

# Thorium-Argon Spectral Atlas for HIDES

Masaaki OTSUKA

Okayama Astrophysical Observatory, National Astronomical Observatory, Kamogata, Okayama  
719-0232, Japan

This atlas consists of one long data file covering the wavelength region from 3800 Å to 8500 Å. All of the data was obtained by HIgh Dispersion Echelle Spectrograph (HIDES) combined with the f/29 coudé focus of the 74-inch telescope at the Okayama Astrophysical Observatory. We used EEV 42-80 CCD whose dimension is 2048 (along the slit)× 4096 (along the wavelength dispersion) and size of a pixel is 13.5  $\mu\text{m}$  square. We set the slit width to 0.95'', which is equivalent to the spectral resolving power of 61,000. The reduction were performed with *IRAF*<sup>1</sup>, `twodspec`. We refered to Palmer & Engleman (1983) for Th and from Norlén (1973) for Ar.

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<sup>1</sup>*IRAF* is distributed by the National Optical Astronomy Observatories, which are operated by the Association of Universities for Research in Astronomy, Inc., under cooperative agreement with the National Science Foundation.

## REFERENCES

Palmer, B.A. & Engleman, R., Jr., 1983, “ATLAS OF THE THORIUM SPECTRUM”, Los Alamos National Laboratory, Los Alamos, New Mexico

Norlén,G., 1973, Physica Scripta, 8, 249.

Table 1.

order	$\lambda_{\text{start}}$	$\lambda_{\text{end}}$	$\text{\AA pixel}^{-1}$	Figure
67	8404.539	8556.139	0.037021	1
68	8281.069	8430.451	0.036479	2
69	8161.180	8308.417	0.035955	3
70	8044.702	8189.807	0.035435	4
71	7931.514	8074.574	0.034935	5
72	7821.451	7962.529	0.034451	6
73	7714.008	7853.542	0.034074	7
74	7610.285	7747.497	0.033507	8
75	7508.921	7644.275	0.033054	9
76	7409.164	7542.871	0.032651	10
77	7313.017	7445.008	0.032232	11
78	7219.344	7349.628	0.031815	12
79	7128.033	7256.690	0.031418	13
80	7039.017	7166.062	0.031025	14
81	6952.191	7077.664	0.030640	15
82	6866.945	6990.907	0.030272	16
83	6784.270	6906.771	0.029915	17
84	6703.569	6824.611	0.029558	18
85	6624.771	6744.386	0.029210	19
86	6547.796	6666.023	0.028871	20
87	6472.601	6589.466	0.028538	21
88	6399.102	6514.647	0.028216	22
89	6327.800	6441.907	0.027865	23
90	6257.014	6369.991	0.027589	24
91	6188.312	6300.031	0.027282	25
92	6121.095	6231.598	0.026985	26
93	6055.334	6164.637	0.026692	27
94	5990.963	6099.100	0.026407	28
95	5927.952	6034.937	0.026126	29
96	5866.258	5972.103	0.025847	30
97	5805.818	5910.582	0.025583	31
98	5746.180	5849.984	0.025349	32
99	5688.177	5790.937	0.025094	33

Table 1—Continued

order	$\lambda_{\text{start}}$	$\lambda_{\text{end}}$	$\text{\AA pixel}^{-1}$	Figure
100	5631.336	5733.069	0.024843	34
101	5575.620	5676.344	0.024597	35
102	5520.996	5620.721	0.024353	36
103	5467.433	5566.189	0.024116	37
104	5414.896	5512.696	0.023883	38
105	5363.361	5460.229	0.023655	39
106	5312.804	5408.741	0.023428	40
107	5263.185	5358.223	0.023208	41
108	5214.484	5308.640	0.022993	42
109	5166.154	5259.580	0.022815	43
110	5119.218	5211.798	0.022608	44
111	5073.122	5164.878	0.022407	45
112	5027.856	5118.792	0.022207	46
113	4983.390	5073.520	0.022010	47
114	4939.699	5029.045	0.021818	48
115	4896.767	4985.352	0.021632	49
116	4854.580	4942.384	0.021442	50
117	4813.114	4900.168	0.021259	51
118	4772.344	4858.669	0.021081	52
119	4732.267	4817.863	0.020902	53
120	4692.858	4777.732	0.020726	54
121	4654.095	4738.268	0.020550	55
122	4615.971	4699.451	0.020386	56
123	4578.463	4661.260	0.020219	57
124	4541.561	4623.689	0.020056	58
125	4505.248	4586.721	0.019896	59
126	4466.168	4547.416	0.019841	60
127	4431.026	4511.644	0.019687	61
128	4396.435	4476.426	0.019534	62
129	4362.377	4441.764	0.019386	63
130	4328.847	4407.624	0.019237	64
131	4295.825	4374.014	0.019094	65
132	4263.309	4340.896	0.018947	66

Table 1—Continued

order	$\lambda_{\text{start}}$	$\lambda_{\text{end}}$	$\text{\AA pixel}^{-1}$	Figure
133	4231.279	4308.285	0.018805	67
134	4199.725	4276.165	0.018667	68
135	4168.639	4244.513	0.018528	69
136	4138.004	4213.339	0.018397	70
137	4107.827	4182.601	0.018260	71
138	4078.079	4152.313	0.018128	72
139	4048.766	4122.465	0.017997	73
140	4019.863	4093.038	0.017869	74
141	3991.379	4064.032	0.017742	75
142	3962.833	4035.088	0.017645	76
143	3935.139	4006.903	0.017525	77
144	3907.831	3979.097	0.017403	78
145	3880.900	3951.677	0.017284	79
146	3854.336	3924.636	0.017167	80
147	3828.127	3897.972	0.017056	81

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Wed 23:26:12 23-  
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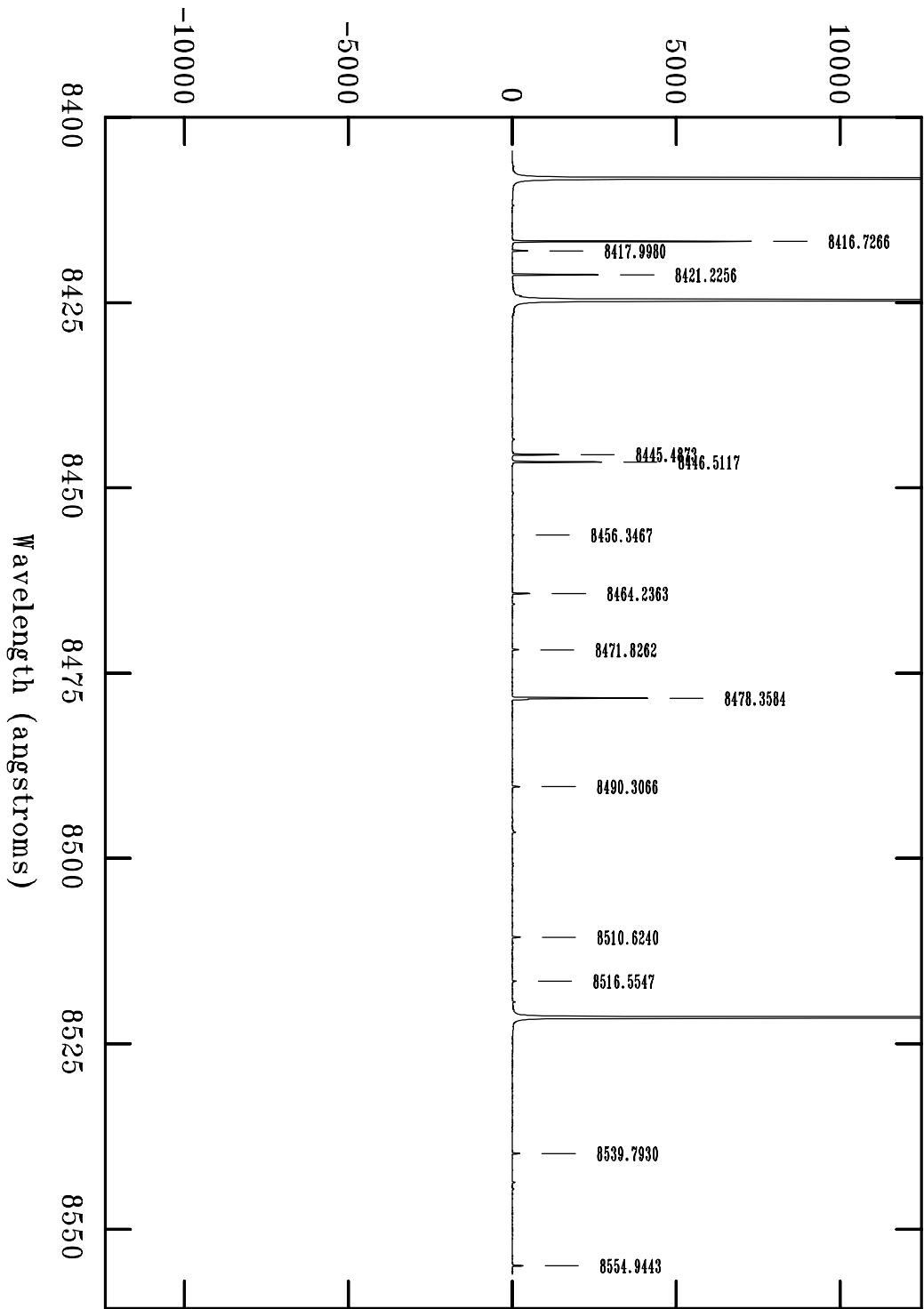


Fig. 1.— order 67

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COMPARISON

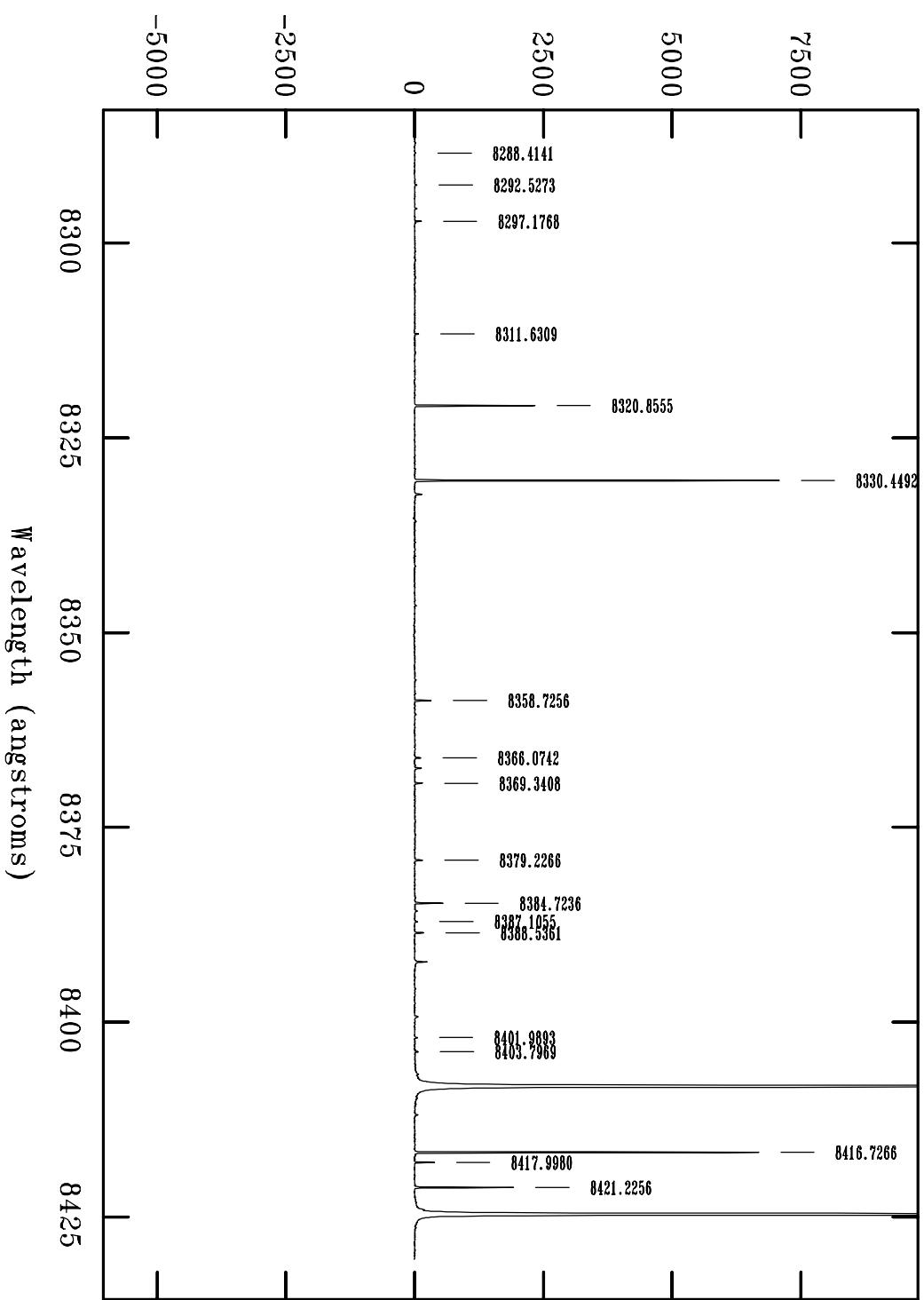


Fig. 2.— order 68

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COMPARISON

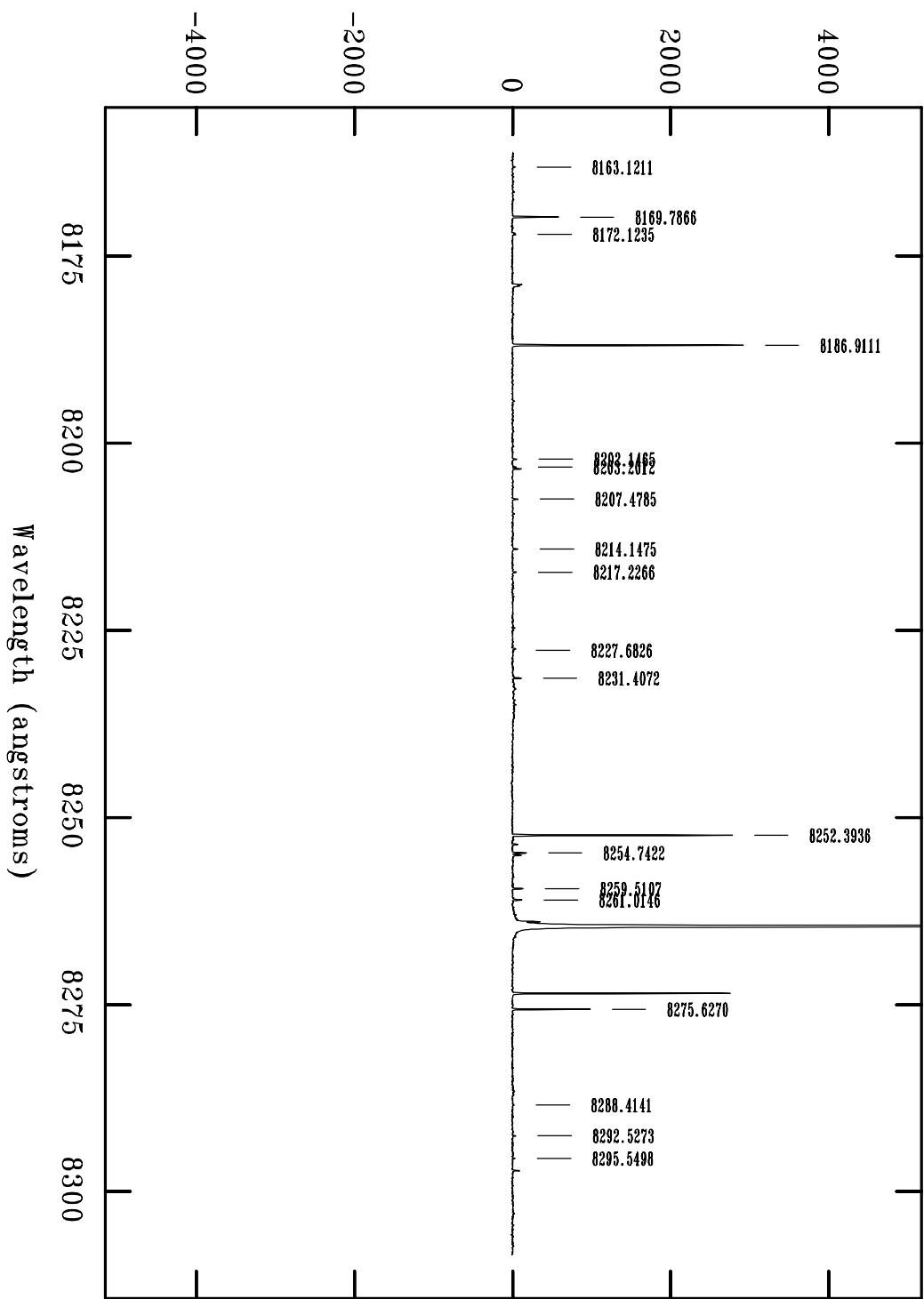


Fig. 3.— order 69

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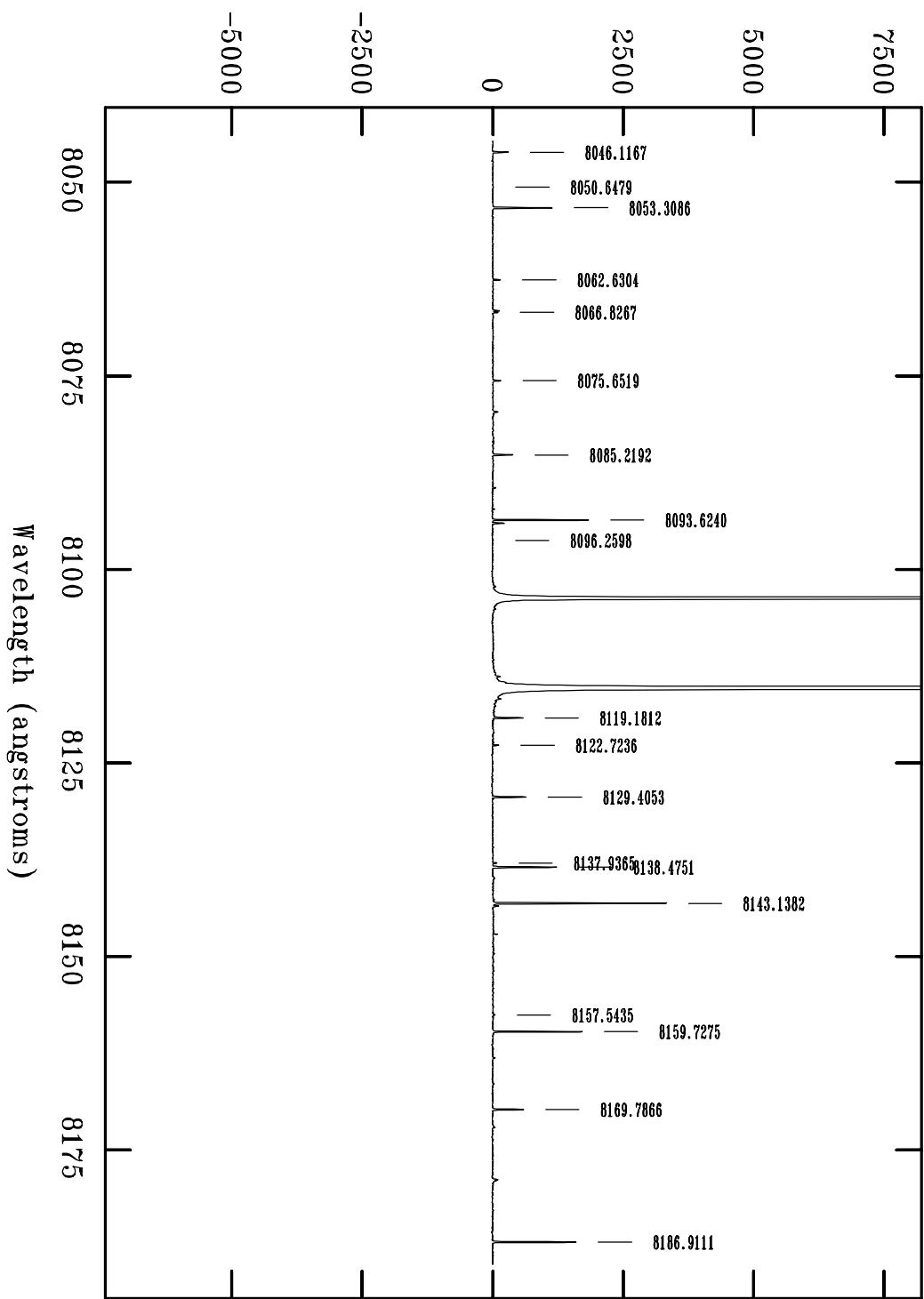


Fig. 4.— order 70

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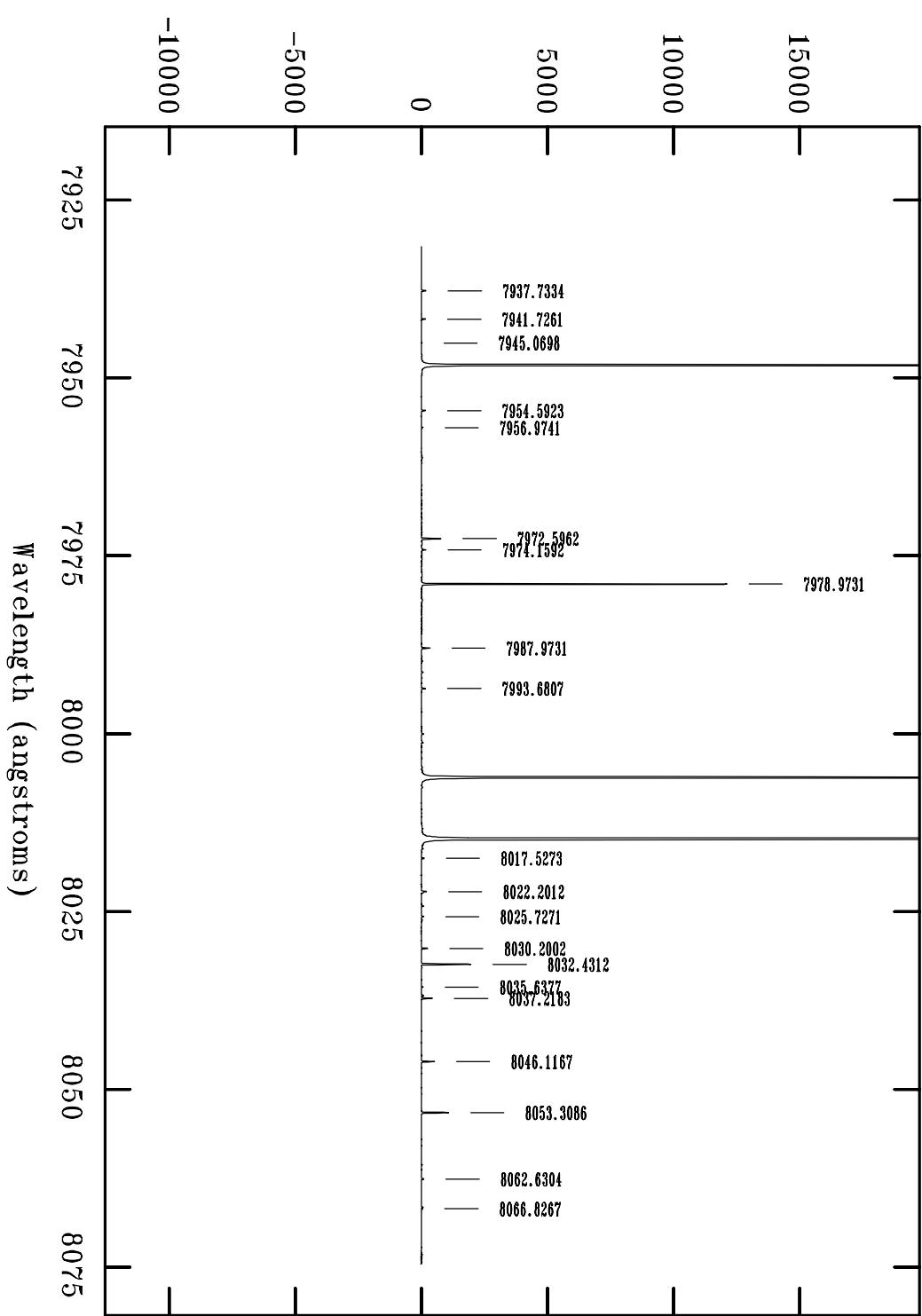


Fig. 5.— order 71

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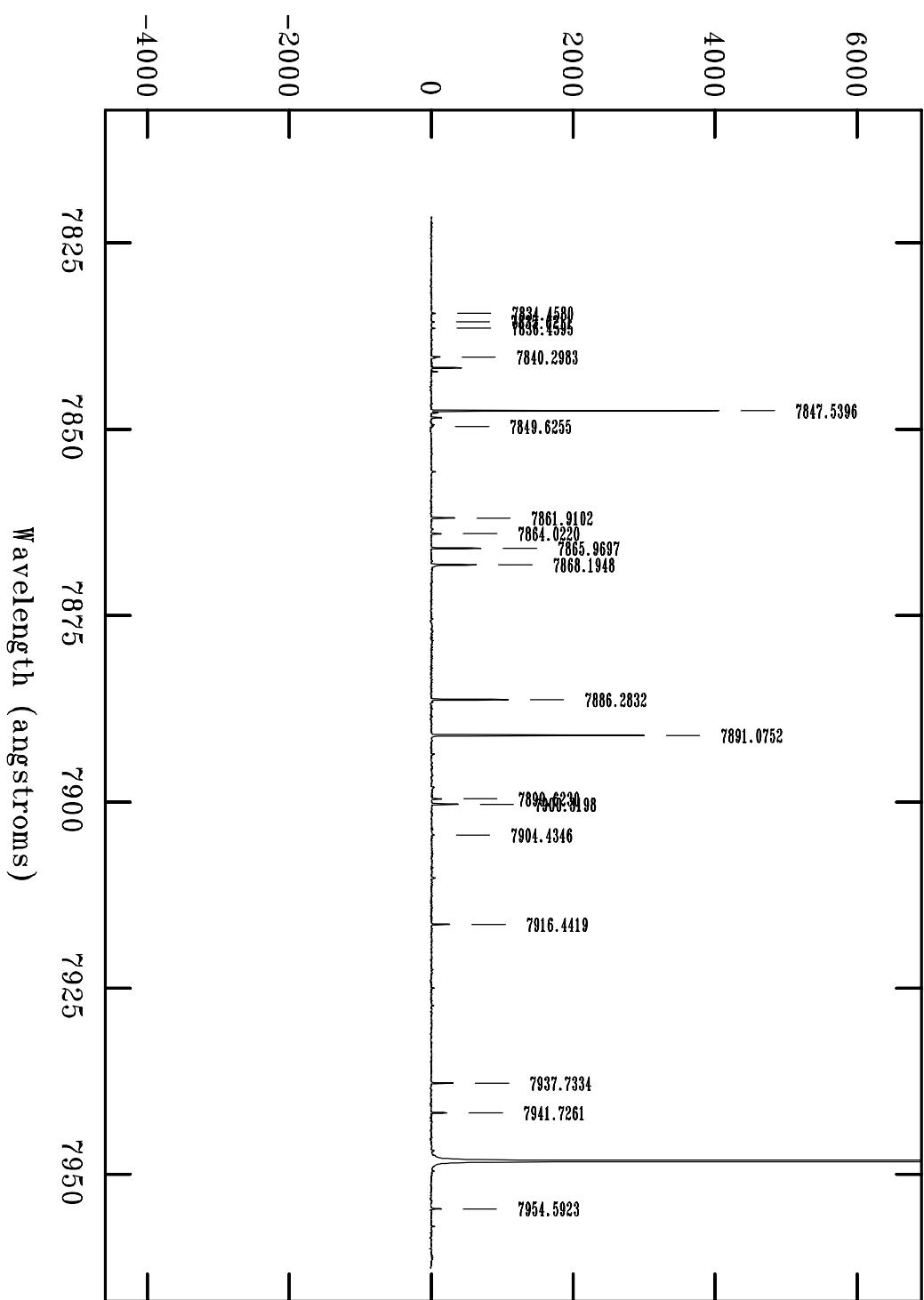


Fig. 6.— order 72

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COMPARISON

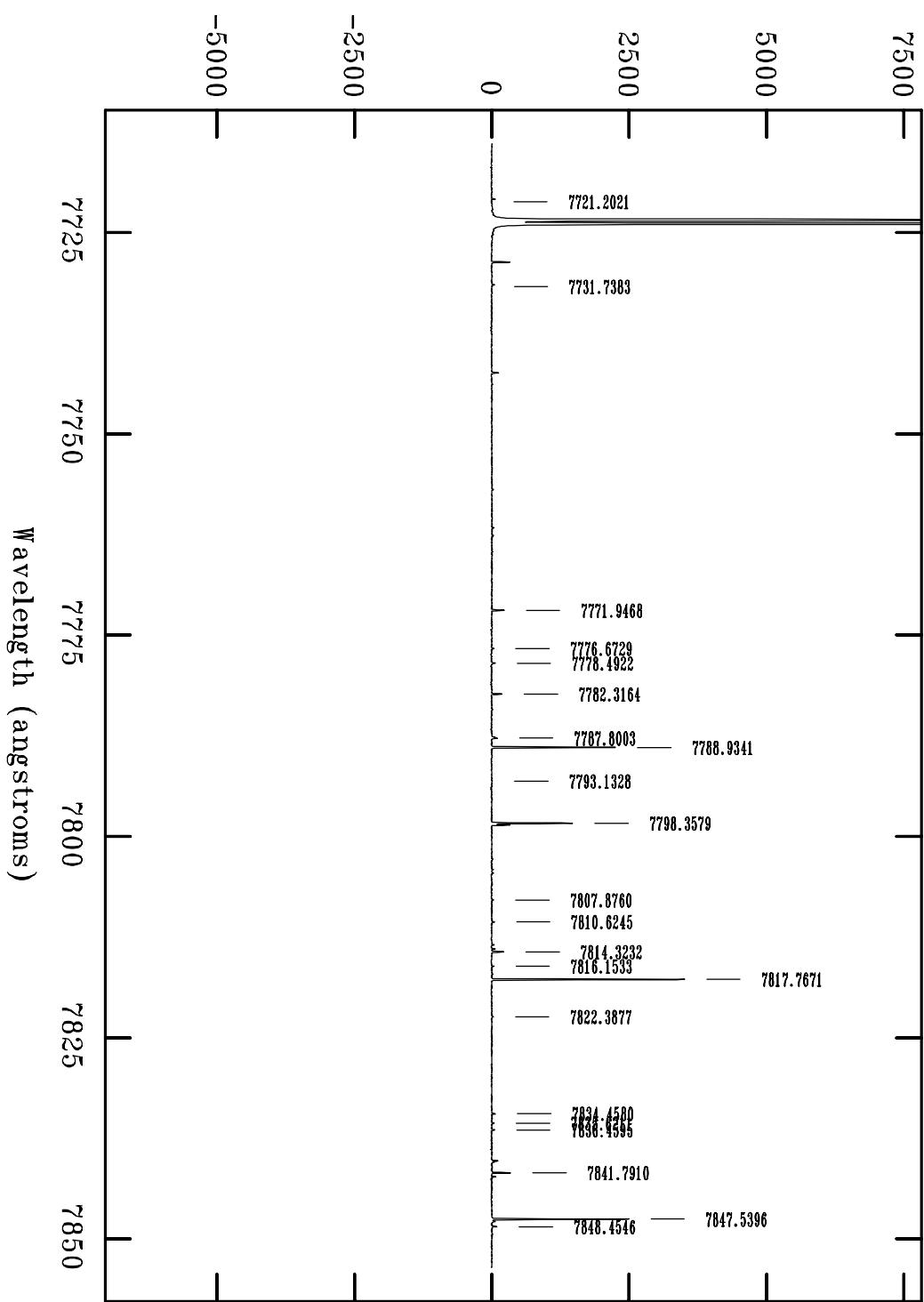


Fig. 7.— order 73

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COMPARISON

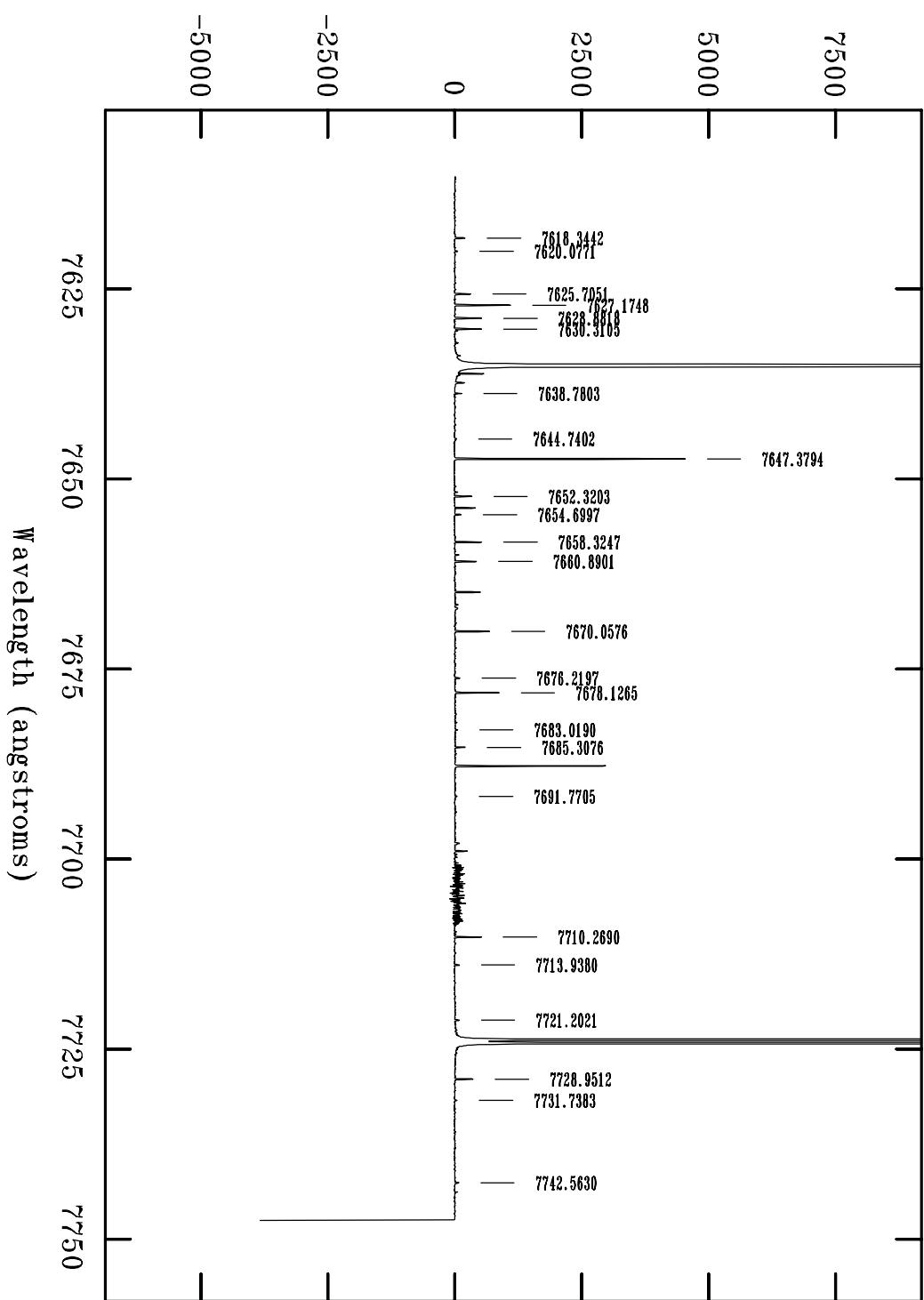


Fig. 8.— order 74

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COMPARISON

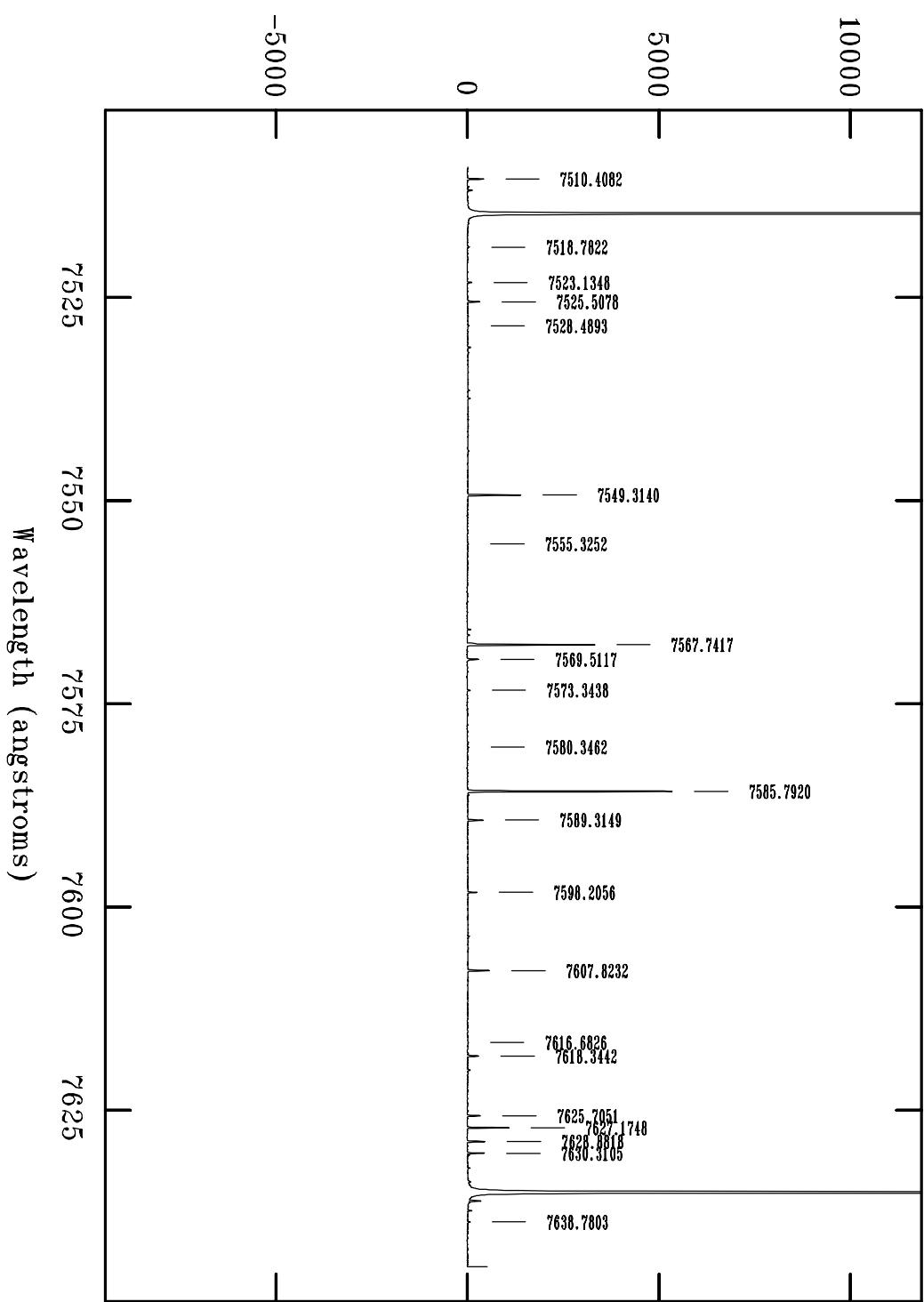


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COMPARISON

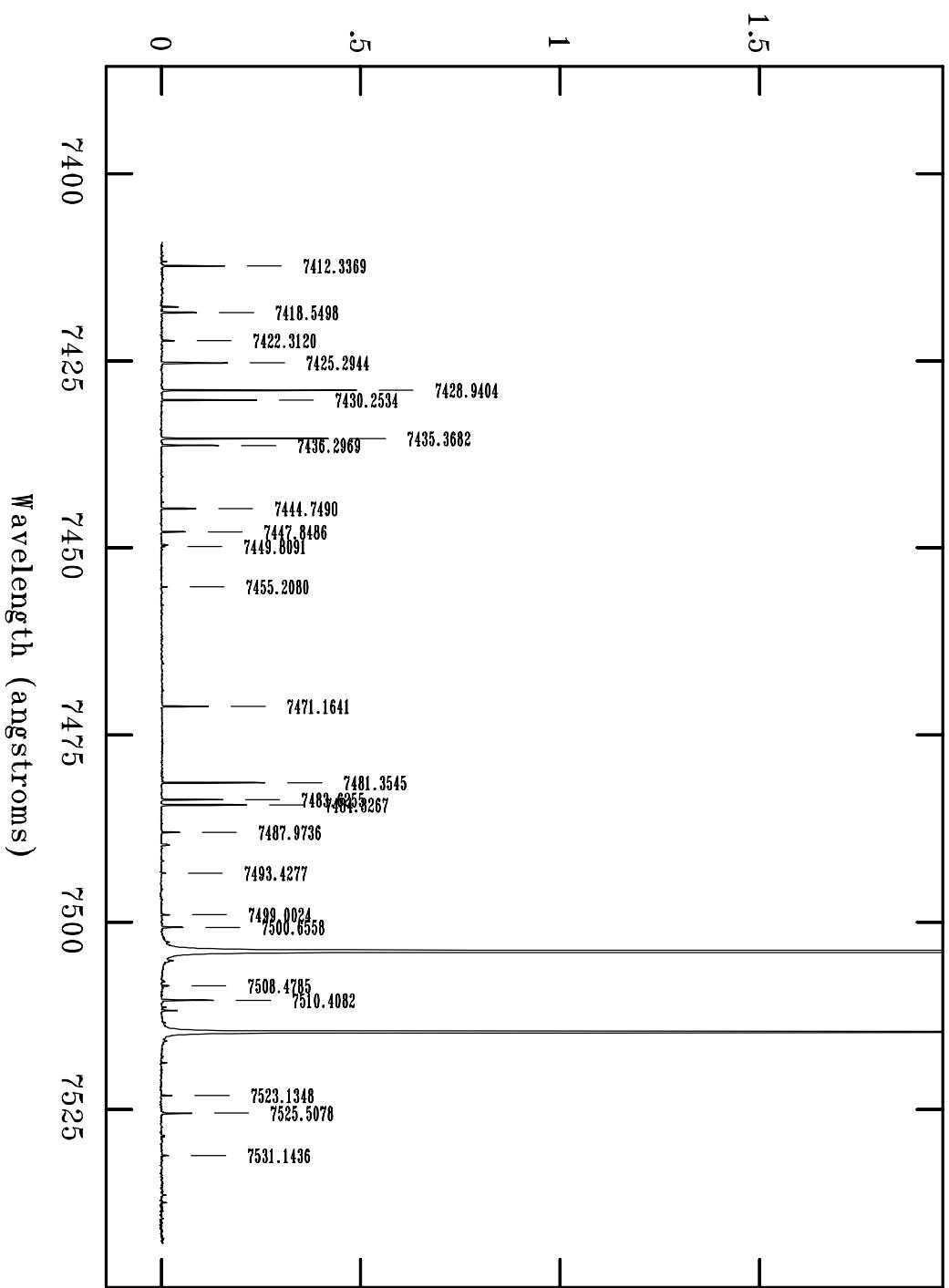


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COMPARISON

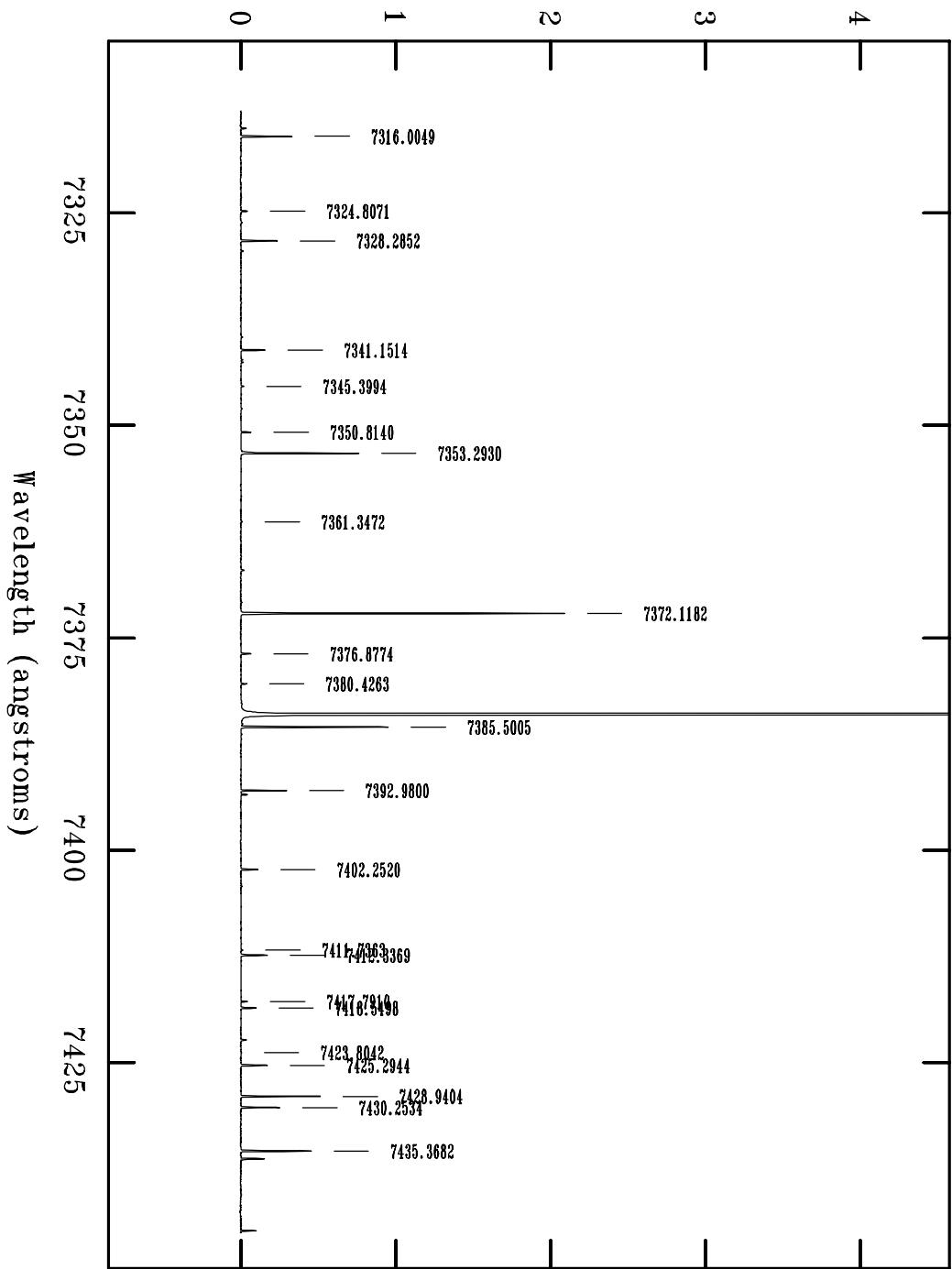


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COMPARISON

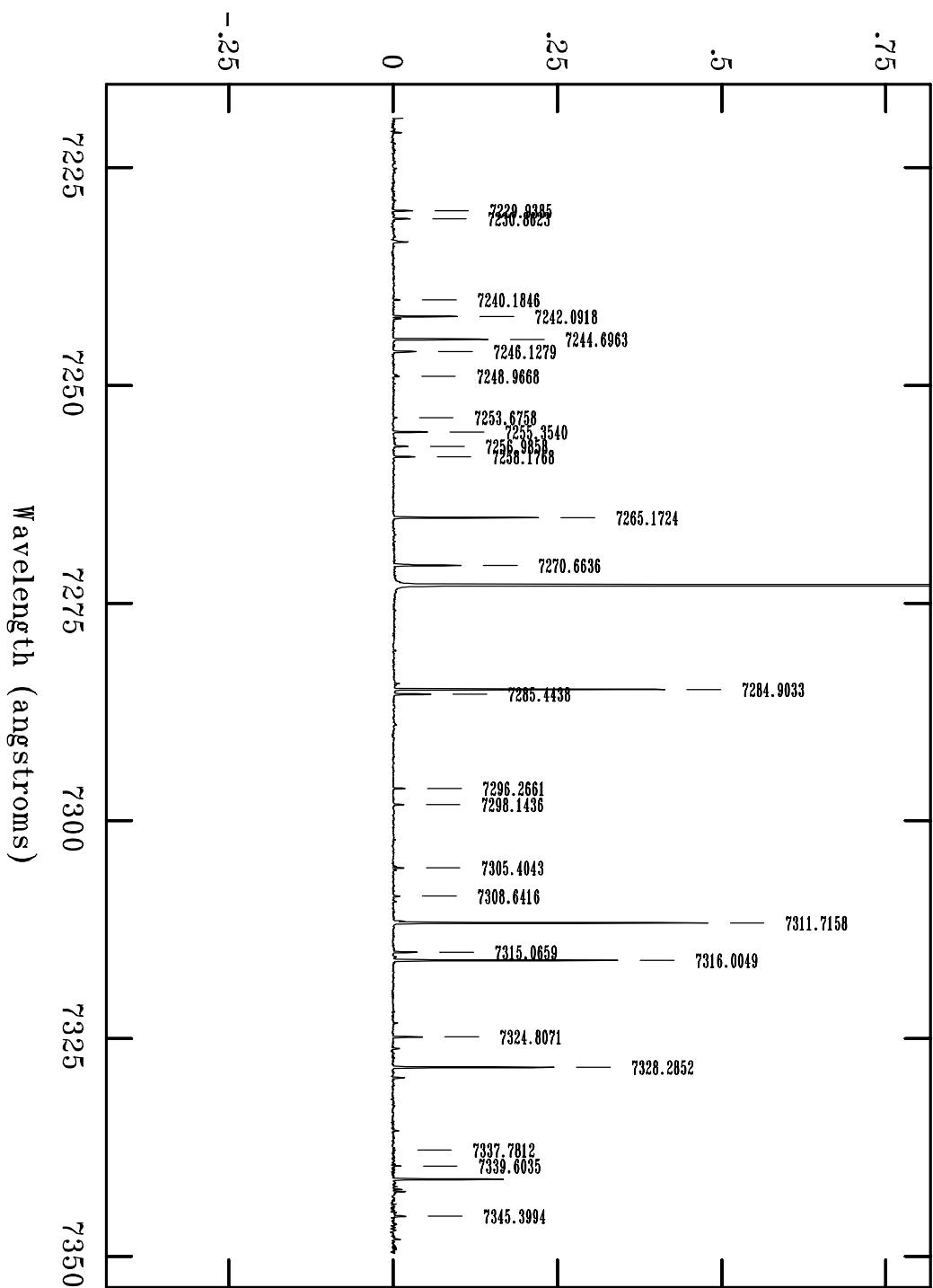


Fig. 12.— order 78

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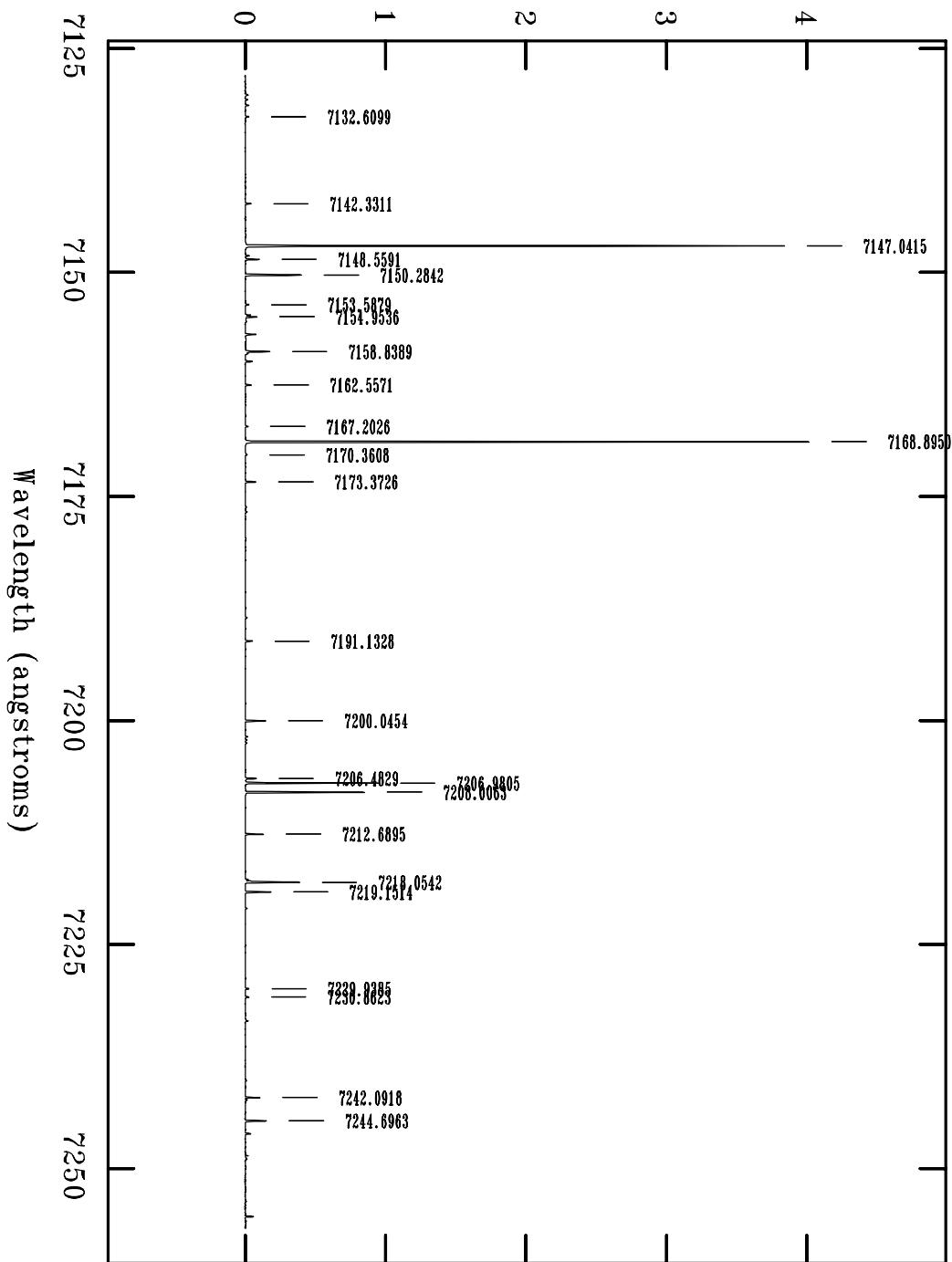


Fig. 13.— order 79

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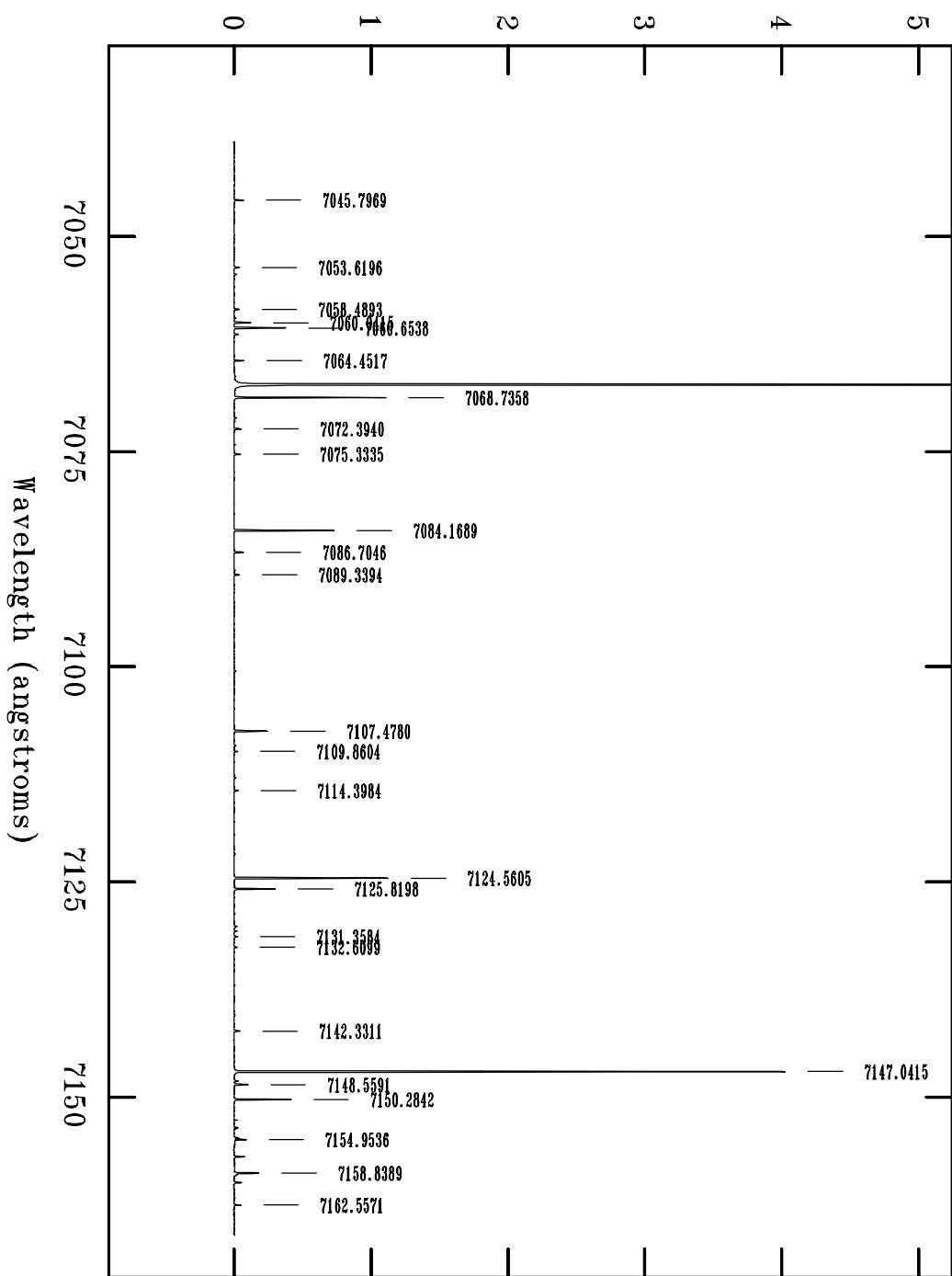


Fig. 14.— order 80

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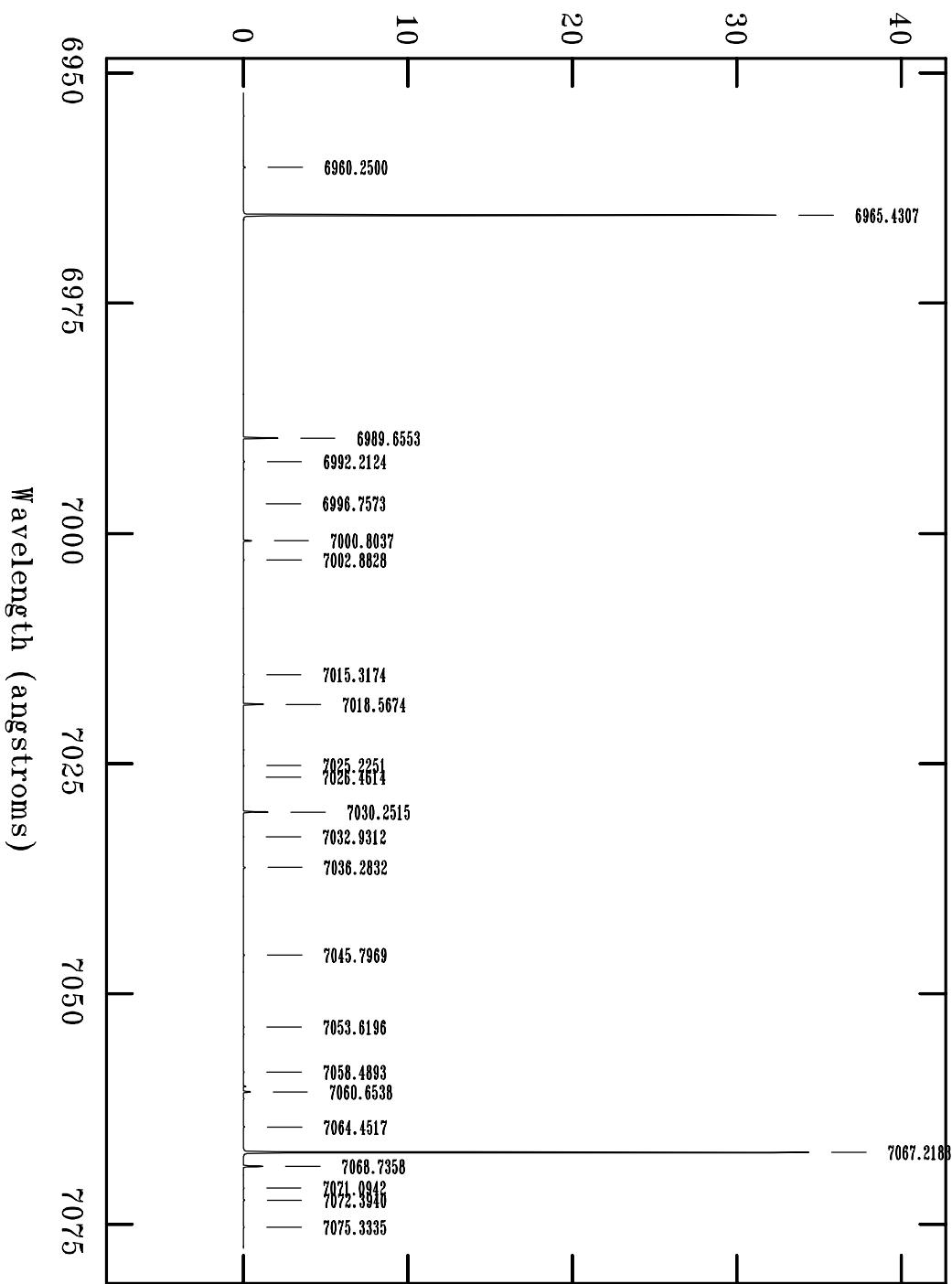


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COMPARISON

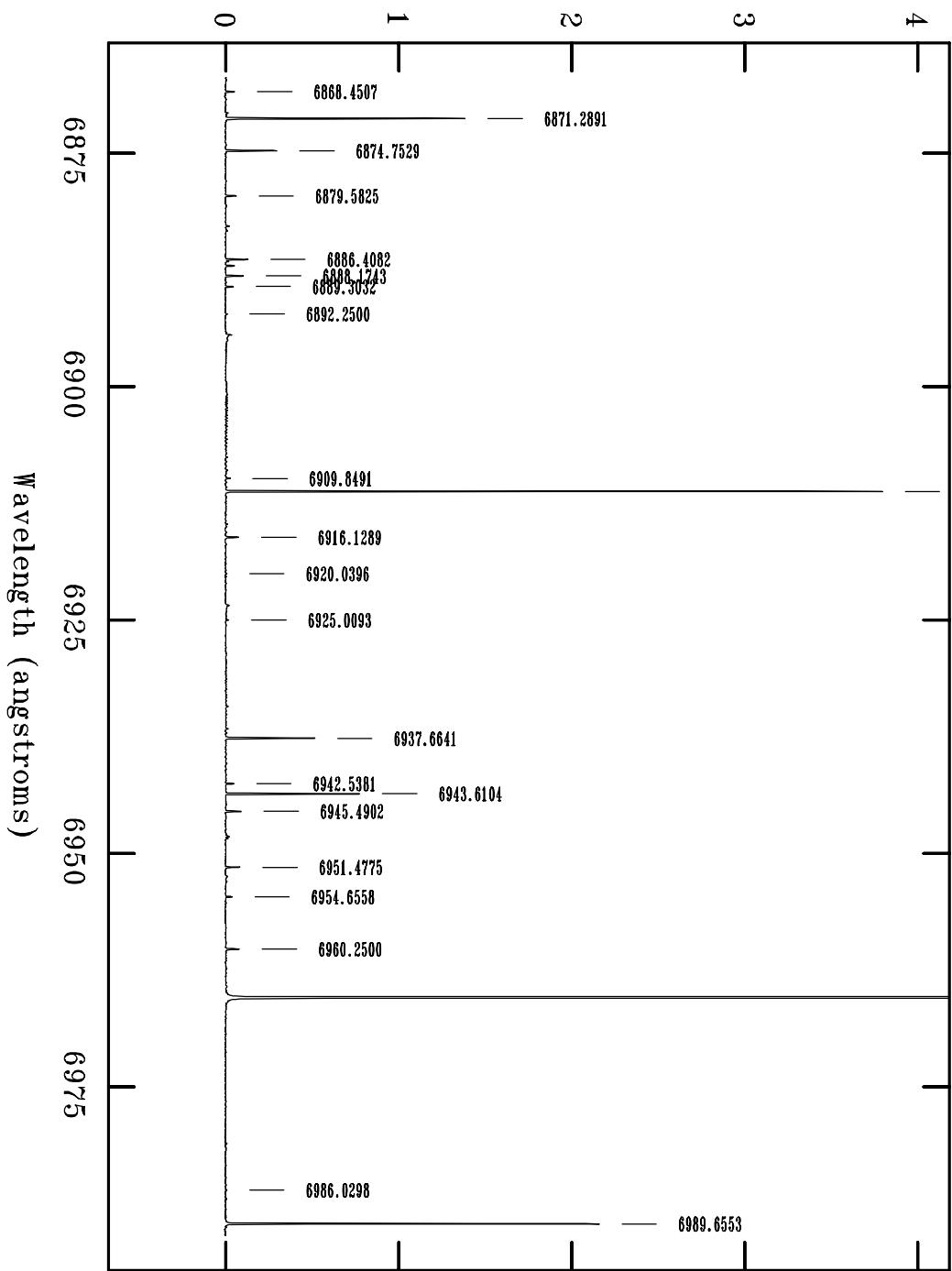


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COMPARISON

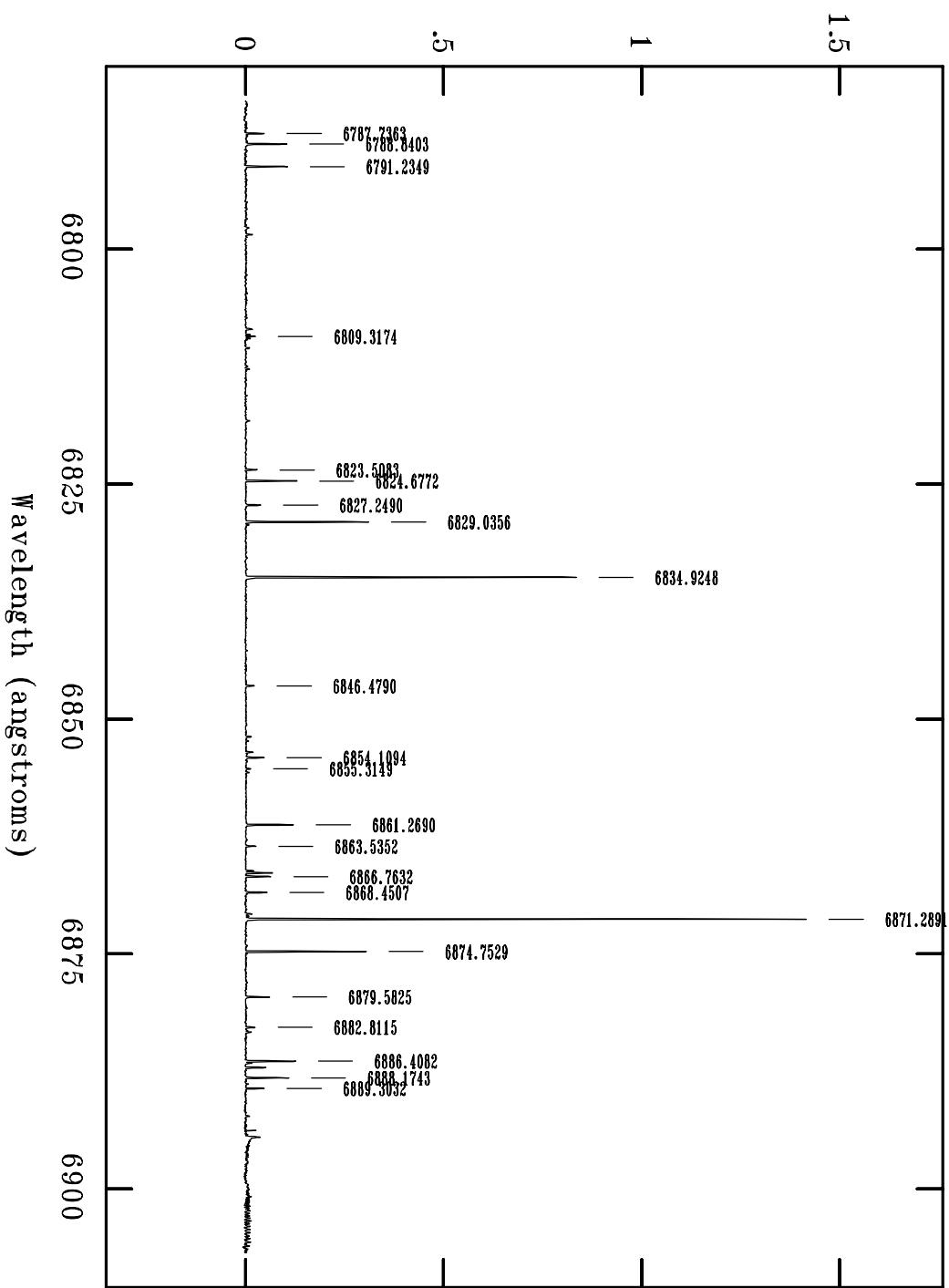


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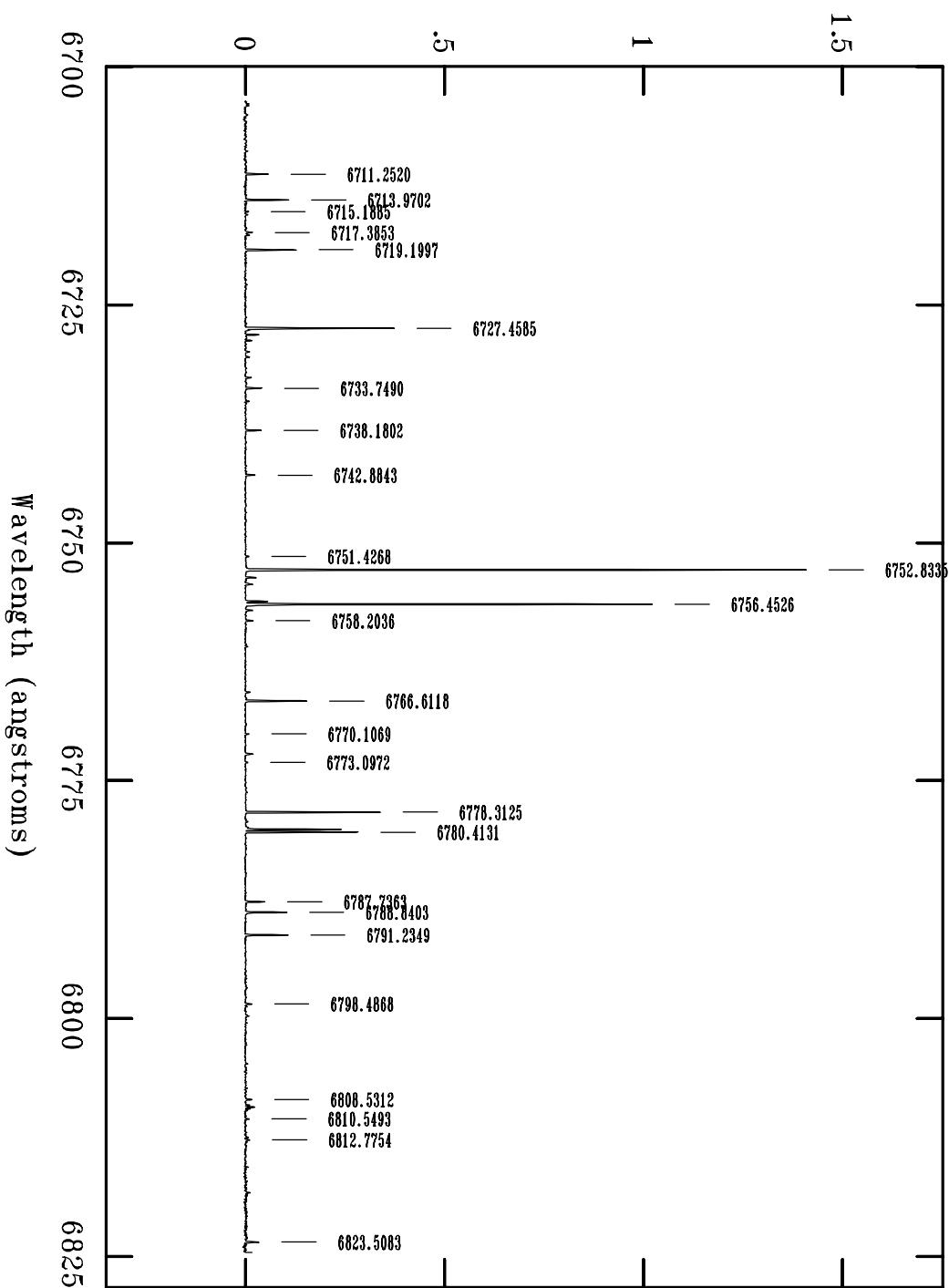


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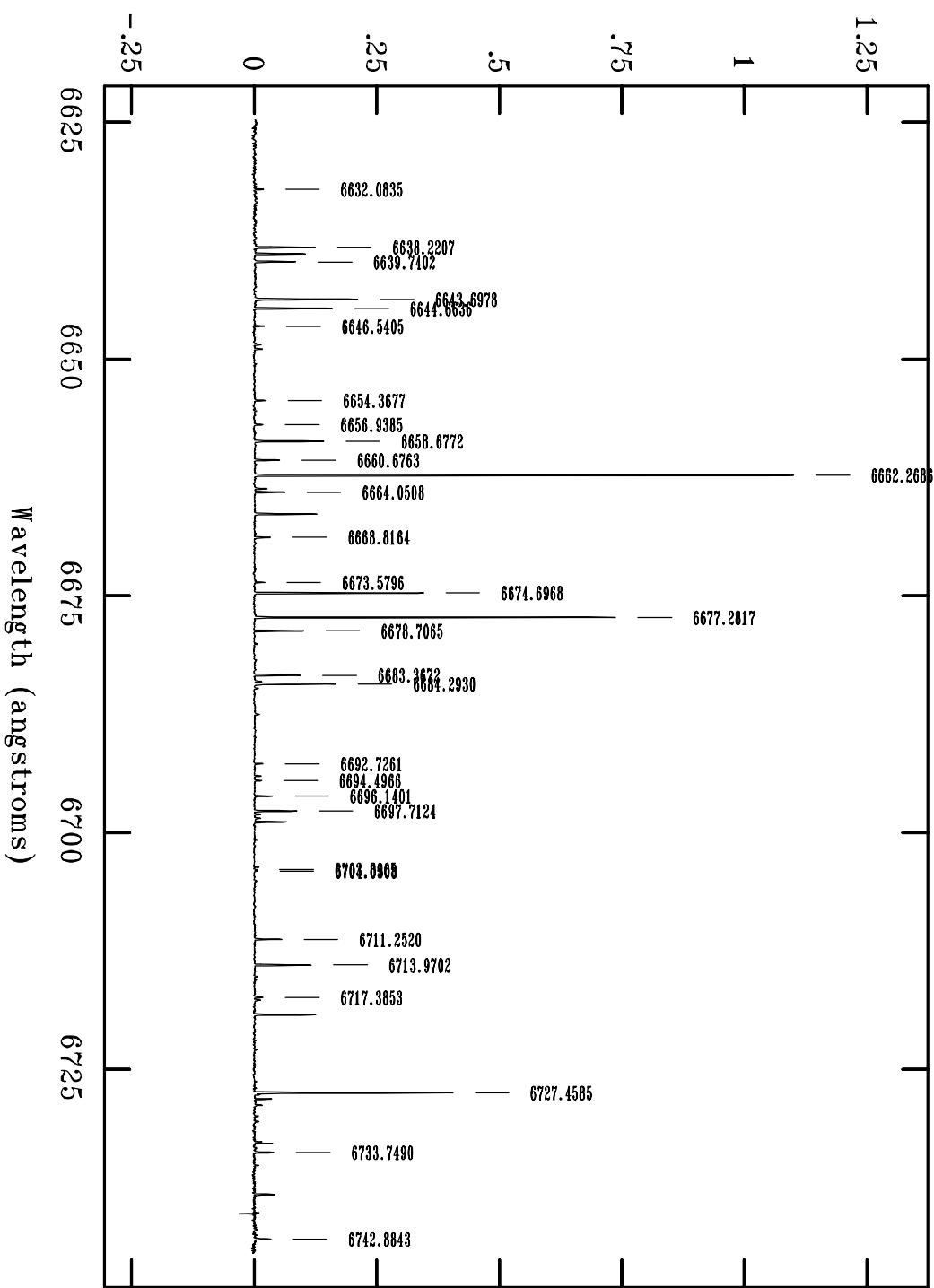


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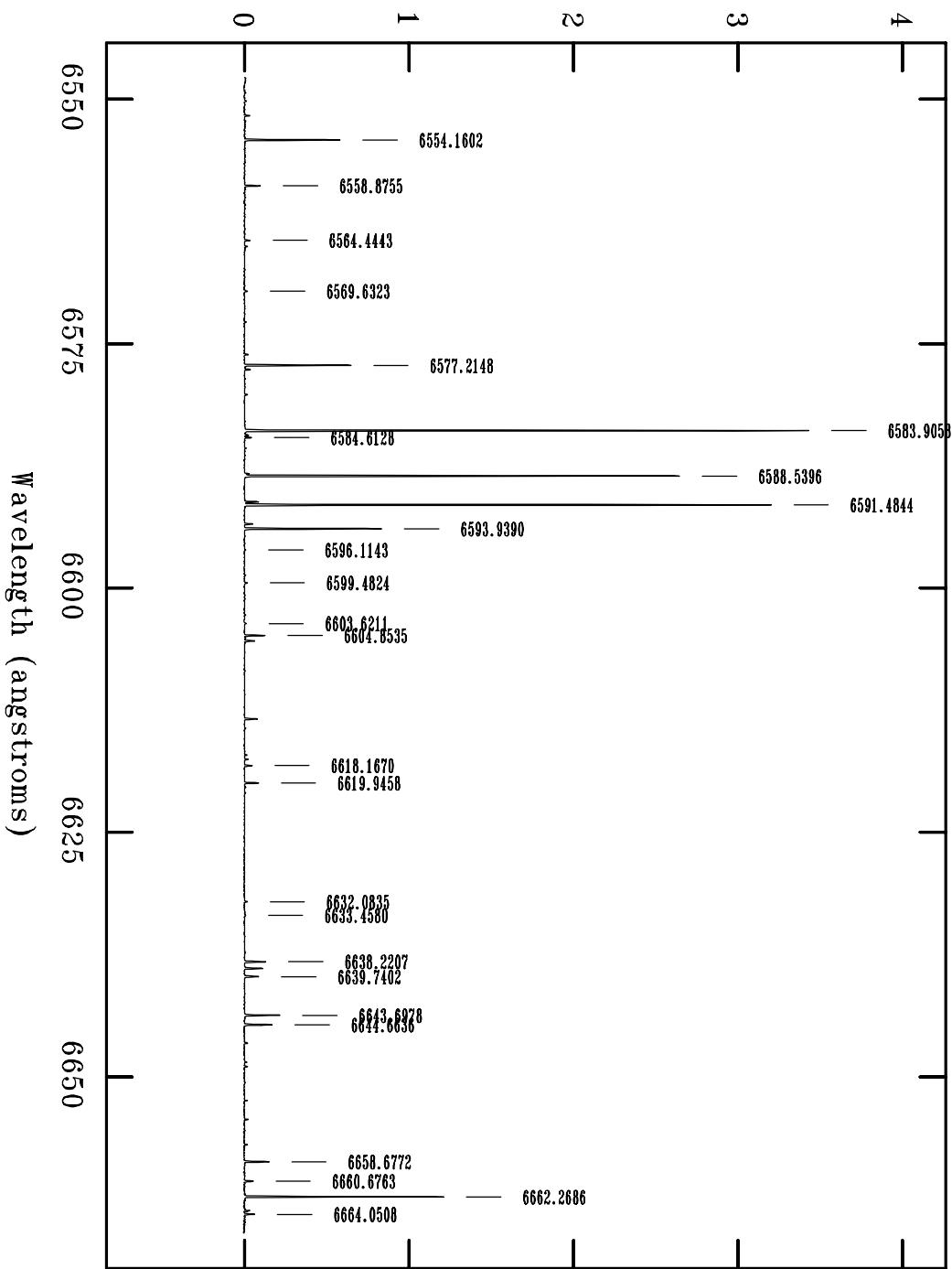


Fig. 20.— order 86

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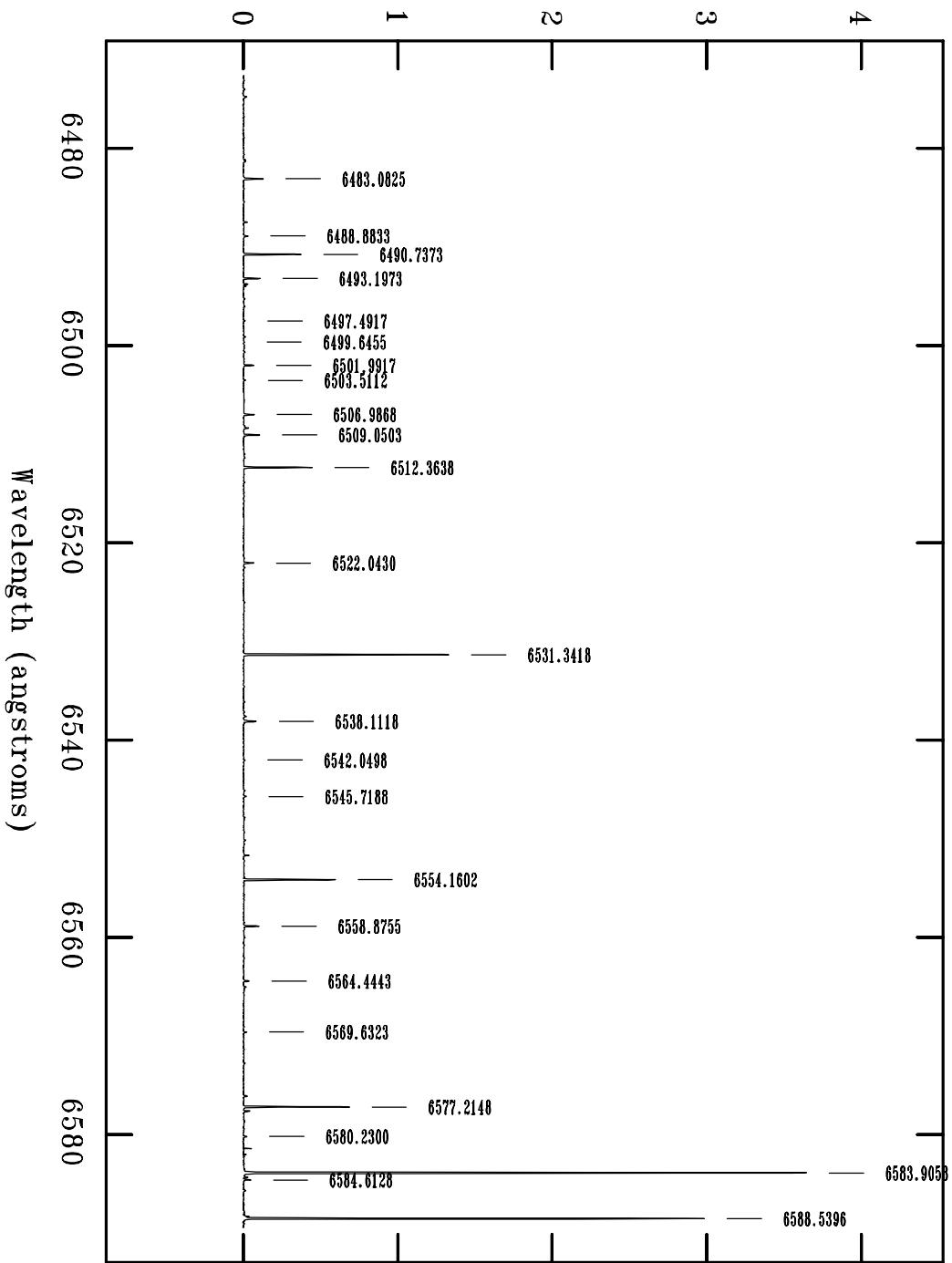


Fig. 21.— order 87

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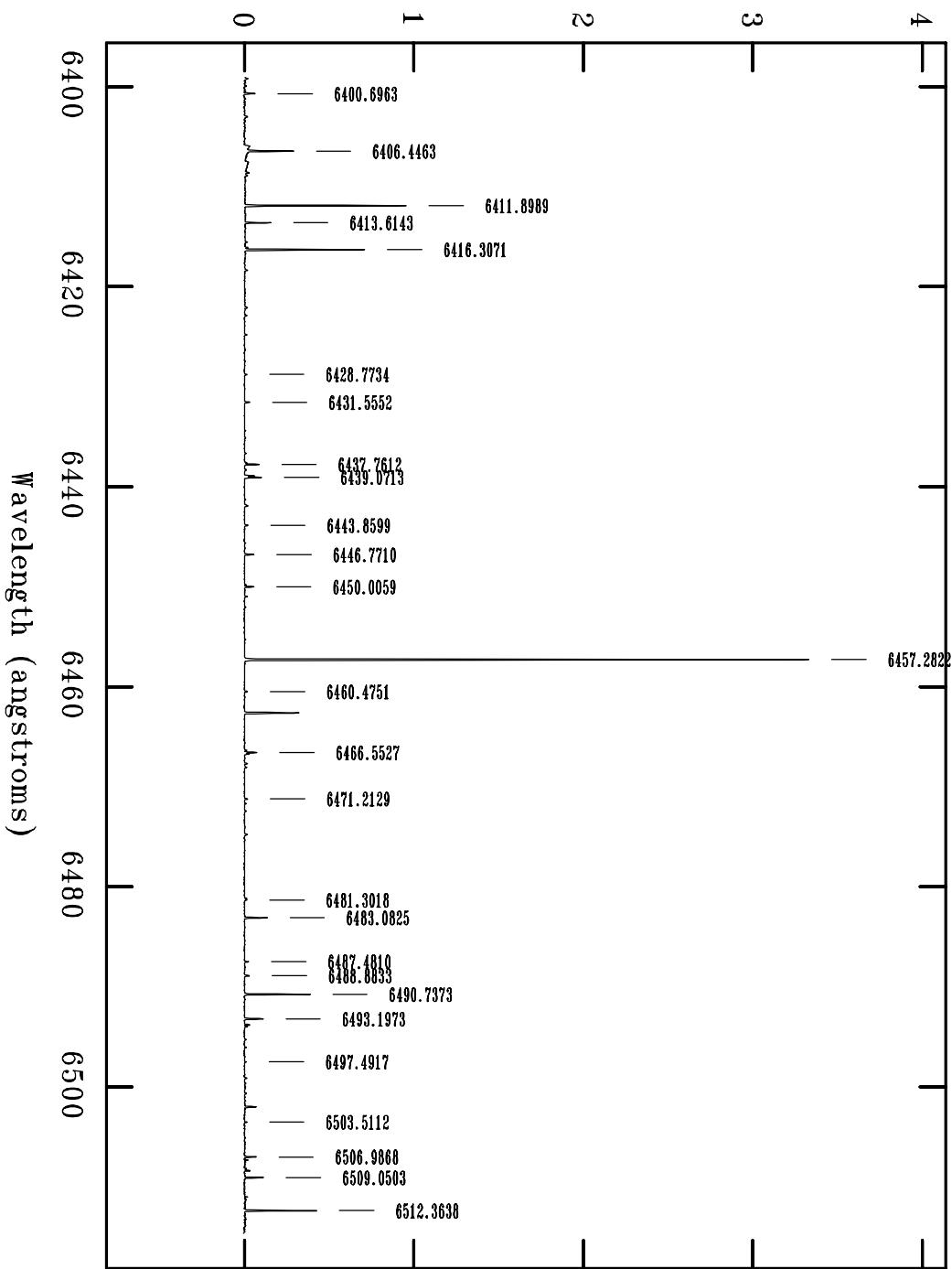


Fig. 22.— order 88

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COMPARISON

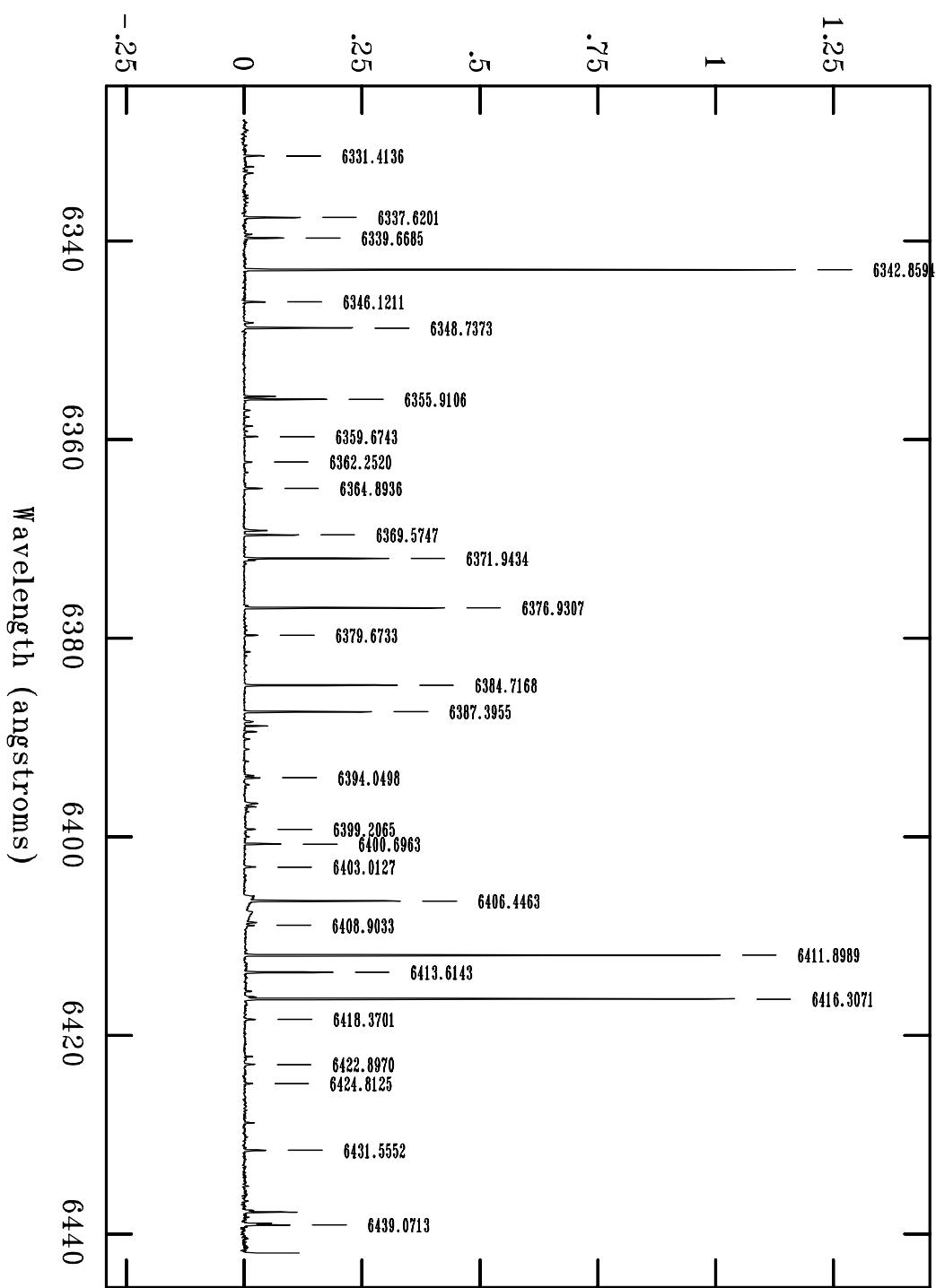


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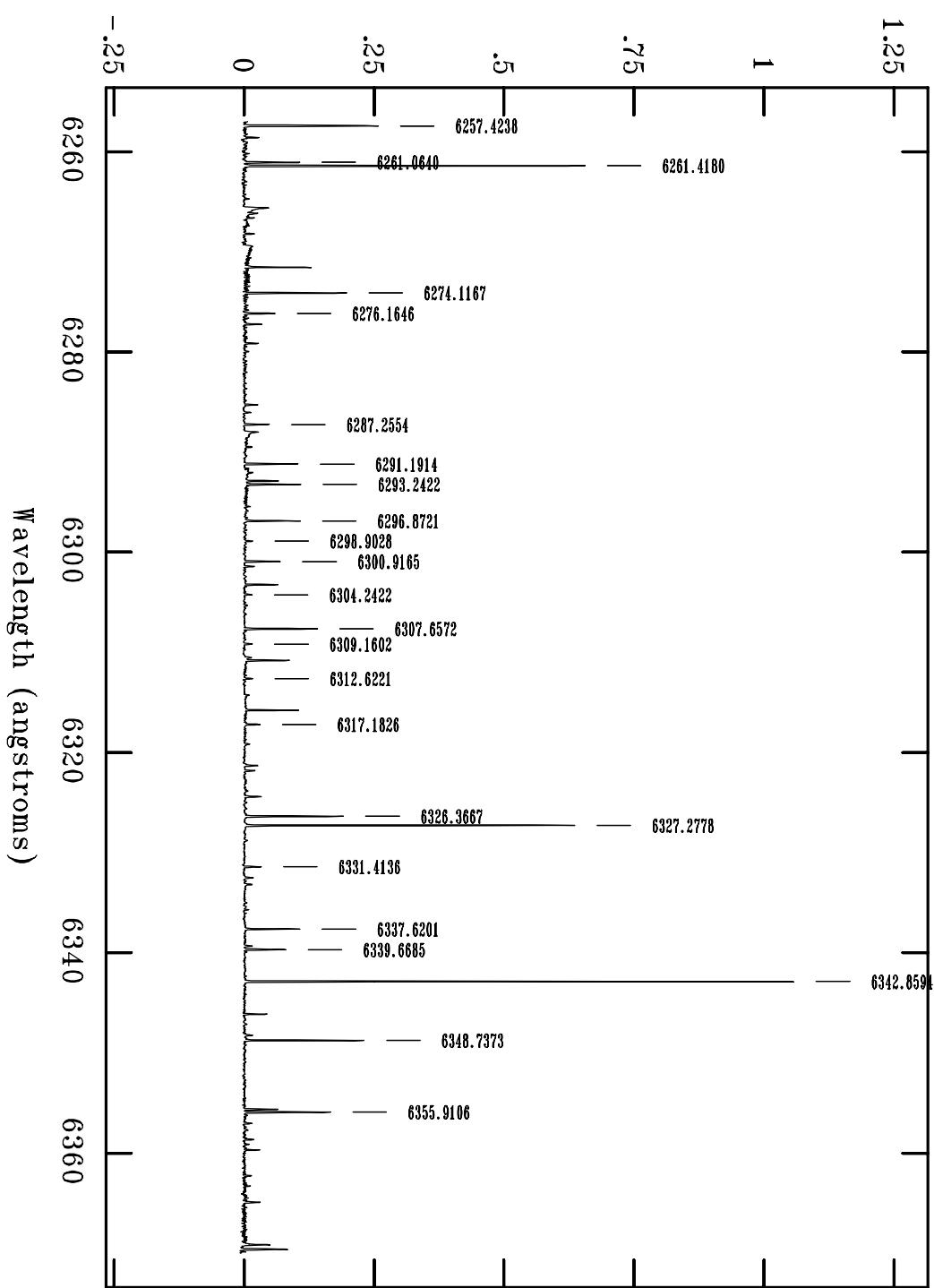


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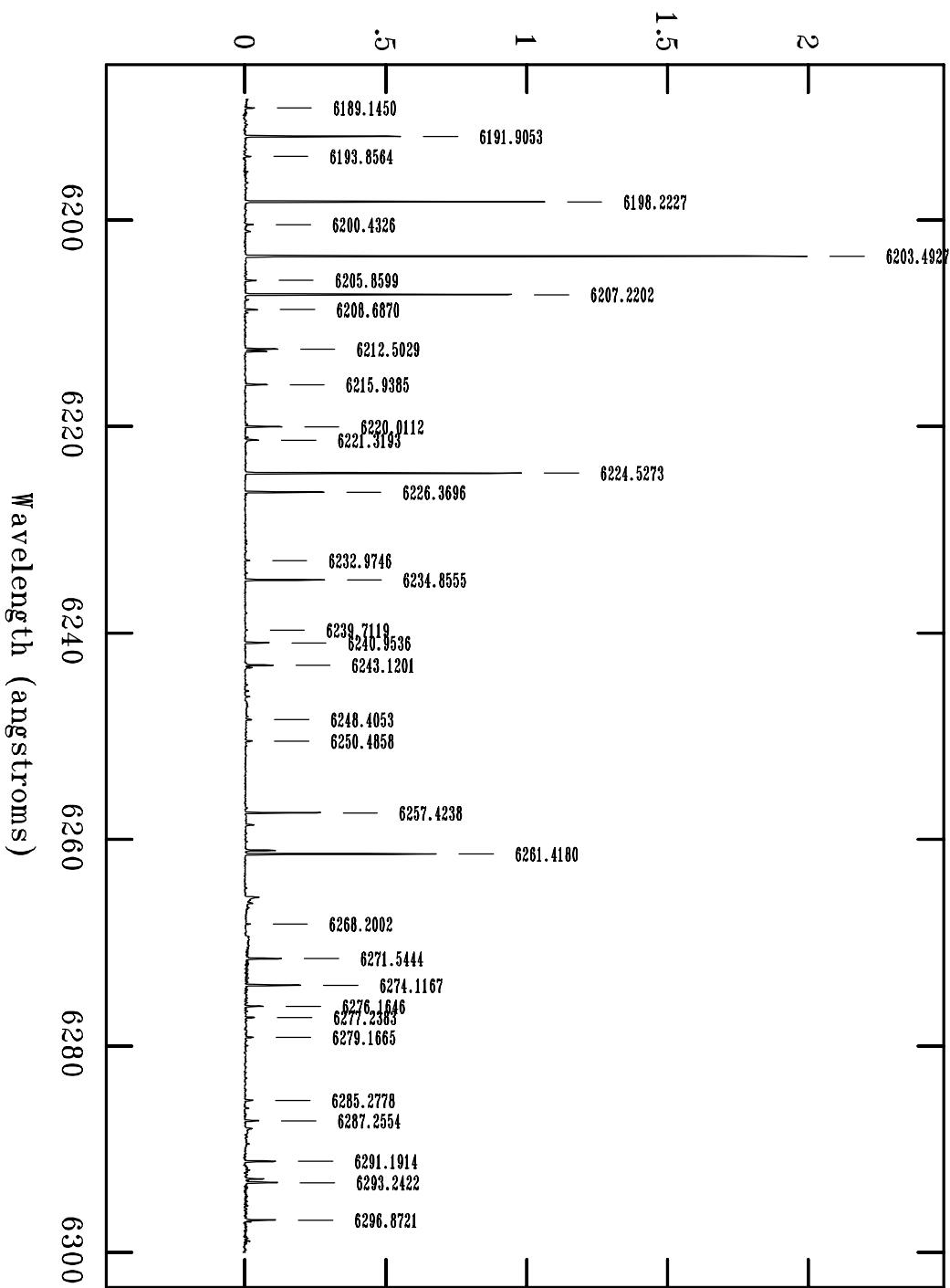


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COMPARISON

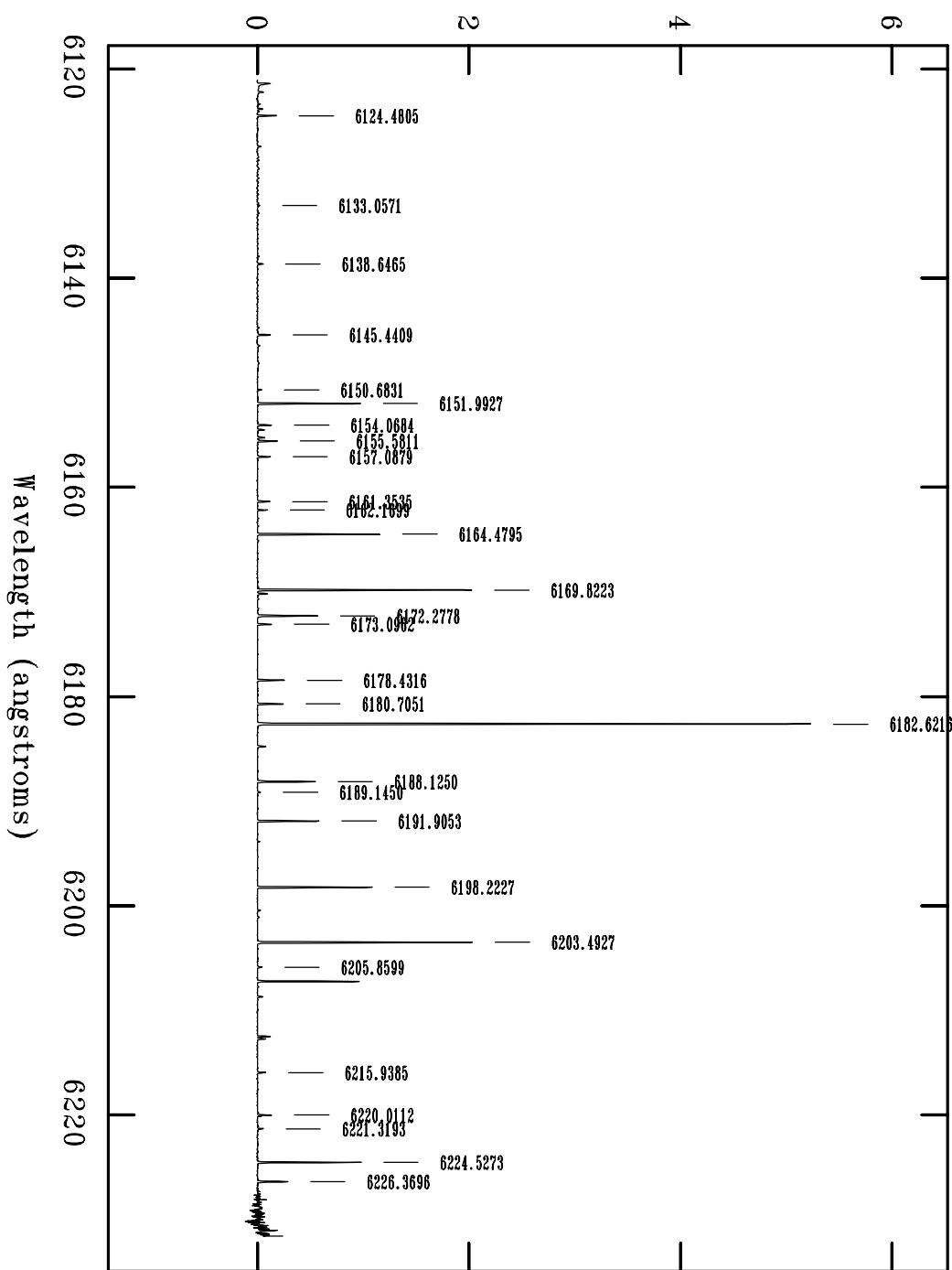


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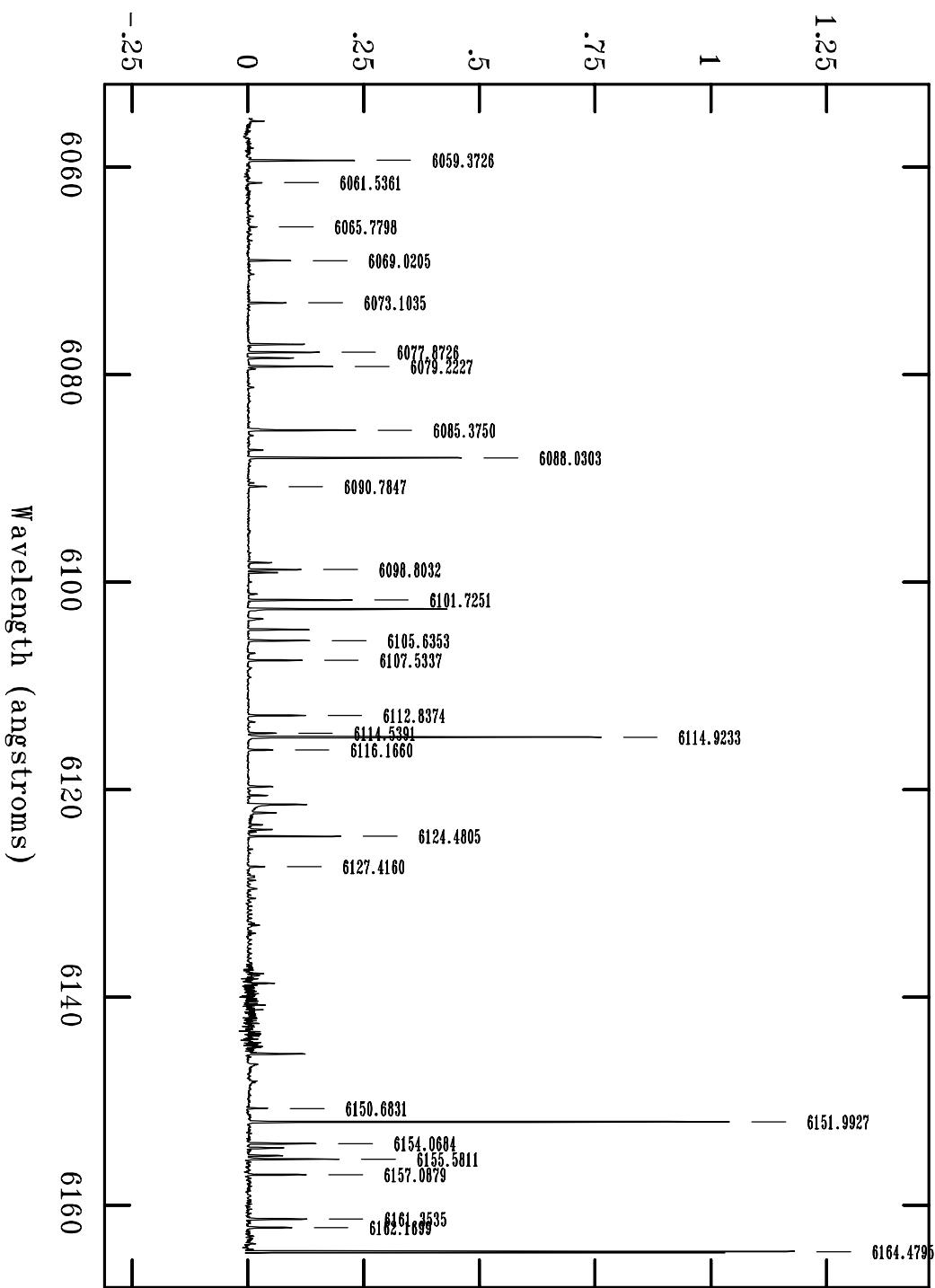


Fig. 27.— order 93

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COMPARISON

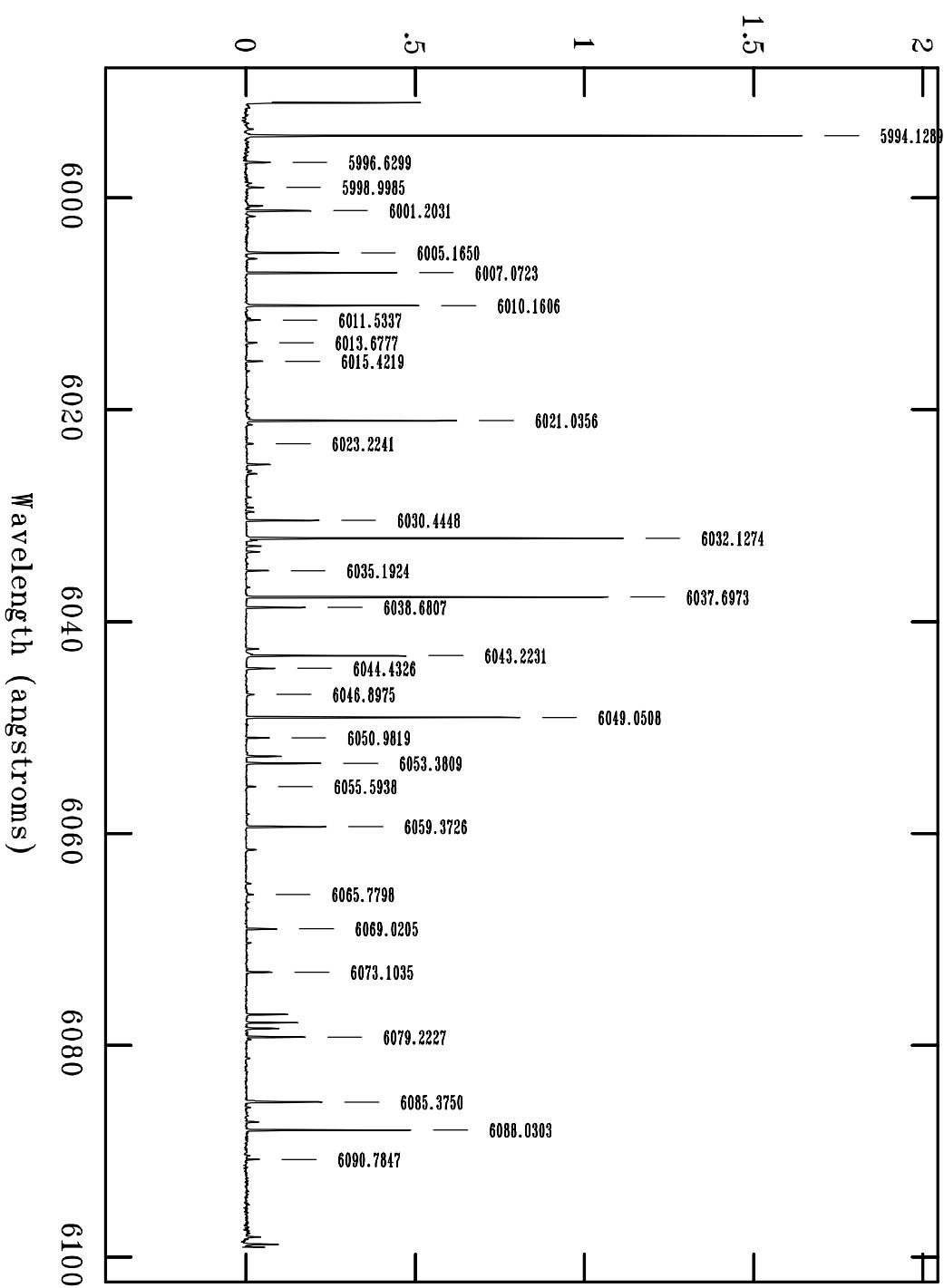


Fig. 28.— order 94

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COMPARISON

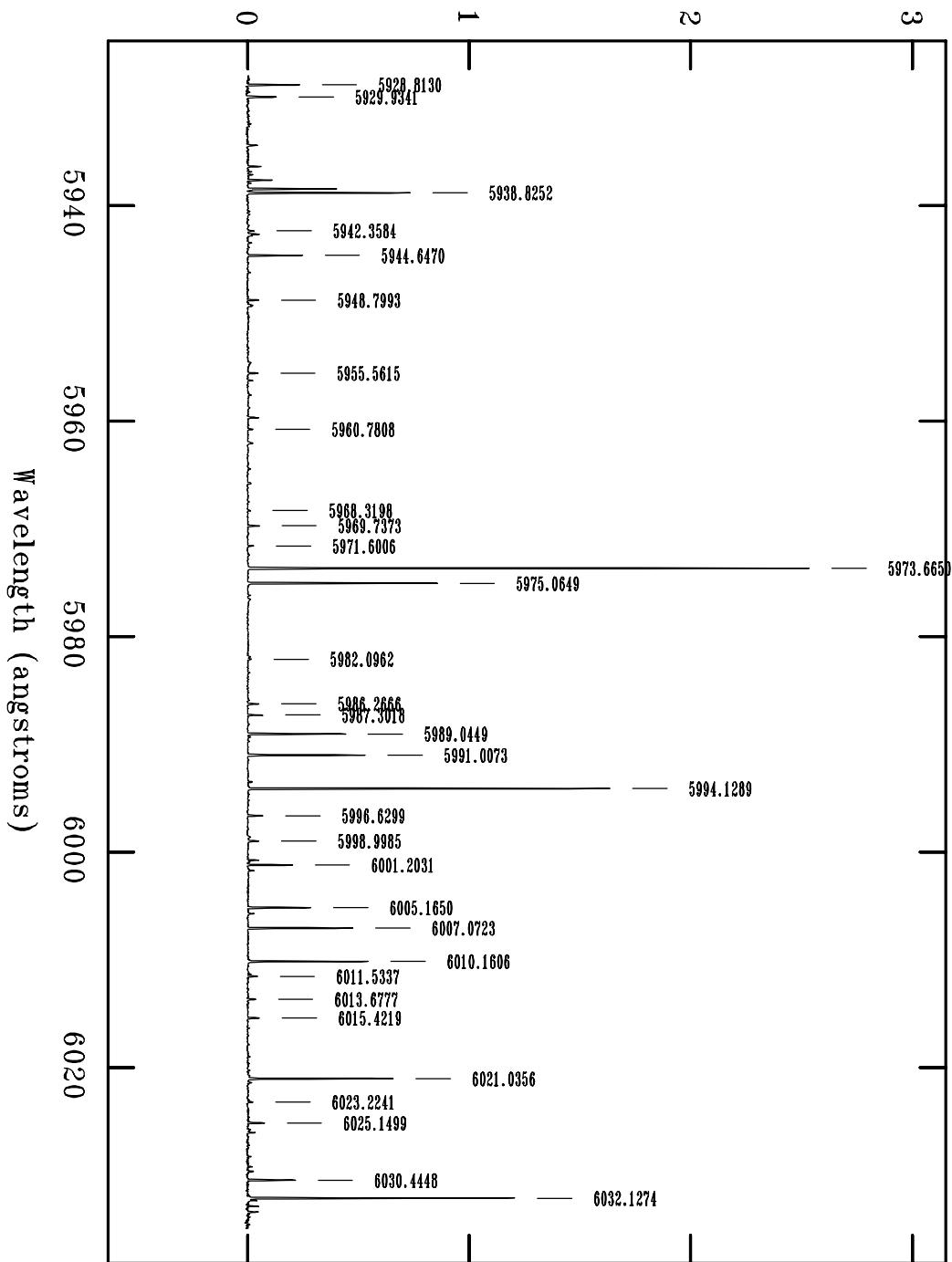


Fig. 29.— order 95

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COMPARISON

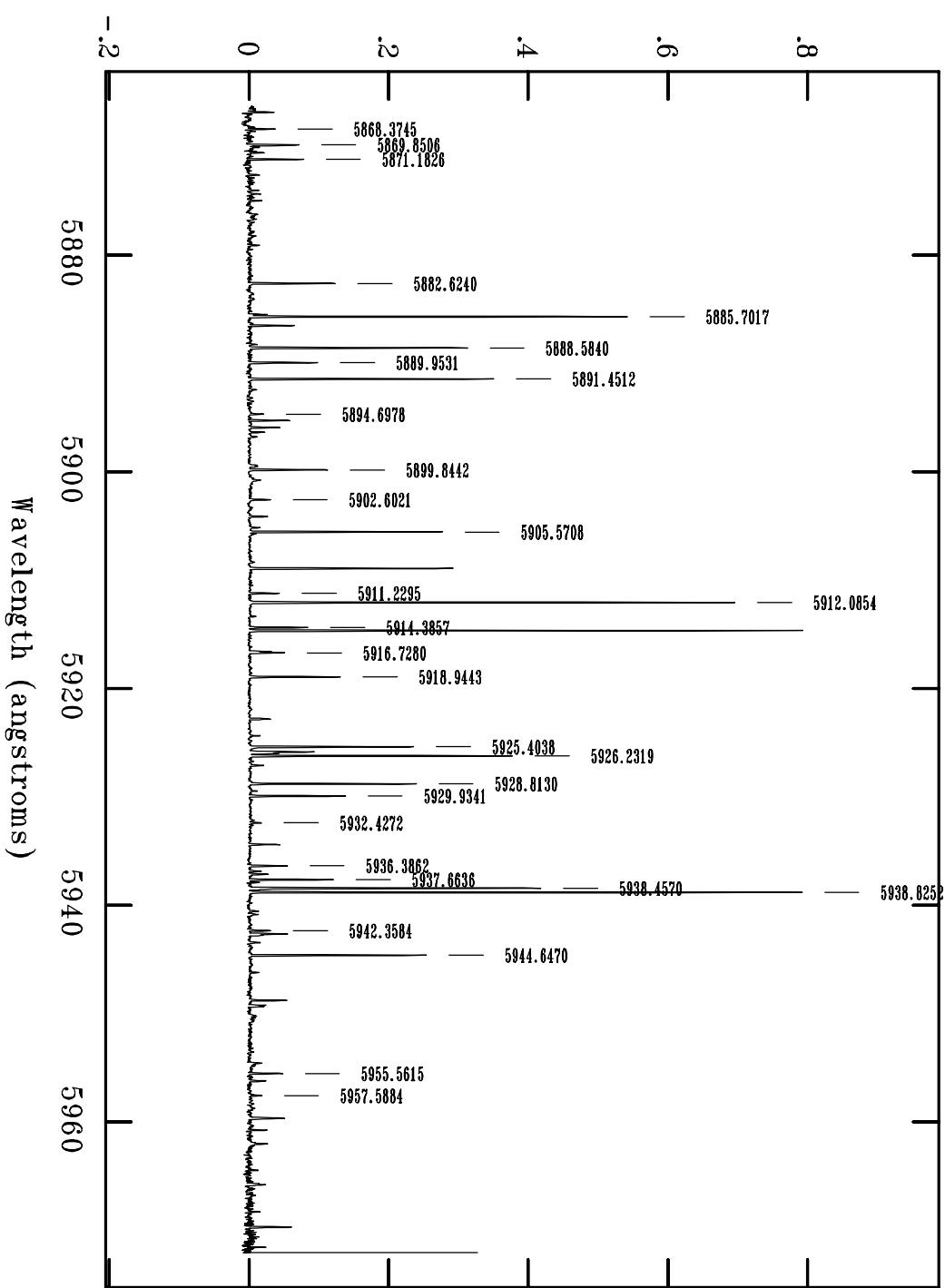


Fig. 30.— order 96

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COMPARISON

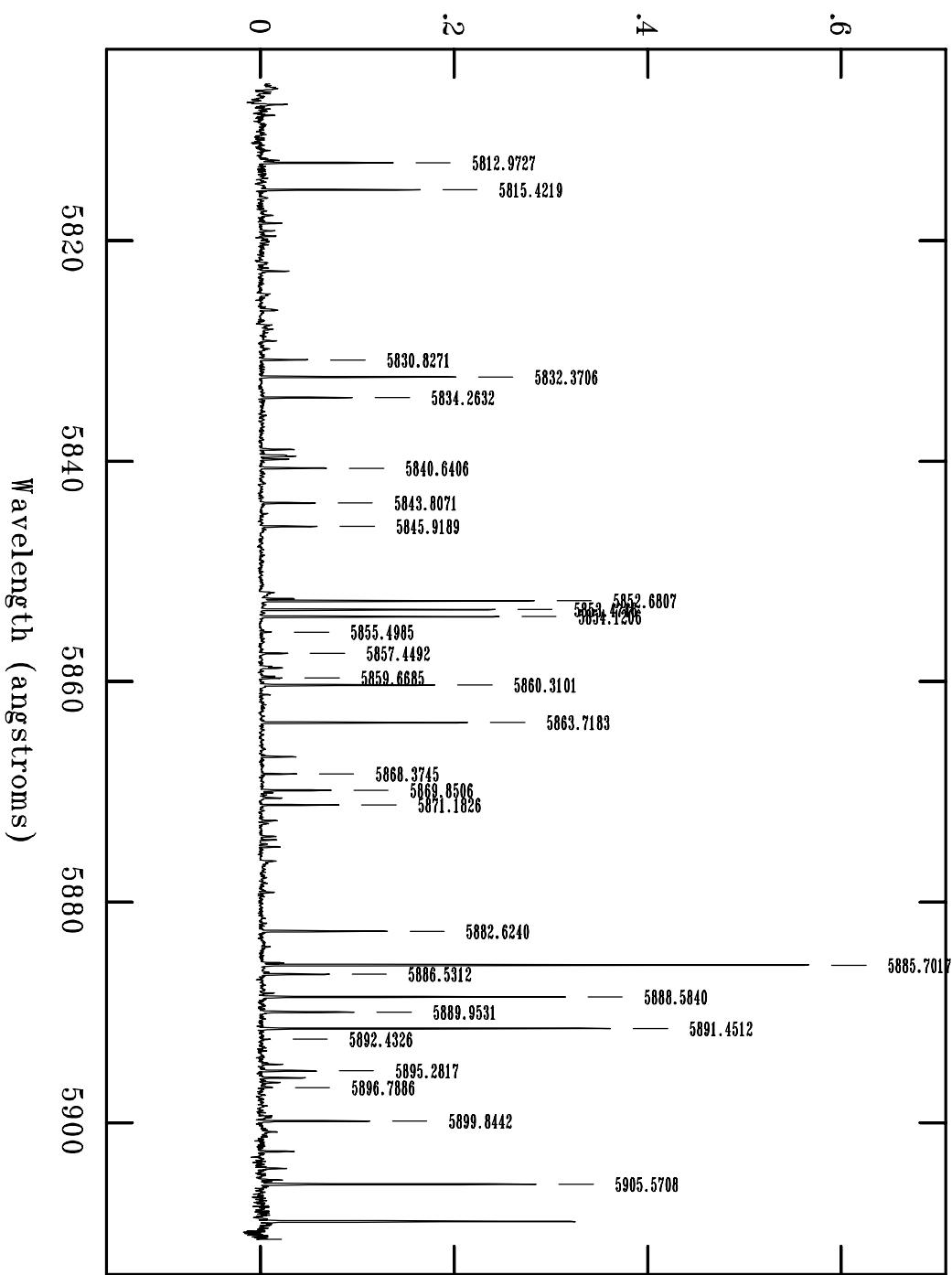


Fig. 31.— order 97

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COMPARISON

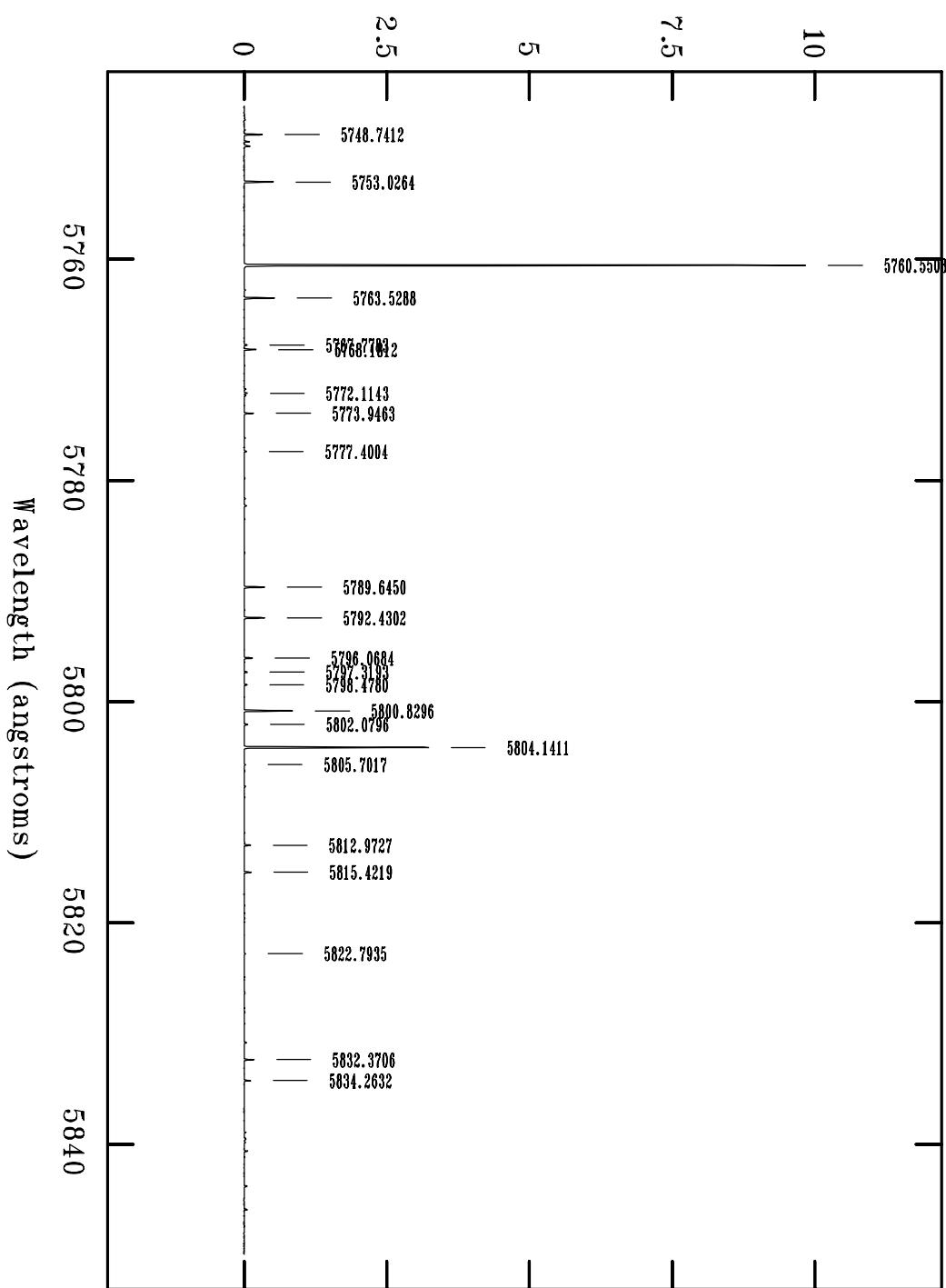


Fig. 32.— order 98

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COMPARISON

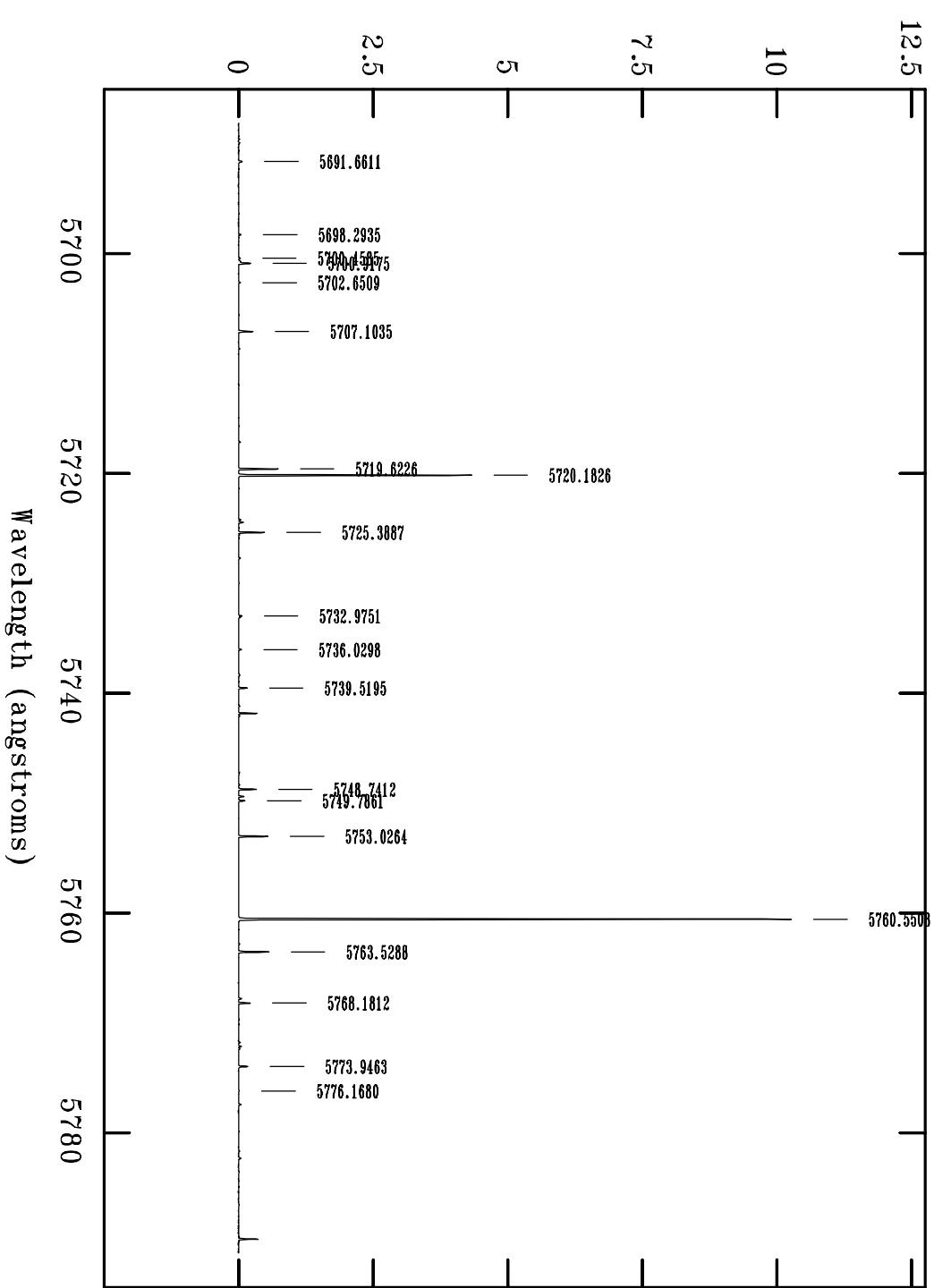


Fig. 33.— order 99

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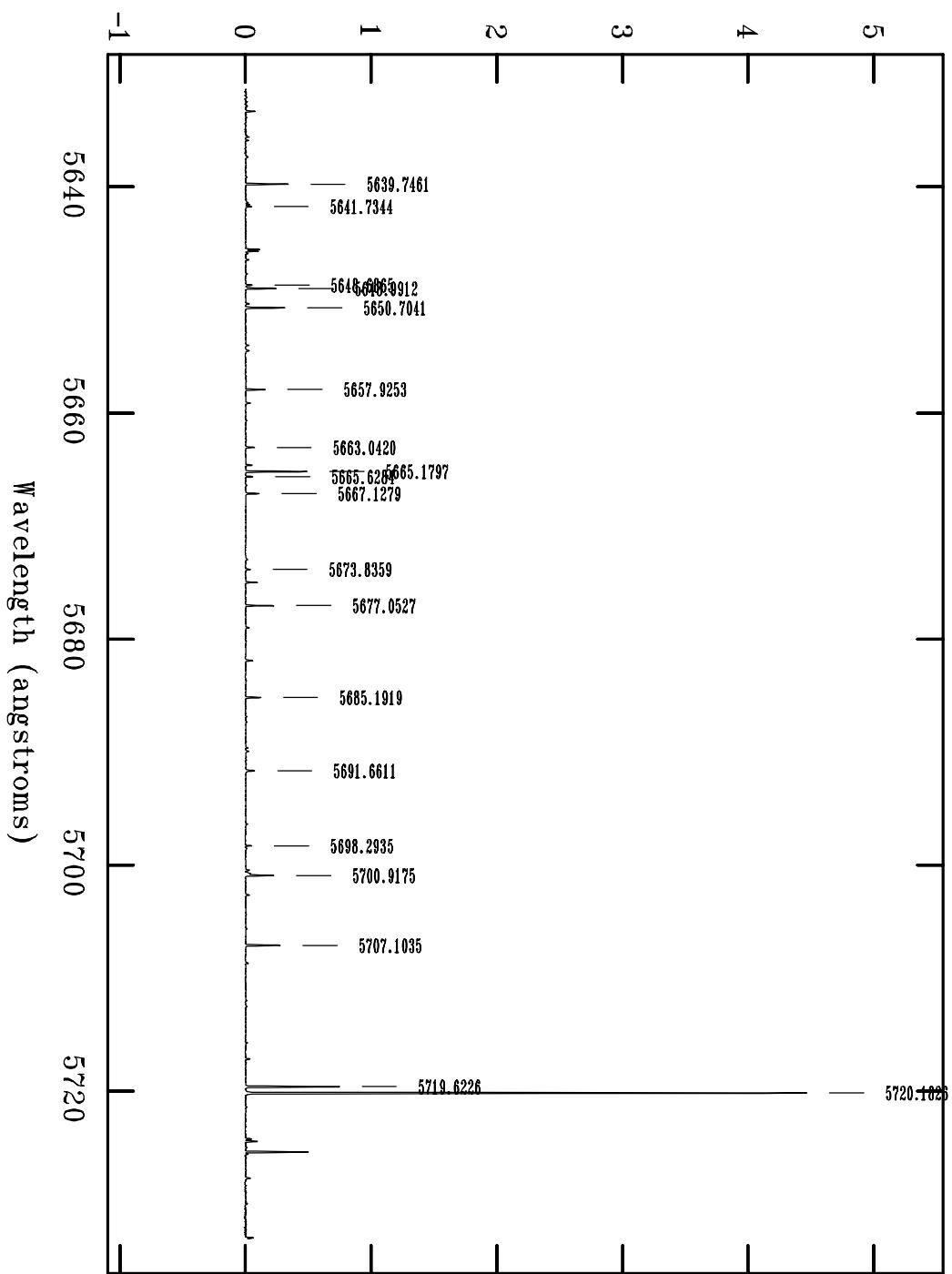


Fig. 34.— order 100

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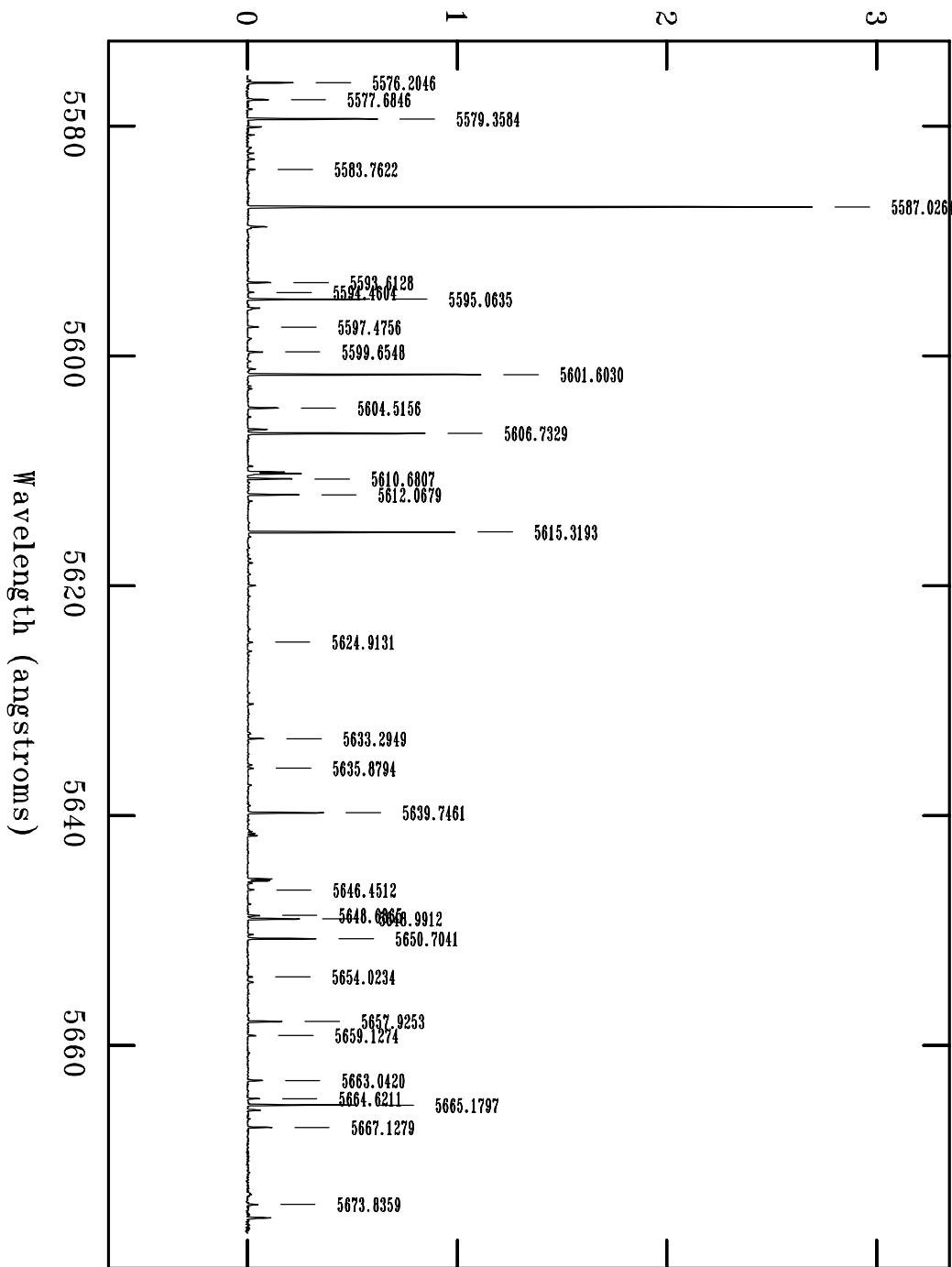


Fig. 35.— order 101

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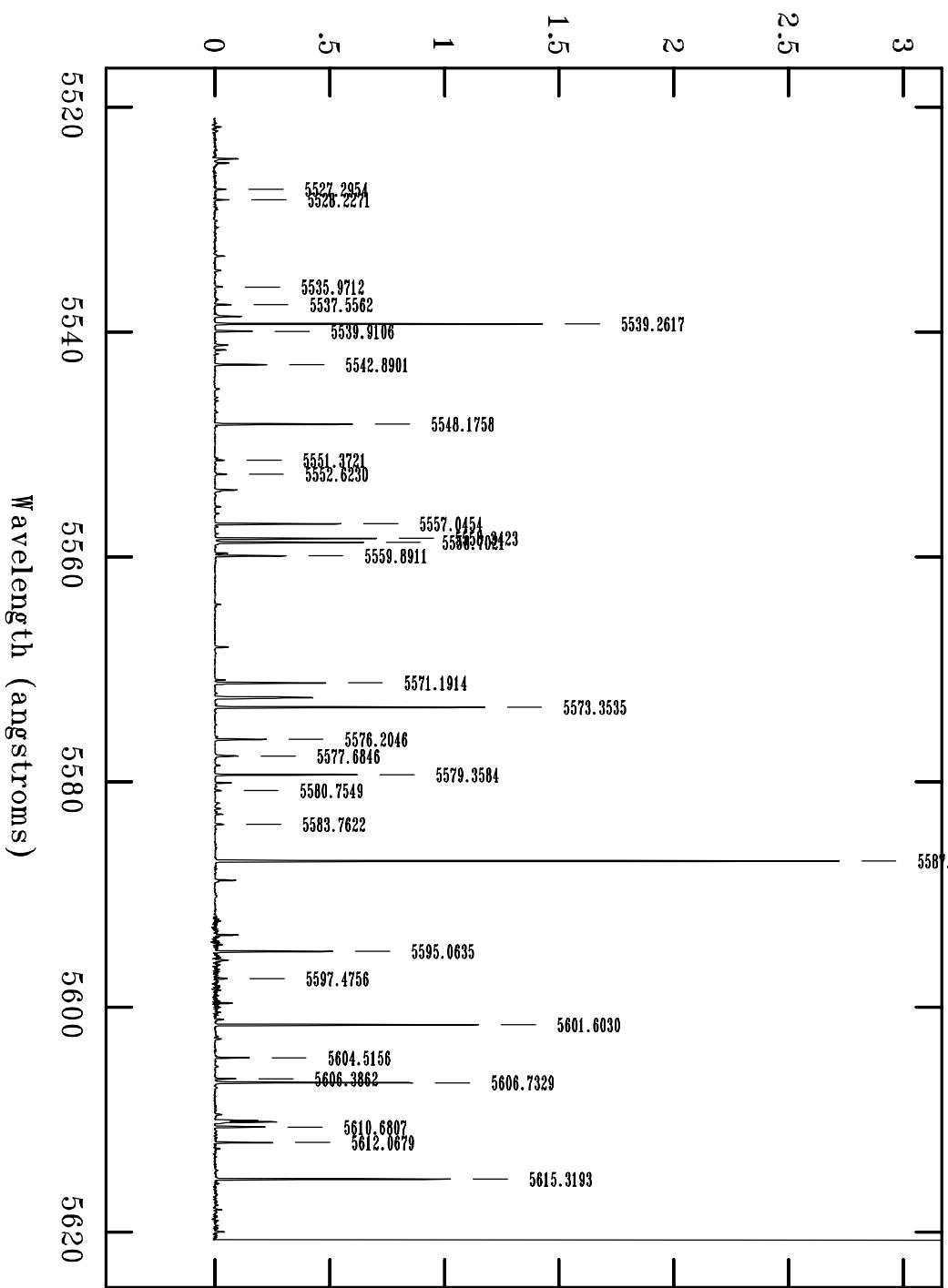


Fig. 36.— order 102

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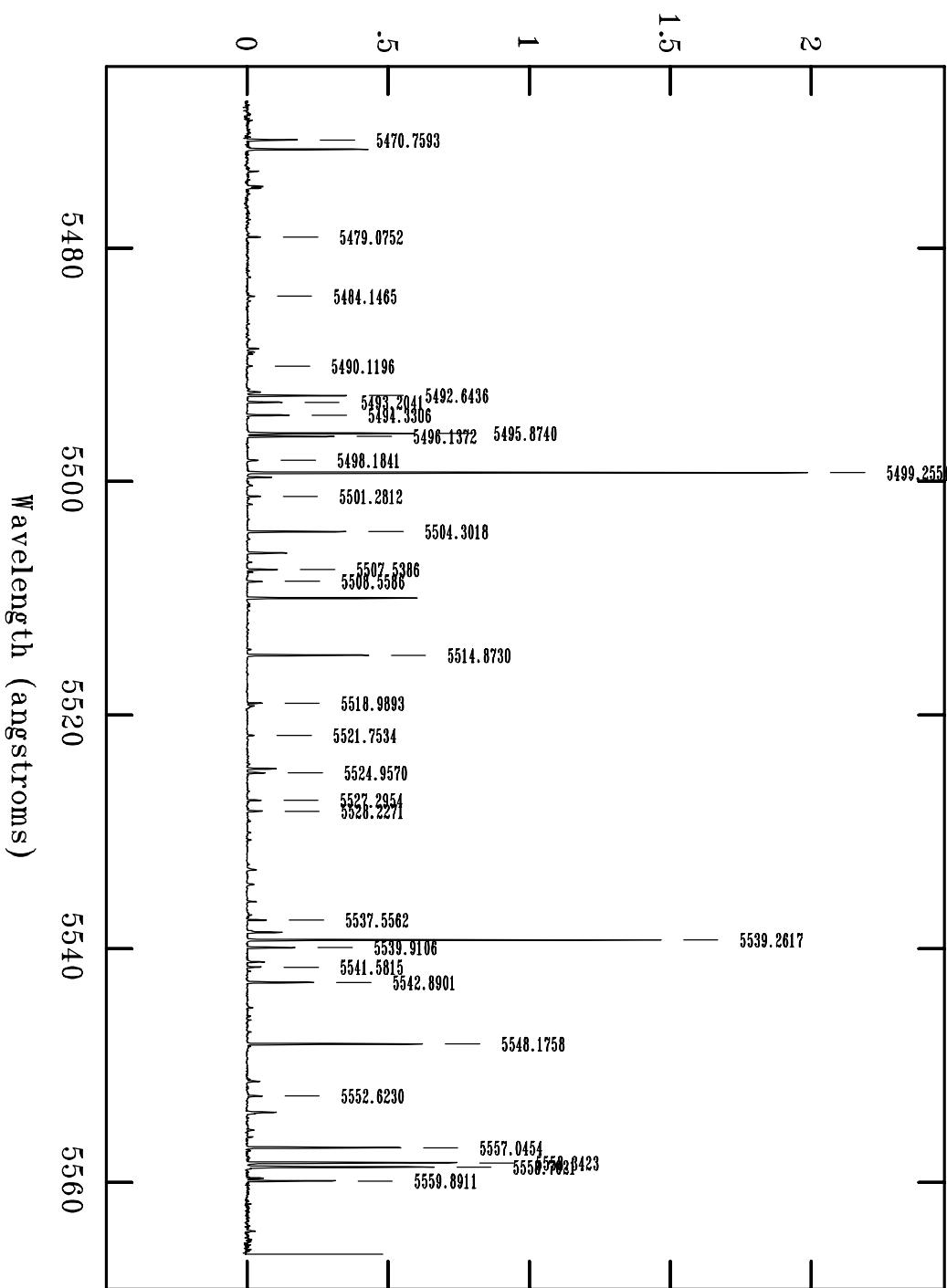


Fig. 37.— order 103

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COMPARISON

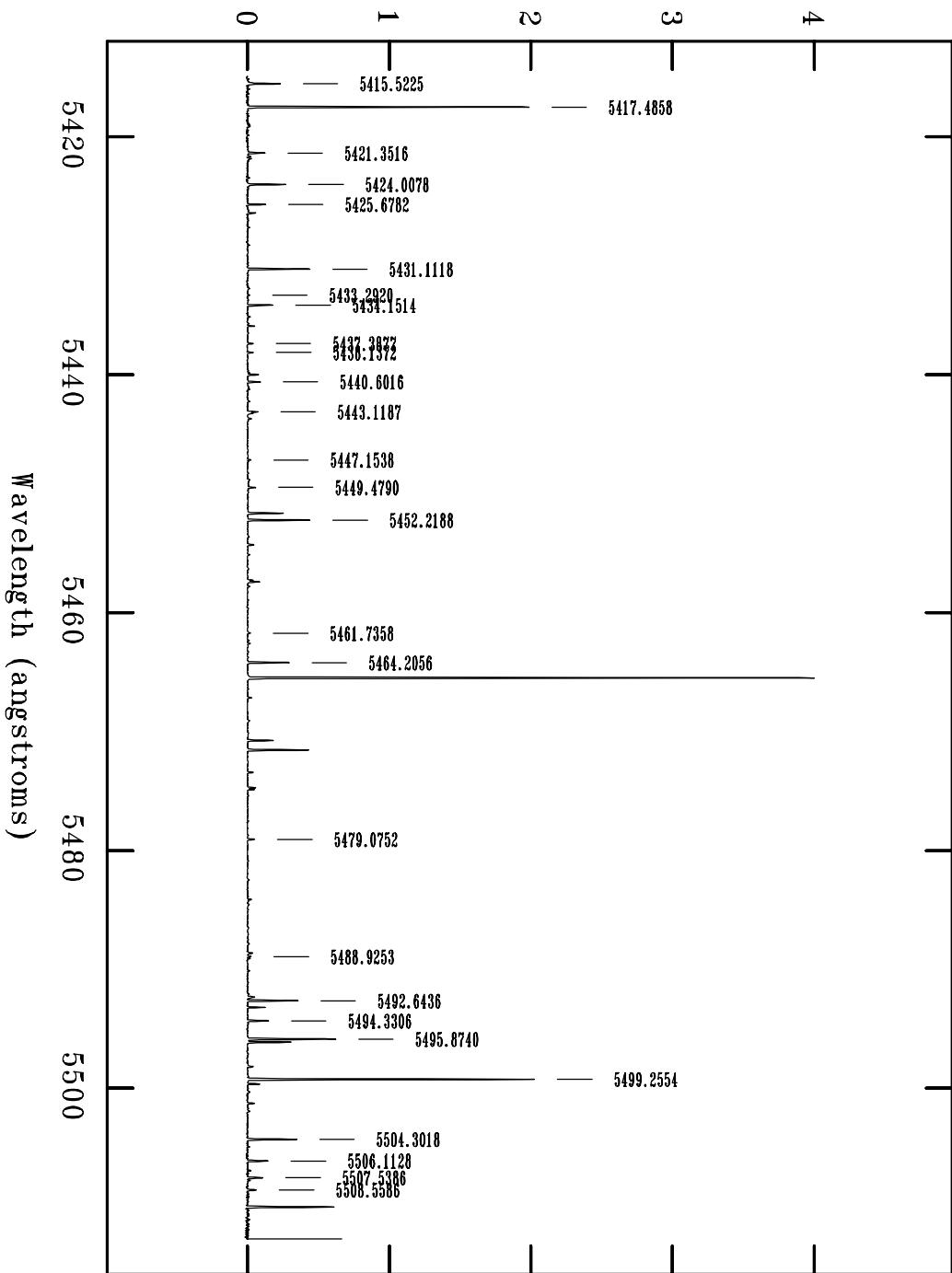


Fig. 38.— order 104

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 02:50:21 24-  
identify comp.90\_107.ap.0017 - Ap 17  
COMPARISON

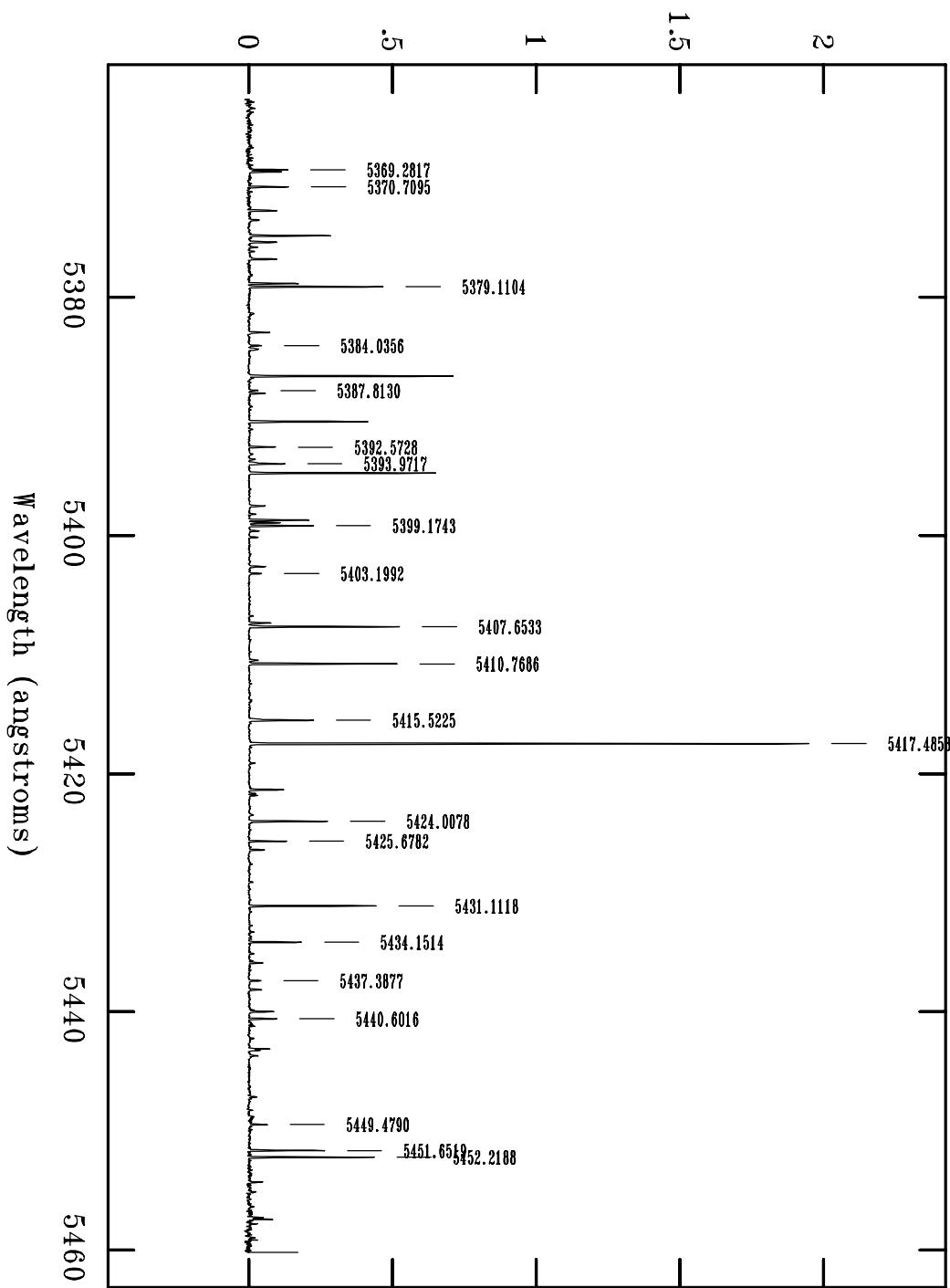


Fig. 39.— order 105

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 03:00:04 24-  
identify comp.90\_107.ap.0018 - Ap 18  
COMPARISON

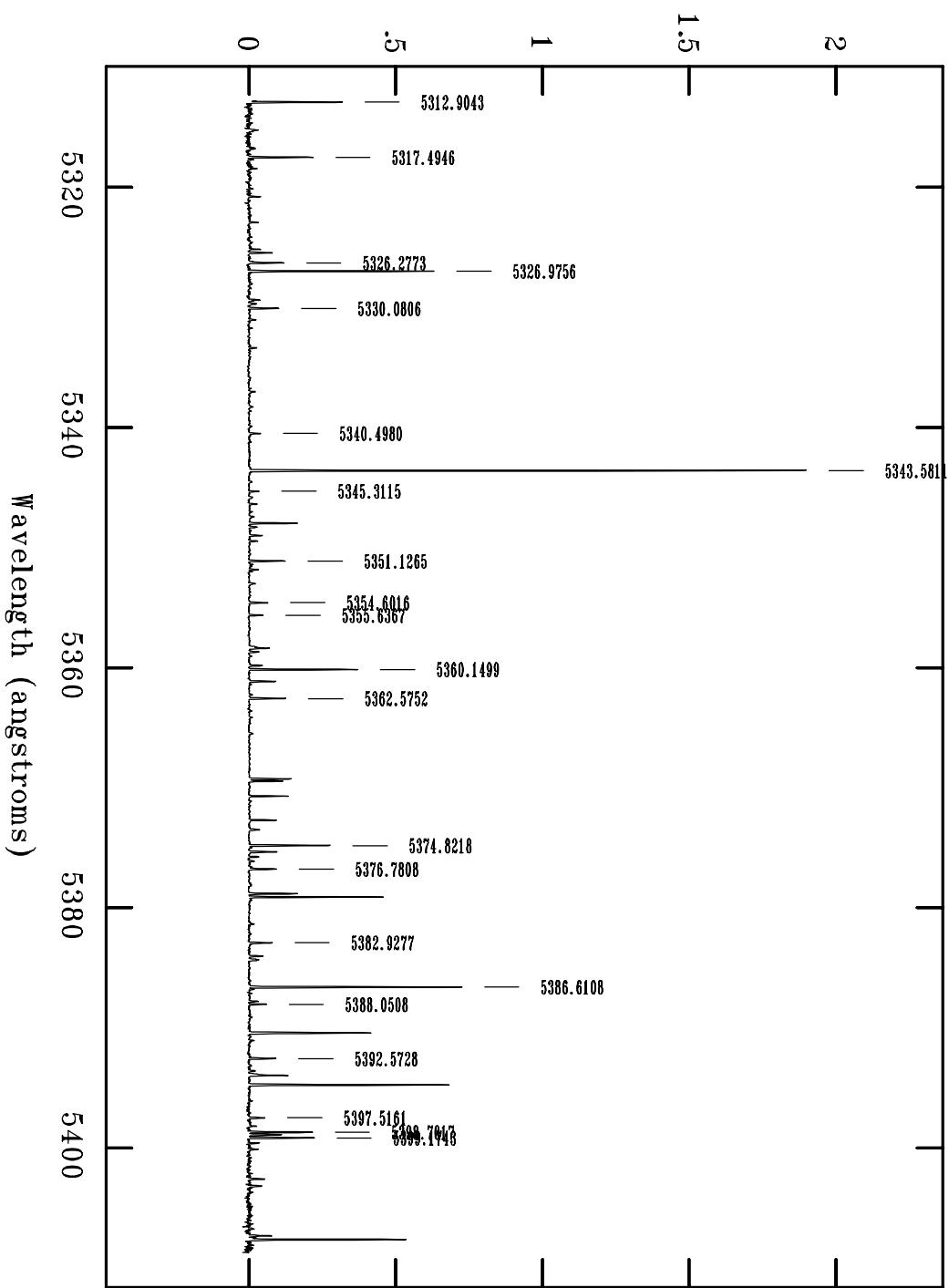


Fig. 40.— order 106

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 03:07:26 24-  
identify comp.90\_107.ap.0019 - Ap 19  
COMPARISON

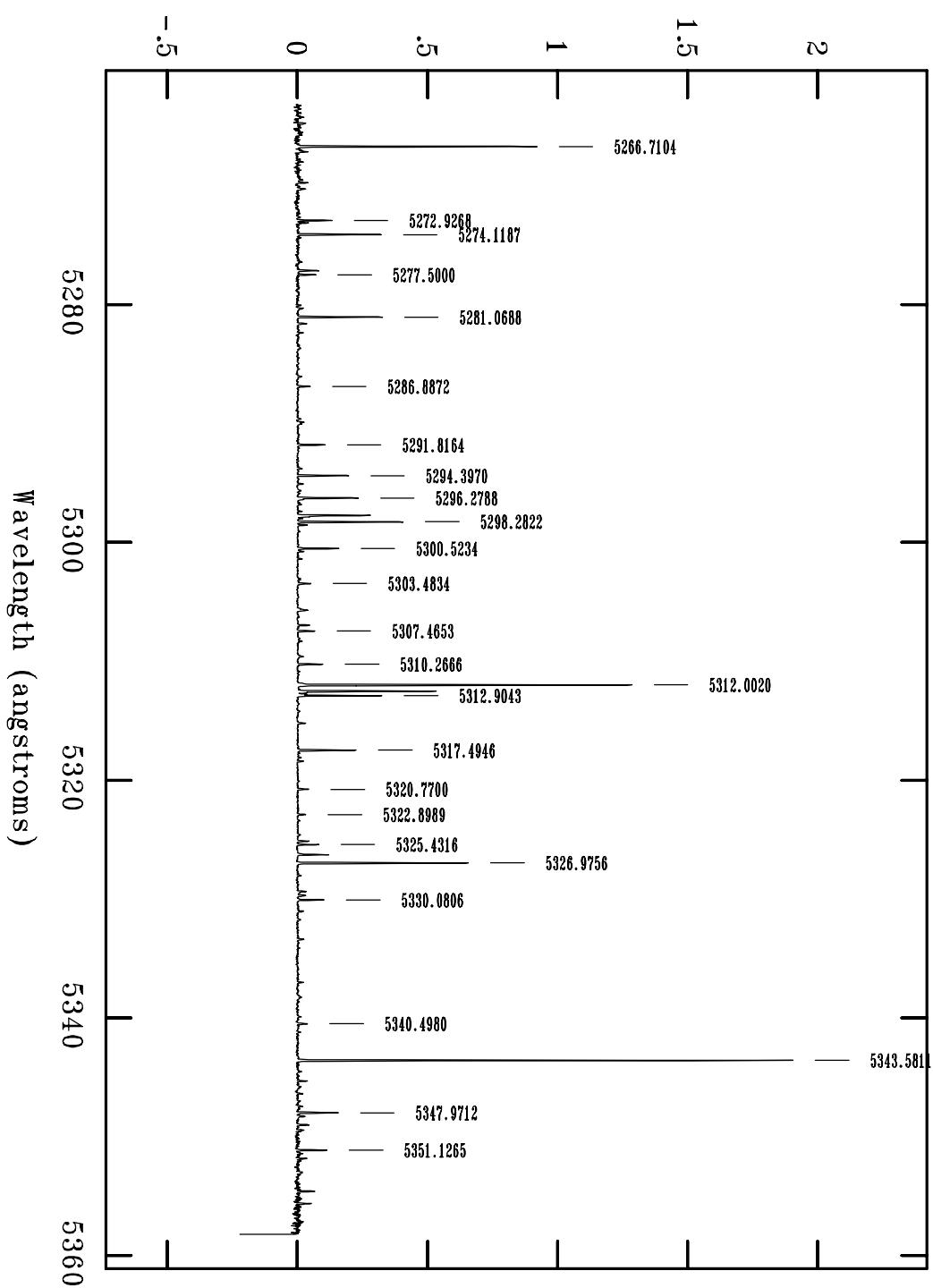


Fig. 41.— order 107

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 03:13:04 24-  
identify comp.90\_107.ap.0020 - Ap 20  
COMPARISON

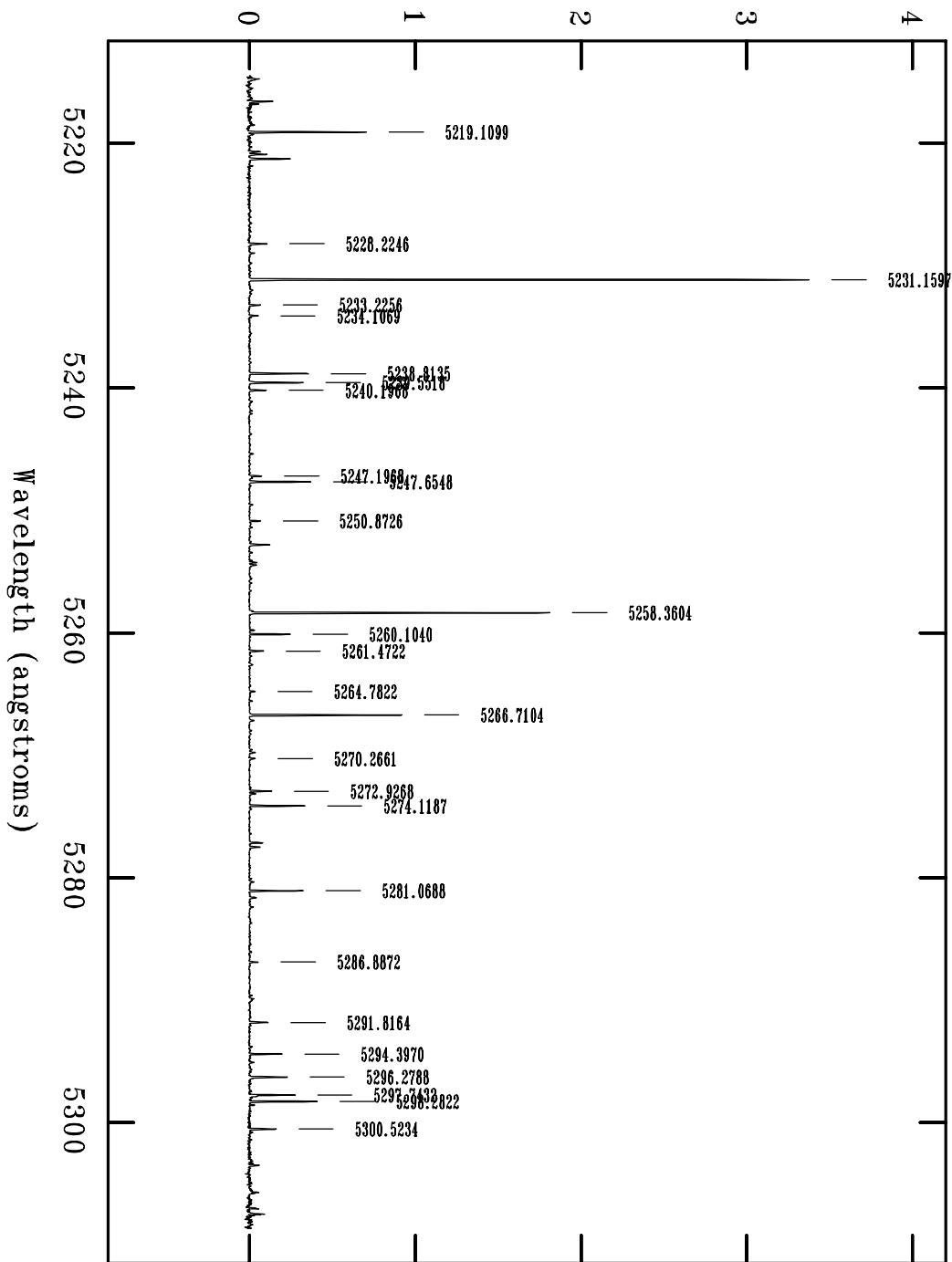


Fig. 42.— order 108

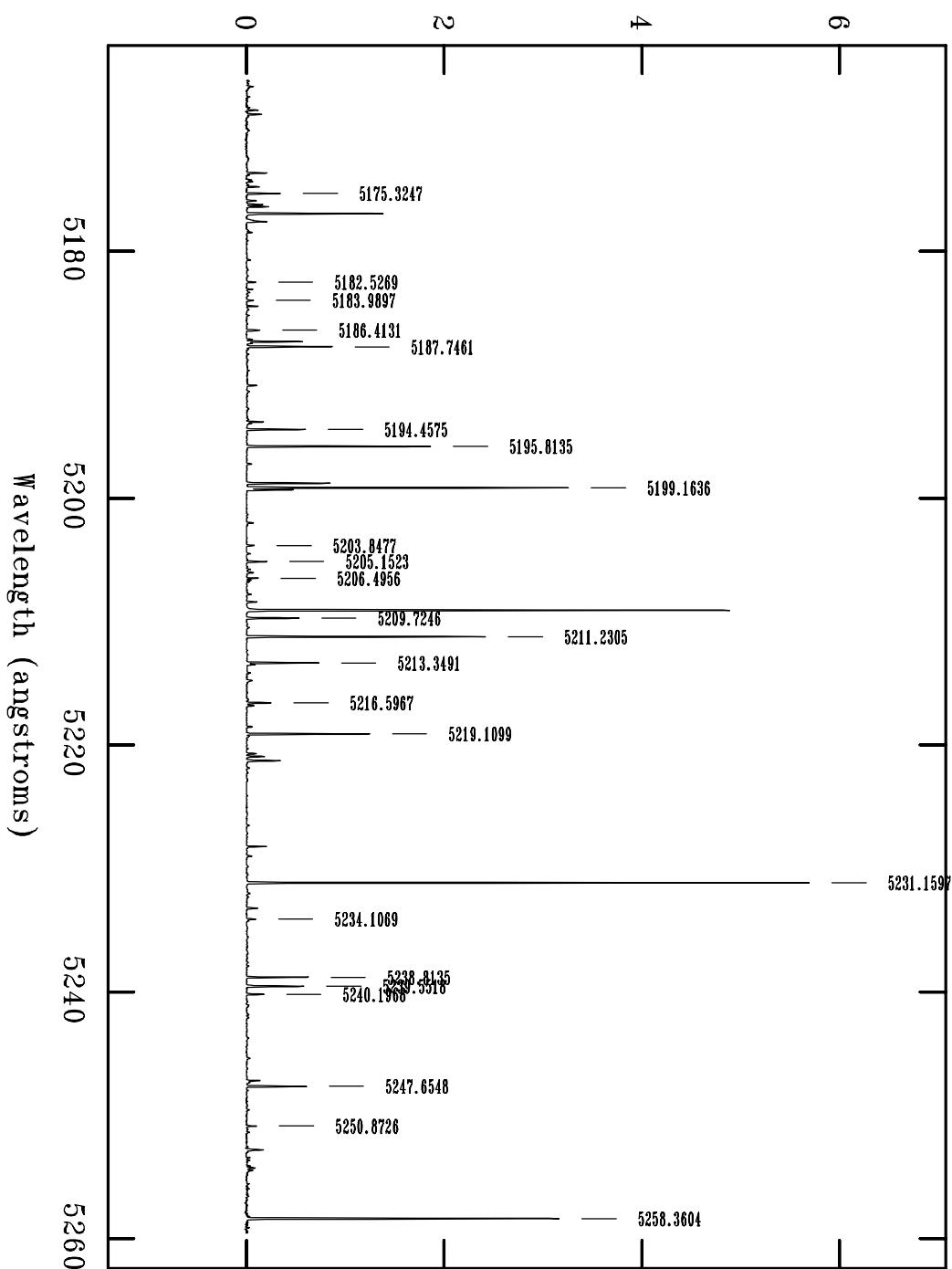


Fig. 43.— order 109

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 04:14:18 24-  
identify comp.101\_124.ap.0012 - Ap 12  
COMPARISON

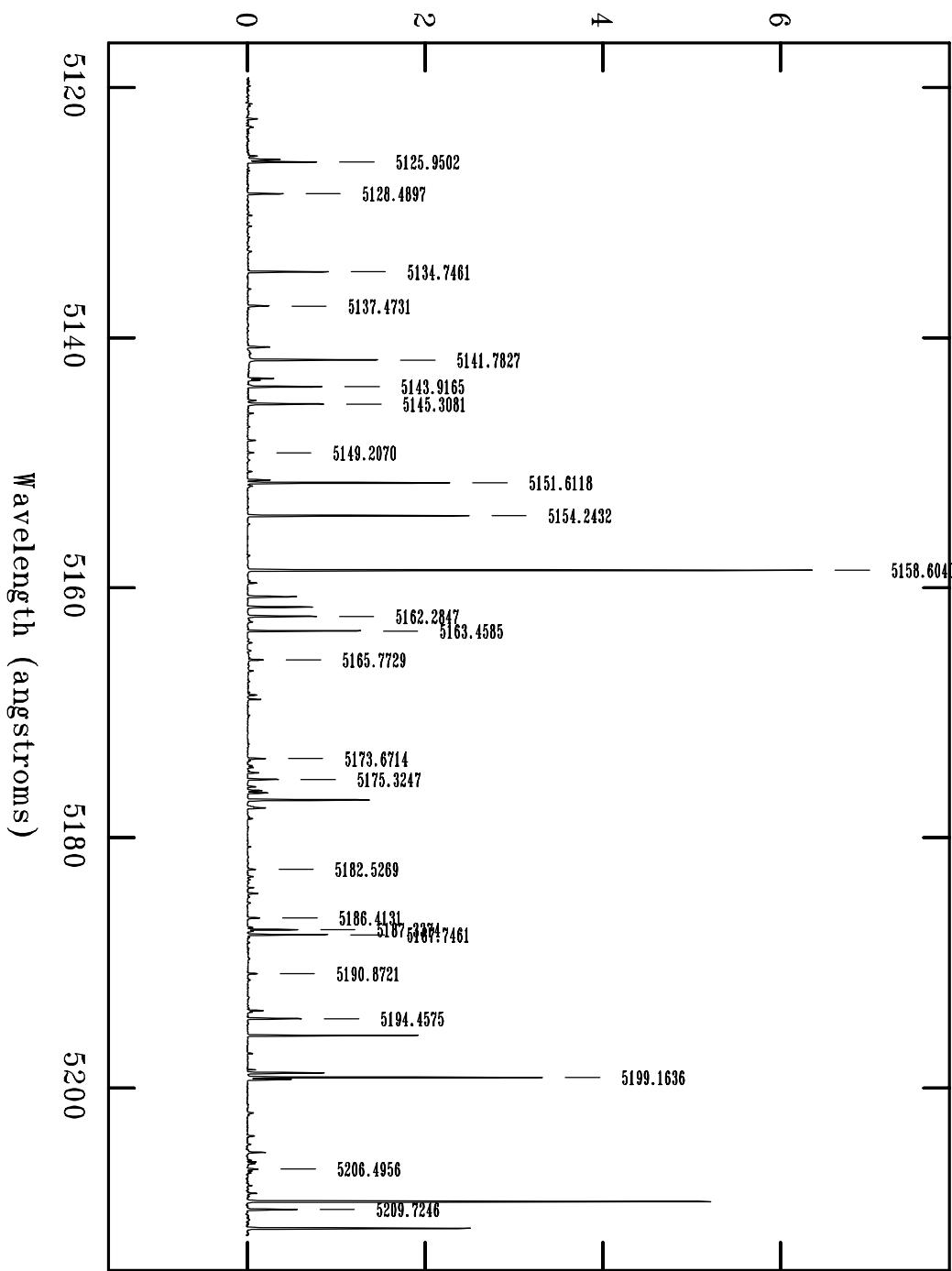


Fig. 44.— order 110

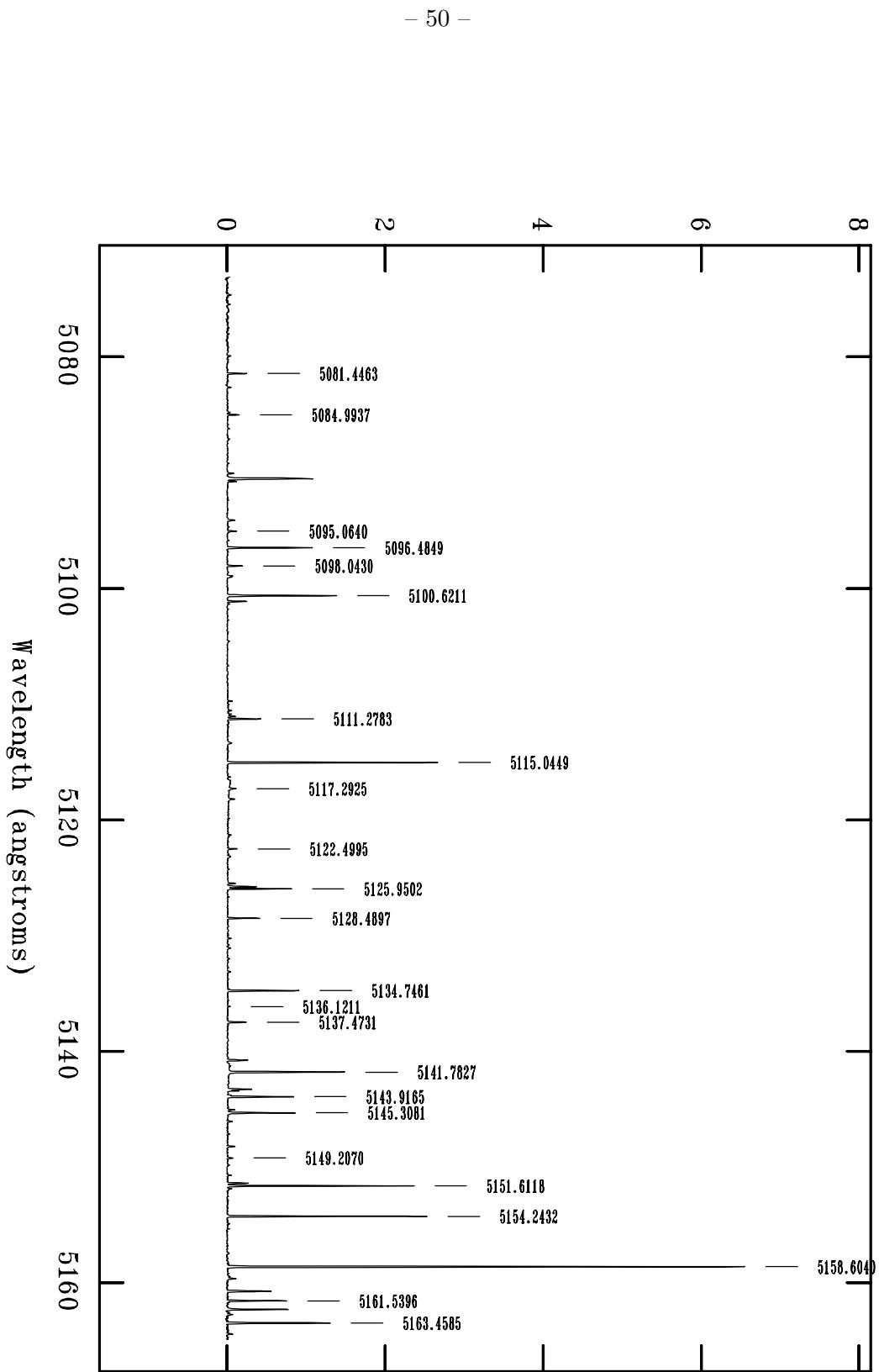


Fig. 45.— order 111

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 04:23:45 24-  
identify comp.101\_124.ap.0014 - Ap 14  
COMPARISON

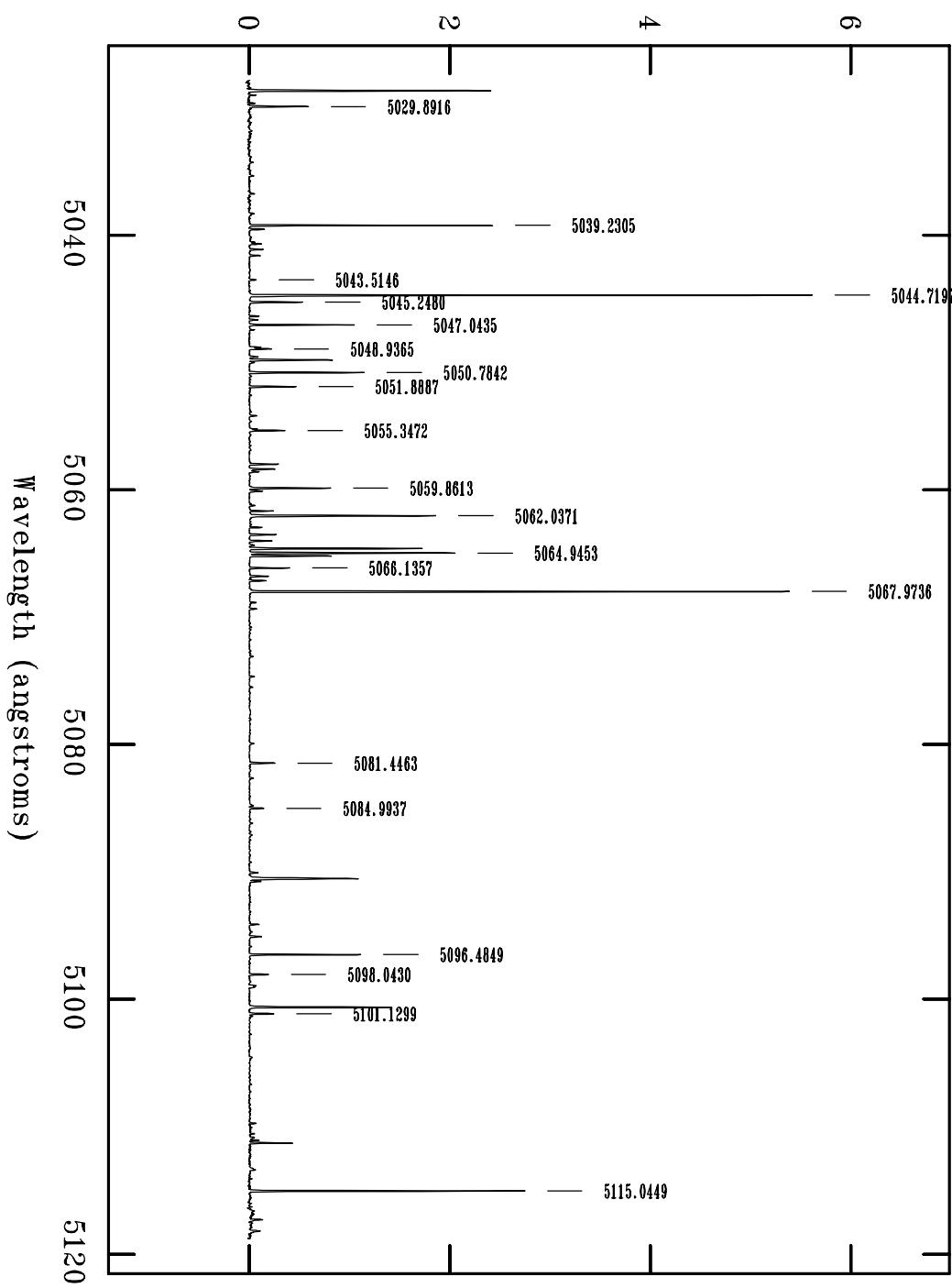


Fig. 46.— order 112

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 04:30:24 24-  
identify comp.101\_124.ap.0015 - Ap 15  
COMPARISON

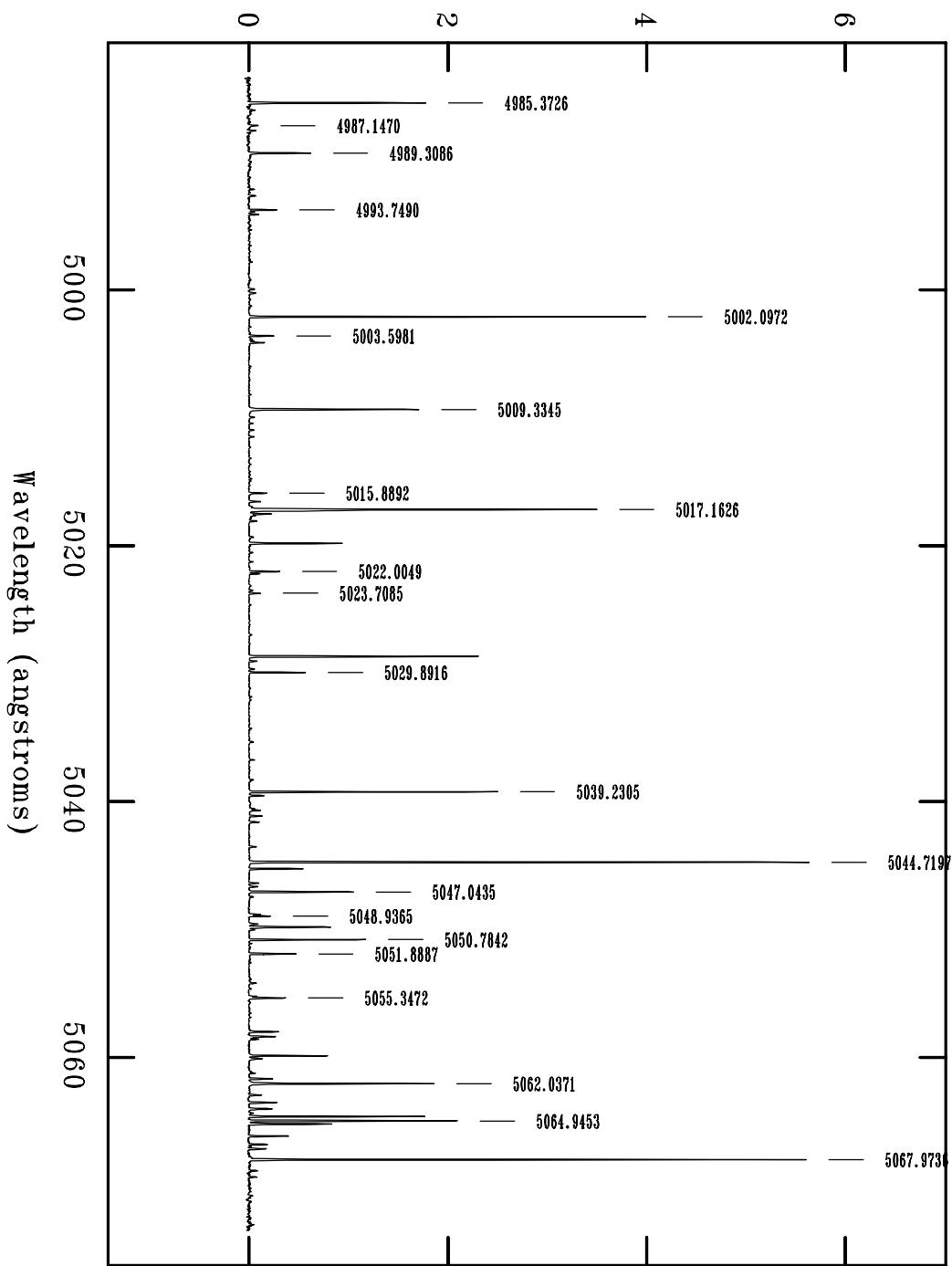


Fig. 47.— order 113

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 04:36:53 24-  
identify comp.101\_124.ap.0016 - Ap 16  
COMPARISON

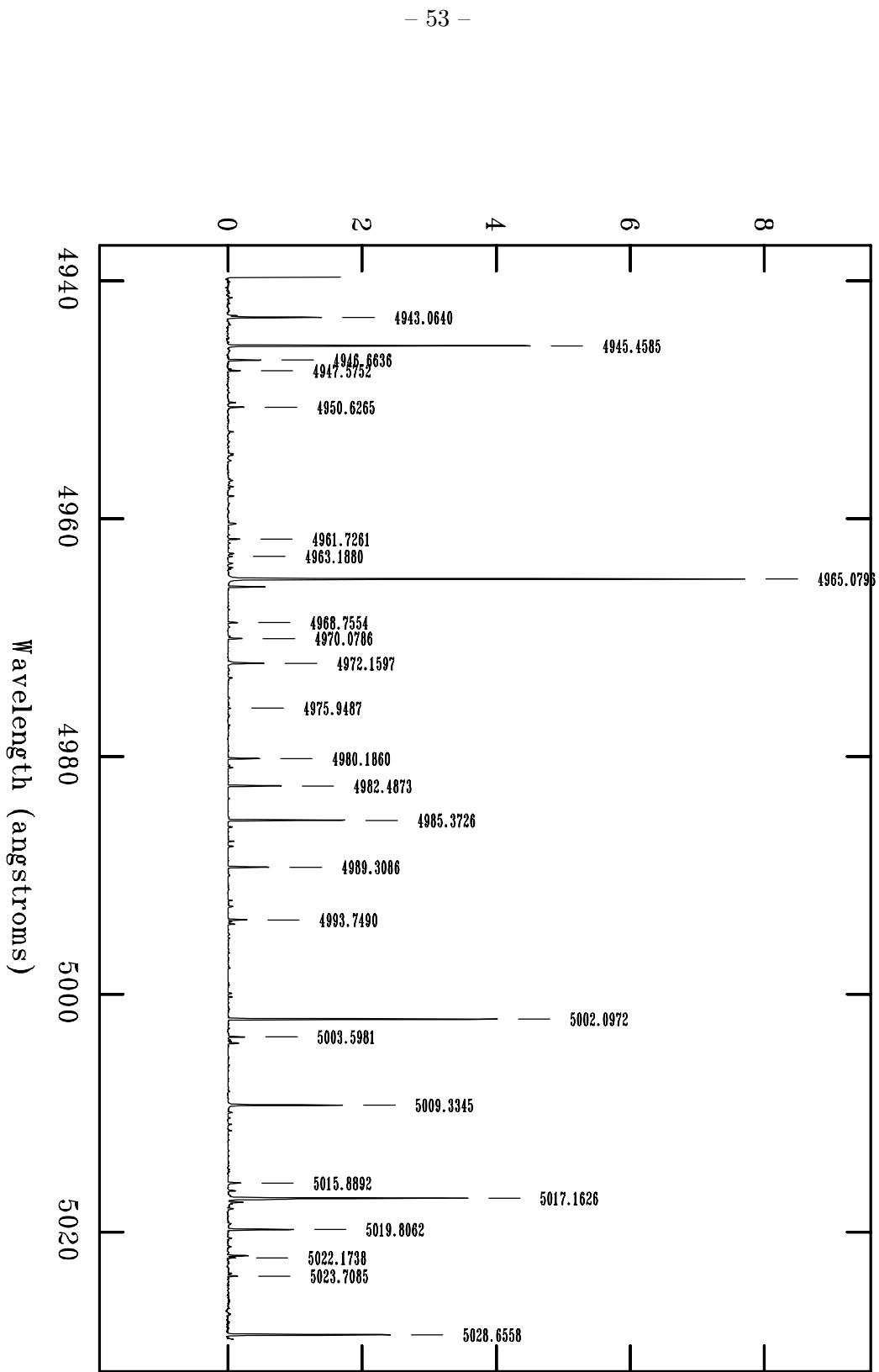


Fig. 48.— order 114

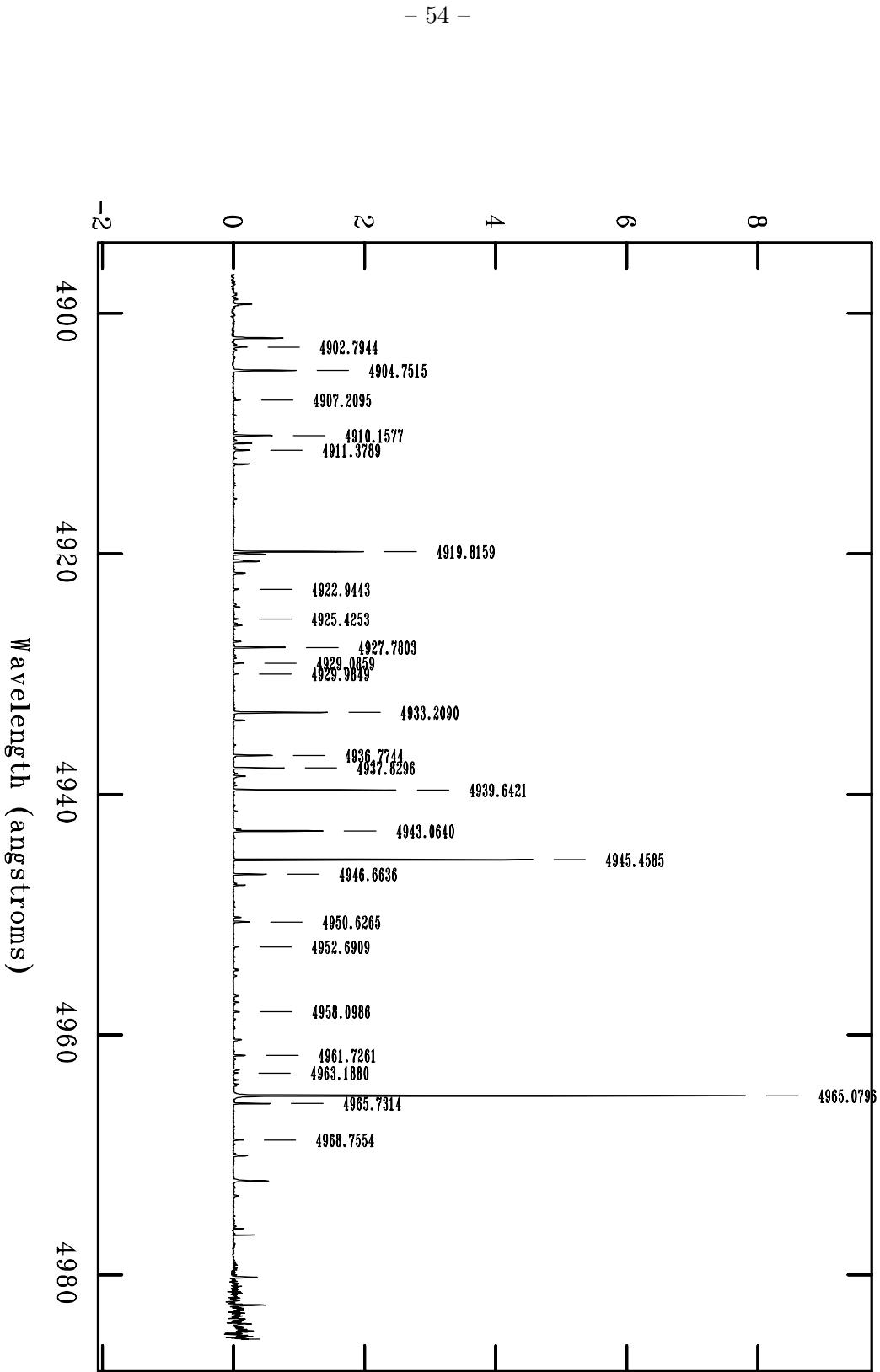


Fig. 49.— order 115

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 04:46:14 24-  
identify comp.101\_124.ap.0018 - Ap 18  
COMPARISON

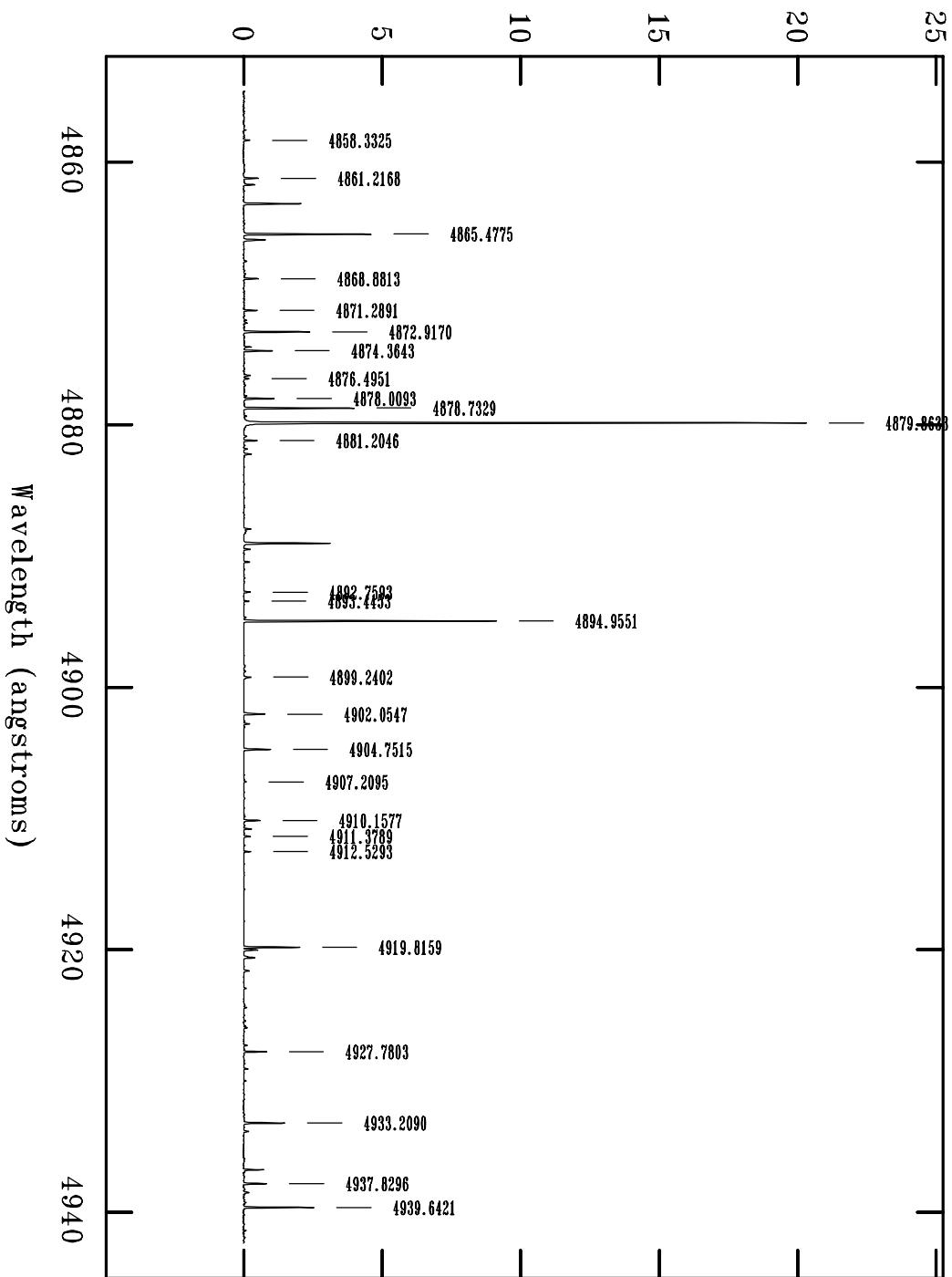


Fig. 50.— order 116

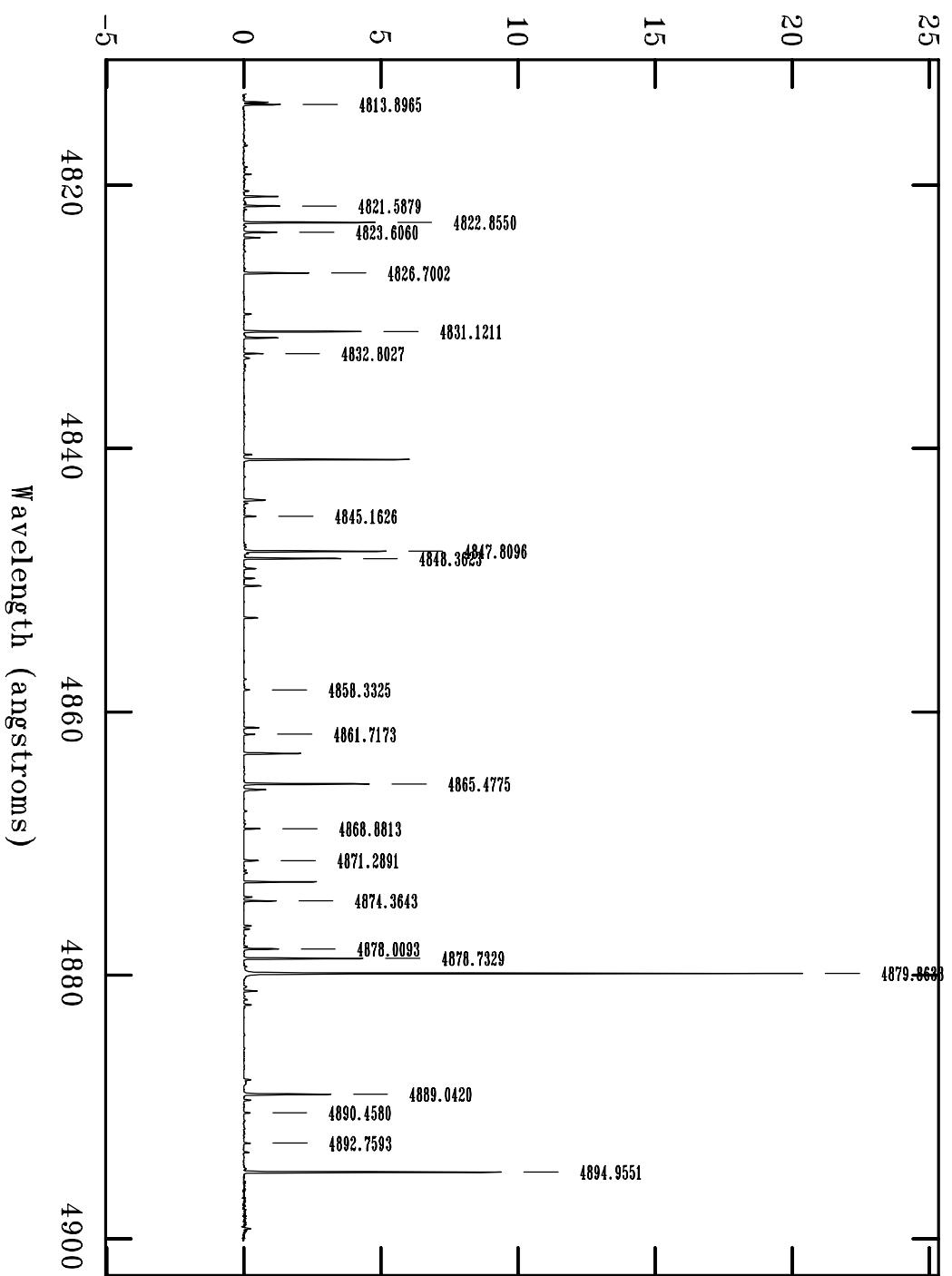


Fig. 51.— order 117

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 05:06:39 24-  
identify comp.101\_124.ap.0020 - Ap 20  
COMPARISON

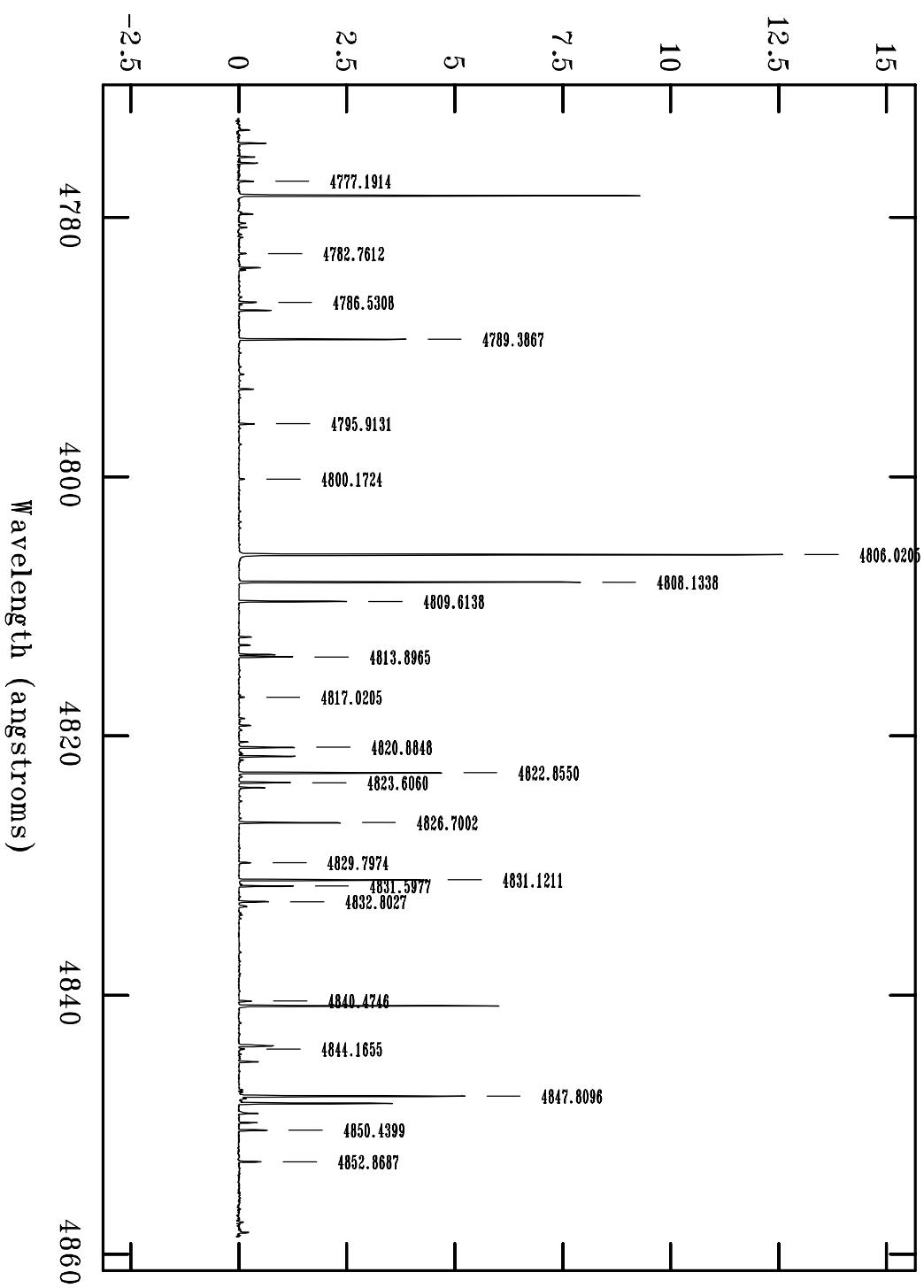


Fig. 52.— order 118

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 11:17:11 24-  
identify comp.101\_124.ap.0021 - Ap 21  
COMPARISON

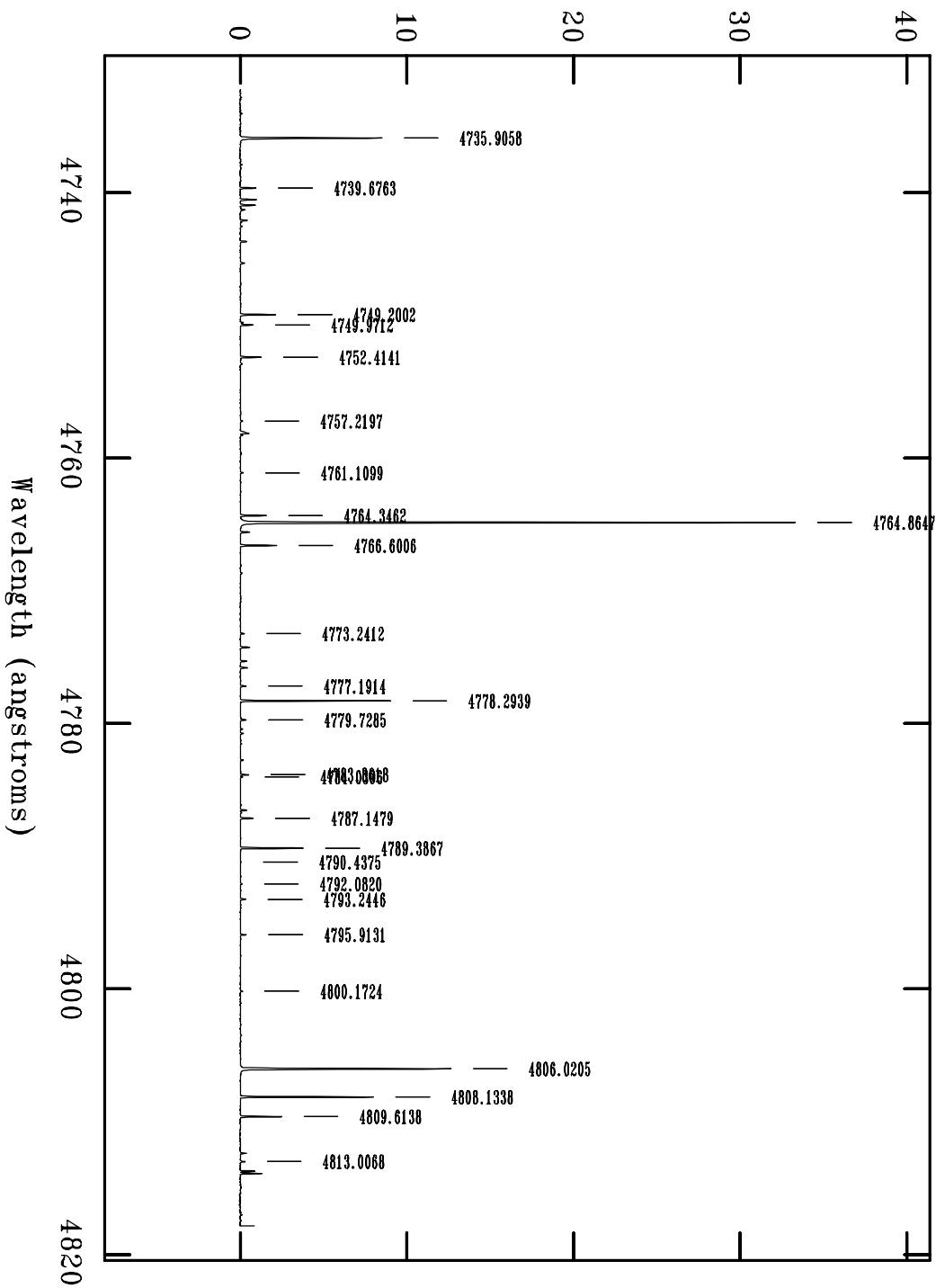


Fig. 53.— order 119

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 11:19:07 24-  
identify comp.101\_124.ap.0022 - Ap 22  
COMPARISON

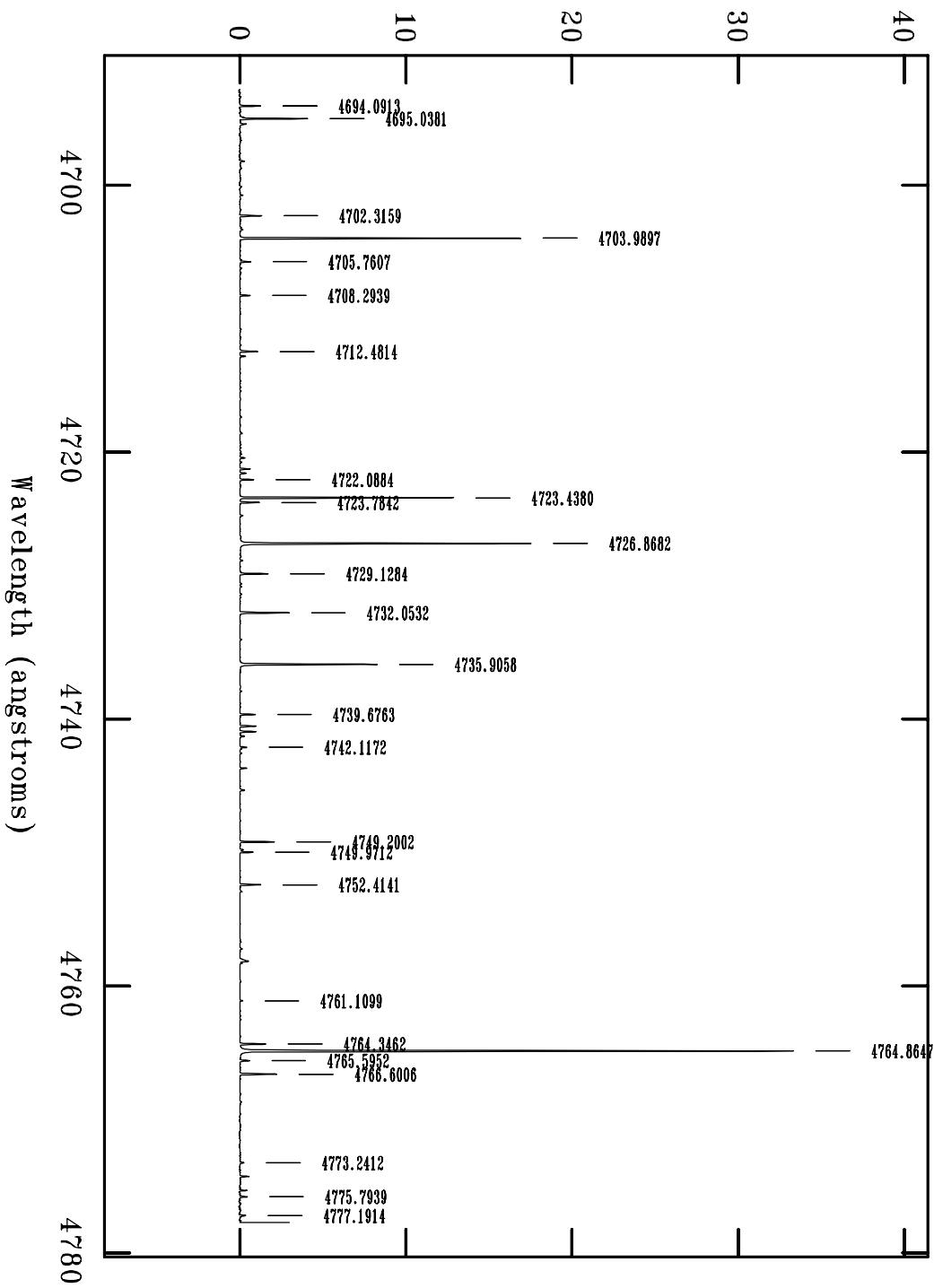


Fig. 54.— order 120

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 05:17:57 24-  
identify comp.101\_124.ap.0023 - Ap 23  
COMPARISON

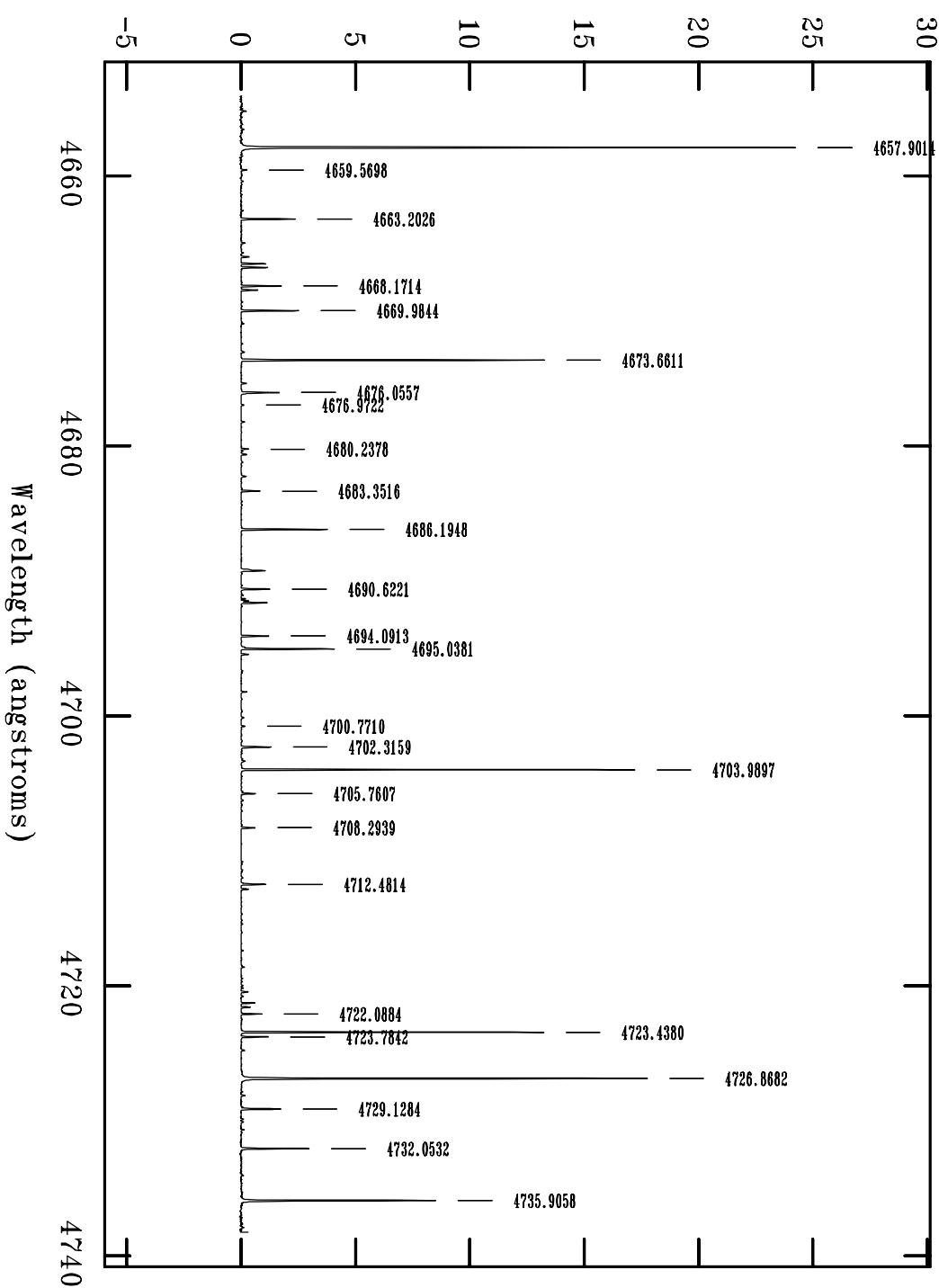


Fig. 55.— order 121

COMPARISON

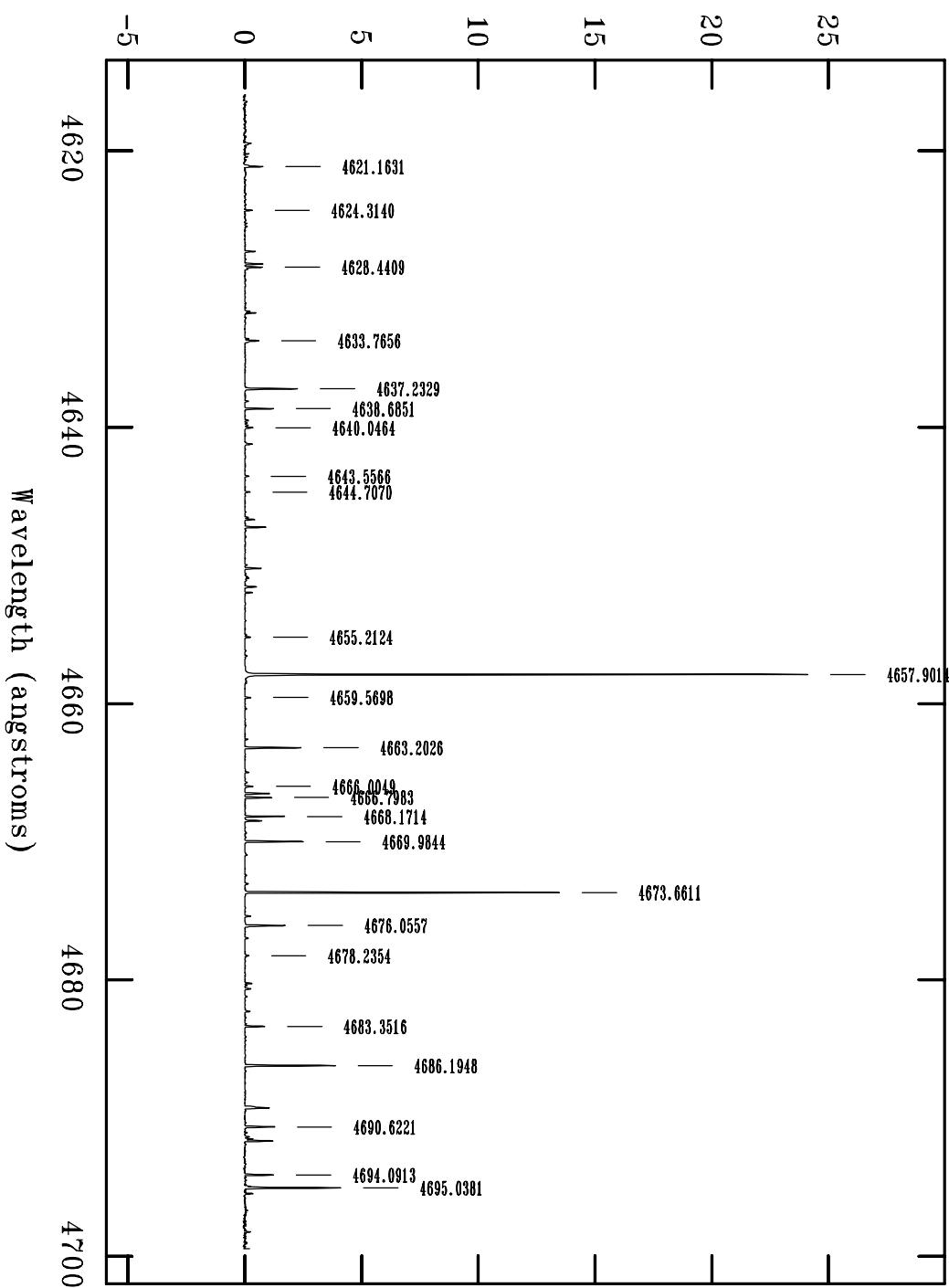


Fig. 56.— order 122

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 05:26:45 24-  
identify comp.101\_124.ap.0025 - Ap 25  
COMPARISON

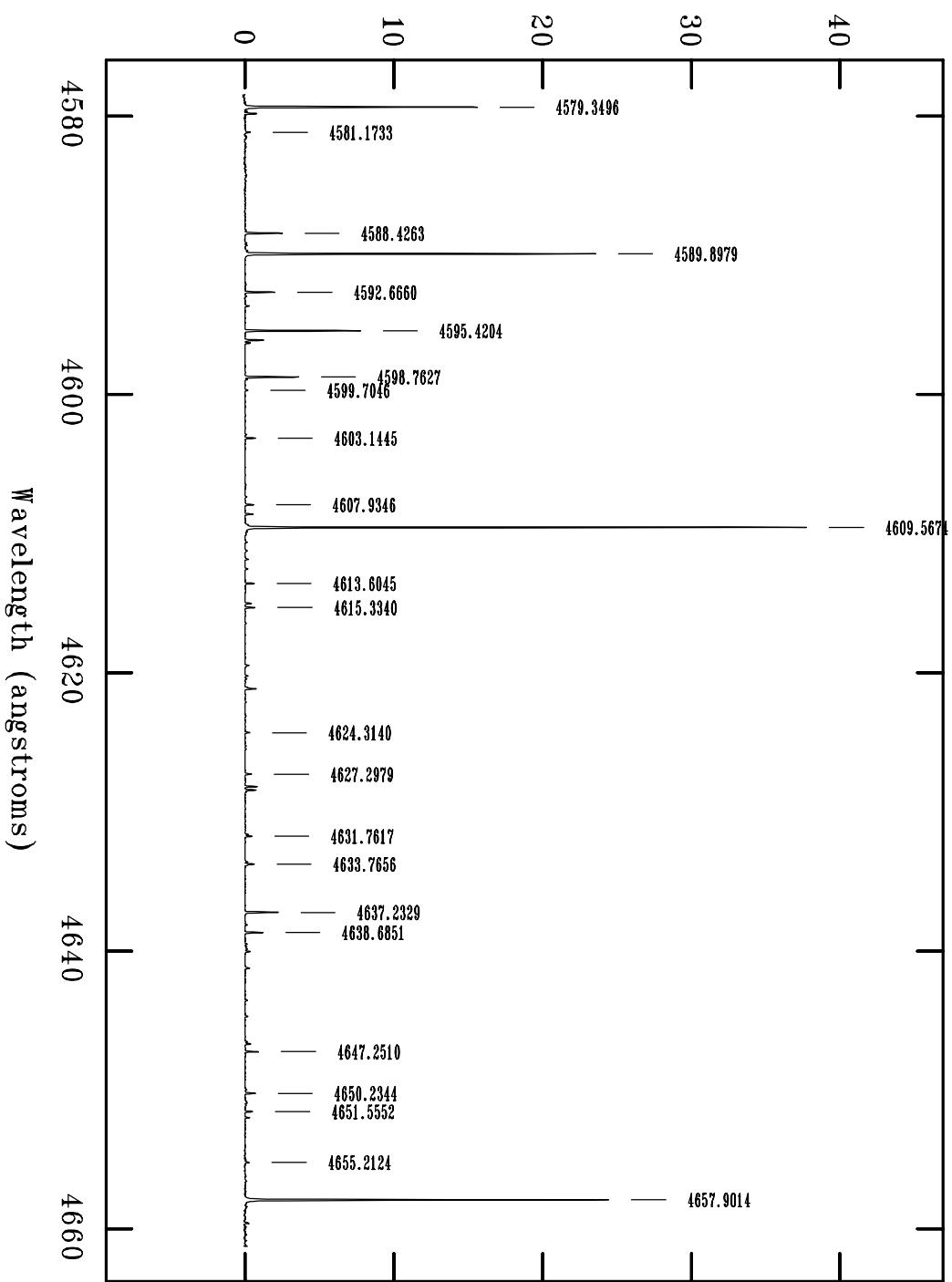


Fig. 57.— order 123

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 05:31:37 24-  
identify comp.101\_124.ap.0026 - Ap 26  
COMPARISON

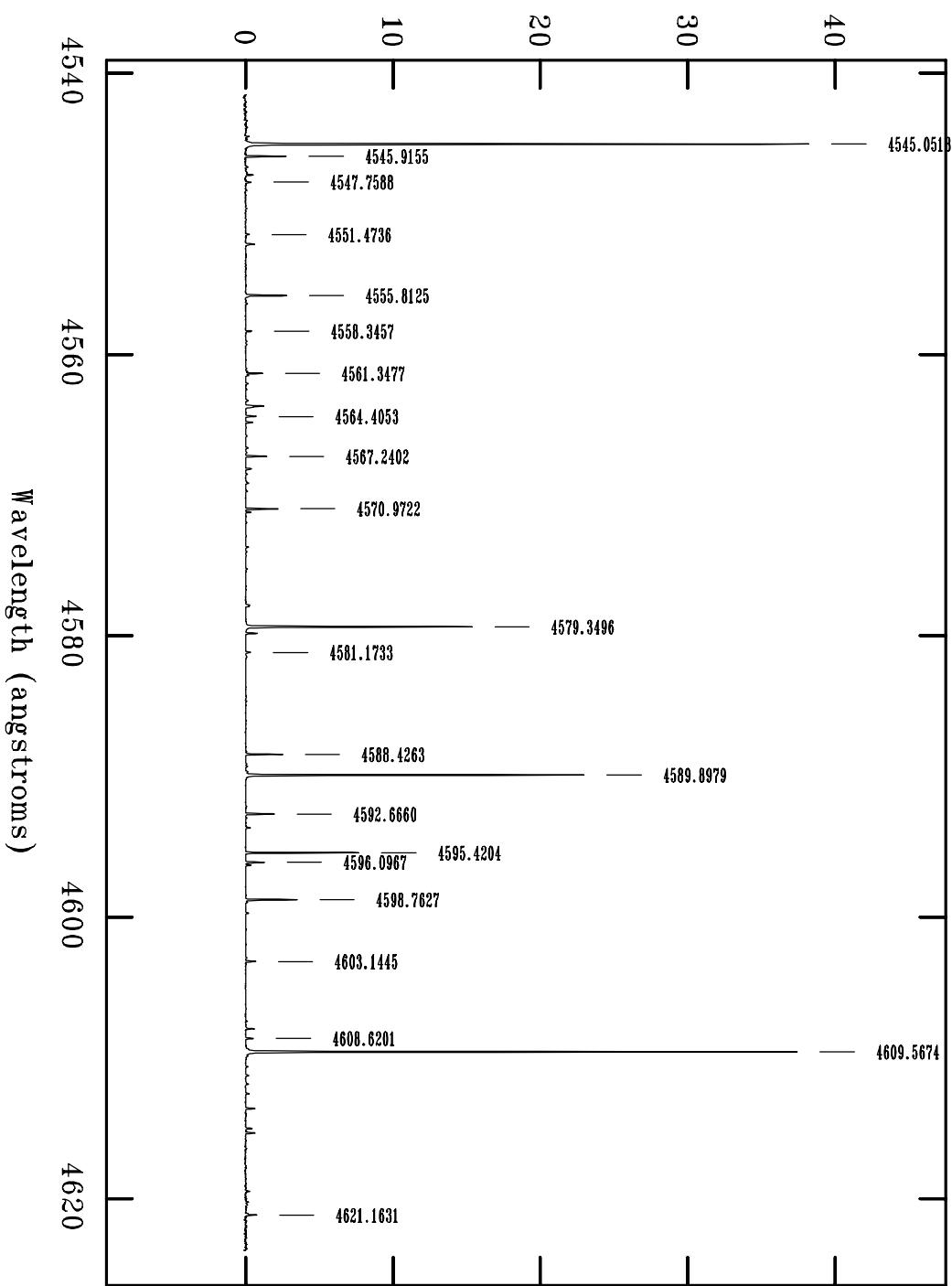


Fig. 58.— order 124

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 05:34:27 24-  
identify comp.101\_124.ap.0027 - Ap 27  
COMPARISON

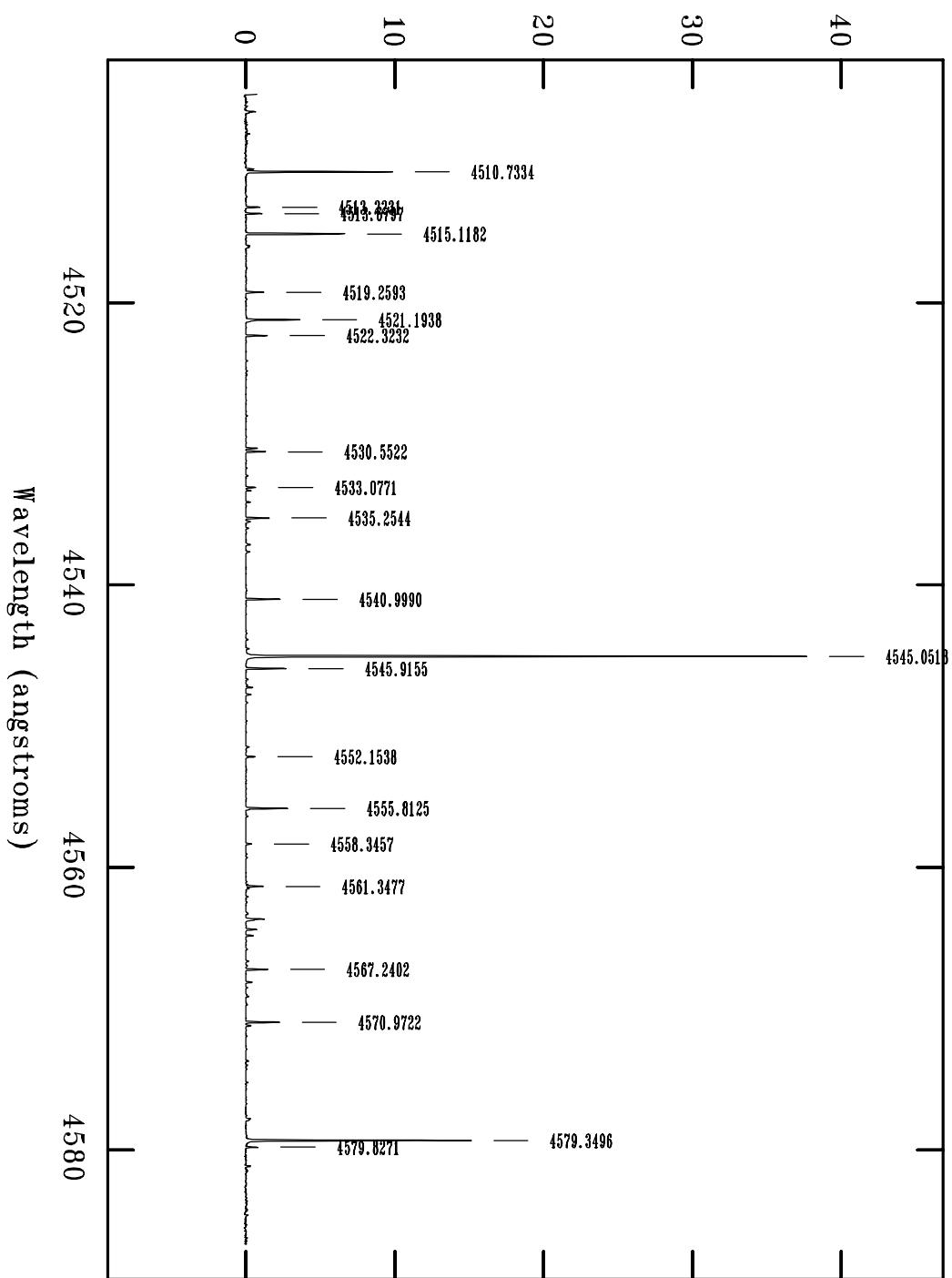


Fig. 59.— order 125

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 06:02:16 24-  
identify comp.122\_142.ap.0006 - Ap 6  
COMPARISON

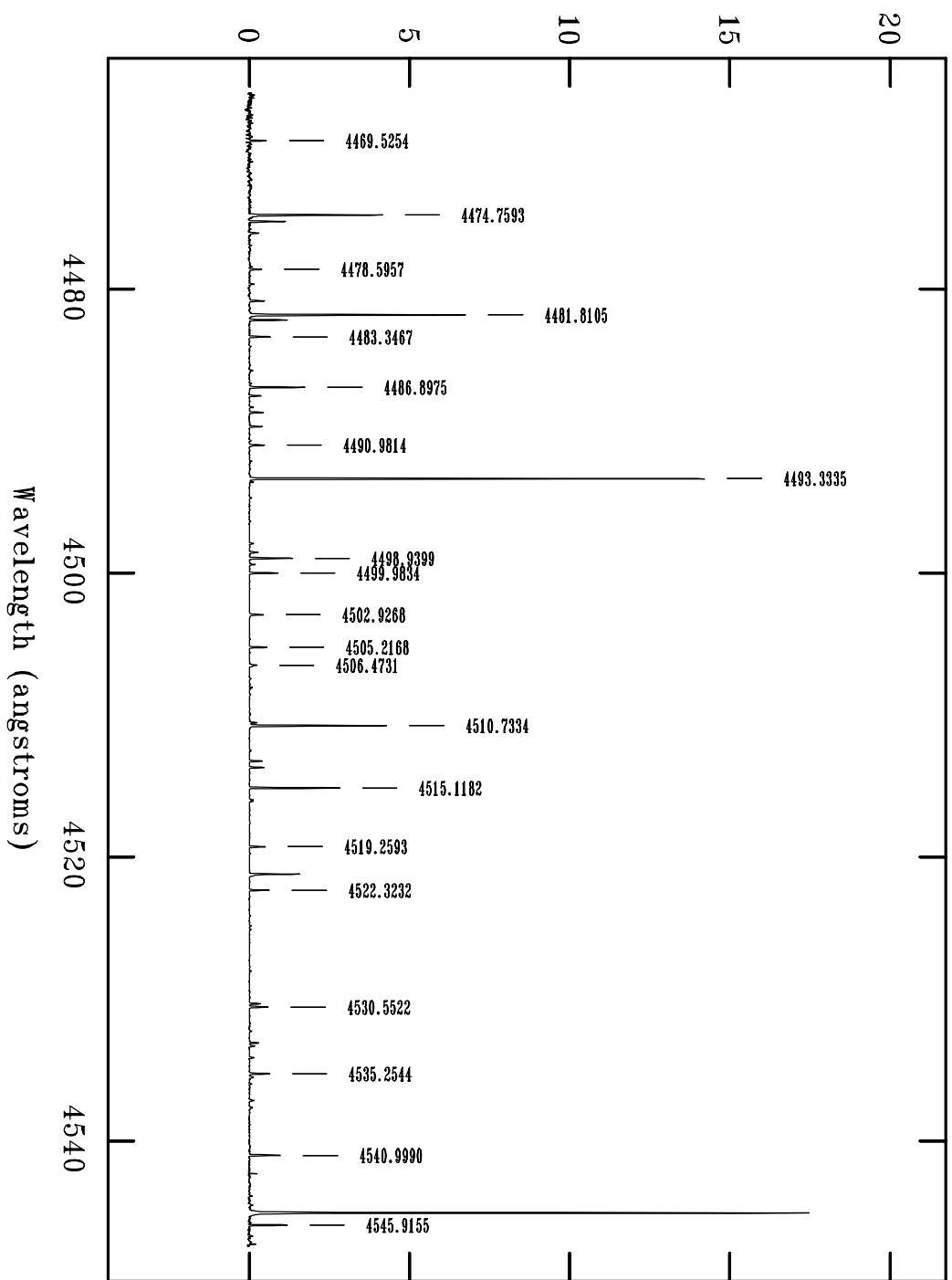


Fig. 60.— order 126

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 06:51:40 24-  
identify comp.122\_142.ap.0007 - Ap 7  
COMPARISON

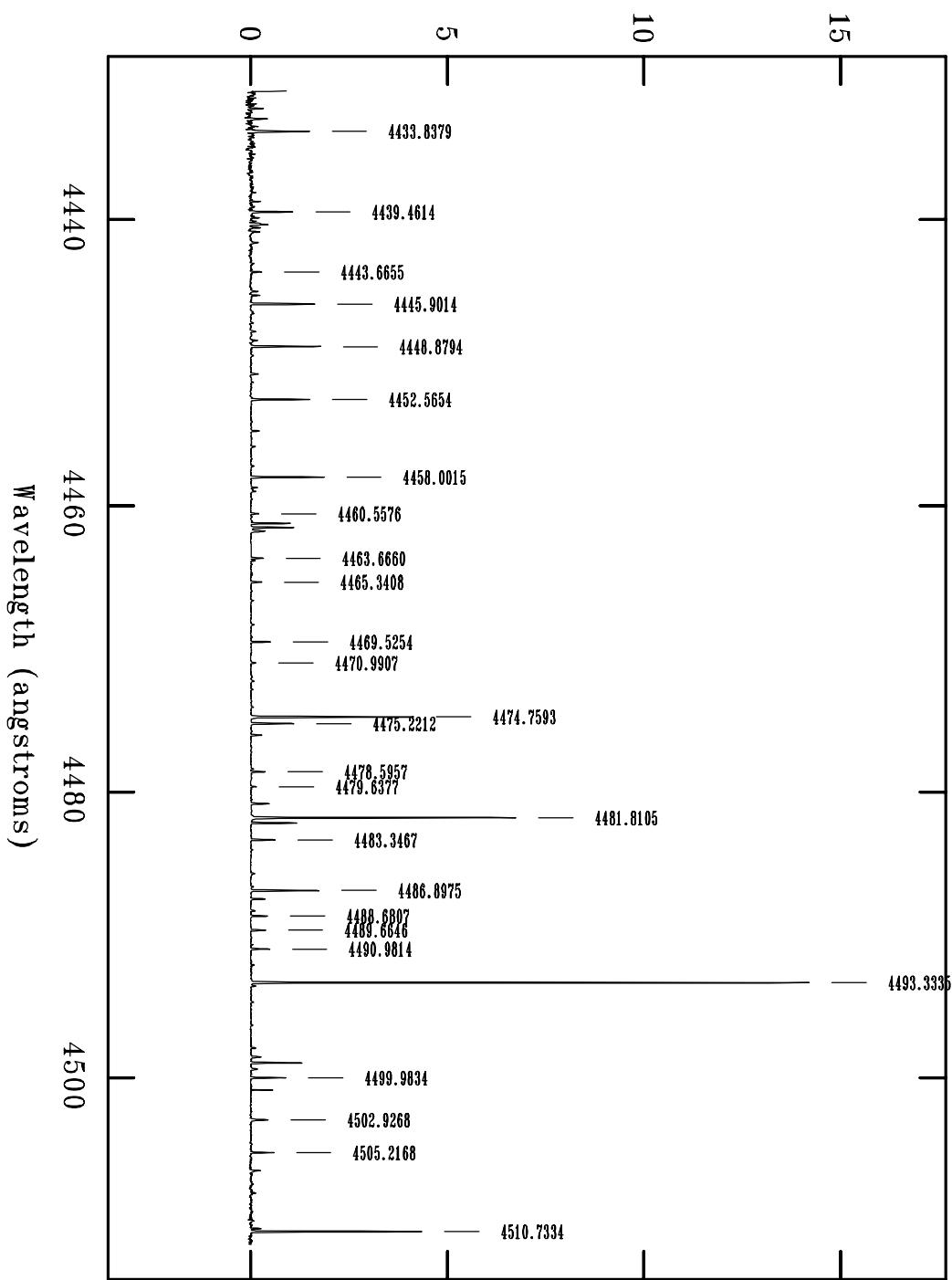


Fig. 61.— order 127

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 06:56:21 24-  
identify comp.122\_142.ap.0008 - Ap 8  
COMPARISON

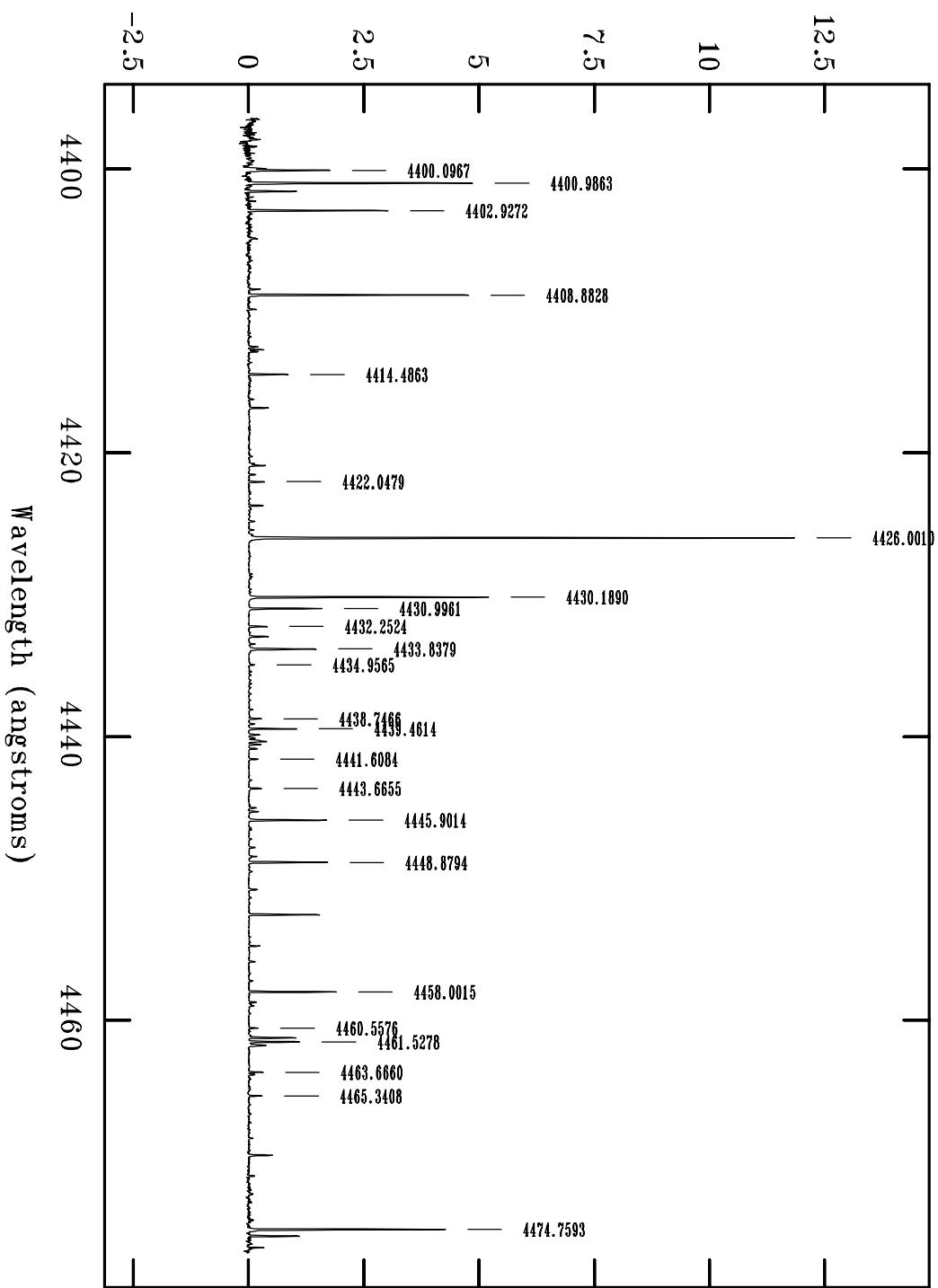


Fig. 62.— order 128

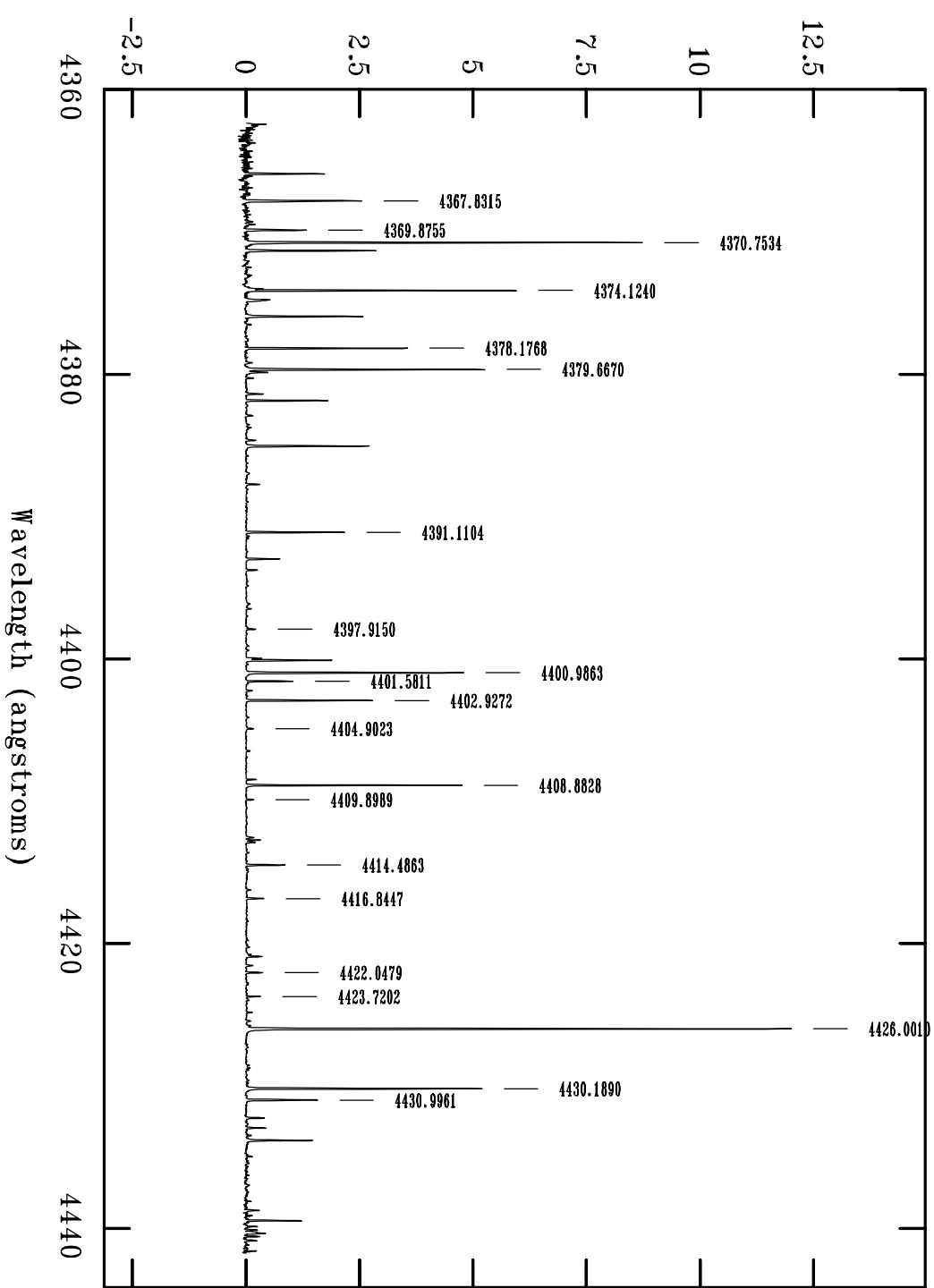


Fig. 63.— order 129

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 07:08:22 24-  
identify comp.122\_142.ap.0010 - Ap 10  
COMPARISON

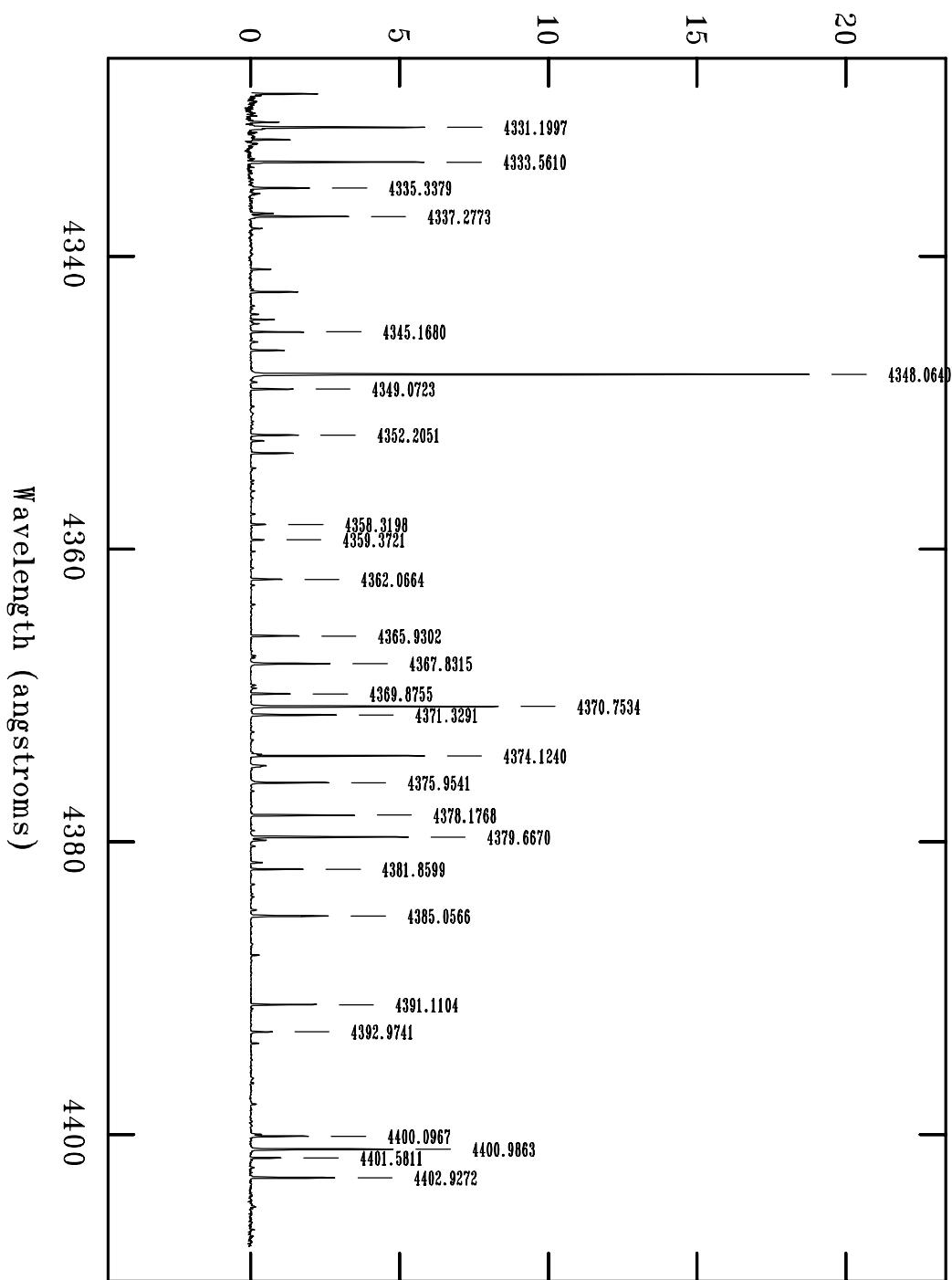


Fig. 64.— order 130

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 07:13:29 24-  
identify comp.122\_142.ap.0011 - Ap 11  
COMPARISON

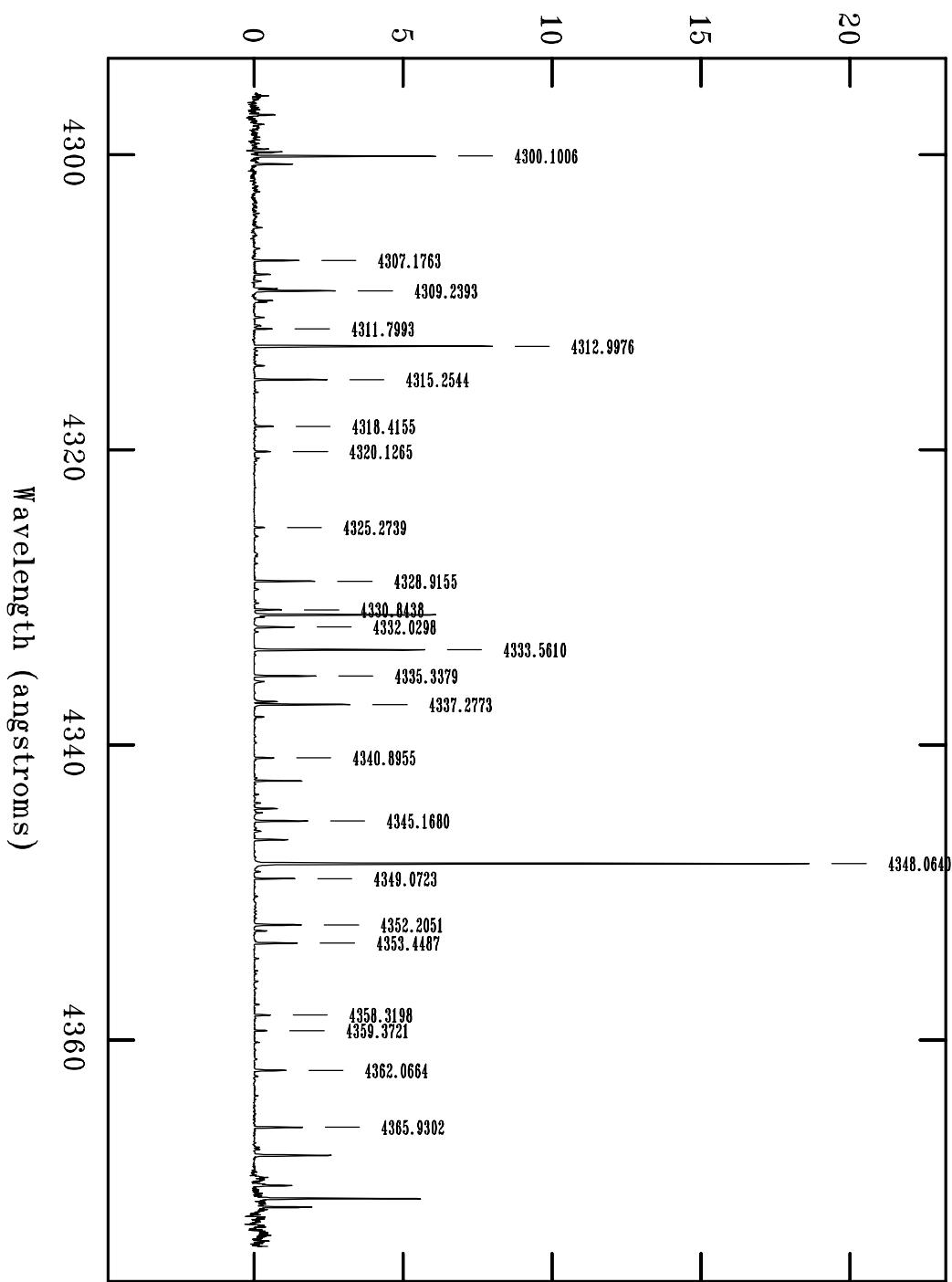


Fig. 65.— order 131

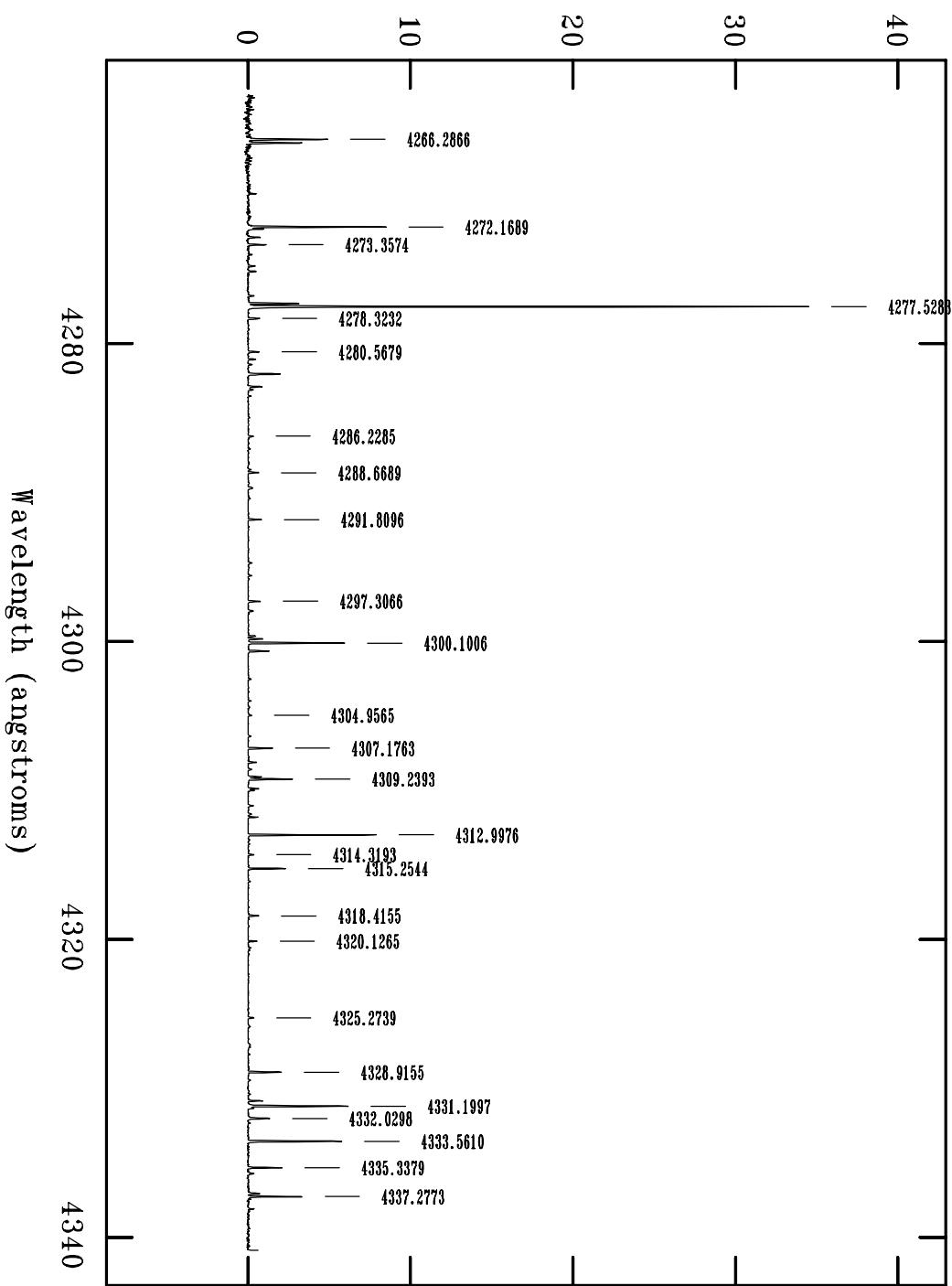


Fig. 66.— order 132

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 07:23:09 24-  
identify comp.122\_142.ap.0013 - Ap 13  
COMPARISON

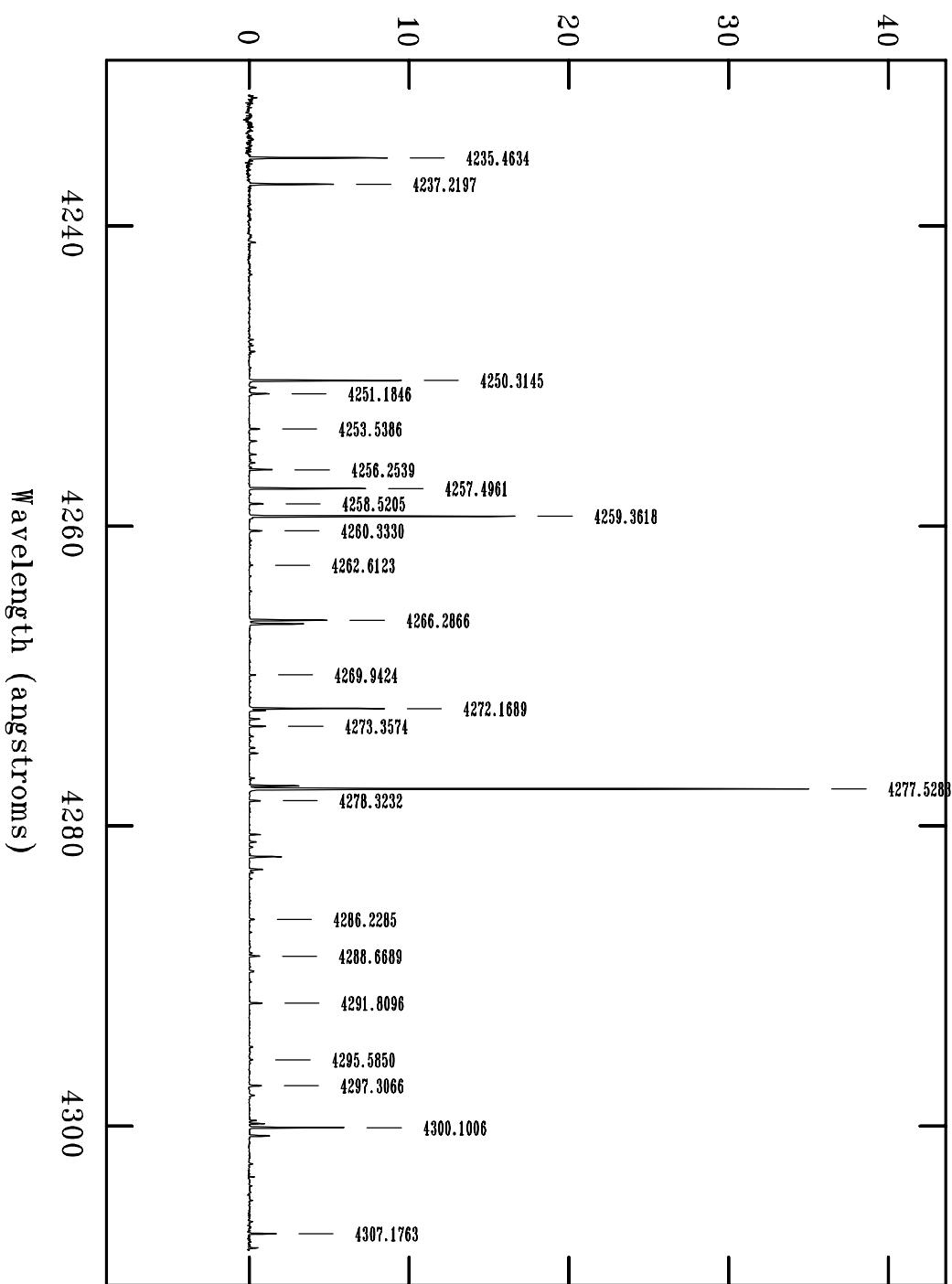


Fig. 67.— order 133

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 07:29:47 24-  
identify comp.122\_142.ap.0014 - Ap 14  
COMPARISON

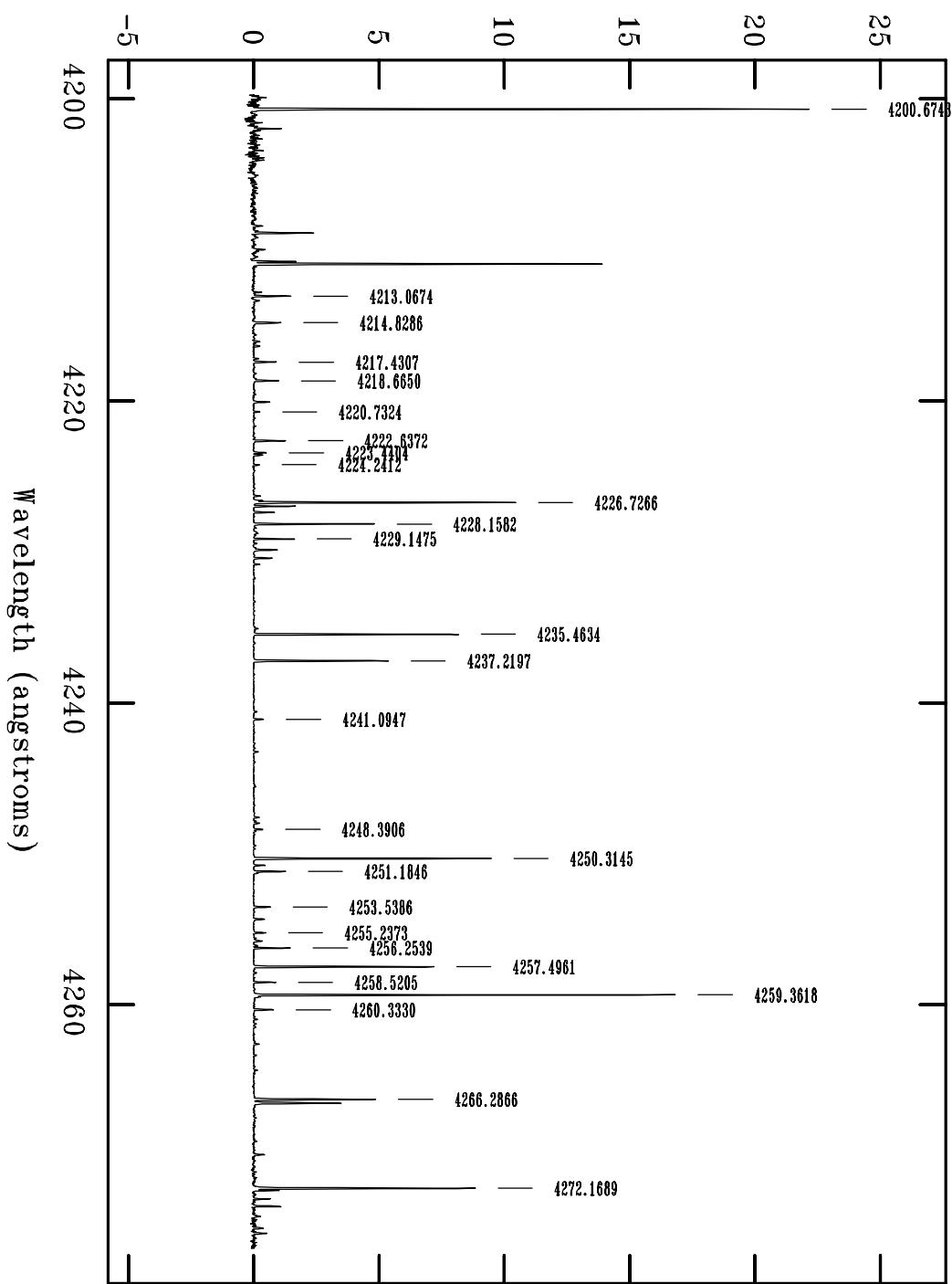


Fig. 68.— order 134

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 07:34:52 24-  
identify comp.122\_142.ap.0015 - Ap 15  
COMPARISON

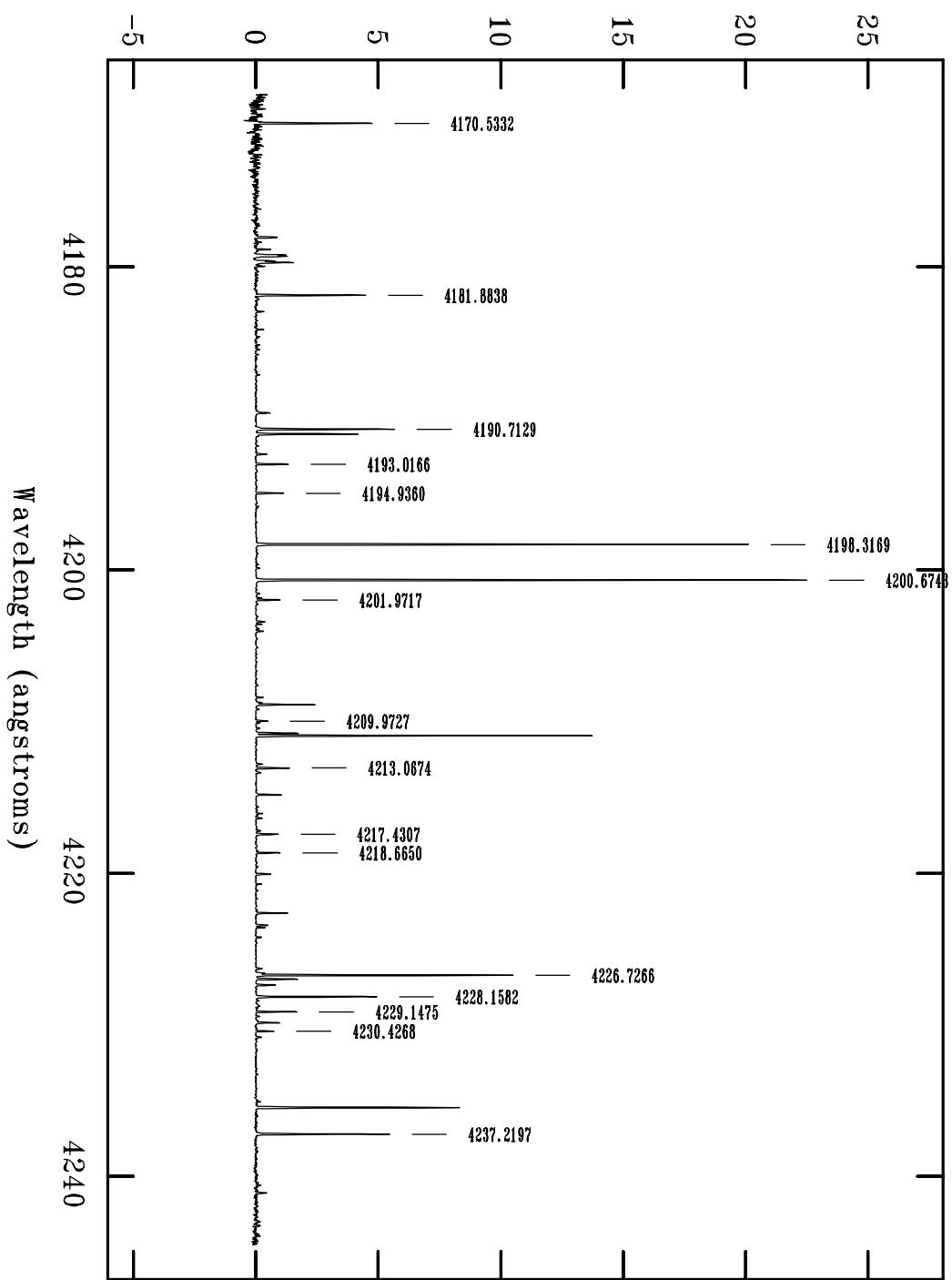


Fig. 69.— order 135

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 07:39:23 24-  
identify comp.122\_142.ap.0016 - Ap 16  
COMPARISON

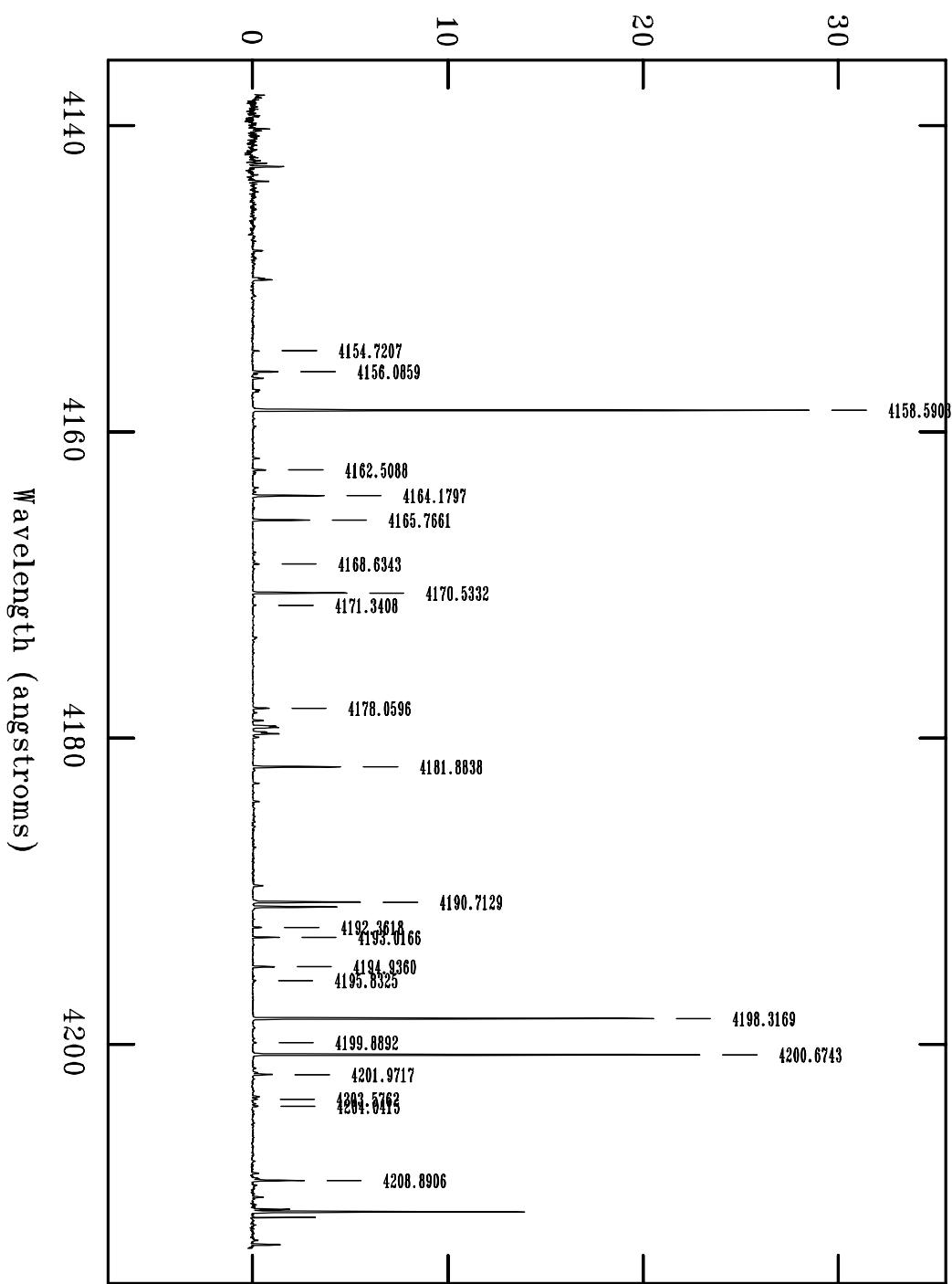


Fig. 70.— order 136

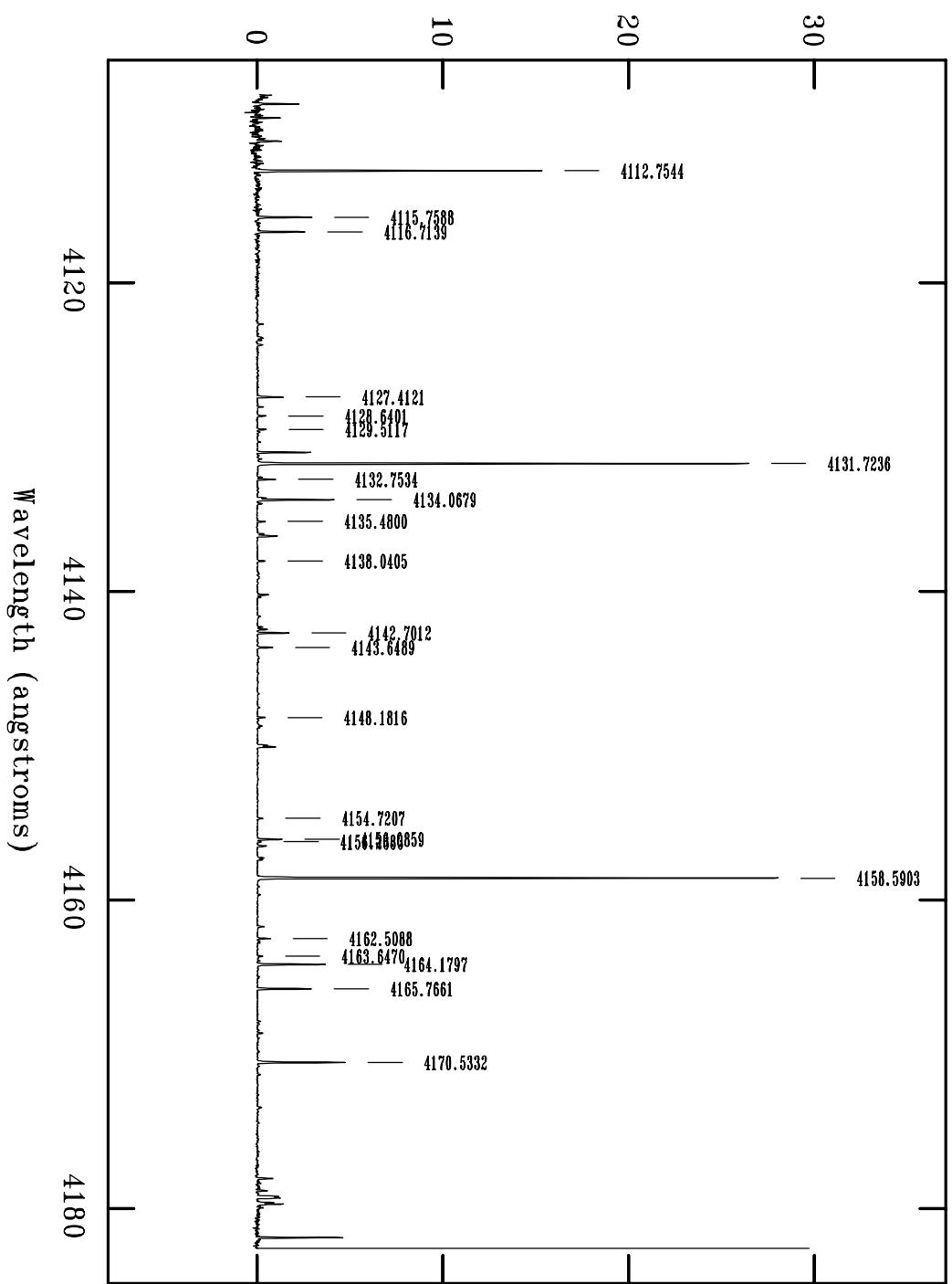


Fig. 71.— order 137

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 07:48:48 24-  
identify comp.122\_142.ap.0018 - Ap 18  
COMPARISON

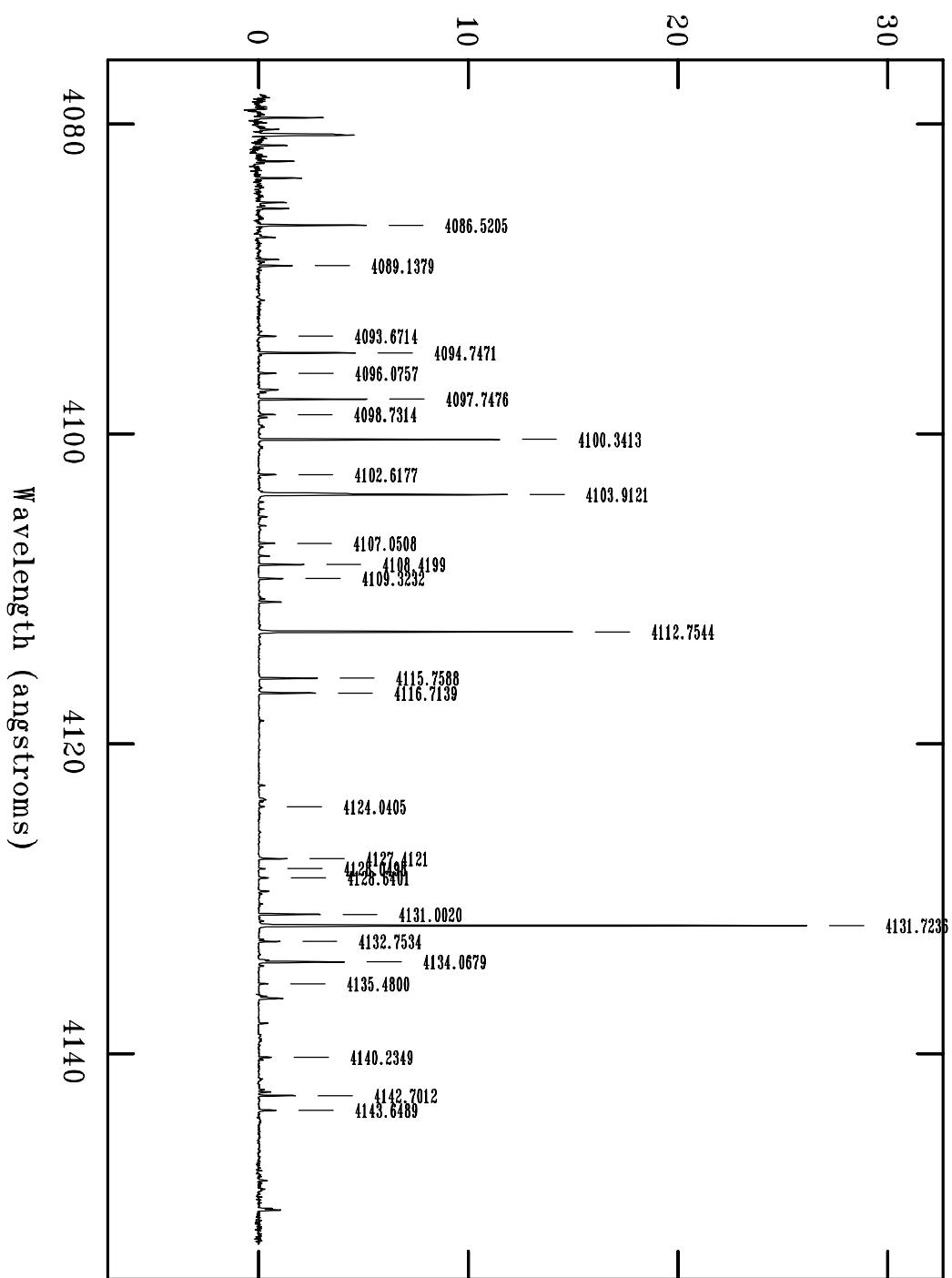


Fig. 72.— order 138

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Fri 17:31:57 01-  
identify comp.122\_142.ap.0019 - Ap 19  
COMPARISON

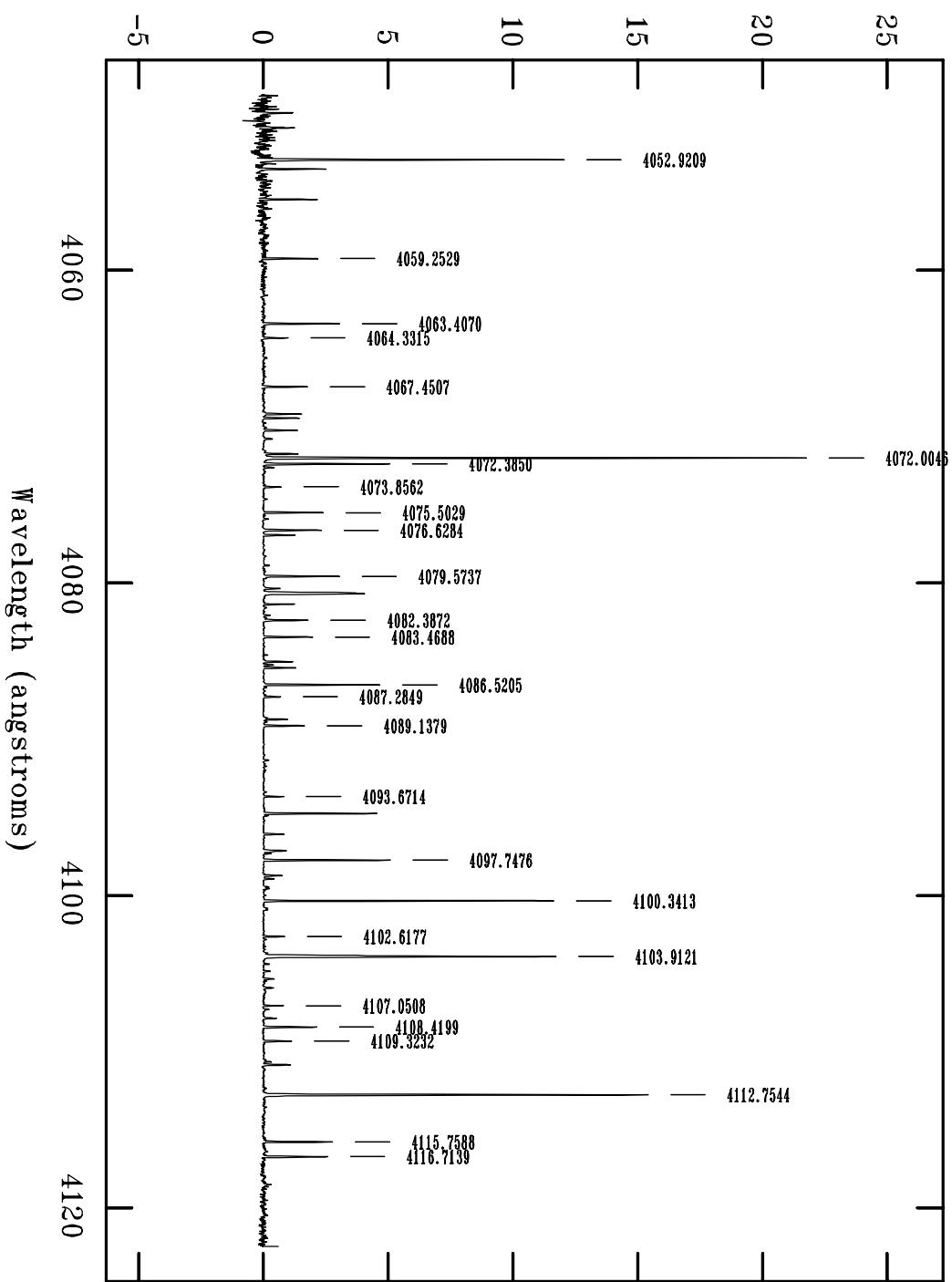


Fig. 73.— order 139

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 08:02:27 24-  
identify comp.122\_142.ap.0020 - Ap 20  
COMPARISON

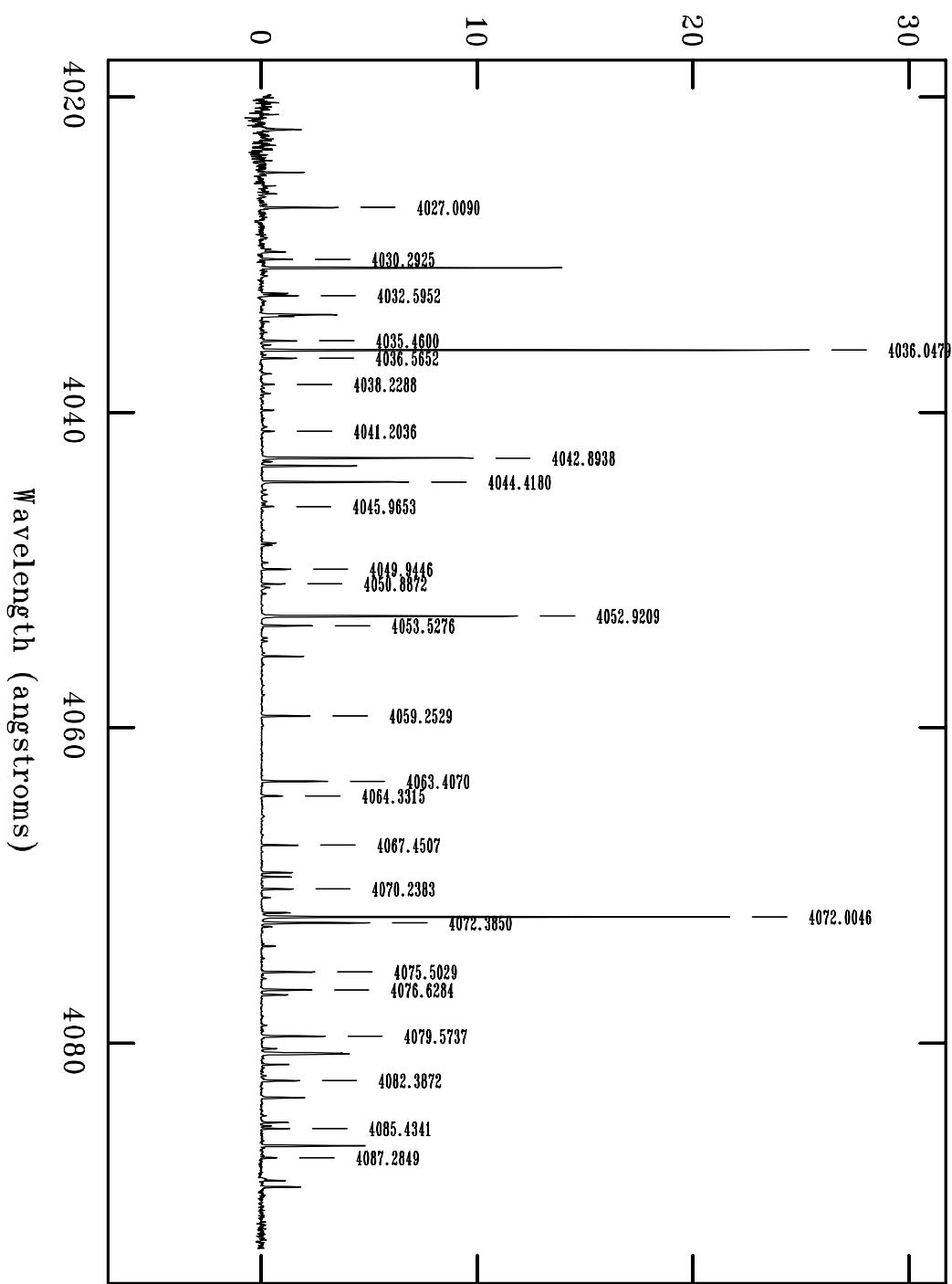


Fig. 74.— order 140

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 08:06:56 24-  
identify comp.122\_142.ap.0021 - Ap 21  
COMPARISON

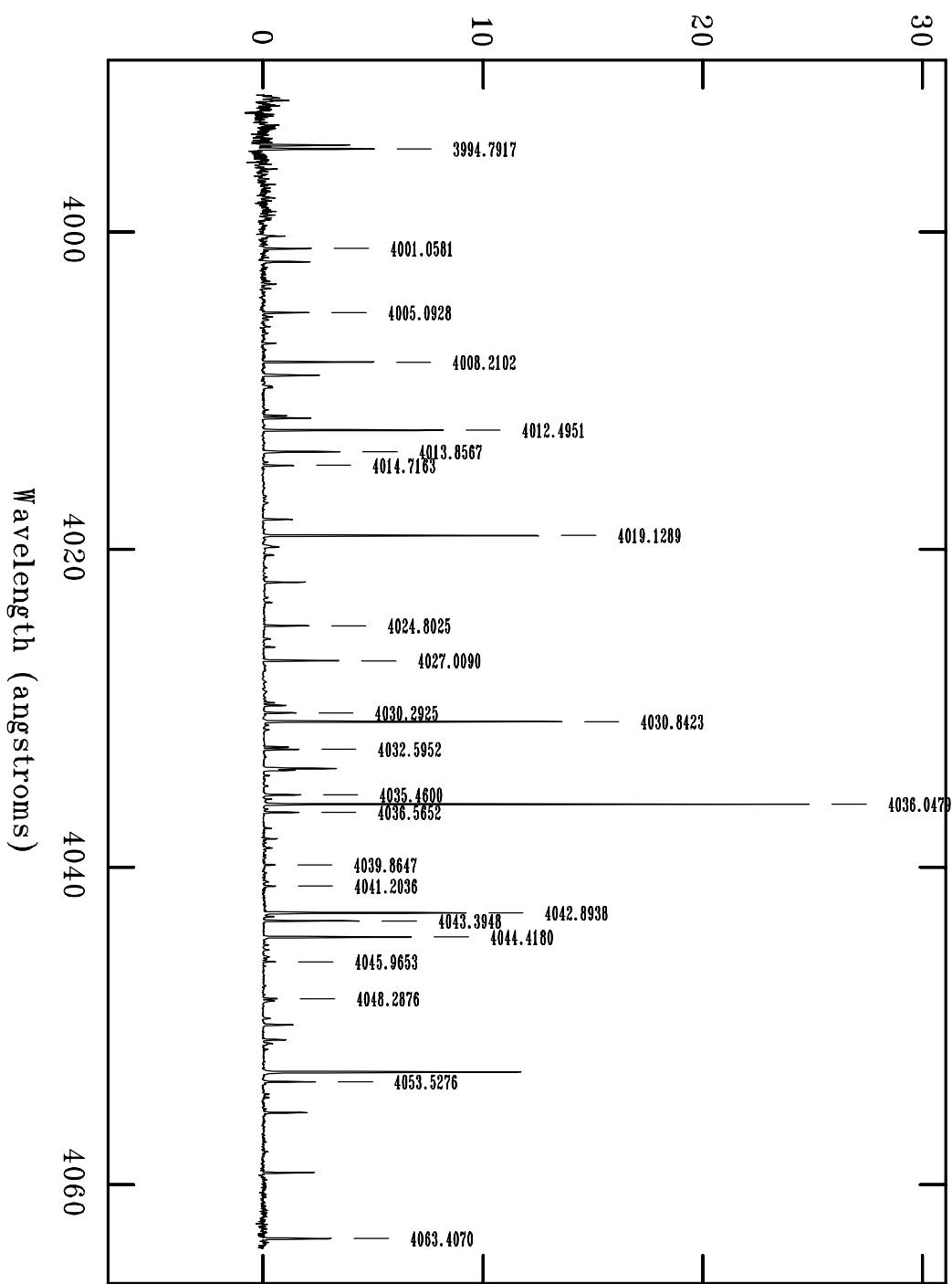


Fig. 75.— order 141

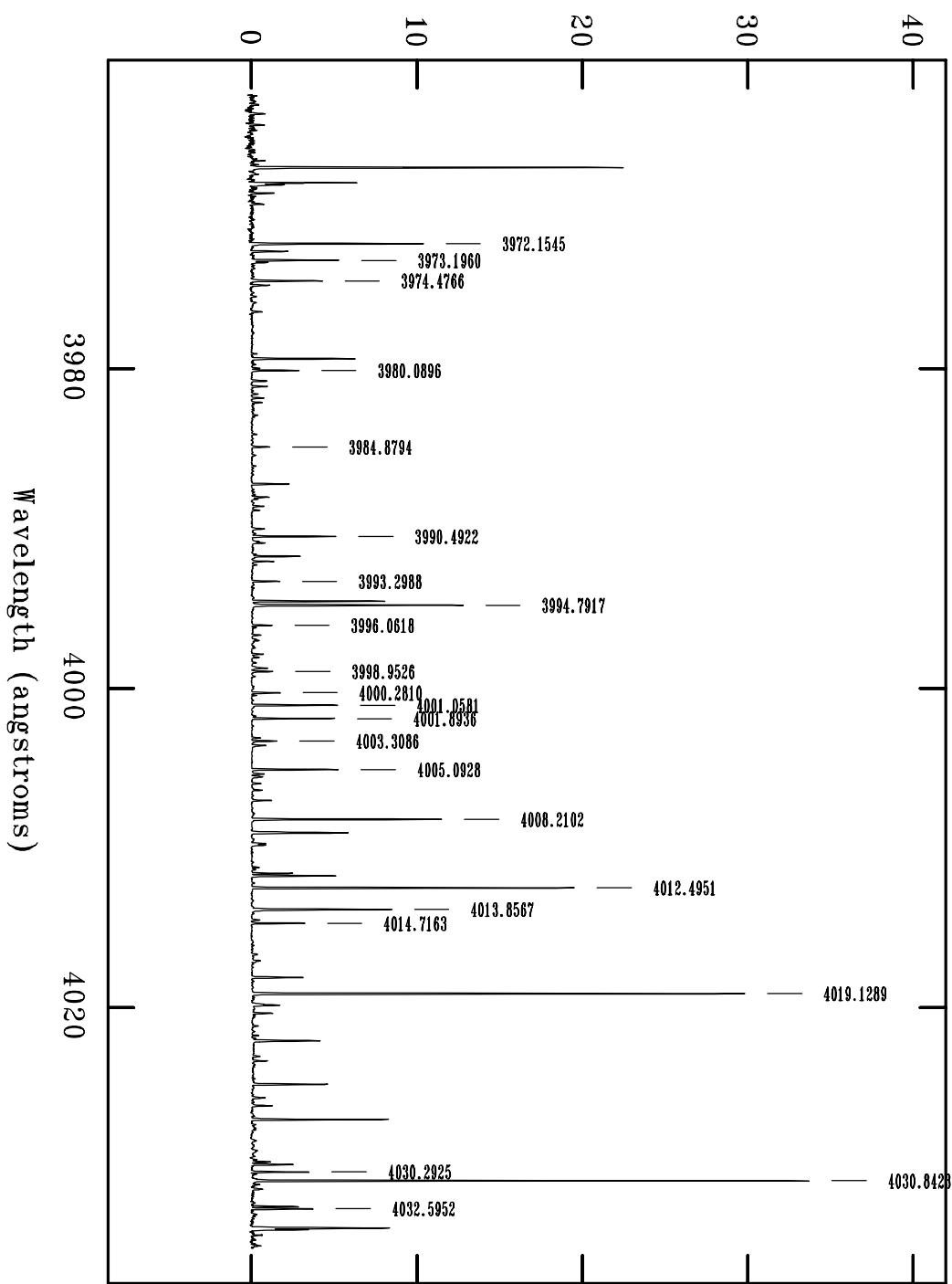


Fig. 76.— order 142

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 08:50:33 24-  
identify comp.136\_153.ap.0010 - Ap 10  
COMPARISON

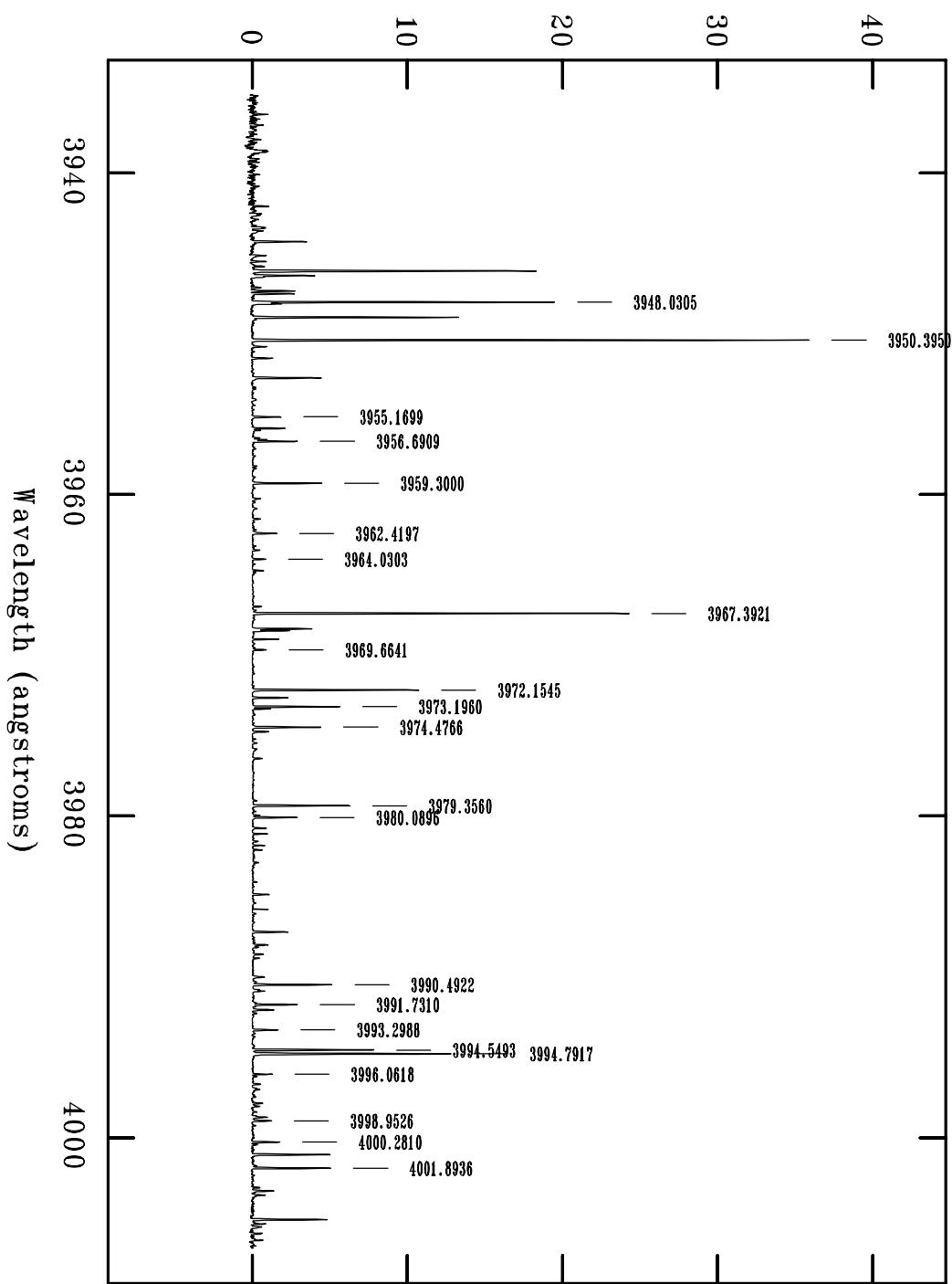


Fig. 77.— order 143

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 08:56:43 24-  
identify comp.136\_153.ap.0011 - Ap 11  
COMPARISON

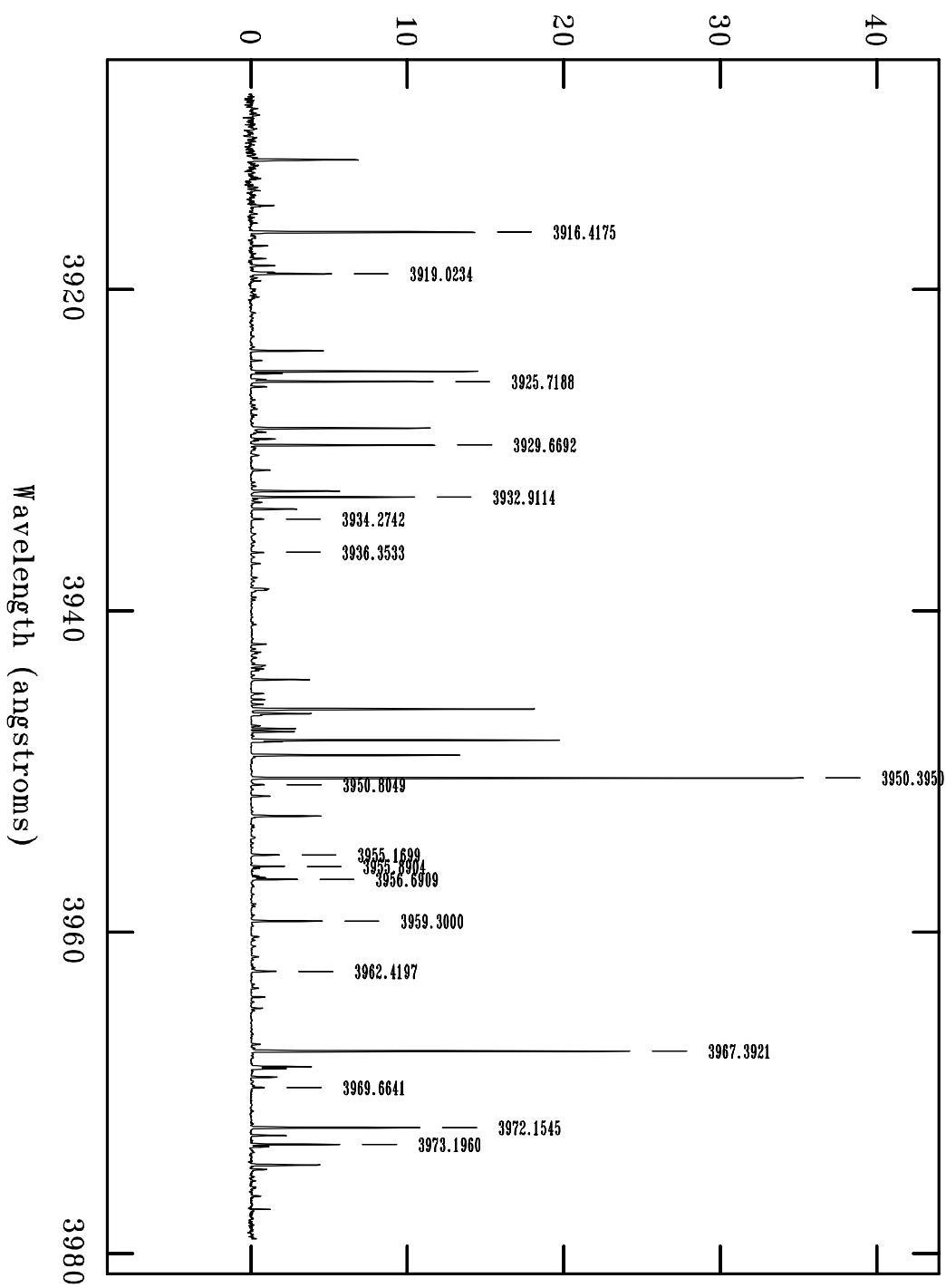


Fig. 78.— order 144

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 09:02:01 24-  
identify comp.136\_153.ap.0012 - Ap 12  
COMPARISON

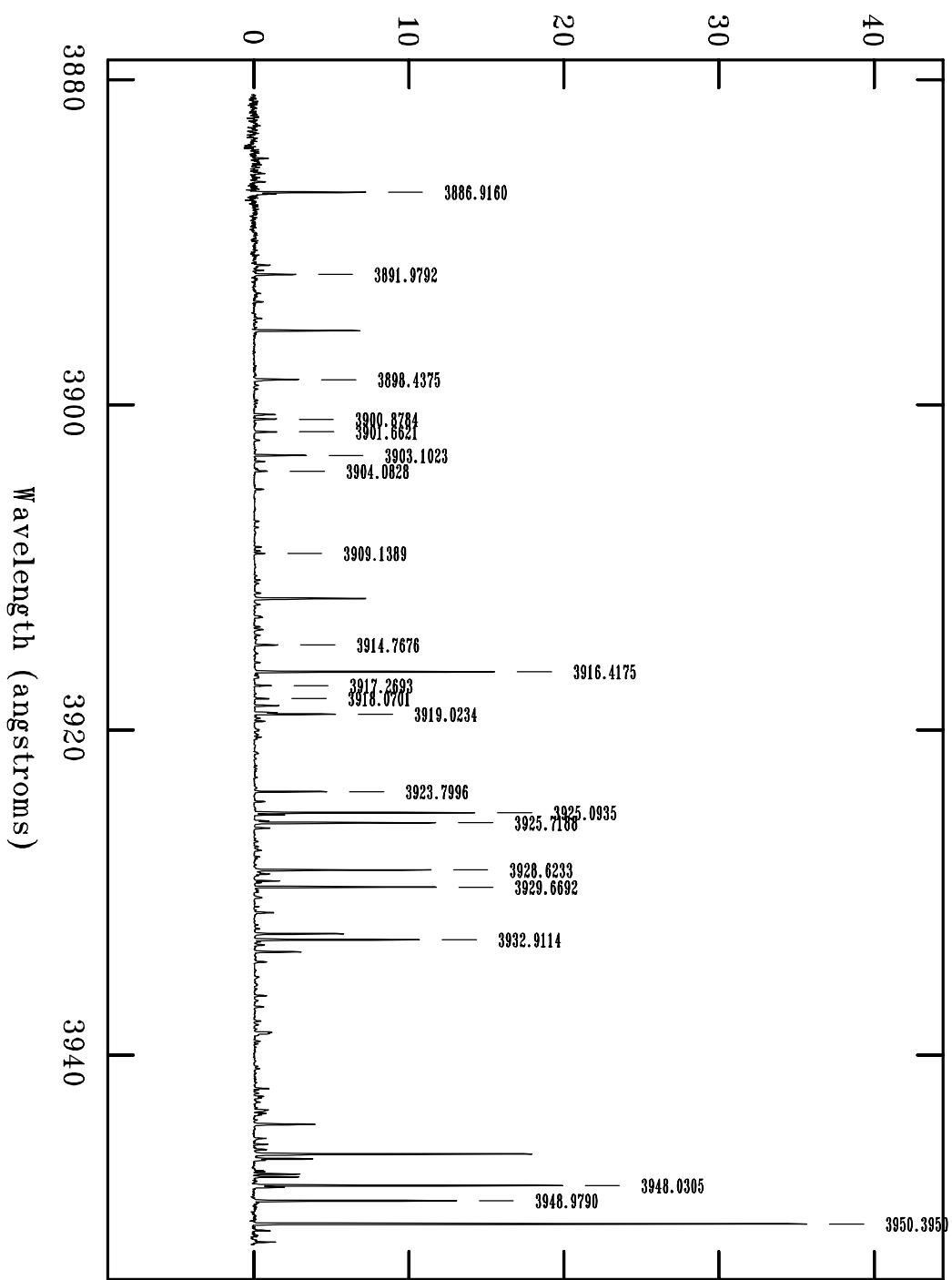


Fig. 79.— order 145

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 09:06:58 24-  
identify comp.136\_153.ap.0013 - Ap 13  
COMPARISON

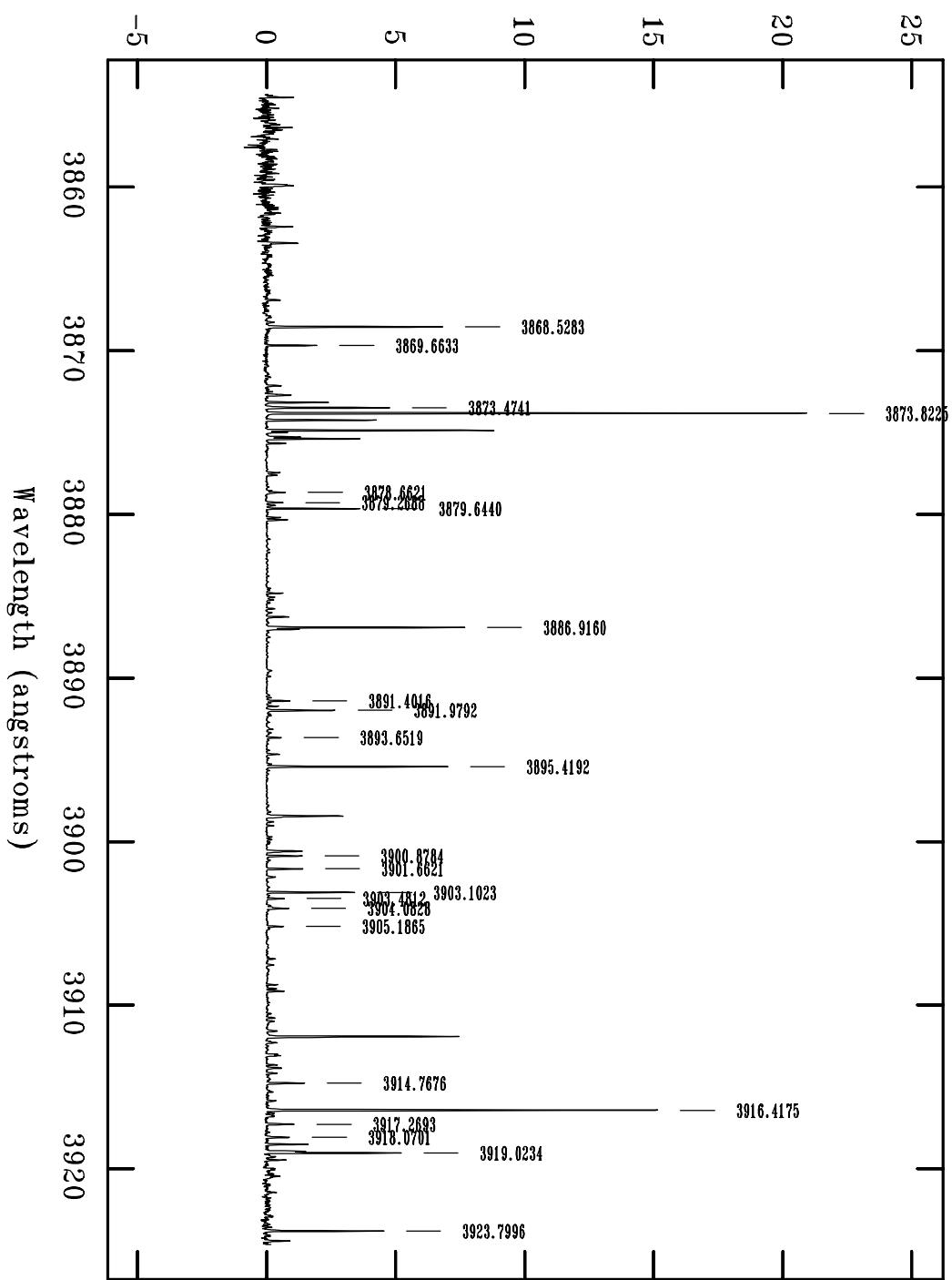


Fig. 80.— order 146

NOAO/IRAF V2.12.1-EXPORT masaaki@kabutogani.oao.nao.ac.jp Thu 09:12:30 24-  
identify comp.136\_153.ap.0014 - Ap 14  
COMPARISON

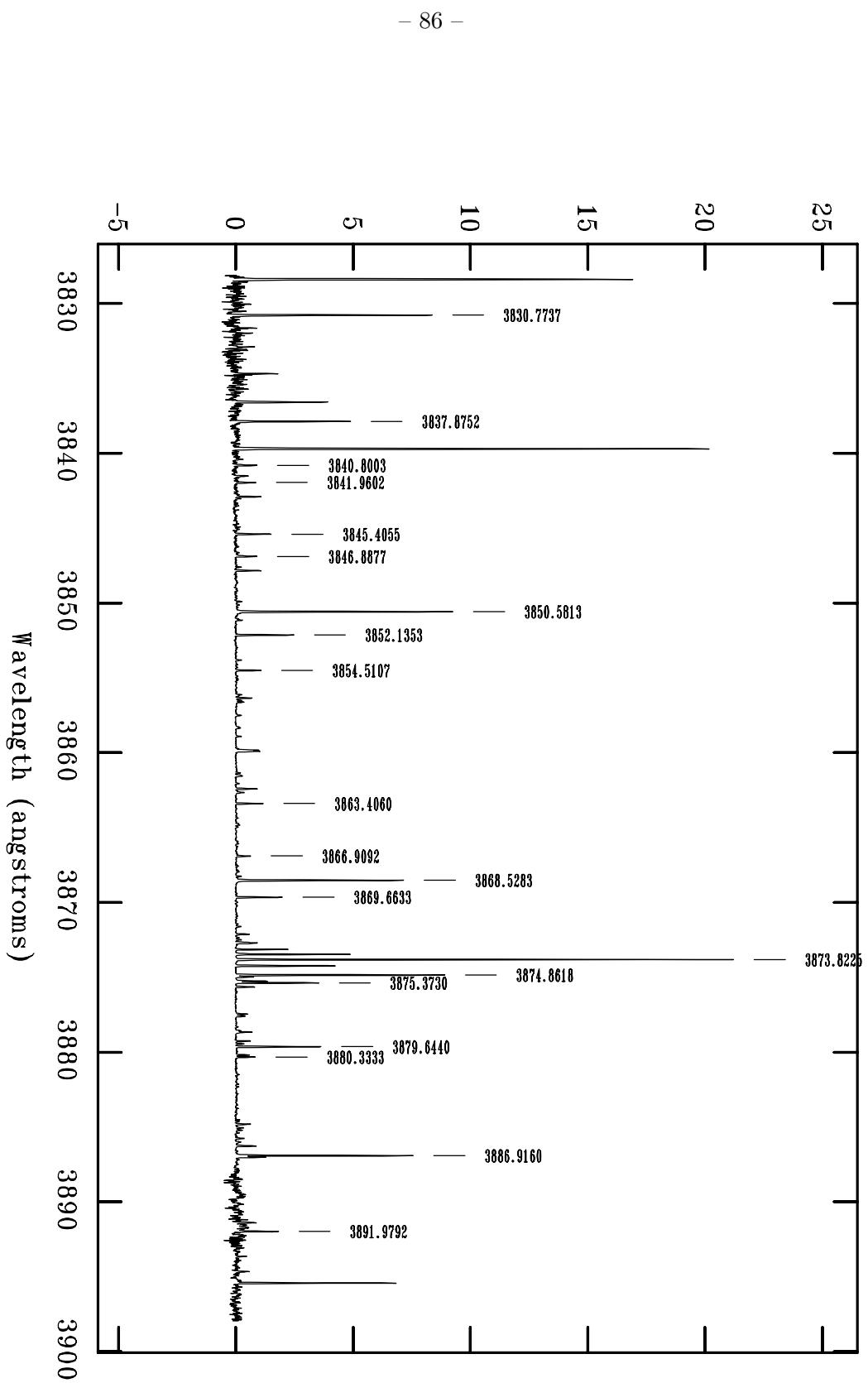


Fig. 81.— order 147