000
4920
4940
4960
4980
Pixel

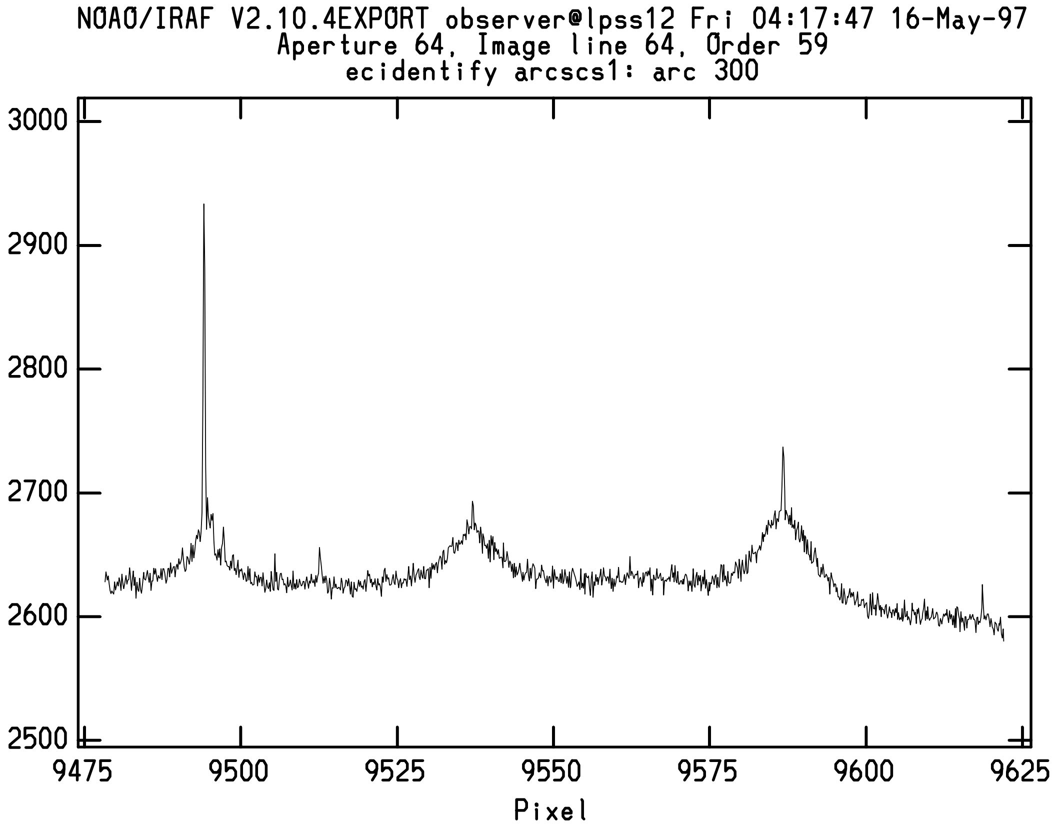

NOAO/IRAF V2.10.4EXPORT observer@lpss12 Fri 04:17:03 16-May-97
Aperture 59, Image line 59, Order 64
ecidentify arcscs1: arc 300
3000
2900
2800
2700
2600
2500
2400
8750
8775
8800
8825
8850
Pixel

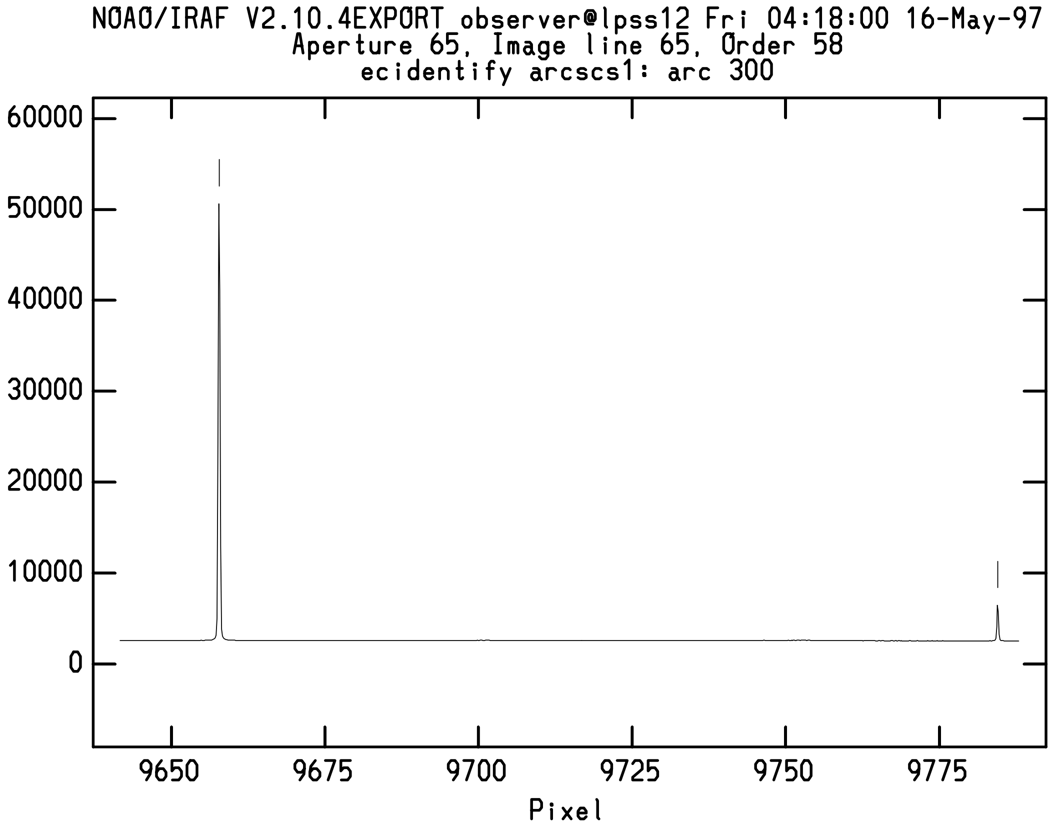

NOAO/IRAF V2.10.4EXPORT observer@lpss12 Fri 04:17:13 16-May-97
Aperture 60, Image line 60, Order 63
ecidentify arcscs1: arc 300
2800
2700
2600
2500
2400
8875
8900
8925
8950
8975
9000
Pixel


NOAO/IRAF V2.10.4EXPORT observer@lpss12 Fri 04:17:24 16-May-97
Aperture 61, Image line 61, Order 62
ecidentify arcscs1: arc 300
2.00E5
1.50E5
1.00E5
50000
0
9025
9050
9075
9100
9125
9150
Pixel

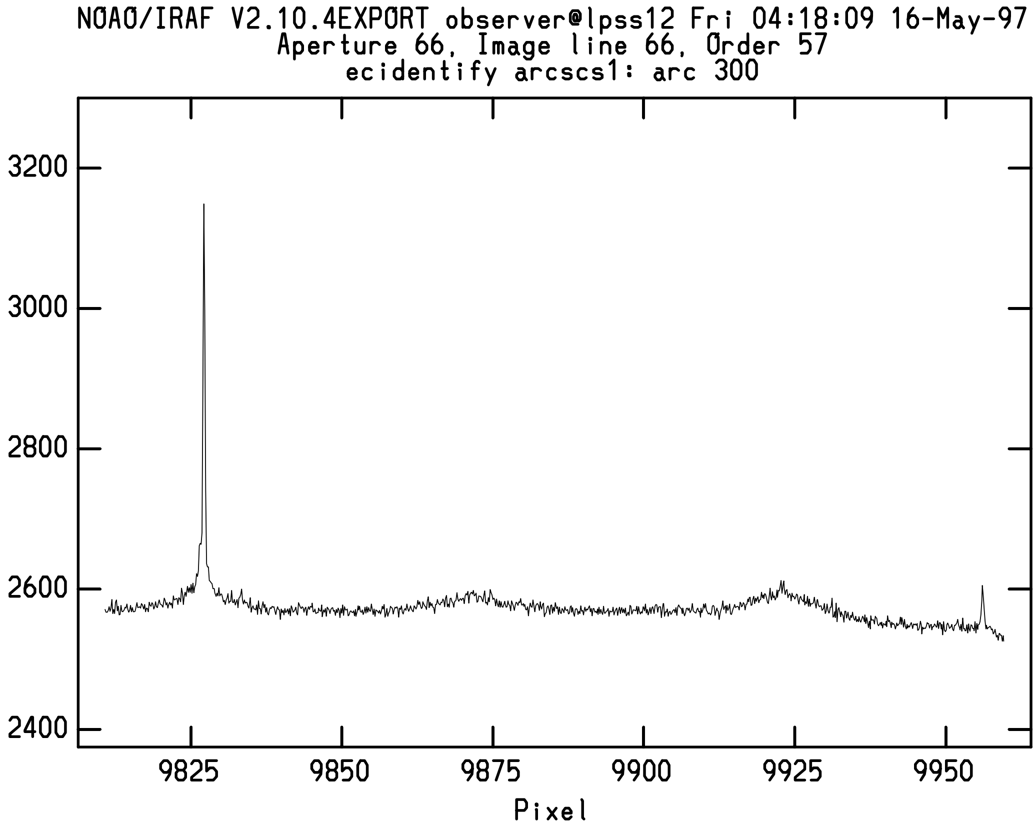

NOAO/IRAF V2.10.4EXPORT observer@lpss12 Fri 04:17:28 16-May-97
Aperture 62, Image line 62, Order 61
ecidentify arcscs1: arc 300
1.00E5
75000
50000
25000
0
9175
9200
9225
9250
9275
9300
Pixel


NOAO/IRAF V2.10.4EXPORT observer@lpss12 Fri 04:17:35 16-May-97
Aperture 63, Image line 63, Order 60
ecidentify arcscs1: arc 300
8000
6000
4000
2000
9325
9350
9375
9400
9425
9450
Pixel

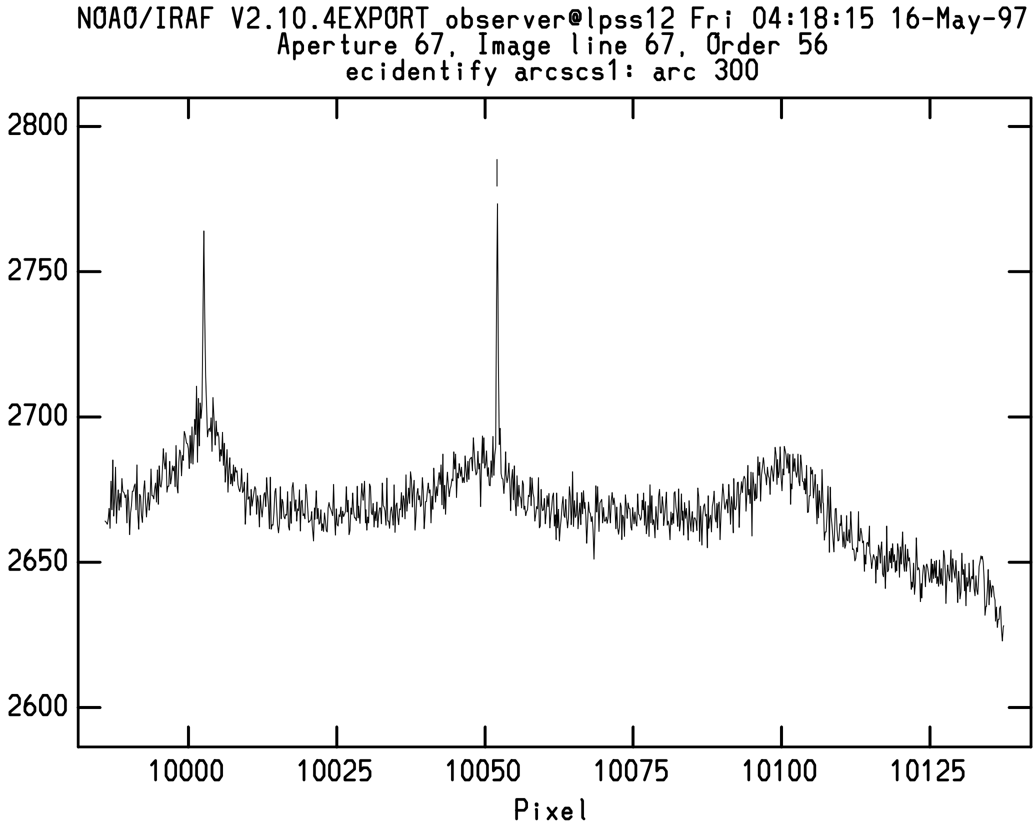

NOAO/IRAF V2.10.4EXPORT observer@lpss12 Fri 04:17:47 16-May-97
Aperture 64, Image line 64, Order 59
ecidentify arcscs1: arc 300
3000
2900
2800
2700
2600
2500
9475
9500
9525
9550
9575
9600
9625
Pixel

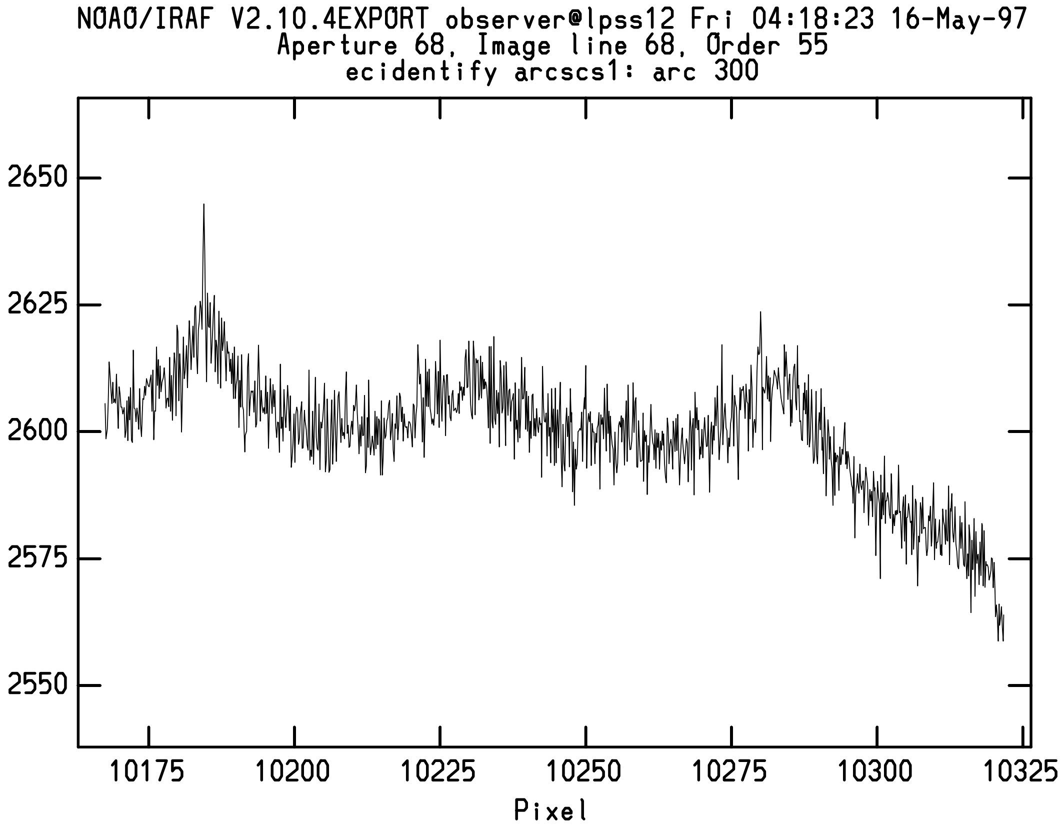


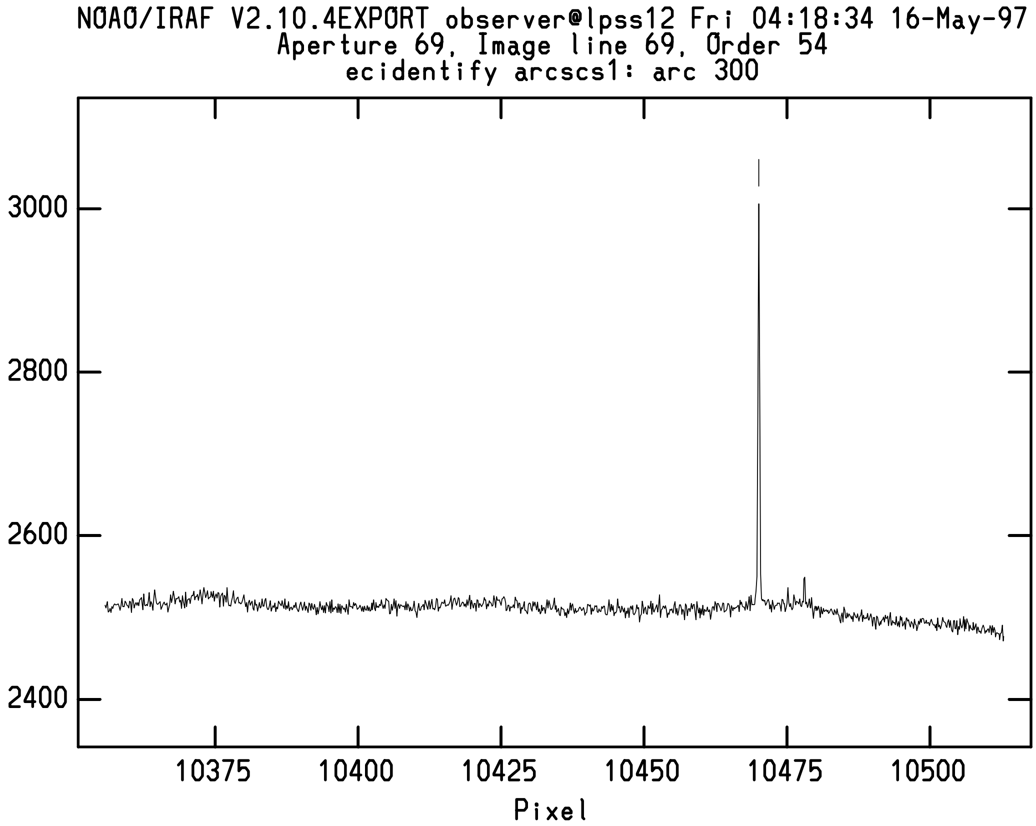
NOAO/IRAF V2.10.4EXPORT observer@lpss12 Fri 04:18:00 16-May-97
Aperture 65, Image line 65, Order 58
ecidentify arcscs1: arc 300
60000
50000
40000
30000
20000
10000
0
9650
9675
9700
9725
9750
9775
Pixel



NOAO/IRAF V2.10.4EXPORT observer@lpss12 Fri 04:18:09 16-May-97
Aperture 66, Image line 66, Order 57
ecidentify arcscs1: arc 300
3200
3000
2800
2600
2400
9825
9850
9875
9900
9925
9950
Pixel


NOAO/IRAF V2.10.4EXPORT observer@lpss12 Fri 04:18:15 16-May-97
Aperture 67, Image line 67, Order 56
ecidentify arcscs1: arc 300
2800
2750
2700
2650
2600
10000
10025
10050
10075
10100
10125
Pixel


NOAO/IRAF V2.10.4EXPORT observer@lpss12 Fri 04:18:23 16-May-97
Aperture 68, Image line 68, Order 55
ecidentify arcscs1: arc 300
2650
2625
2600
2575
2550
10175
10200
10225
10250
10275
10300
10325
Pixel


NOAO/IRAF V2.10.4EXPORT observer@lpss12 Fri 04:18:34 16-May-97
Aperture 69, Image line 69, Order 54
ecidentify arcscs1: arc 300
3000
2800
2600
2400
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10400
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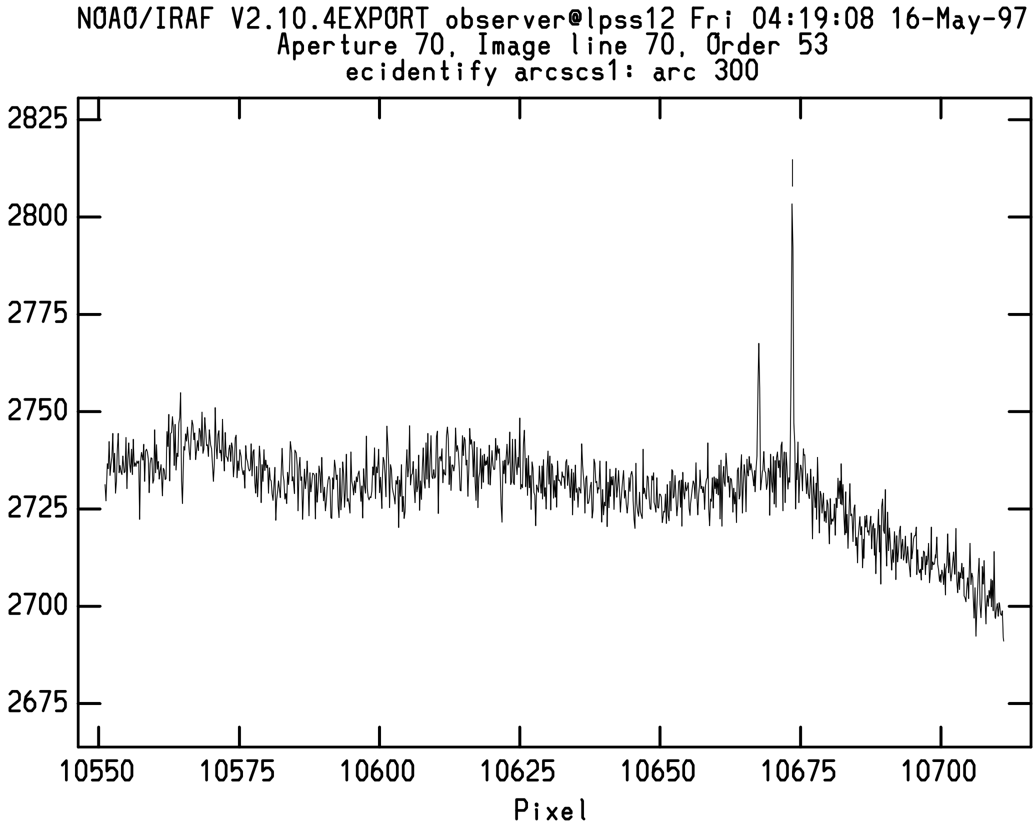
10450
10475
10500
Pixel


NOAO/IRAF V2.10.4EXPORT observer@lpss12 Fri 04:19:08 16-May-97
Aperture 70, Image line 70, Order 53
ecidentify arcscs1: arc 300
2825
2800
2775
2750
2725
2700
2675
10550
10575
10600
10625
10650
10675
10700
Pixel