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An Atlas of the Thorium-Argon Spectrum for the ESO Echelle Spectrograph in the λλ 3400–9000 Å Region

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FOREWORD

This atlas is an extended and upgraded version of the "Atlas of the Thorium-Argon Spectrum for the ESO Echelle Spectrograph", ESO scientific report no. 2 in 1984. As the previous one it complements the Operating Manual of the ESO Echelle Spectrograph, CASPEC. It consists of two parts:

1. The first part is based on the CCD frames used for the previous atlas, which cover the spectral range 3700 - 9000 Å. The instrumental set-up was the following: 31.6 lines/mm echelle grating, 300 lines/mm cross disperser, short camera. The Thorium-Argon comparison lamp is from Juniper Co. England. ESO CCD # 3 was used for these exposures. It is an RCA device, with 320 × 512 pixels of 30 μm square.

   The following data are presented :

   a) Three plots showing the correlation of echelle orders with wavelength, with resolution and residuals respectively (Figs. 1, 2, 3) and a table showing the variation of the resolution with wavelength and order (Tab. 1).

   b) The photographic reproductions of 7 CCD frames (Figs. 4-10), taken with CASPEC at different positions of the cross-disperser to include the comparison spectrum from λ 3700 to λ 9000 Å. The orders numbers are also indicated.

   c) Plots of the individual echelle orders, where the coordinates are the relative intensity versus pixel number. The wavelength identifications are marked on the plots.

2. The second part is based on two new CCD frames and extends the wavelength identifications in the blue-UV side of the spectrum down to 3400 Å. For these exposures the CASPEC set-up was the following: 52.6 lines/mm echelle grating, 300 lines/mm cross-disperser, short camera. The detector was the UV sensitive ESO CCD # 7 (1). It is a GEC CCD with 385 × 576 pixels, 22 μm in size, which has been coated in the ESO lab to enchance the UV sensitivity (2). The data are presented in the same format as in the first part (Figs. 11-15 and Tab. 2).

Appendix 1 is a list of the saturated lines in the red part of the instrumental range that are not indicated in the plots. Appendix 2 contains the identifications of the lines used in the wavelength calibration. The term "W.M." indicates that the listed wavelength is the intensity weighted mean of two or more blended lines. The listing is also available on tape upon request.

In the plots of the spectral orders, the intensities have not been corrected for the blaze function or for variations in the pixel to pixel sensitivity of the CCD.

The accuracy of the wavelength scale has improved considerably with respect to the first edition of the Atlas. This has been made possible by the use of a new, more accurate source for the lines in the Thorium spectrum, the Atlas by Palmer and Engleman (3), in addition to the references used in the first (4, 5, 6, 7, 8). A draft atlas of line identifications

of the CASPEC spectra with the 52.6 lines/mm echelle prepared at La Silla by A. Gilliotte was also useful. The spectral orders were extracted and wavelength calibrated using the Echelle Data Reduction package inside MIDAS, the ESO Data Reduction Software running on the ESO VAX 8600 computers (9, 10). By using a first set of line identifications, a preliminary wavelength calibration was established, leading to additional identifications. The final list is the result of 3 of these iterations. The criteria for identification were the wavelength coincidence, the relative intensities and the energy levels as indicated in the references quoted above. The actual resolution of the plots is at most 2 pixels. Lines separated by less than 2 pixels have not been measured by the automatic procedure and are therefore not included in the Atlas. Fig. 3 and Fig. 13 show the residuals $(\lambda_m - \lambda_o)$ for the lines in the final calibration of typical frames taken with 31.6 and 52.6 echelle gratings respectively. For the calibration of the spectra taken with the 31.6 lines/mm echelle, the RMS of the residuals varies from 0.018 Å in the blue to 0.041 Å in the red; this corresponds to about 1/7 of pixel size in Å. For the 52.6 lines/mm echelle the RMS is about 0.013 Å at 4000 Å corresponding to 1/7 of pixel size in Å

The Atlas has been conceived mainly as an aid to the users of the ESO Echelle Spectrograph. When comparing the plots with spectra taken at the telescope, one should keep in mind that small shifts in the central wavelengths of the orders can be introduced by a change in the inclination of the echelle or a difference in the mounting of the CCD between different runs.

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PART 1

31.6 lines/mm echelle

$\lambda\lambda$ 3700 - 9000 Å

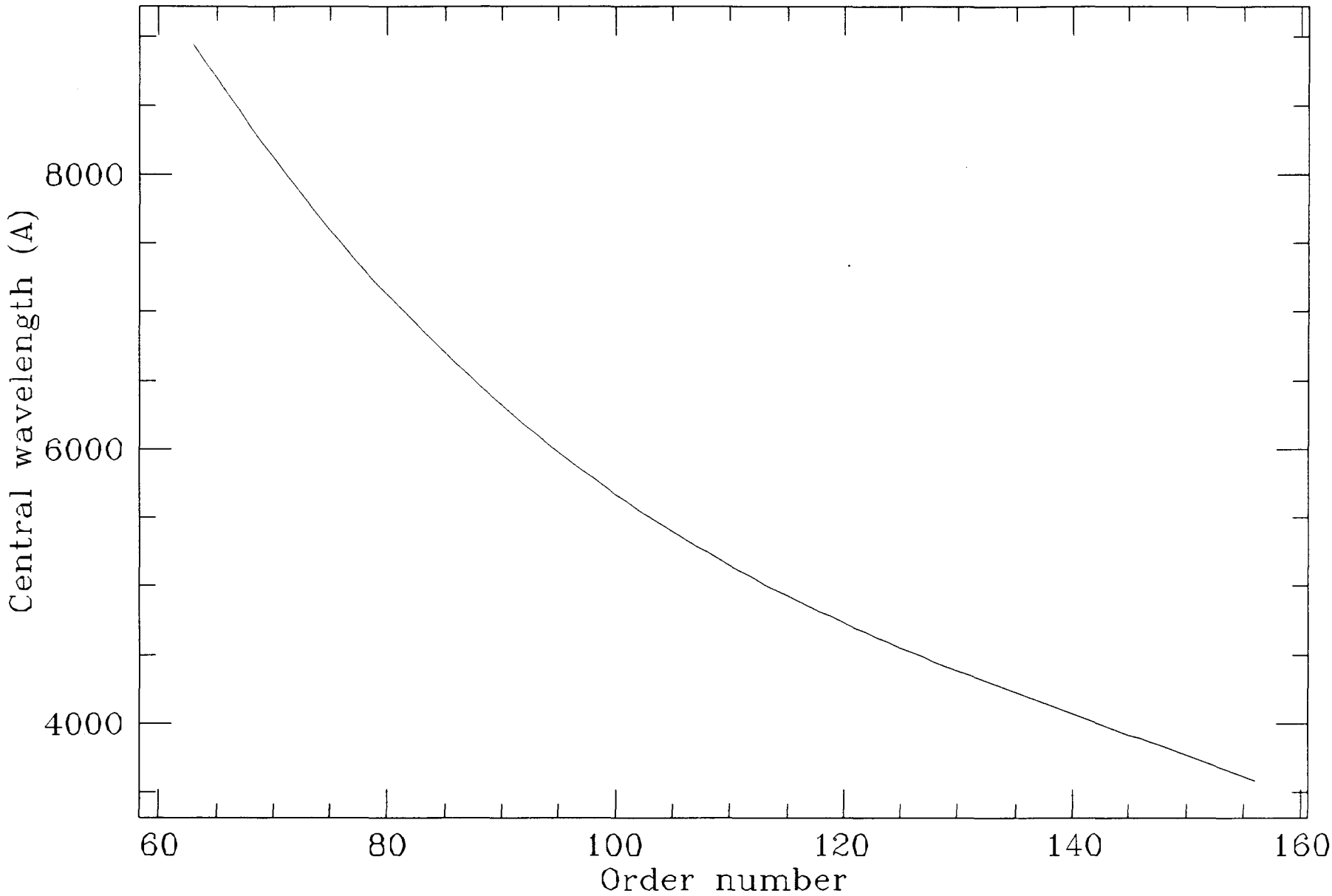

Central wavelength (A)
8000
6000
4000
60
80
100
120
140
160
Order number

Fig. 1

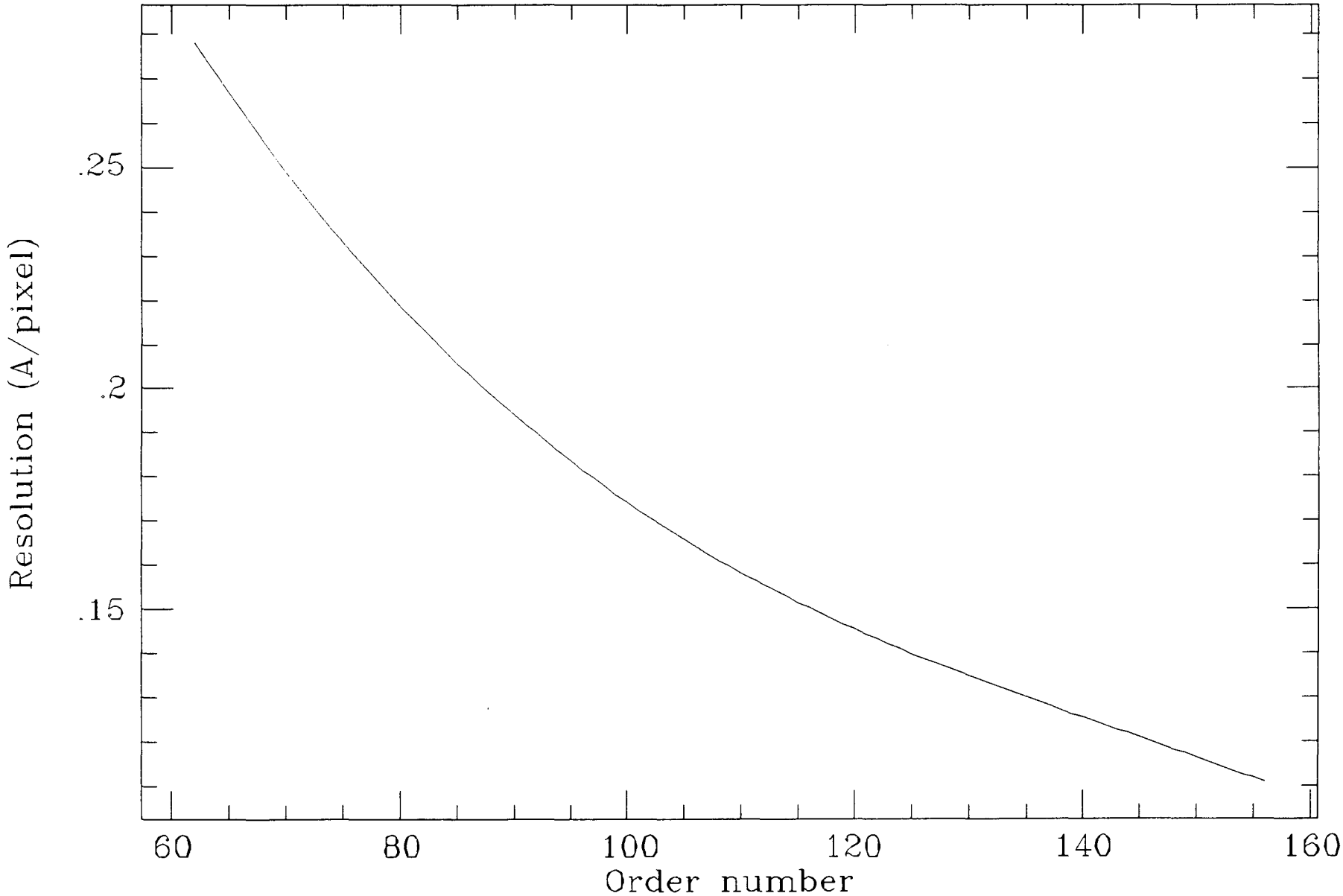


Fig. 2

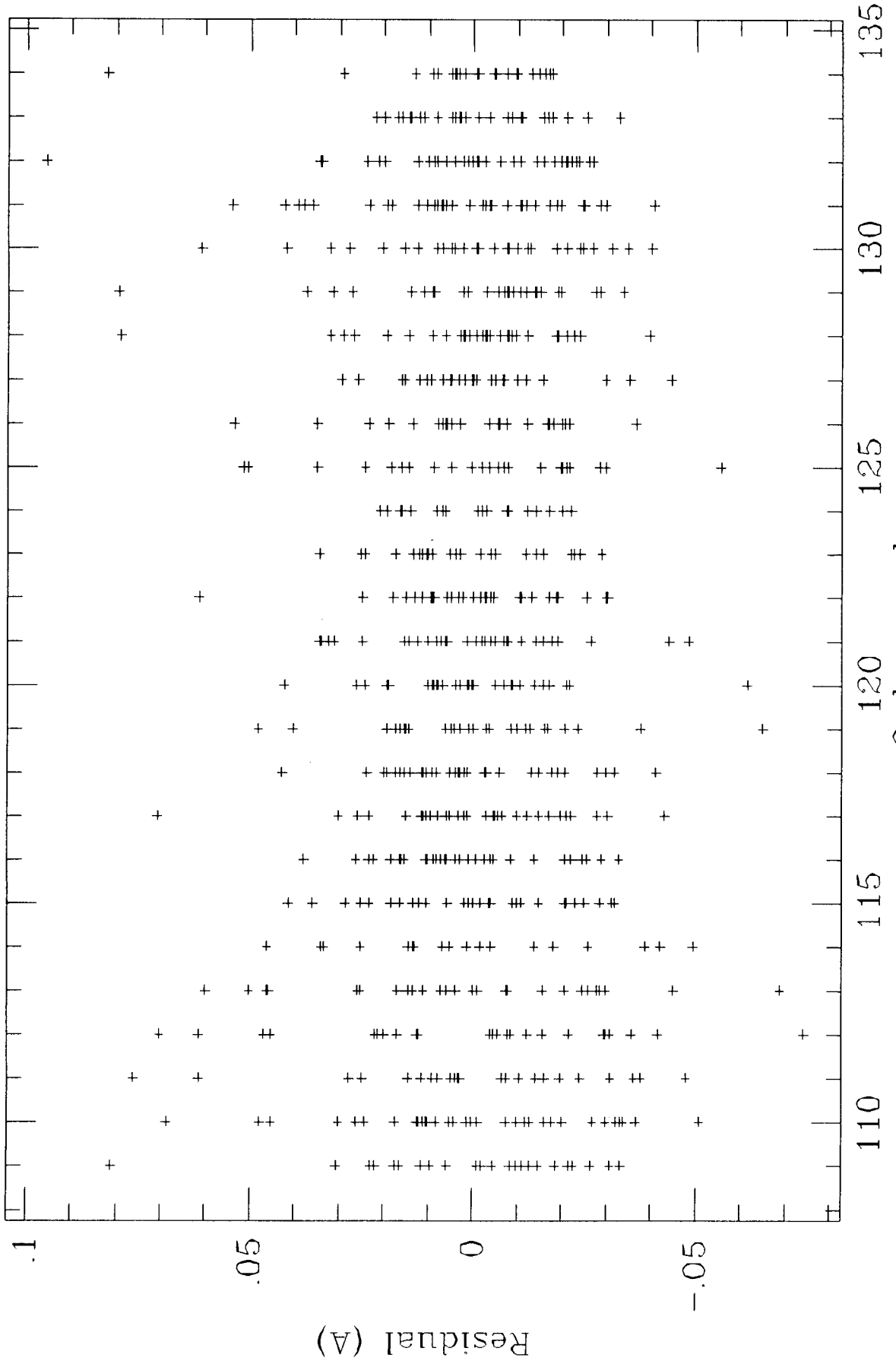


Fig. 3

Order	**Resolution** (Å/pixel)	**Central Wavelength** (Å)
150	0.117± 0.01	3768
140	0.125	4070
130	0.135	4381
120	0.145	4732
110	0.158	5152
100	0.174	5671
90	0.194	6319
80	0.217	7126
70	0.249	8122

Table 1: Resolution for various orders

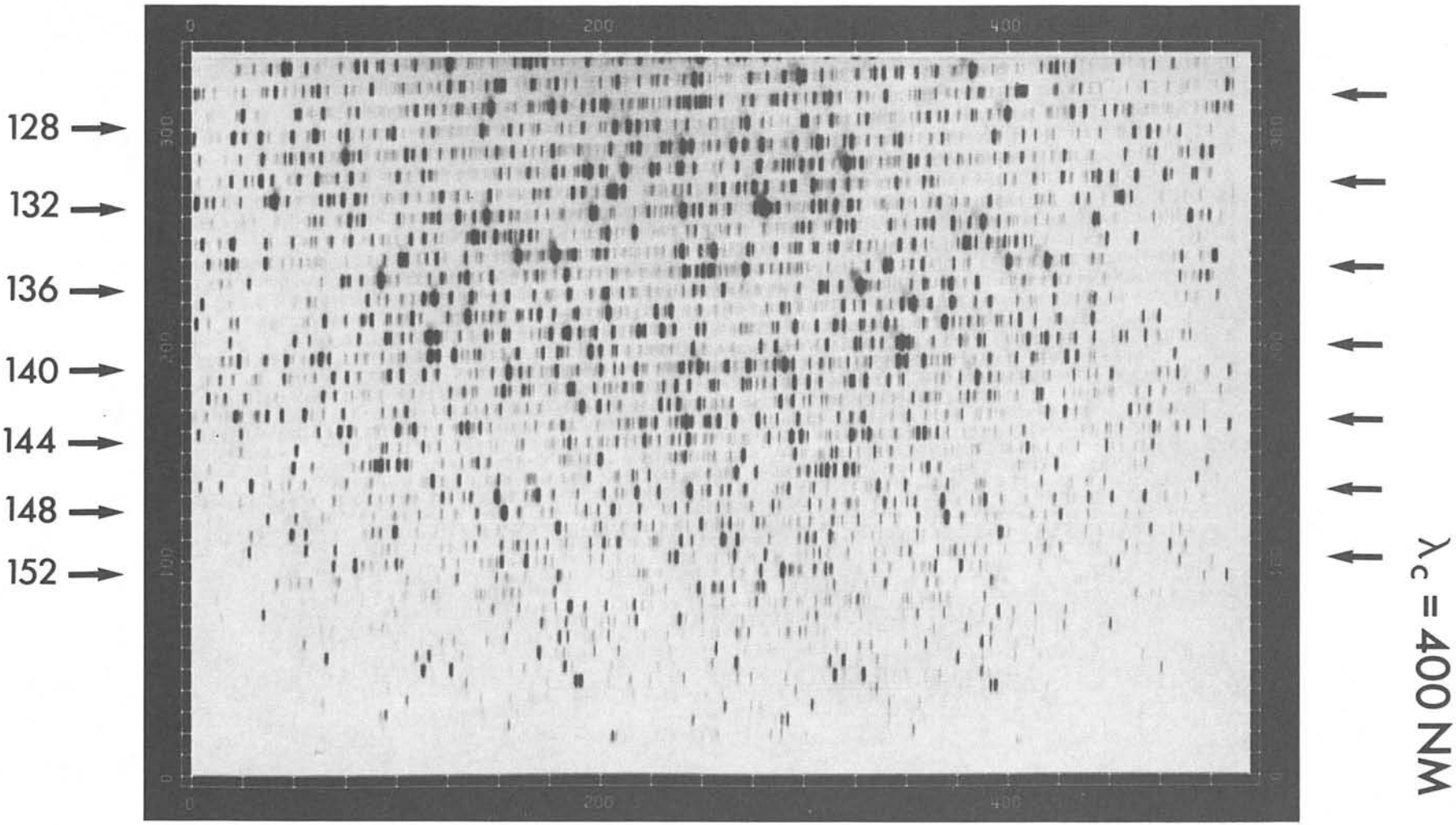
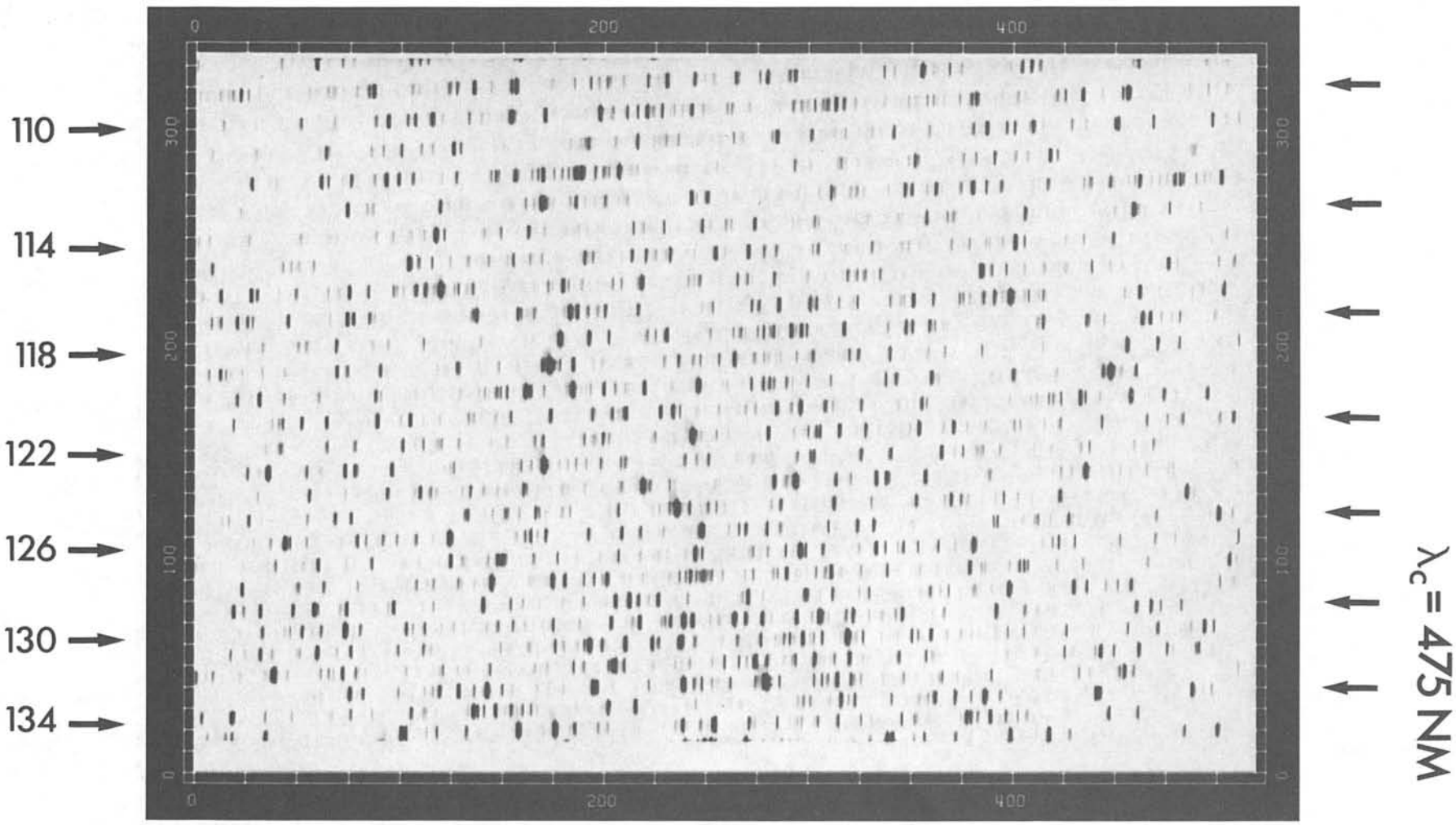


Fig. 4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114
118
122
126
130
134
0
200
400
300
200
100
0
λ_c = 475 NM

Fig. 5

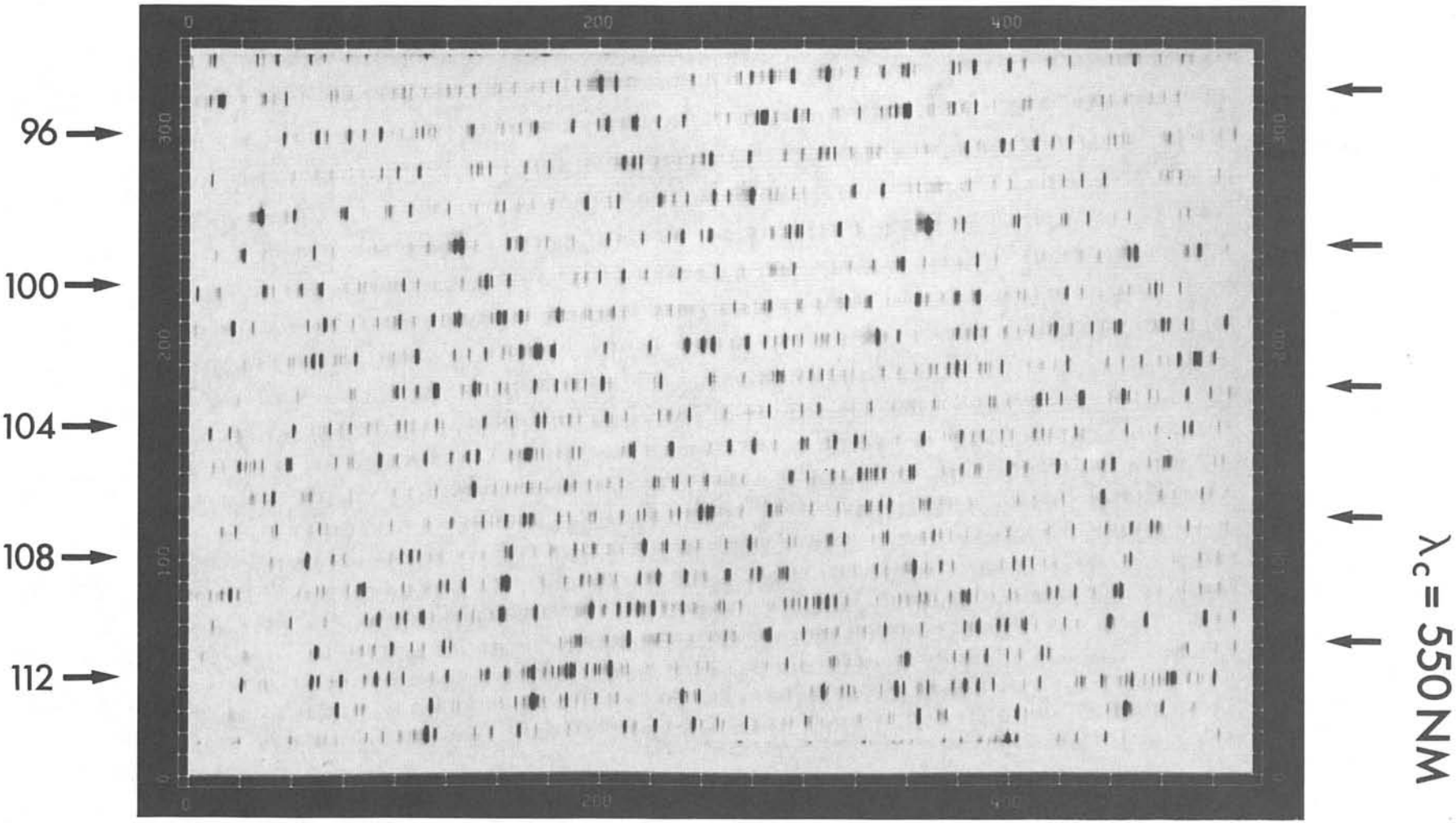

Fig. 6

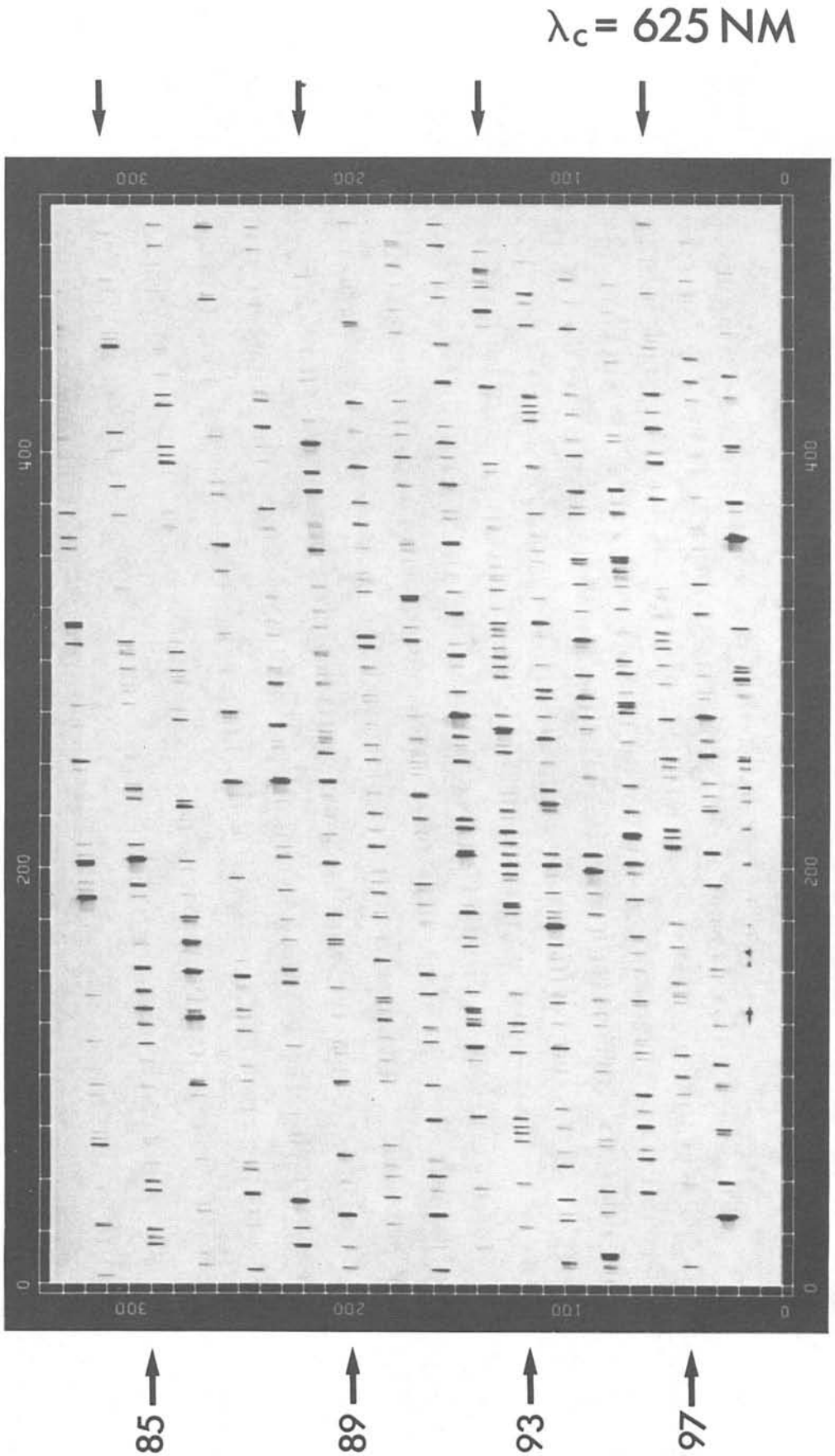

Fig. 7

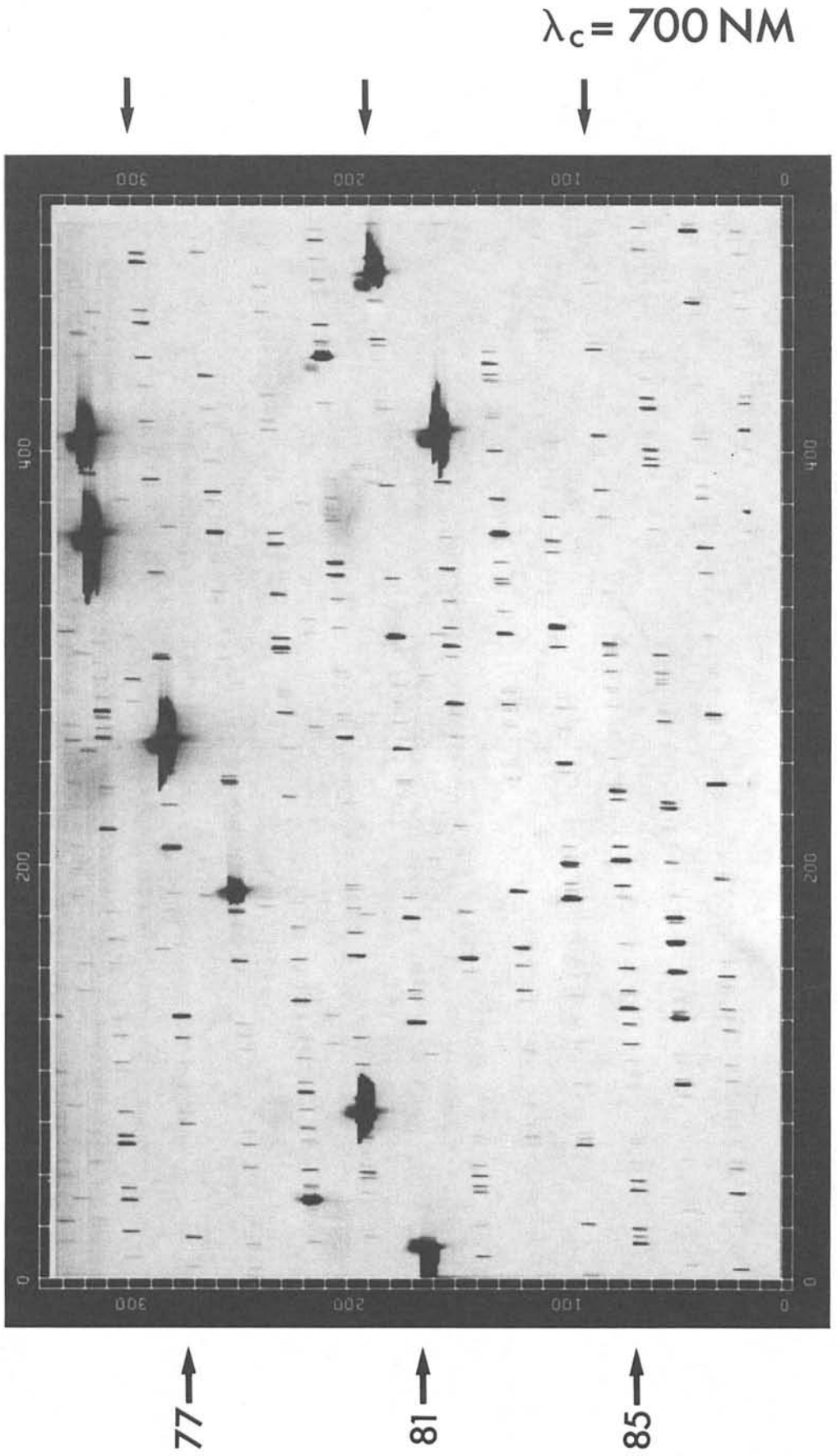

Fig. 8

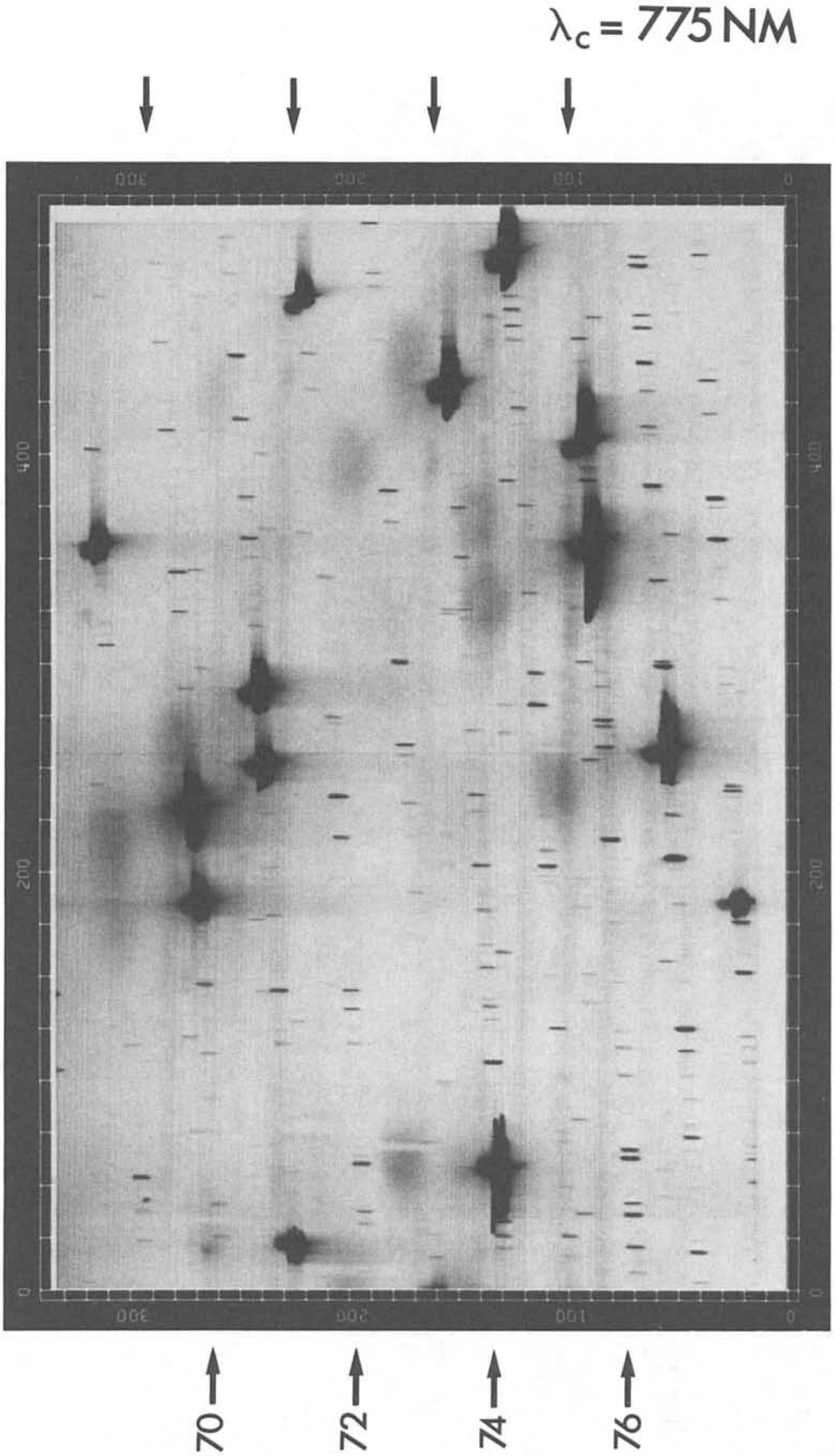

Fig. 9

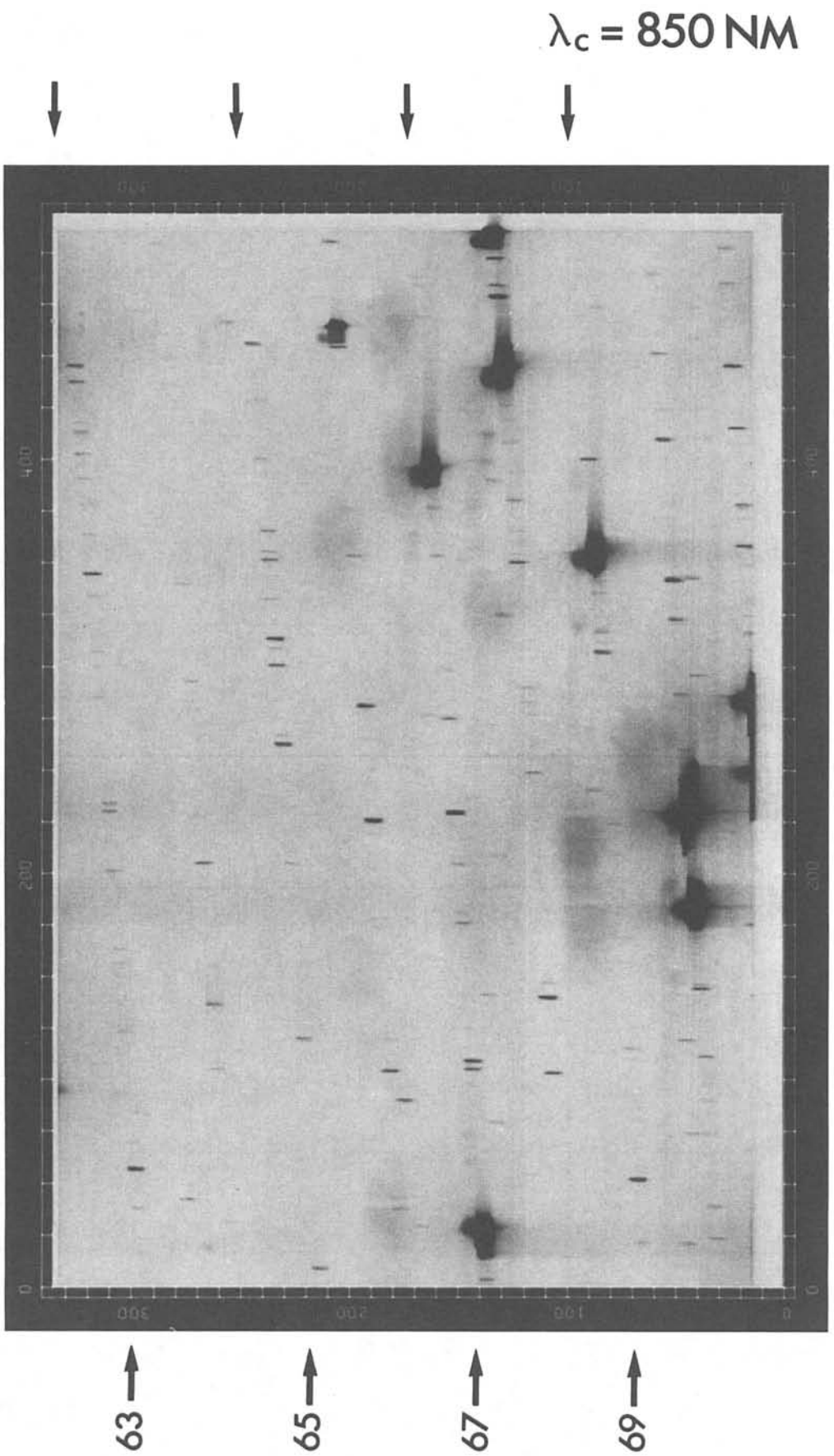

Fig. 10

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3642.249
3639.833
3635.943
3634.582
FLUX
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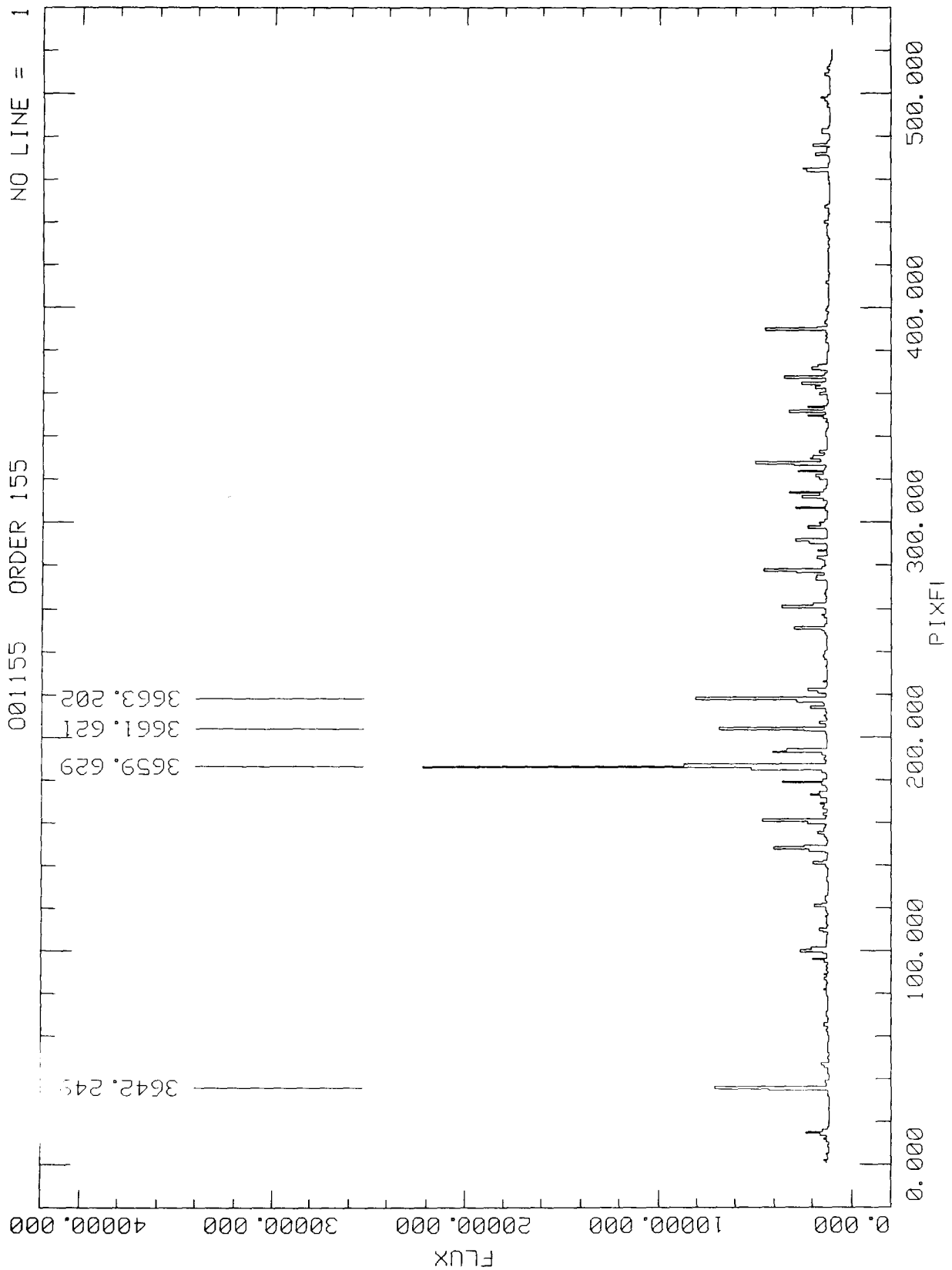
10000.000
20000.000
30000.000
40000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000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3663.202
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10000.000
20000.000
30000.000
40000.000
PIXFI
0.000
100.000
200.000
300.000
400.000
500.000

001154 ORDER 154
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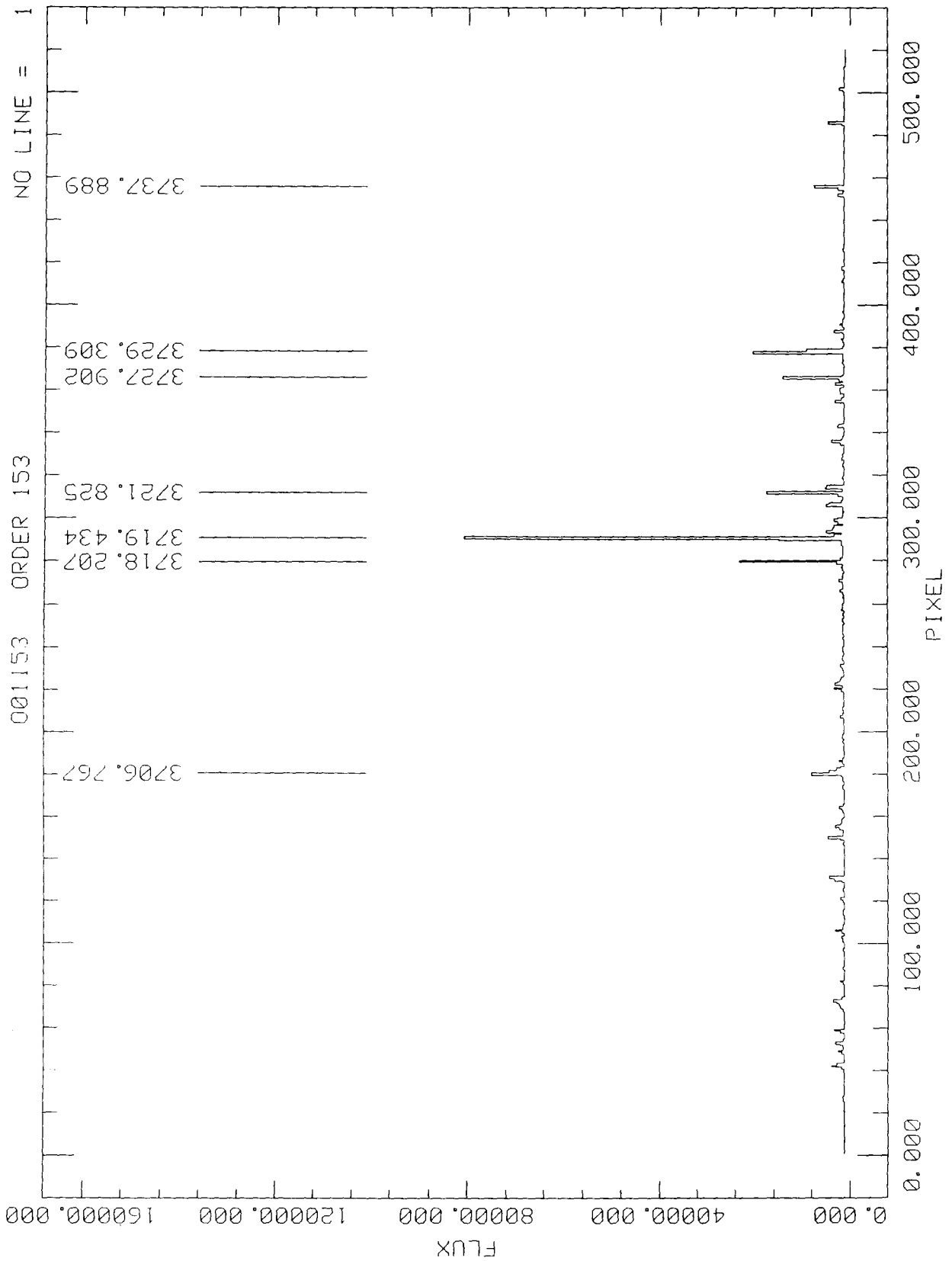
3700.978
3694.178
3692.566
3691.876
3690.623
3682.545
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
0.000
10000.000
20000.000
30000.000
40000.000
FLUX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3721.825
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3718.207
3706.767
FLUX
160000.000
120000.000
80000.000
40000.000
0.000
PIXEL
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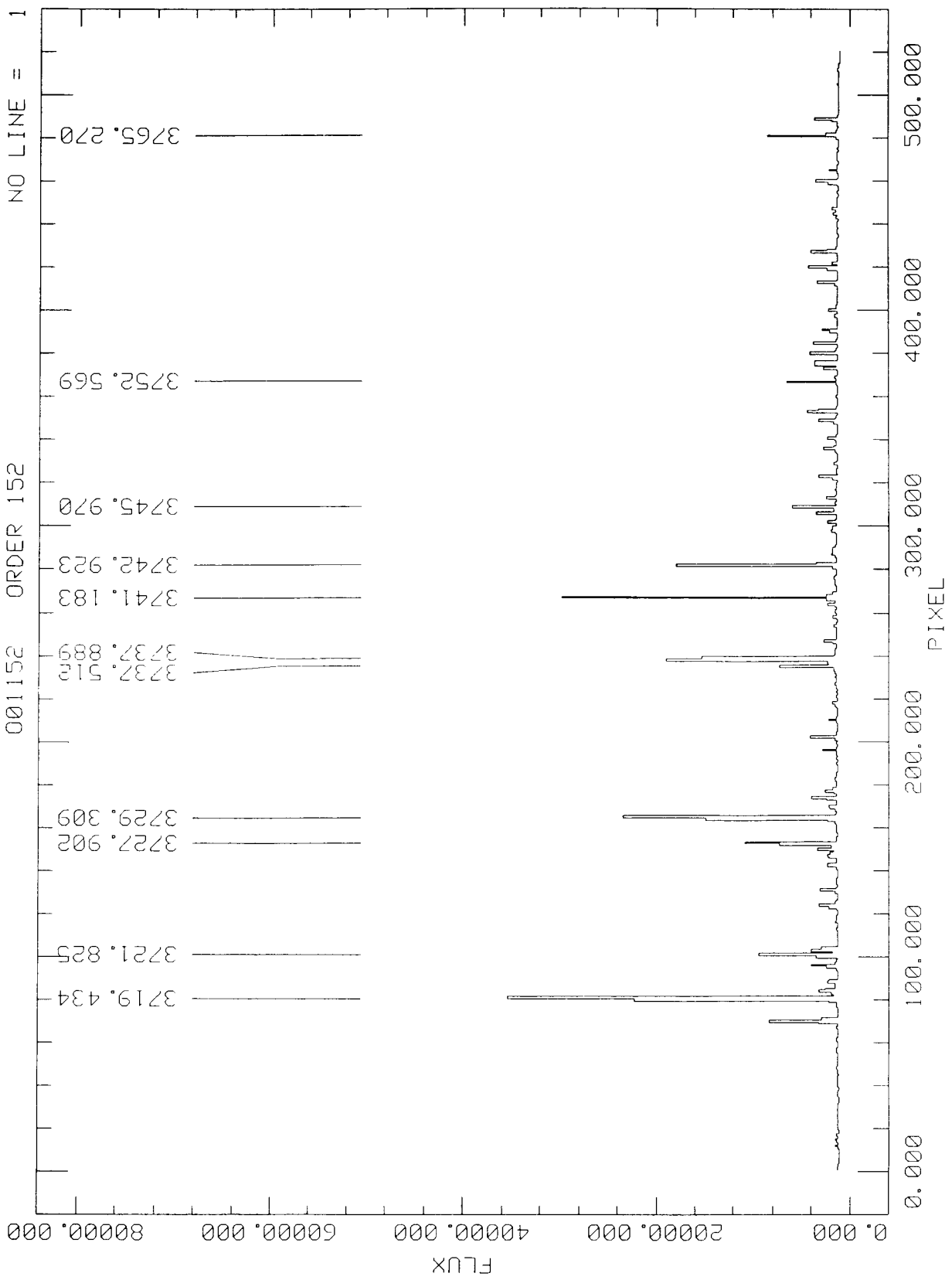
500.000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3727.902
3721.825
3719.434
0.000
100.000
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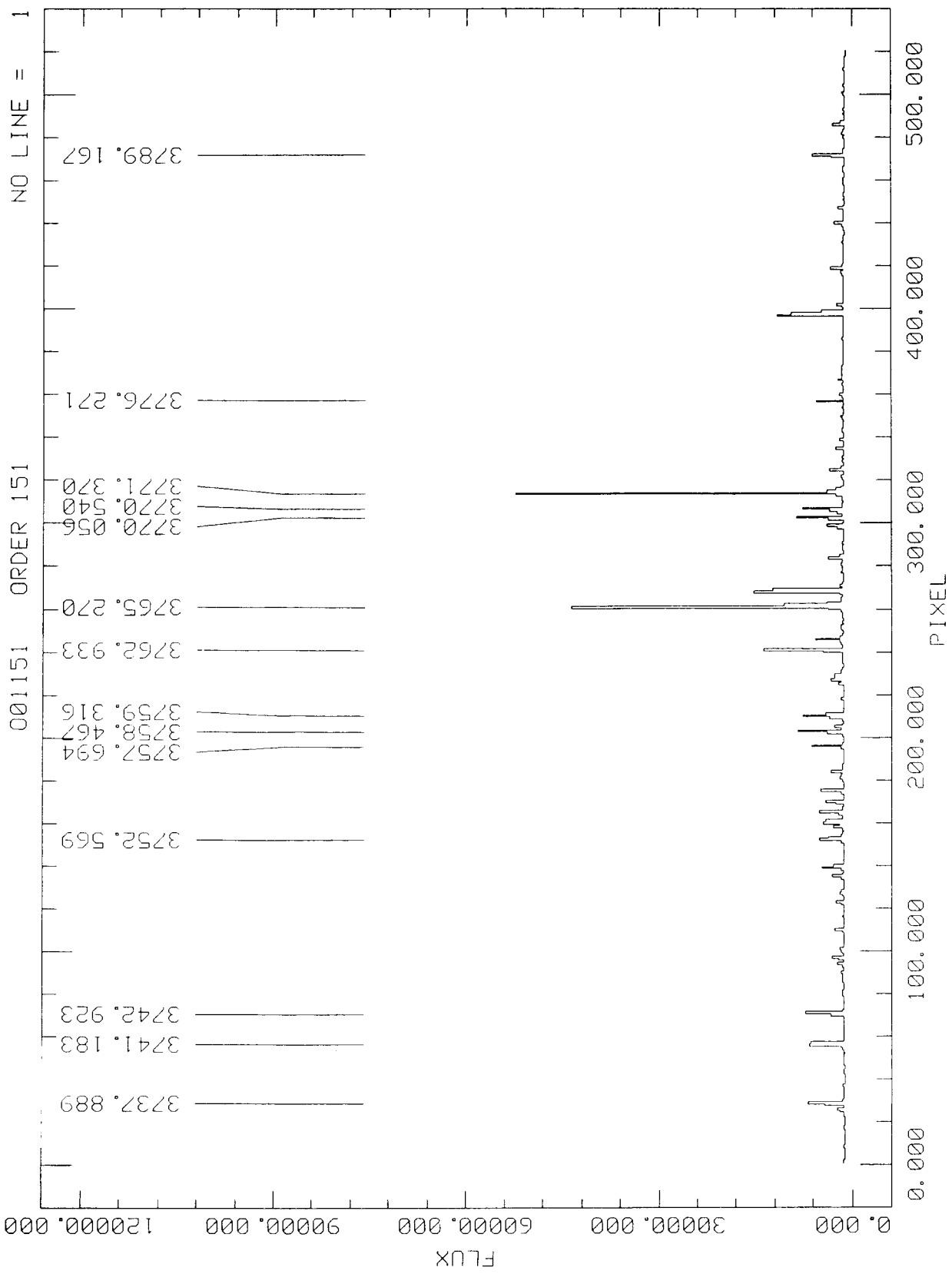
80000.000
FLUX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3757.694
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FLUX
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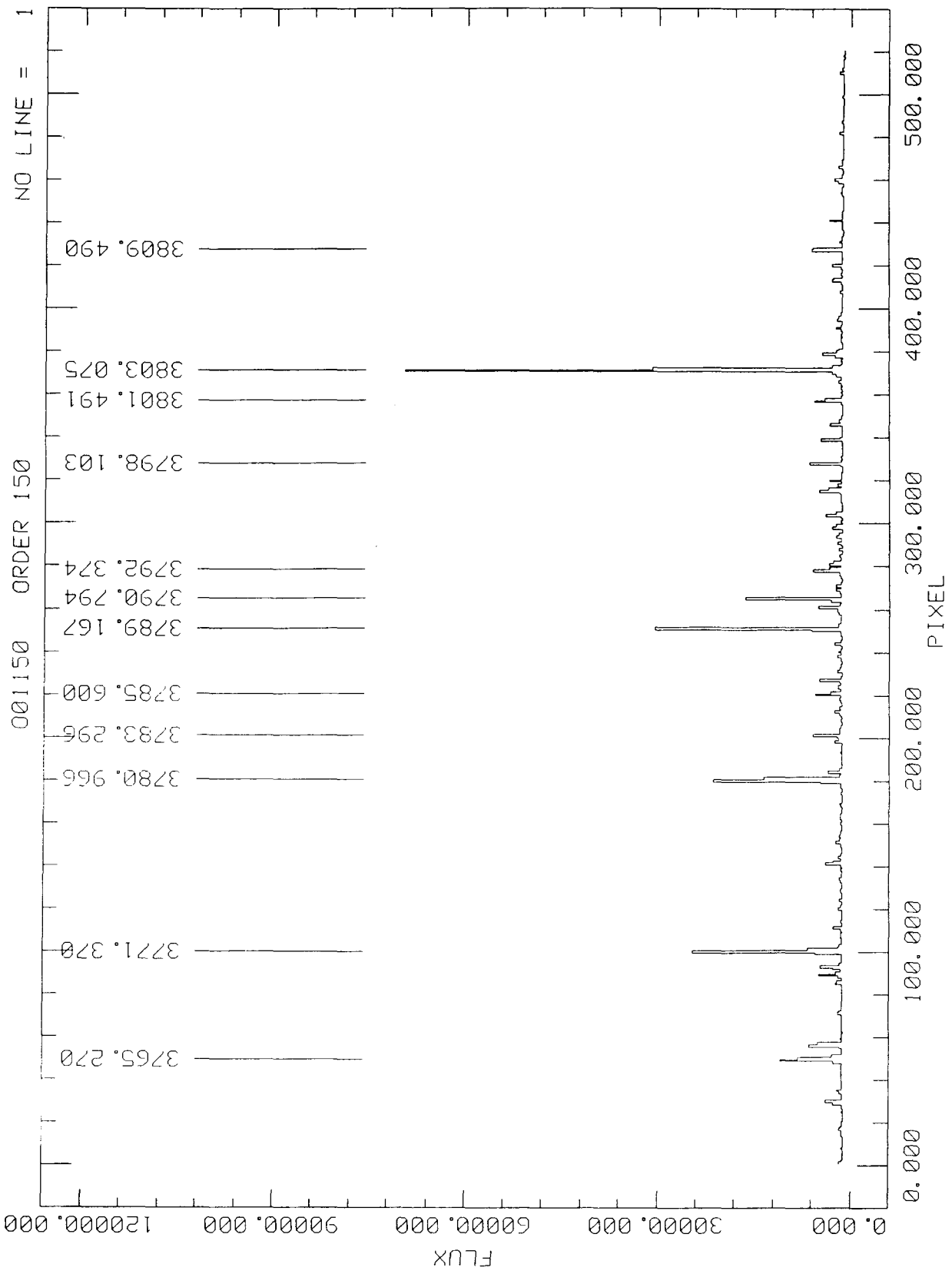
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3801.491
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3780.966
3771.378
3765.270
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30000.000
60000.000
90000.000
120000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000

FLUX
0.000
40000.000
80000.000
120000.000
160000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
3789.167
3801.491
3803.075
3807.874
3809.490
3810.995
3813.067
3818.685
3820.792
3825.111
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3837.875
3839.700
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40000.000
80000.000
120000.000
160000.000
PIXEL
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300.000
400.000
500.000
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3830.773
3834.679
3836.572
3837.875
3839.700
3840.800
3841.960
3842.896
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3850.570
3852.135
3854.510
3859.839
3868.530
001148 ORDER 148
NO LINE = 1

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80000.000
120000.000
160000.000
PIXEL
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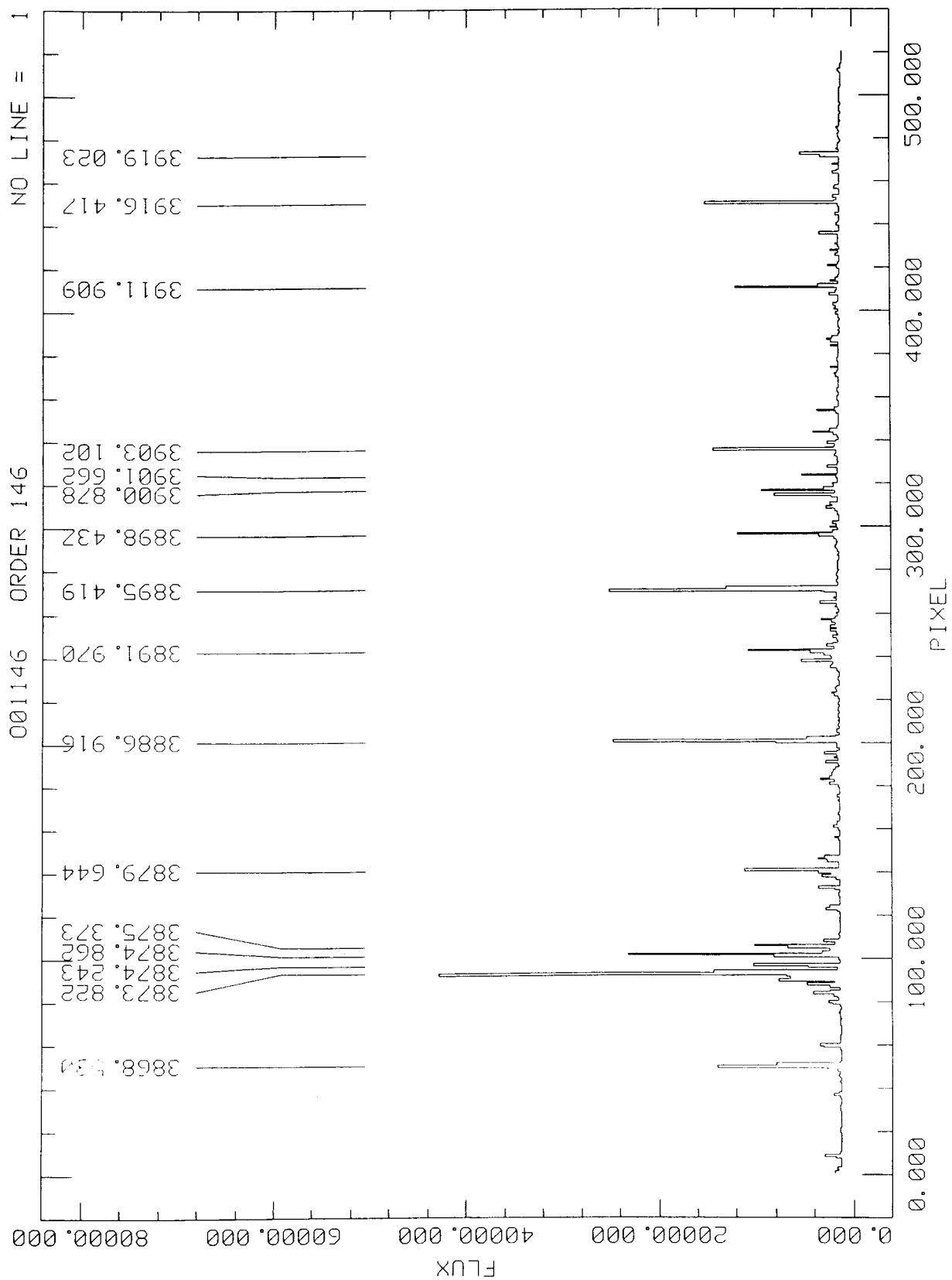
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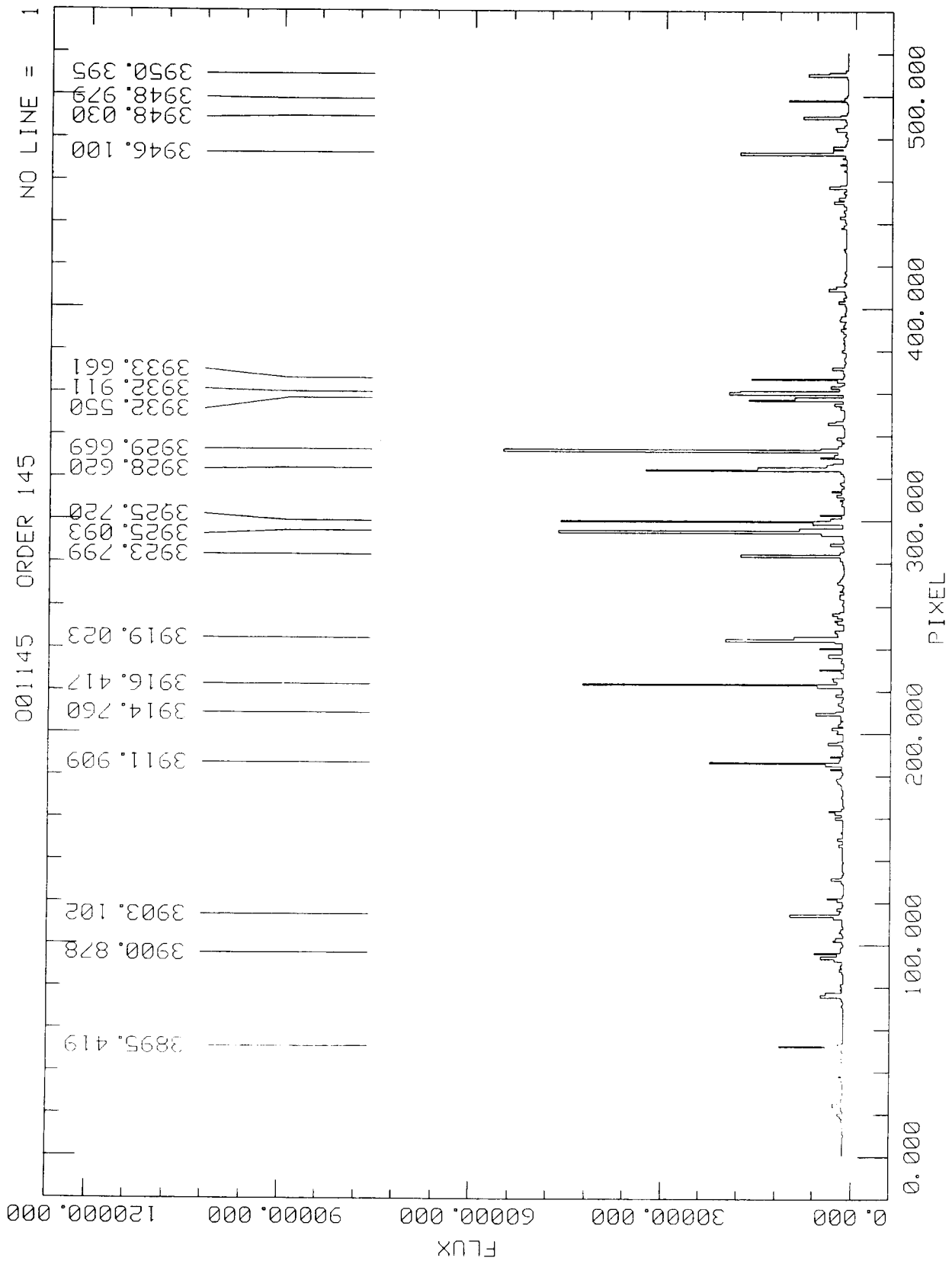
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3911.909
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3895.419
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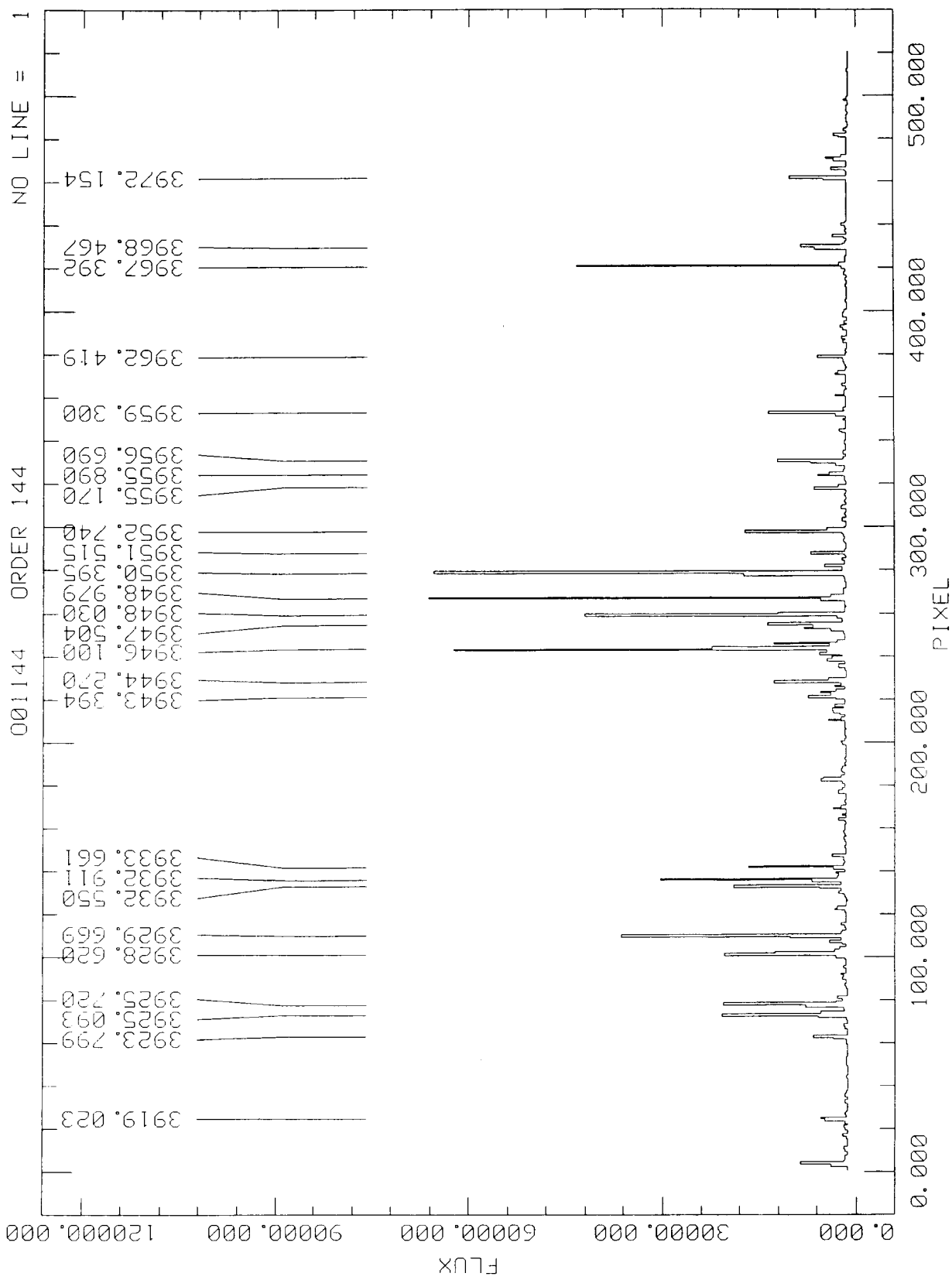
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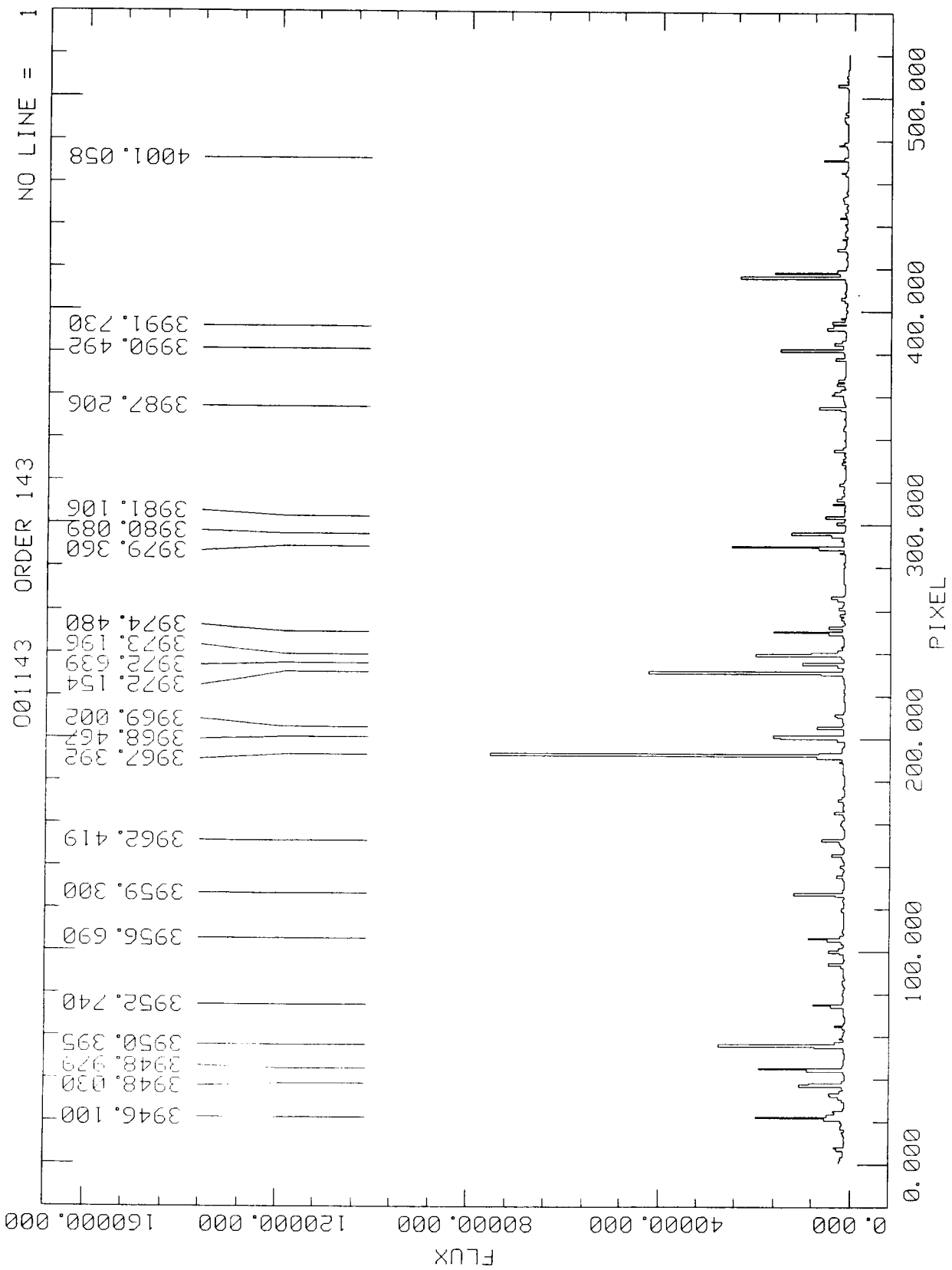
PIXEL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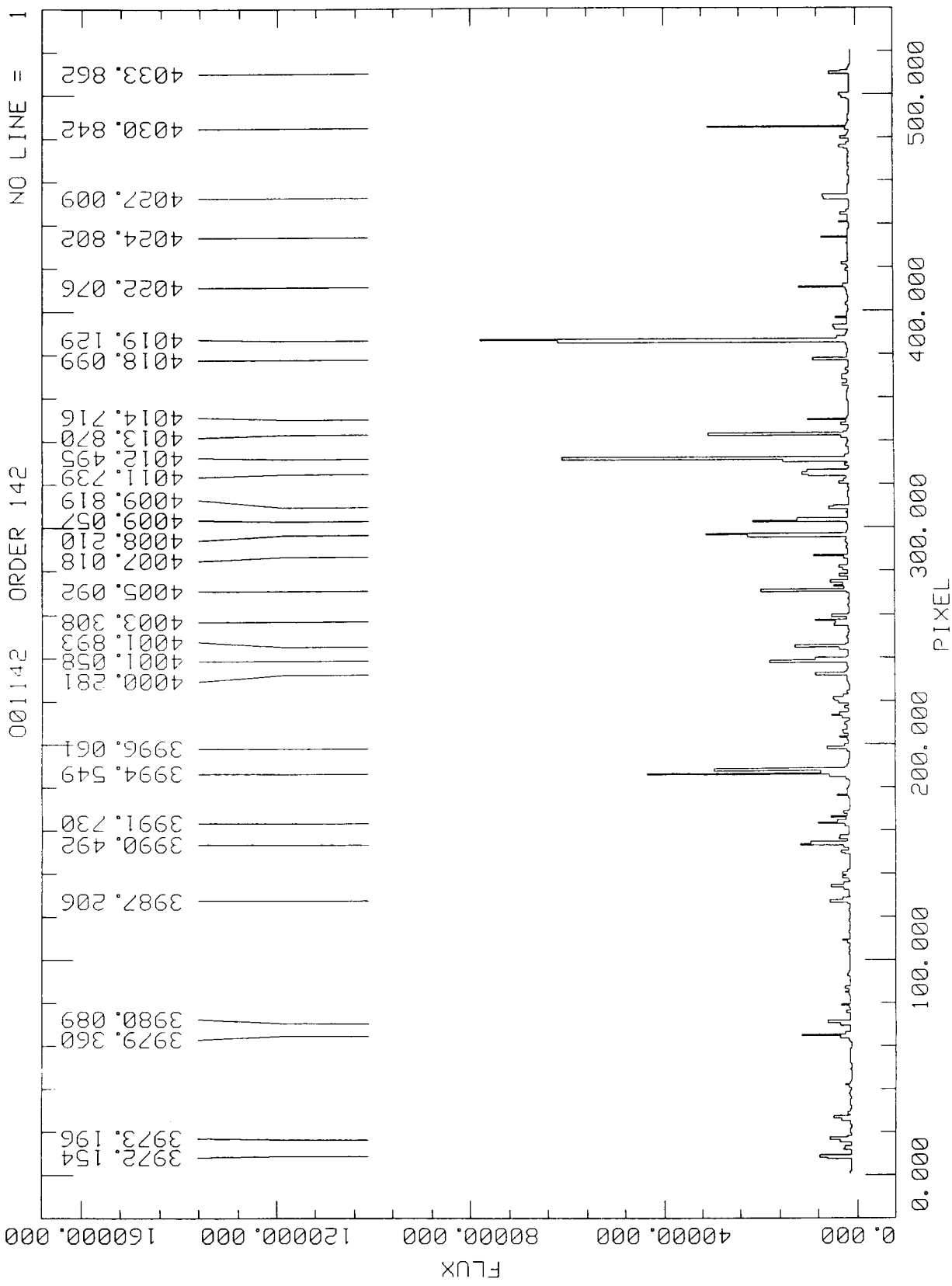
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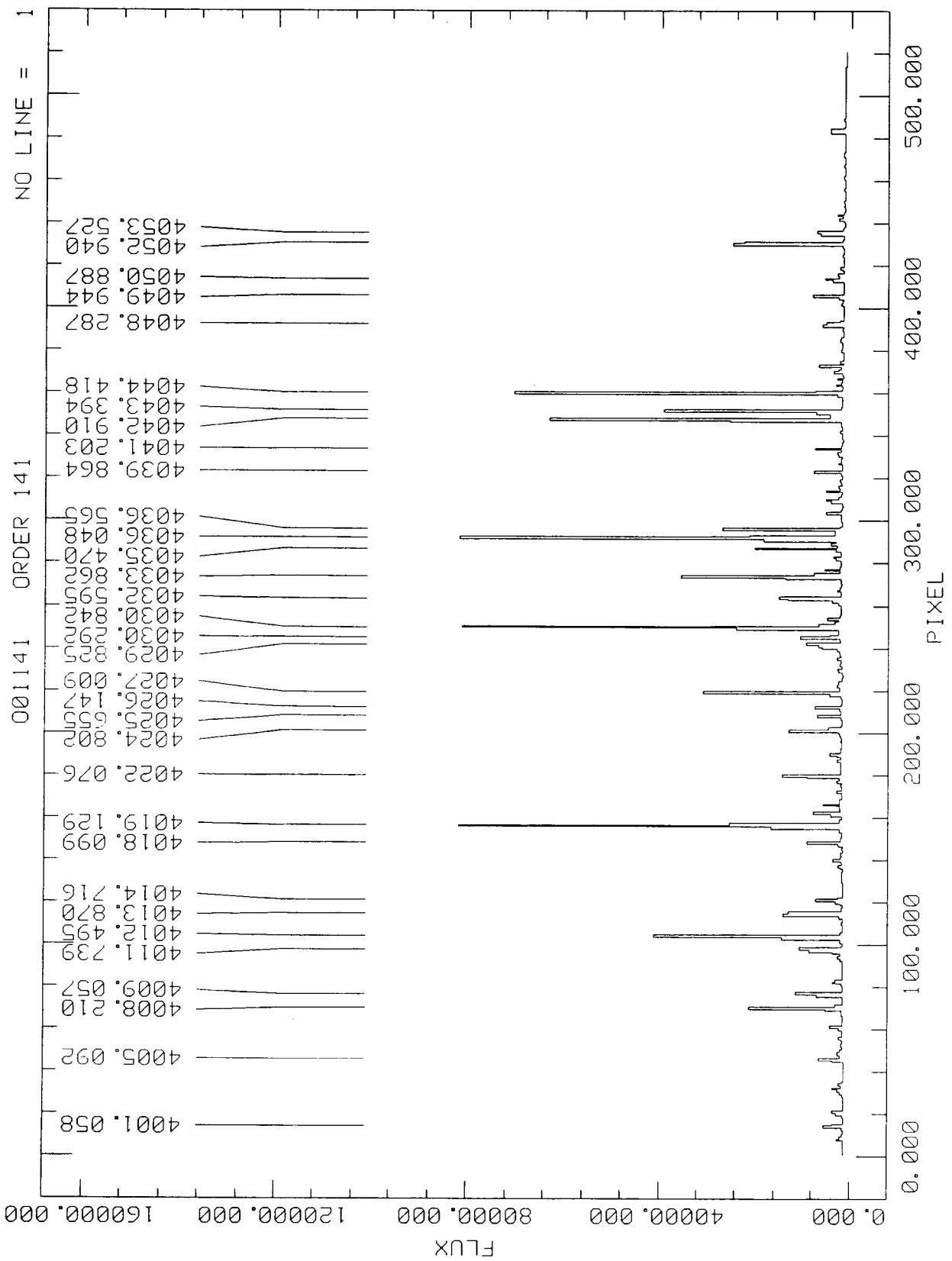
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40000.000
80000.000
120000.000
160000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000

FLUX
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40000.000
80000.000
120000.000
160000.000
PIXEL
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4083.468
4085.042
4085.434
4086.520
001140 ORDER 140
NO LINE = 1

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80000.000
120000.000
160000.000
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400.000
500.000
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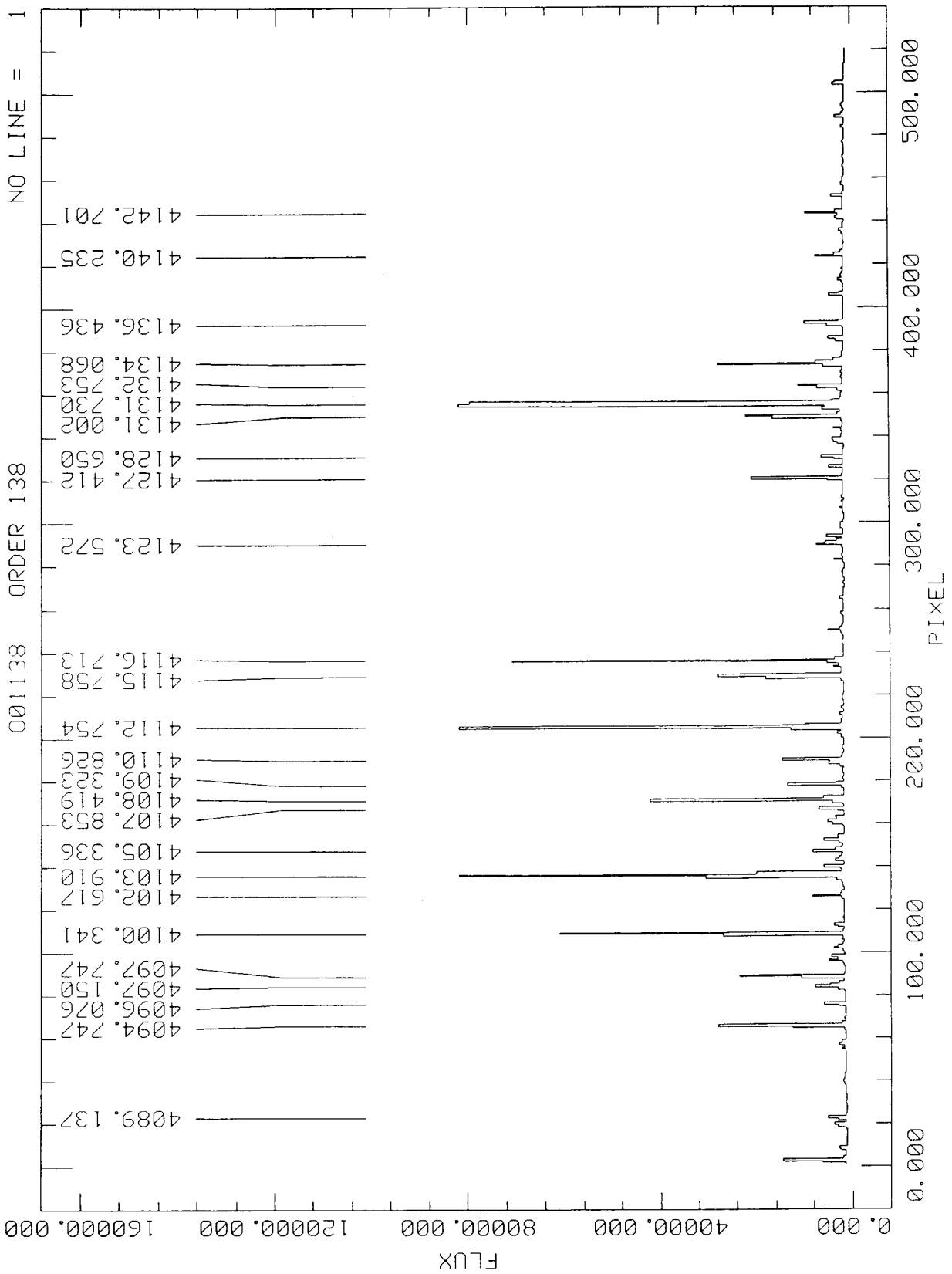
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4096.076
4097.150
4097.747
4100.341
4102.617
4103.910
4105.336
4107.853
4108.419
4109.323
4110.826
4112.754
4115.758
4116.713
4123.572
4127.412
4128.650
4131.002
4131.730
4132.753
4134.068
4136.436
4140.235
4142.701
FLUX
0.000
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120000.000
160000.000
0.000
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200.000
300.000
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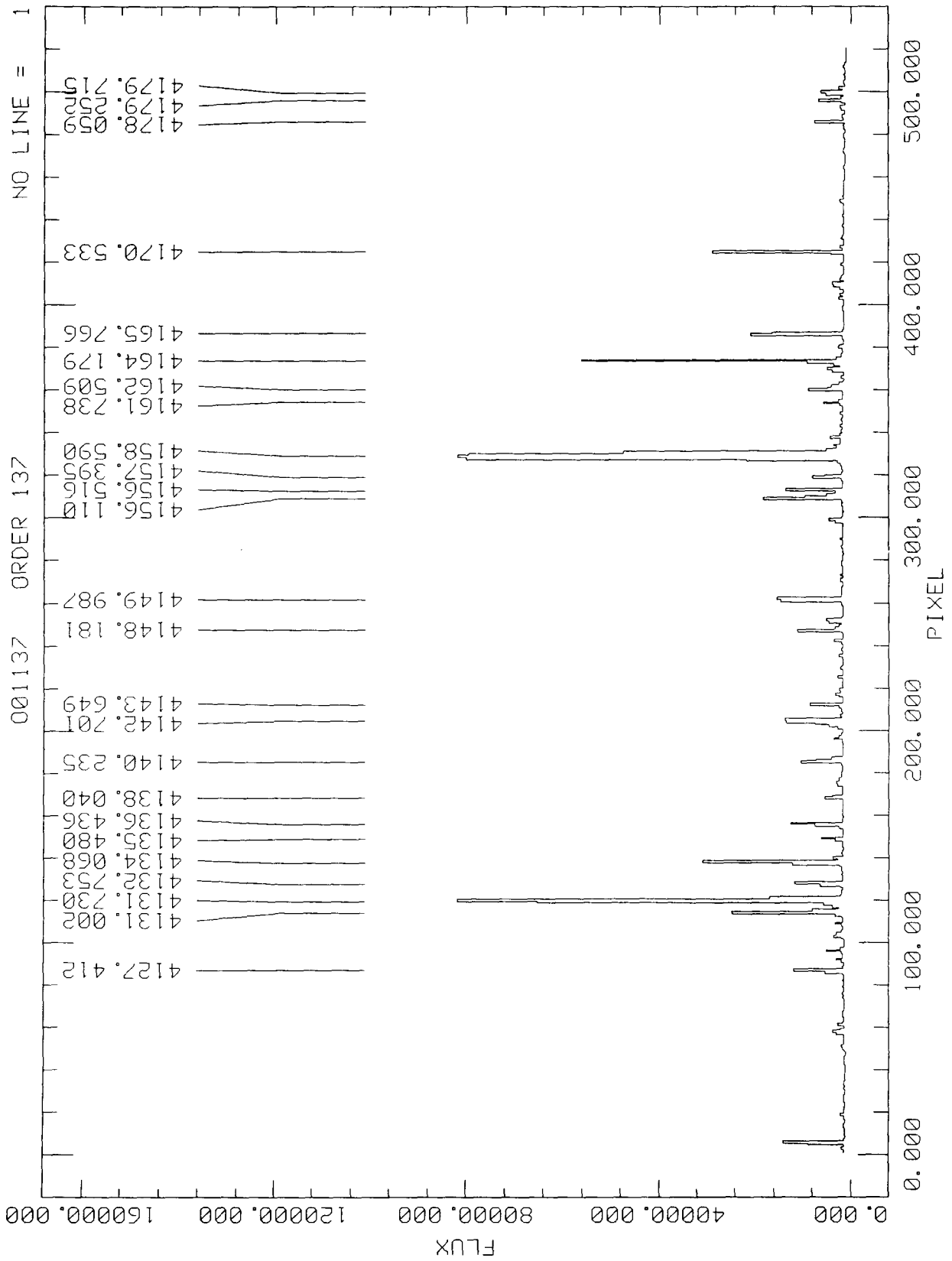
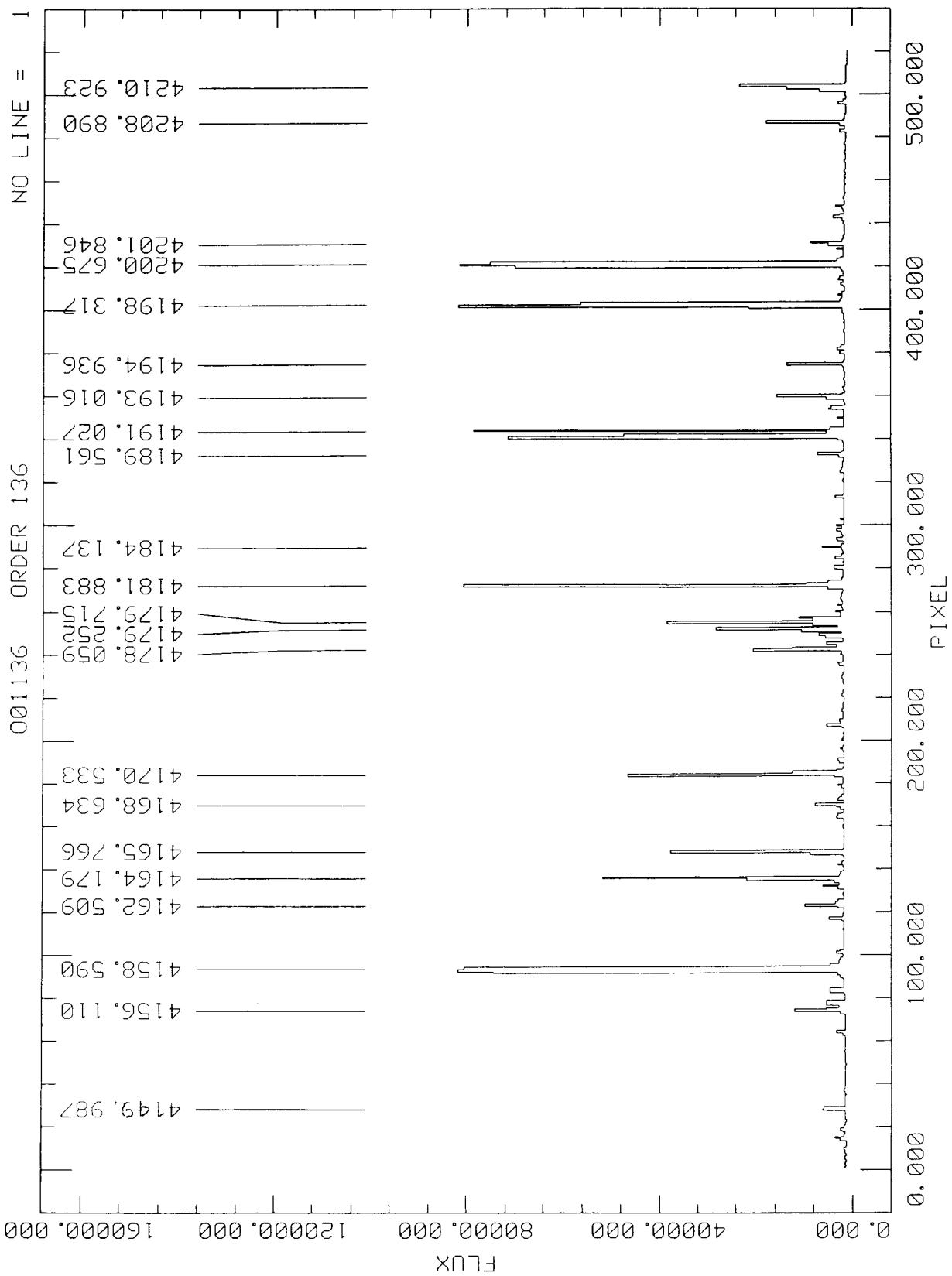
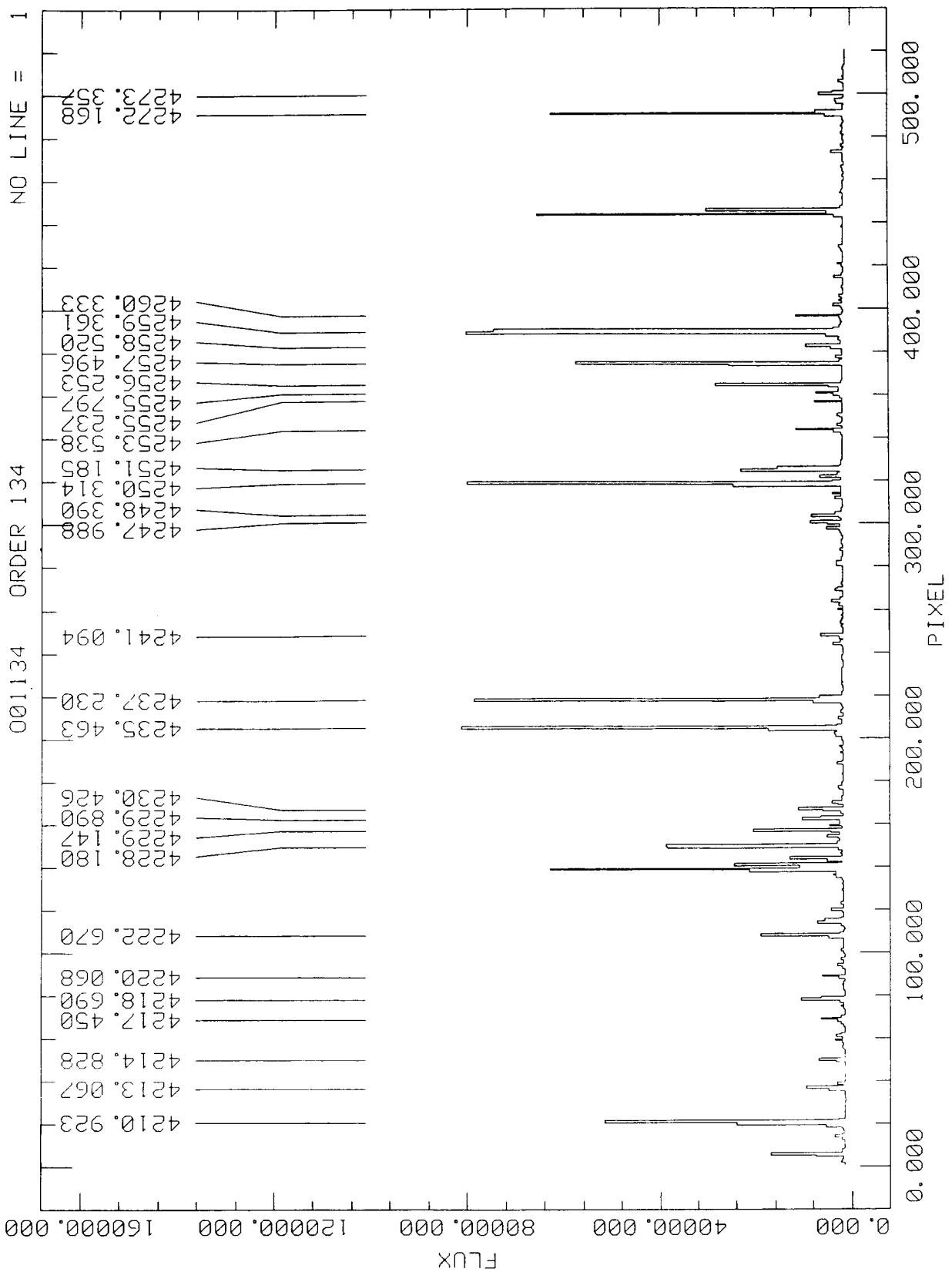
500.000
PIXEL

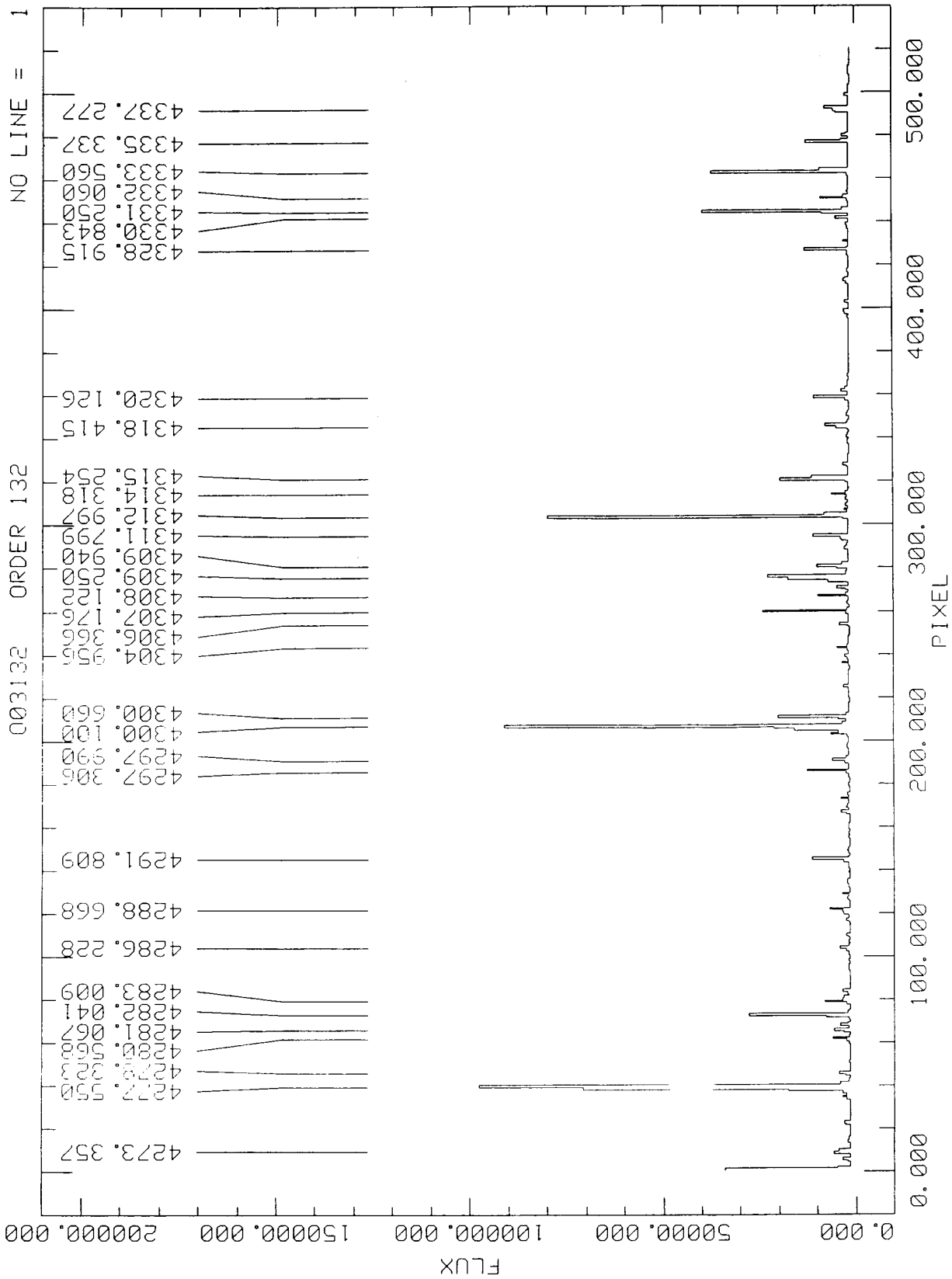

001137 ORDER 137
NO LINE = 1
4179.715
4179.255
4178.059
4170.533
4165.766
4164.179
4162.509
4161.738
4158.590
4157.395
4156.516
4156.110
4149.987
4148.181
4143.649
4142.701
4140.235
4138.040
4136.436
4135.480
4134.068
4132.753
4131.730
4131.002
4127.412
FLUX
160000.000
120000.000
80000.000
40000.000
0.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000


NO LINE = 1
001136 ORDER 136
4210.923
4208.890
4201.846
4200.675
4198.317
4194.936
4193.016
4191.027
4189.561
4184.137
4181.883
4179.715
4179.255
4178.059
4170.533
4168.634
4165.766
4164.179
4162.509
4158.590
4156.110
4149.987
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
0.000
40000.000
80000.000
120000.000
160000.000
FLUX

FLUX
0.000
40000.000
80000.000
120000.000
160000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4178.059
4179.252
4179.715
4181.883
4189.561
4190.712
4193.016
4194.936
4198.317
4200.675
4204.041
4208.411
4208.890
4210.004
4210.923
4213.067
4214.828
4216.069
4217.450
4218.690
4220.068
4222.670
4223.593
4226.726
4227.387
4228.180
4229.890
4230.426
4235.463
4237.230
001135 ORDER 135
NO LINE = 1


001134 ORDER 134 NO LINE = 1
4272.168
4273.357
4260.333
4259.361
4258.520
4257.496
4256.253
4255.797
4255.237
4253.538
4251.185
4250.314
4248.390
4247.988
4241.094
4237.230
4235.463
4230.426
4229.890
4229.147
4228.180
4222.670
4220.068
4218.690
4217.450
4214.828
4213.067
4210.923
FLUX
0.000
40000.000
80000.000
120000.000
160000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000

FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4250.314
4251.185
4253.538
4255.797
4256.253
4257.496
4258.520
4259.361
4260.333
4266.286
4269.942
4272.168
4272.874
4273.357
4274.024
4275.190
4276.807
4277.550
4278.323
4280.568
4281.067
4281.414
4282.041
4283.518
4286.228
4288.668
4291.809
4297.306
4299.839
4300.100
4300.660
4307.176
003133 ORDER 133
NO LINE = 1


NO LINE = 1
003132 ORDER 132
4337.277
4335.337
4333.560
4332.060
4331.250
4330.843
4328.915
4320.126
4318.415
4315.254
4314.318
4312.997
4311.799
4309.940
4309.250
4308.122
4307.176
4306.366
4304.955
4300.100
4300.660
4297.990
4297.306
4291.809
4288.668
4286.228
4283.009
4282.041
4281.067
4280.056
4273.357
FLUX
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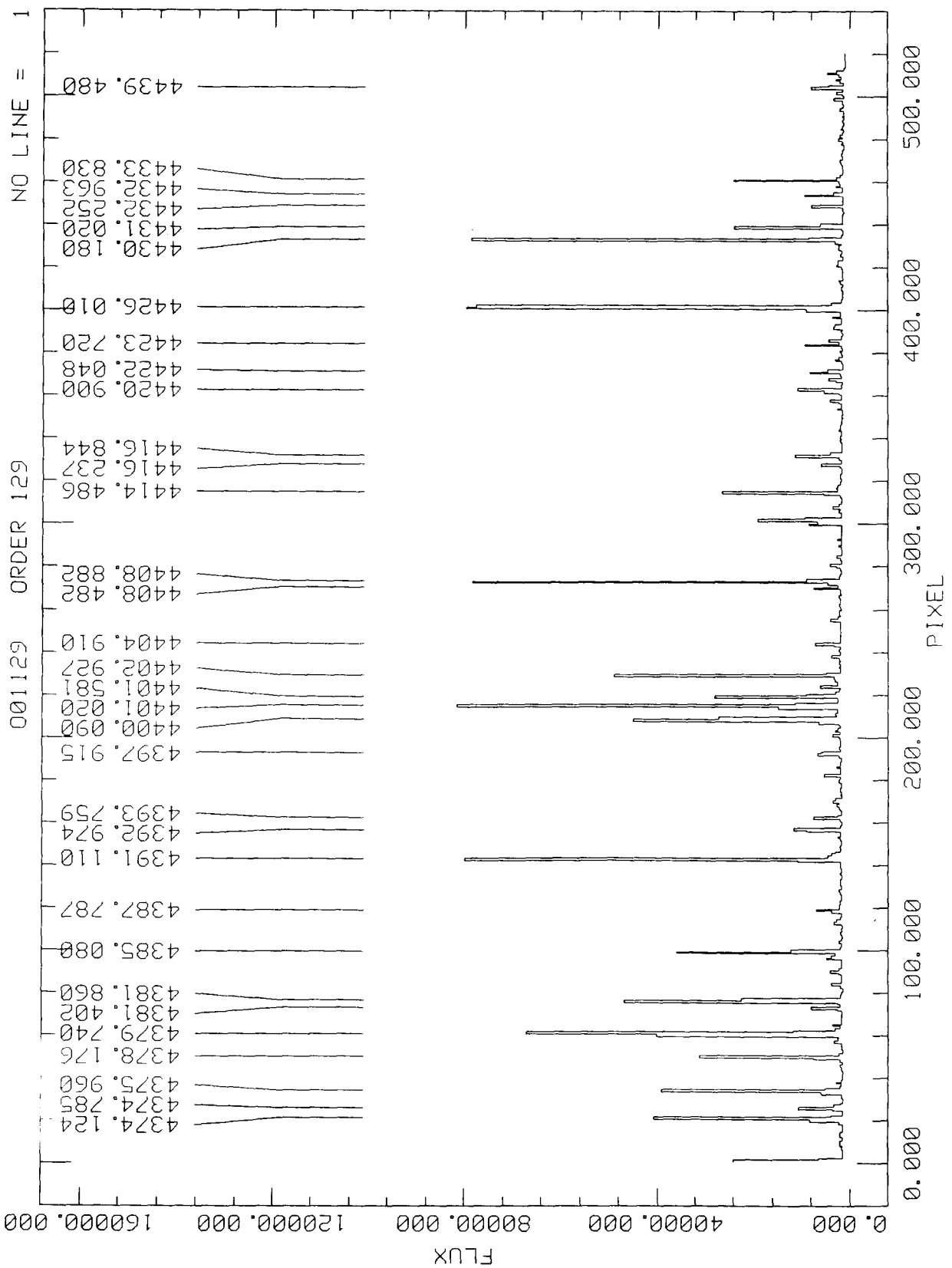
100000.000
150000.000
200000.000
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL

FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4307.176
4308.122
4309.250
4309.940
4311.799
4312.997
4315.254
4318.415
4320.126
4325.274
4328.915
4330.843
4331.250
4333.560
4340.895
4342.444
4343.951
4344.326
4345.851
4346.436
4348.110
4349.072
4352.230
4352.612
4353.448
4358.320
4359.372
4362.070
4365.930
4367.870
4370.760
4371.360
003131 ORDER 131
NO LINE = 1

FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4342.444
4344.326
4345.162
4346.436
4348.110
4349.072
4352.230
4352.612
4353.448
4358.320
4359.372
4362.070
4363.794
4365.930
4367.870
4369.494
4369.875
4370.760
4371.360
4374.124
4374.785
4375.960
4378.176
4379.740
4381.402
4381.860
4384.656
4385.080
4387.787
4391.110
4392.974
4400.090
4401.020
4401.581
4402.927
003130 ORDER 130
NO LINE = 1


001129 ORDER 129 NO LINE = 1
FLUX
PIXEL
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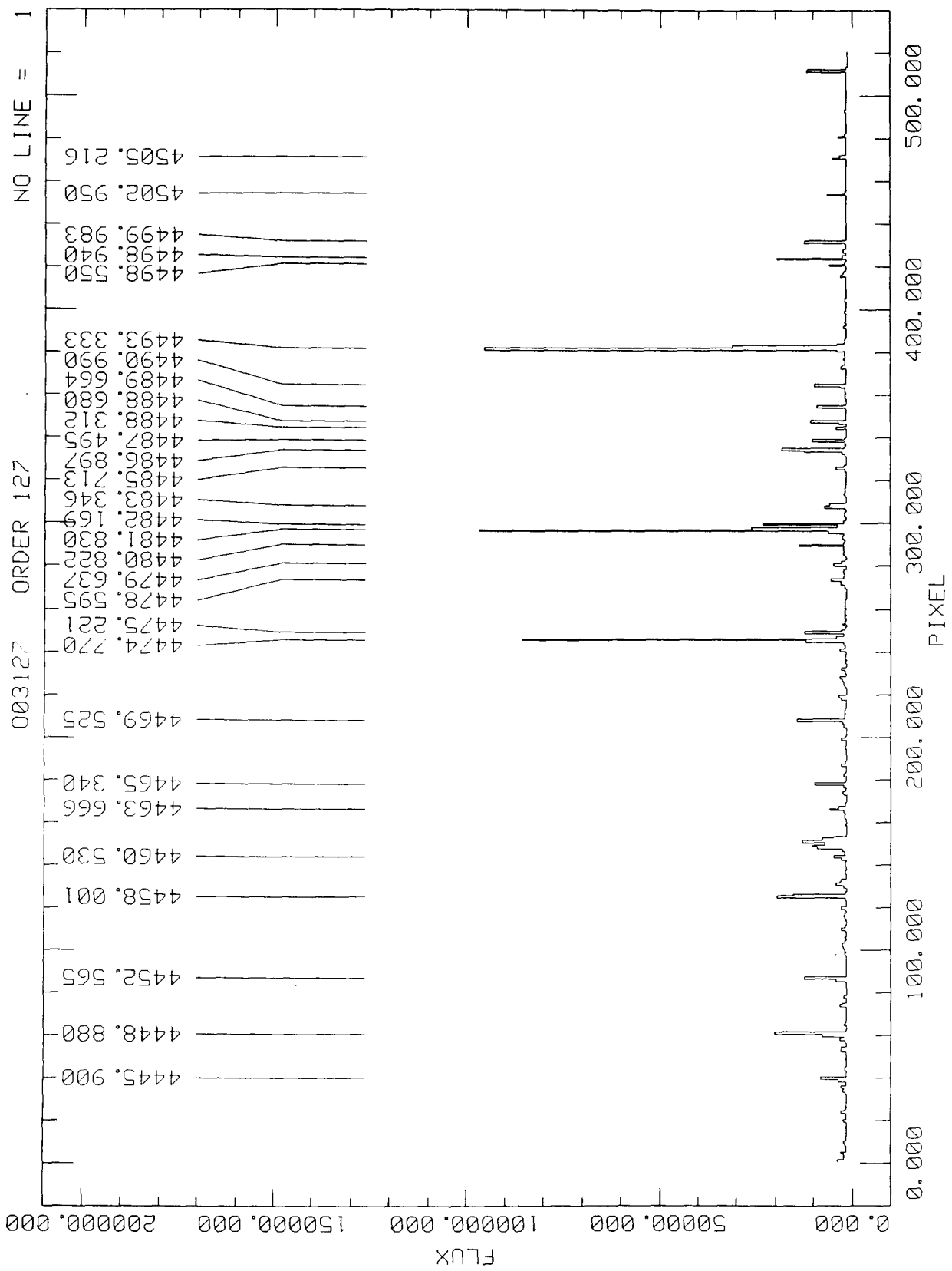
40000.000
80000.000
120000.000
160000.000
0.000
100.000
200.000
300.000
400.000
500.000
4374.124
4374.785
4375.960
4378.176
4379.740
4381.402
4381.860
4385.080
4387.787
4391.110
4392.974
4393.759
4397.915
4400.090
4401.020
4401.581
4402.927
4404.910
4408.482
4408.882
4414.486
4416.237
4416.844
4420.900
4422.048
4423.720
4426.010
4430.180
4431.020
4432.252
4432.963
4433.830
4439.480

FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4408.882
4414.486
4416.844
4420.900
4422.048
4423.720
4426.010
4430.180
4431.020
4432.252
4432.964
4433.830
4438.746
4439.123
4439.480
4440.324
4441.608
4443.665
4445.033
4445.315
4445.900
4447.834
4448.554
4448.880
4450.793
4452.565
4458.001
4461.241
4463.666
4465.340
4469.525
4474.770
003128 ORDER 128
NO LINE = 1


NO LINE = 1
003127 ORDER 127
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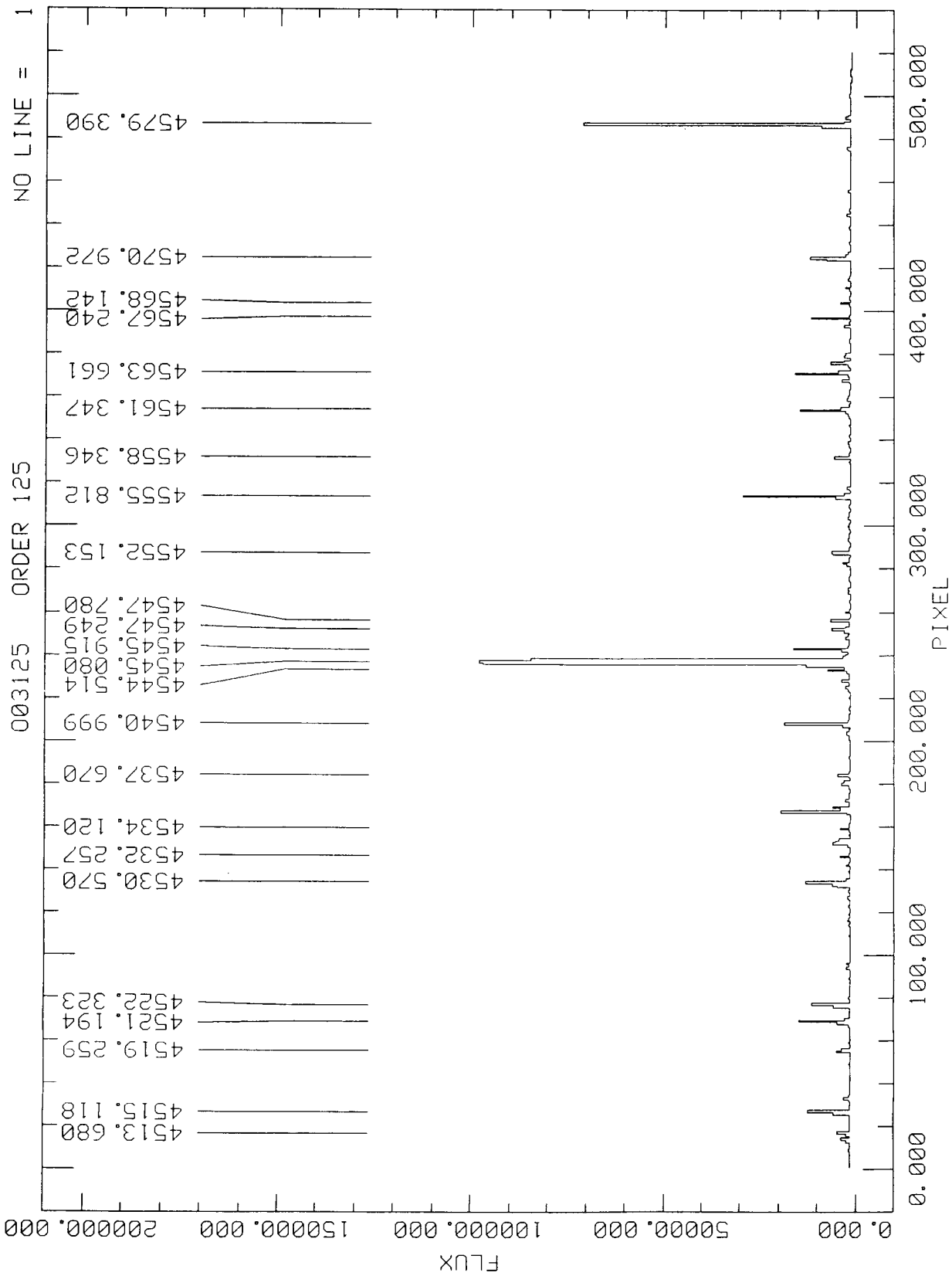
4502.950
4499.983
4498.940
4498.550
4493.333
4490.990
4489.664
4488.680
4488.312
4487.495
4486.897
4485.713
4483.346
4482.169
4481.830
4480.822
4479.637
4478.595
4475.221
4474.770
4469.525
4465.340
4463.666
4460.530
4458.001
4452.565
4448.880
4445.900
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
0.000
50000.000
100000.000
150000.000
200000.000
FLUX

FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4480.822
4481.830
4483.346
4486.897
4487.495
4488.680
4489.664
4490.990
4493.333
4498.550
4498.940
4499.983
4502.950
4505.216
4506.494
4510.733
4513.223
4513.680
4515.118
4516.064
4519.259
4521.194
4522.323
4533.304
4535.253
4540.999
4545.080
4545.915
003126 ORDER 126
NO LINE = 1


NO LINE = 1
003125 ORDER 125
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4570.972
4568.142
4567.240
4563.661
4561.347
4558.346
4555.812
4552.153
4547.780
4547.249
4545.915
4545.080
4544.514
4540.999
4537.670
4534.120
4532.257
4530.570
4522.323
4521.194
4519.259
4515.118
4513.680
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
0.000
50000.000
100000.000
150000.000
200000.000
FLUX

FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4552.153
4555.812
4561.347
4563.661
4567.240
4570.972
4577.823
4579.390
4579.827
4581.173
4588.426
4589.930
4592.666
4593.643
4595.420
4596.097
4598.770
4603.144
4607.934
4609.600
4613.604
003124 ORDER 124
NO LINE = 1

FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4588.426
4589.930
4592.666
4595.420
4596.097
4598.770
4603.144
4607.934
4608.620
4609.600
4611.859
4612.543
4613.604
4615.024
4615.334
4619.479
4621.163
4628.441
4631.761
4633.765
4637.250
4638.685
4640.046
4641.253
4646.686
4647.251
4651.555
003123 ORDER 123
NO LINE = 1

FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4628.441
4631.761
4633.765
4637.250
4638.685
4640.046
4641.253
4646.686
4647.251
4650.234
4651.555
4651.989
4655.212
4657.940
4659.569
4663.202
4666.005
4666.798
4668.171
4669.984
4673.660
4676.055
4680.232
4680.646
4683.351
4686.194
4689.251
4690.622
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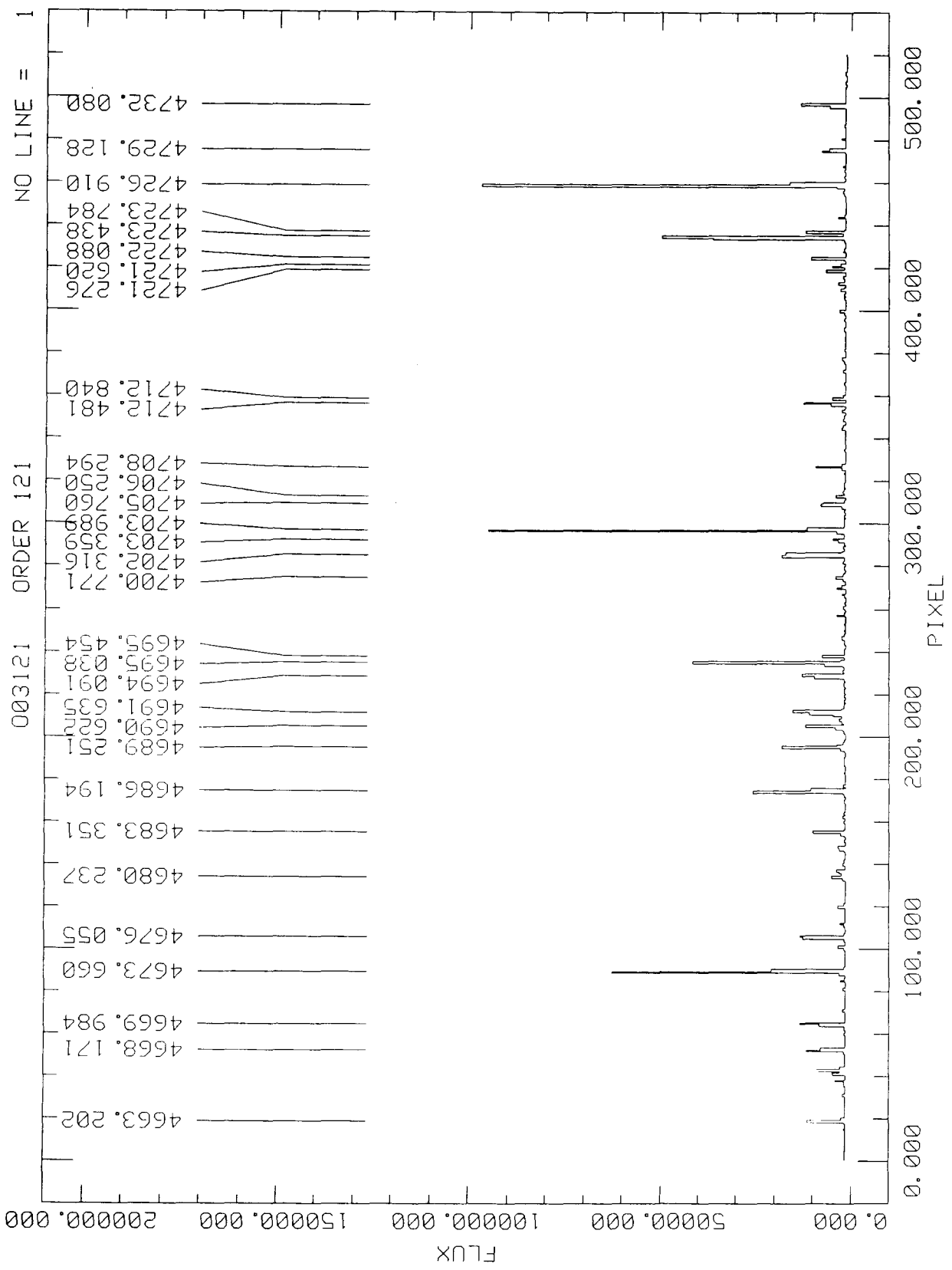
4694.091
4695.038
003122 ORDER 122
NO LINE = 1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4726.910
4723.784
4723.438
4722.088
4721.620
4721.276
4712.840
4712.481
4708.294
4706.250
4705.760
4703.989
4703.359
4702.316
4700.771
4695.454
4695.038
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4691.635
4690.622
4689.251
4686.194
4683.351
4680.237
4676.055
4673.660
4669.984
4668.171
4663.202
FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000

FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4702.316
4703.989
4705.760
4708.294
4712.481
4712.840
4720.458
4722.088
4723.438
4724.772
4726.910
4728.133
4729.128
4732.080
4735.930
4739.675
4740.529
4740.952
4742.117
4743.687
4745.337
4749.200
4749.971
4752.414
4758.128
4764.346
4764.890
4766.600
003120 ORDER 120
NO LINE = 1

FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4739.675
4740.529
4740.952
4743.687
4745.337
4749.200
4749.971
4752.414
4758.128
4764.346
4764.890
4765.595
4766.600
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4774.259
4775.794
4777.191
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4779.728
4782.761
4783.861
4786.531
4787.148
4789.386
4793.244
4795.913
4806.070
4808.133
4809.614
003119 ORDER 119
NO LINE = 1

FLUX
0.000
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100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4783.861
4786.531
4787.148
4789.386
4795.913
4806.070
4808.133
4809.614
4812.375
4813.007
4813.896
4817.020
4818.647
4819.193
4820.464
4820.884
4821.587
4822.854
4823.606
4823.996
4826.700
4829.797
4831.121
4831.597
4832.802
4833.178
4840.843
4843.941
4845.162
4847.900
4848.362
4850.439
003118 ORDER 118
NO LINE = 1

FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4820.884
4821.587
4822.854
4823.606
4823.996
4826.700
4831.121
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4832.802
4840.843
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4845.162
4847.900
4848.362
4849.140
4850.439
4852.868
4858.332
4861.216
4861.717
4863.172
4865.472
4865.910
4867.590
4868.881
4871.289
4872.917
4874.364
4878.009
4878.733
4879.900
4881.204
4882.250
4887.947
4889.060
4894.955
003117 ORDER 117
NO LINE = 1

FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4863.172
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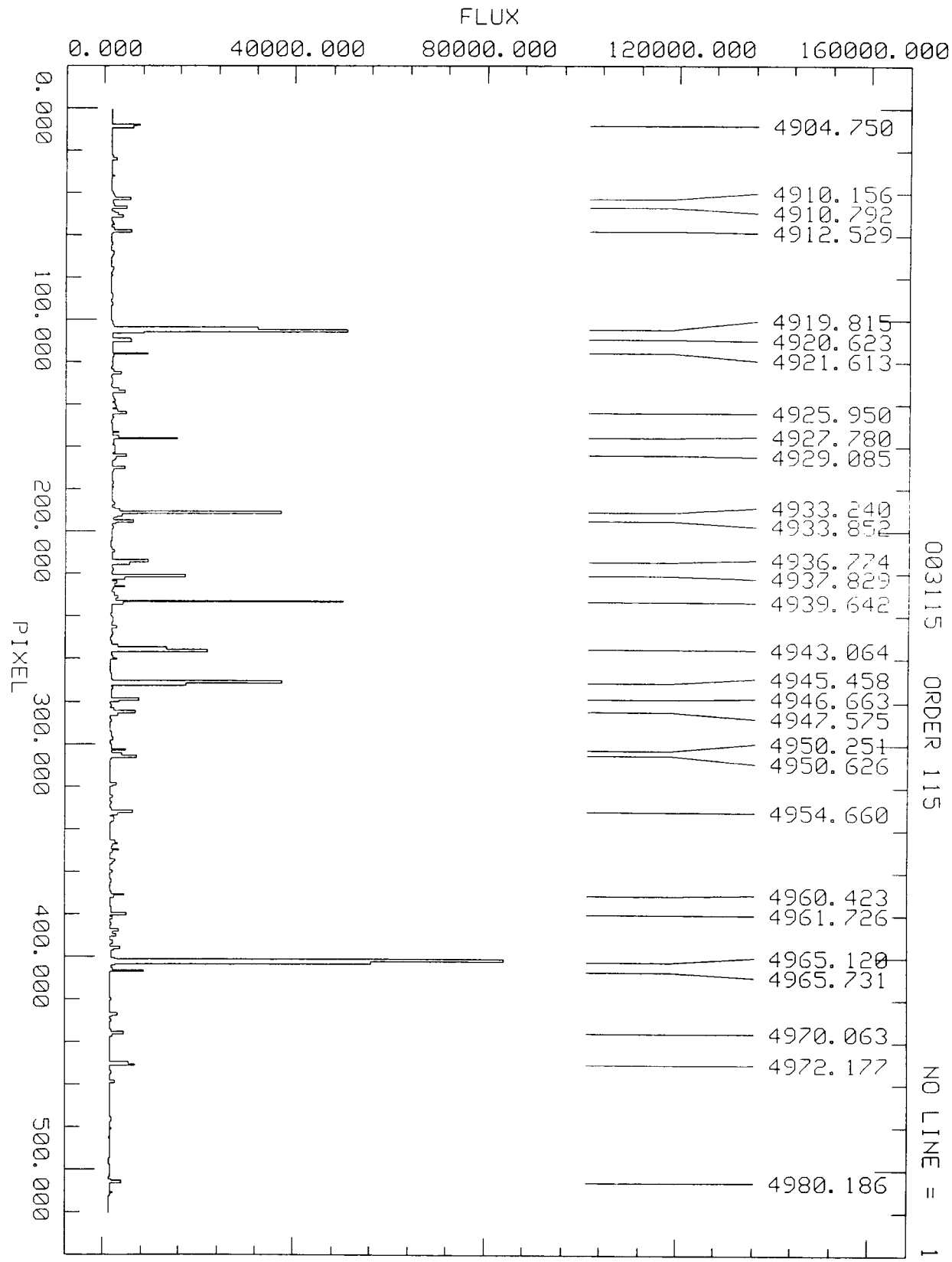
4865.910
4868.881
4871.289
4872.917
4874.364
4876.260
4878.009
4878.733
4879.900
4881.204
4882.250
4887.947
4889.060
4889.490
4892.760
4893.445
4894.955
4898.458
4899.240
4902.054
4902.770
4904.750
4910.156
4910.792
4911.378
4912.529
4919.815
4920.623
4921.613
4927.780
4933.240
4936.774
4937.829
003116 ORDER 116
NO LINE = 1


FLUX
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120000.000
160000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
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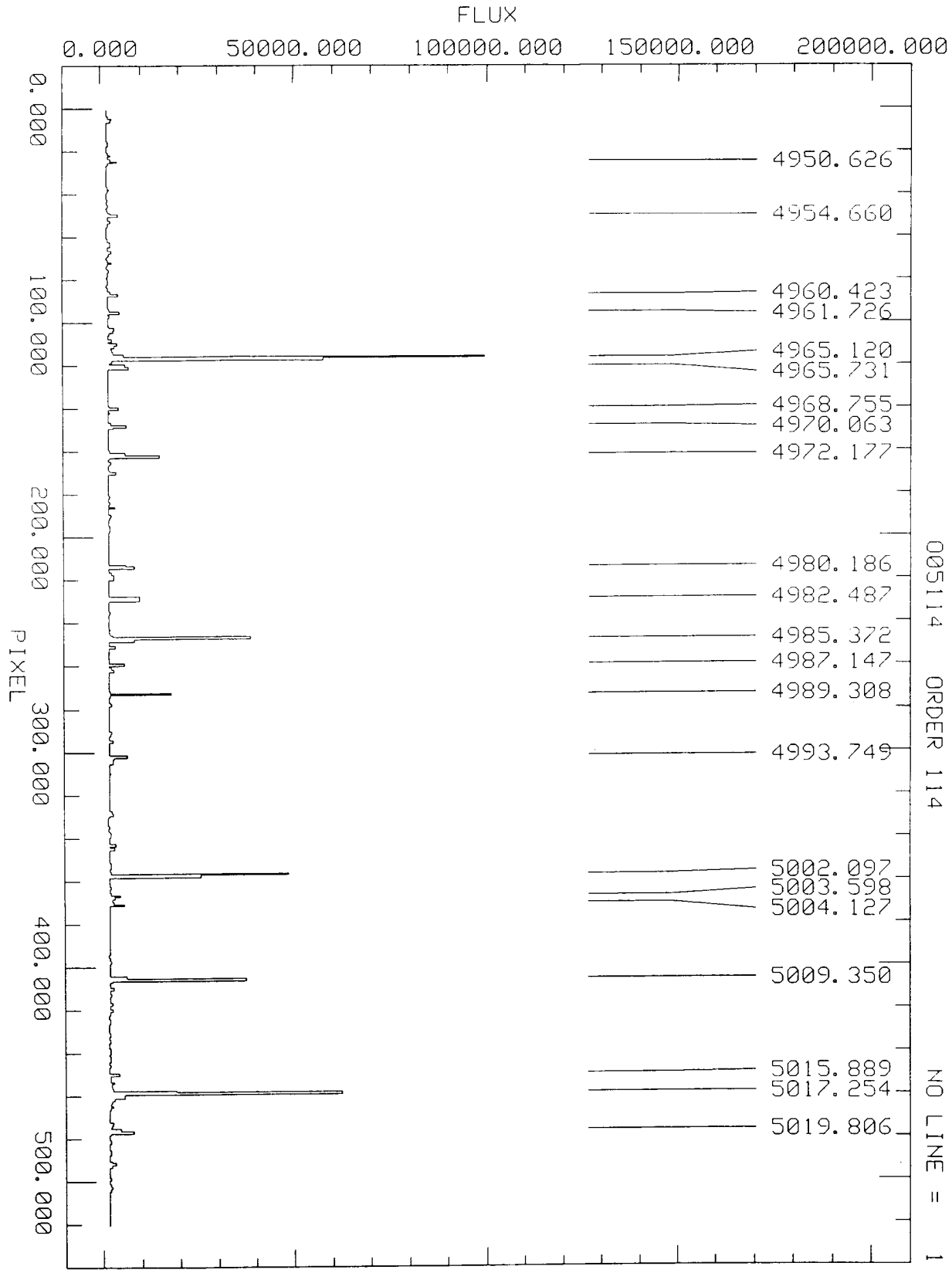
4910.156
4910.792
4912.529
4919.815
4920.623
4921.613
4925.950
4927.780
4929.085
4933.240
4933.852
4936.774
4937.829
4939.642
4943.064
4945.458
4946.663
4947.575
4950.251
4950.626
4954.660
4960.423
4961.726
4965.120
4965.731
4970.063
4972.177
4980.186
003115 ORDER 115
NO LINE = 1


FLUX
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200000.000
PIXEL
0.000
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200.000
300.000
400.000
500.000
4950.626
4954.660
4960.423
4961.726
4965.120
4965.731
4968.755
4970.063
4972.177
4980.186
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4987.147
4989.308
4993.749
5002.097
5003.598
5004.127
5009.350
5015.889
5017.254
5019.806
005114 ORDER 114
NO LINE = 1

FLUX
0.000
50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
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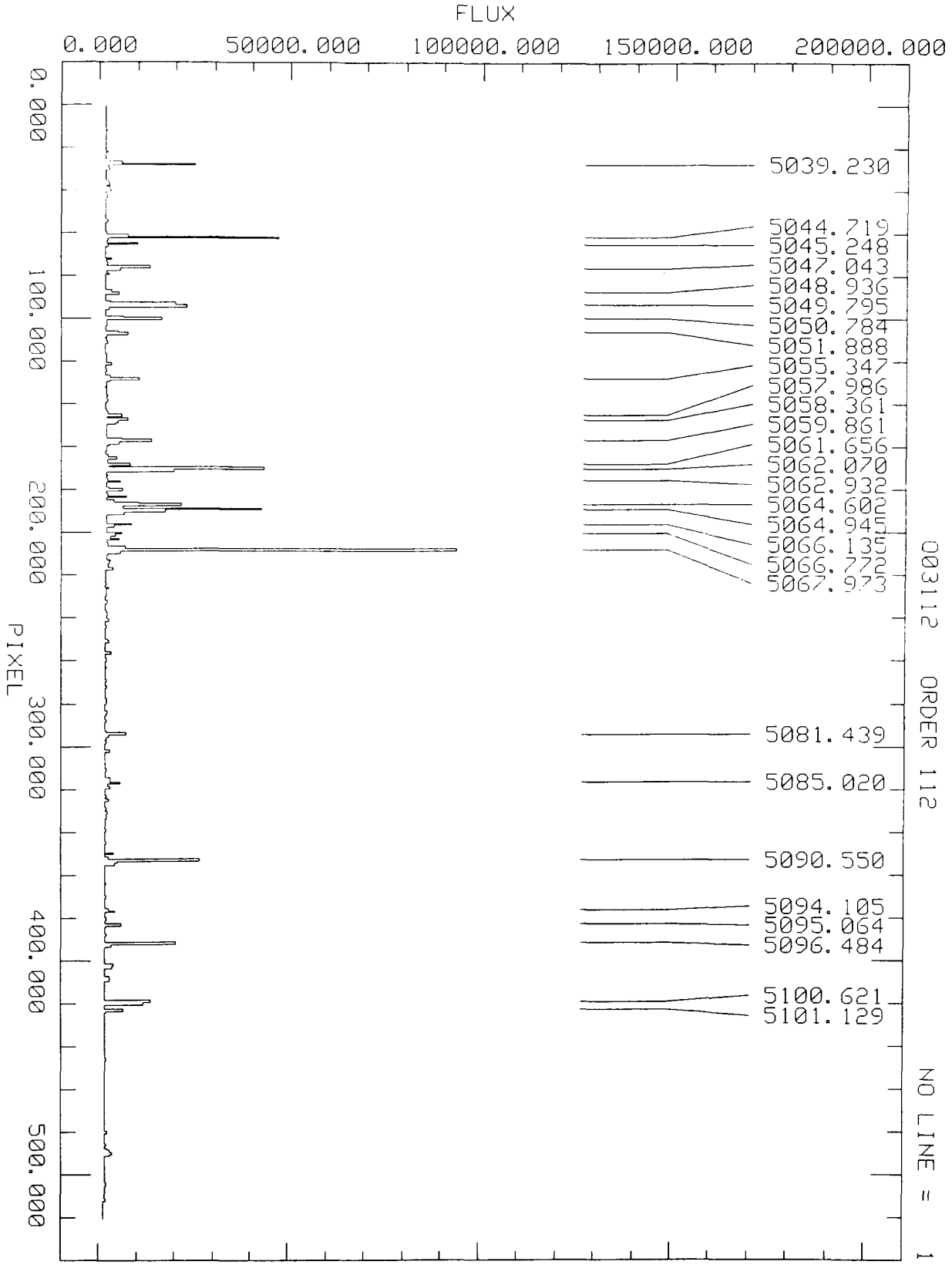
5009.350
5015.889
5017.254
5019.324
5019.806
5022.005
5028.655
5029.891
5039.230
5041.122
5044.719
5045.248
5047.043
5048.936
5049.795
5050.784
5051.888
5055.347
5057.986
5058.361
5059.861
5061.656
5062.070
5064.602
5064.945
5066.772
5067.973
005113 ORDER 113
NO LINE = 1


FLUX
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50000.000
100000.000
150000.000
200000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
5039.230
5044.719
5045.248
5047.043
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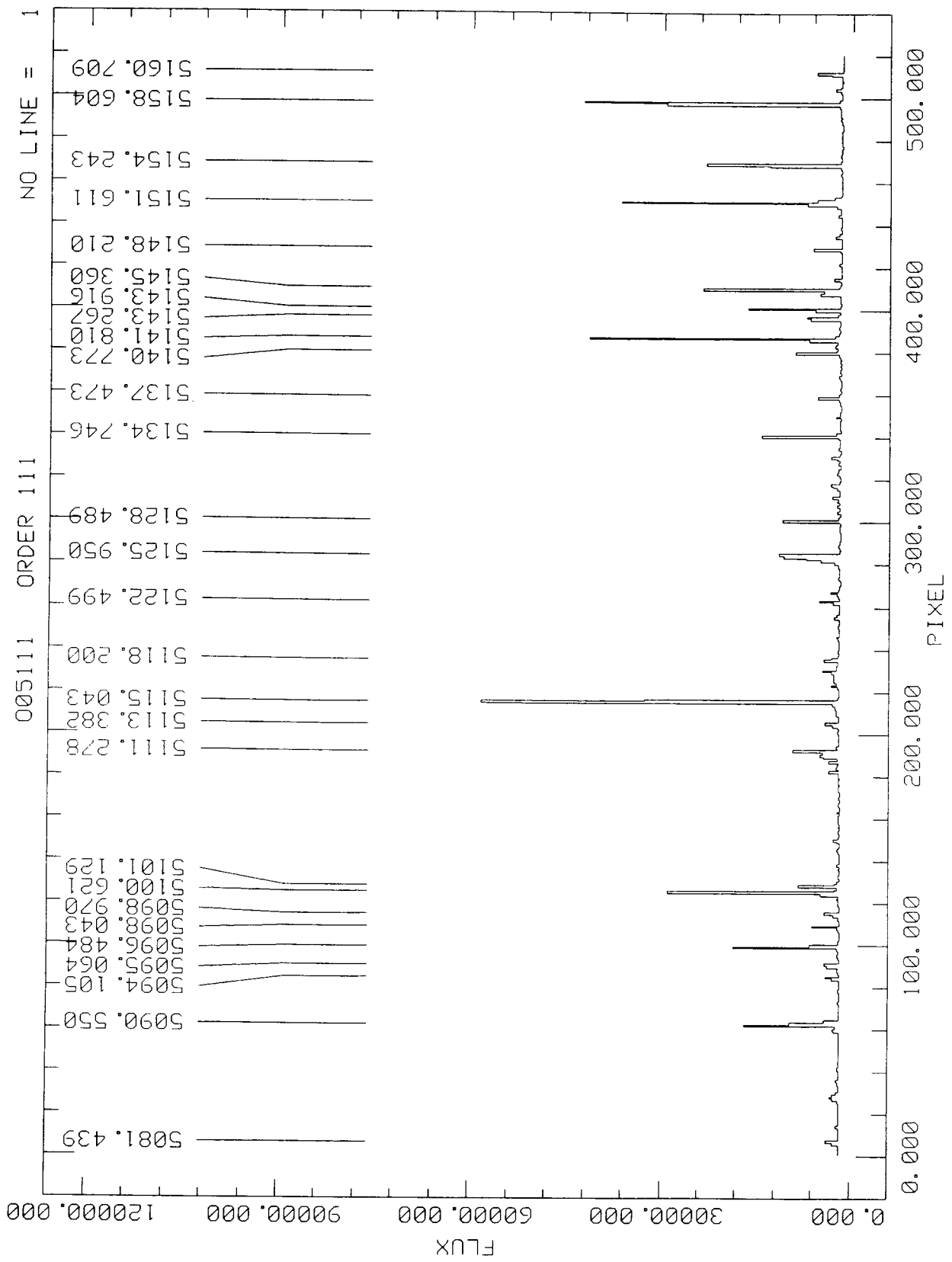
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FLUX
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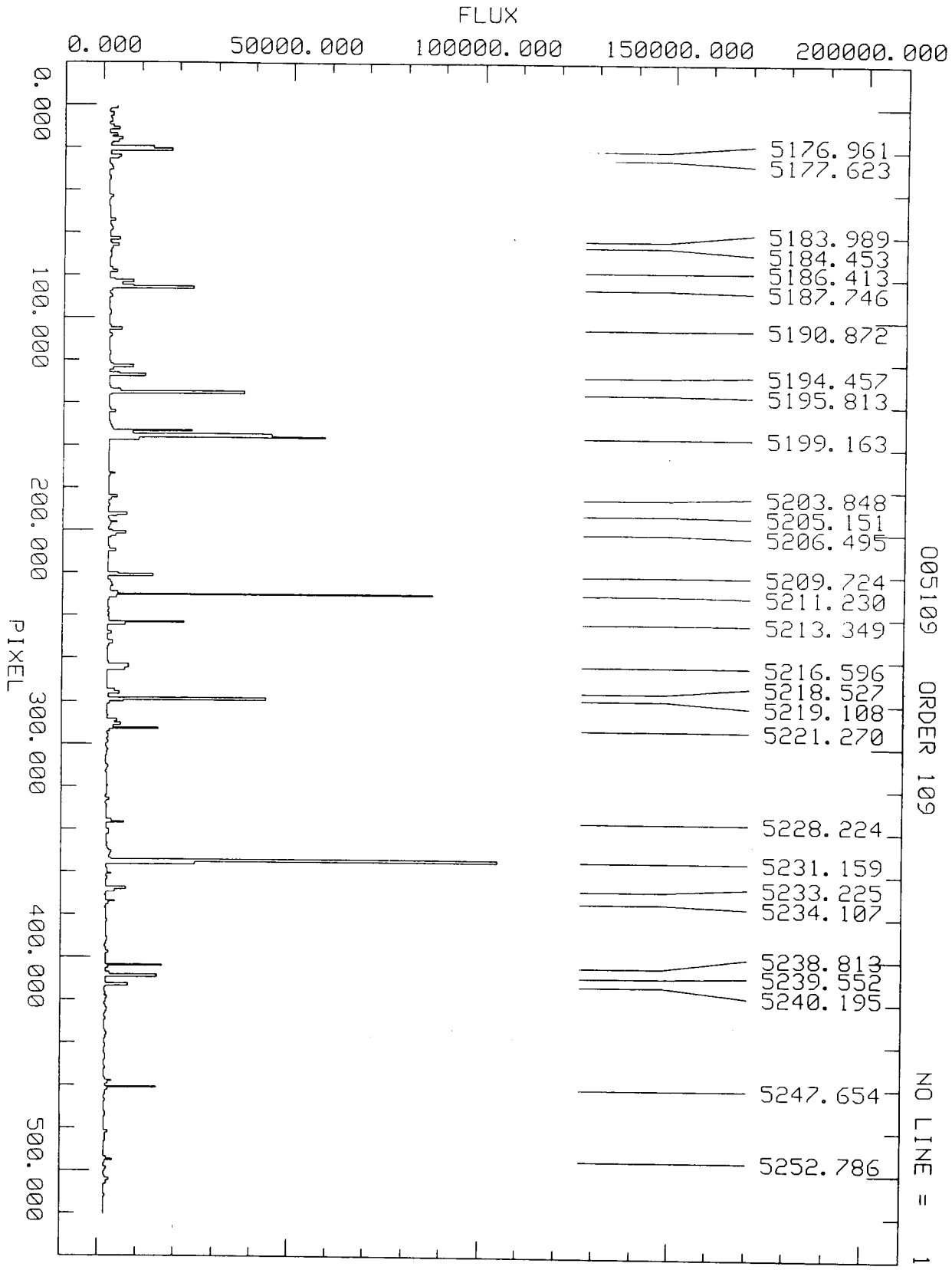
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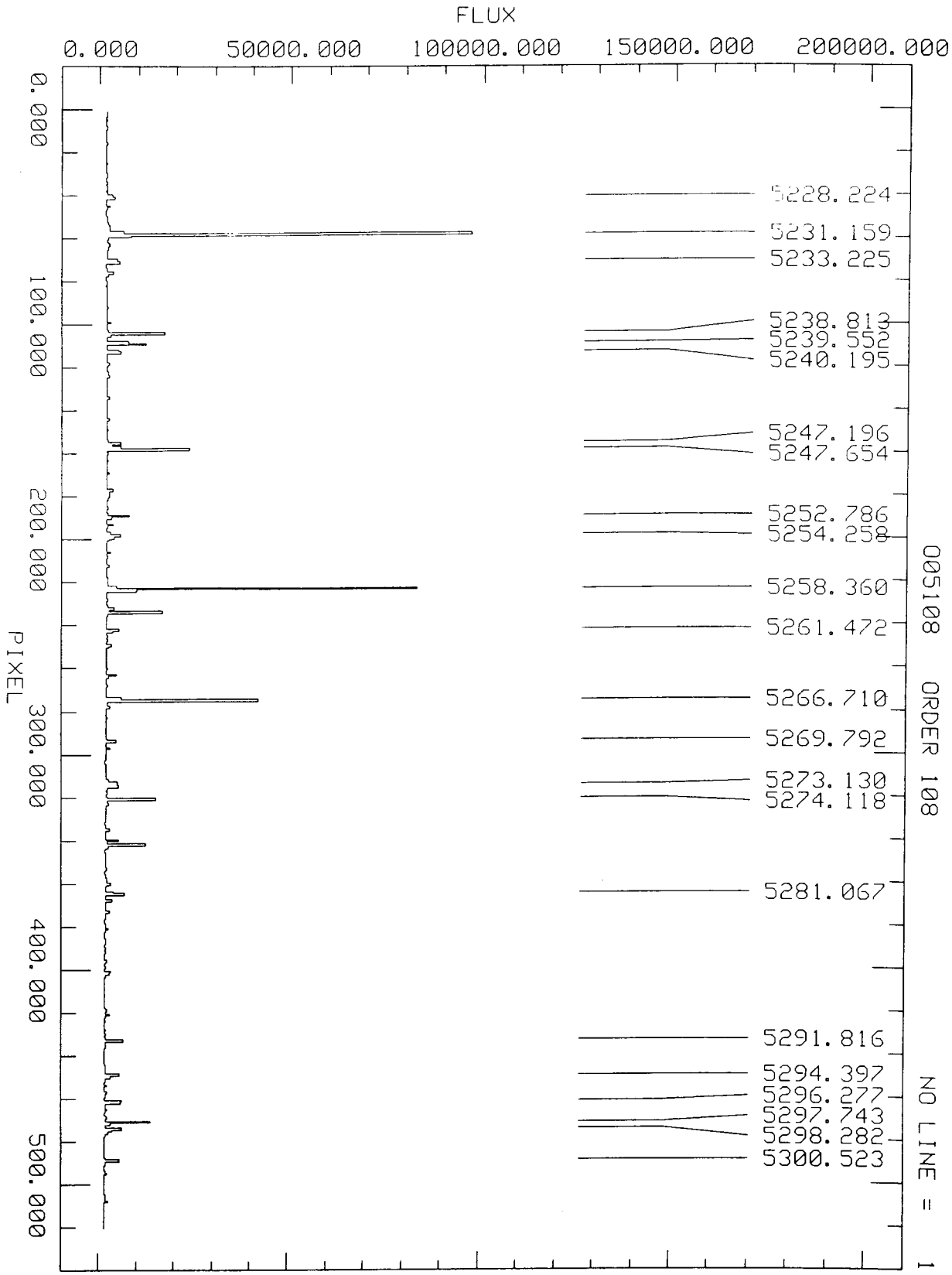
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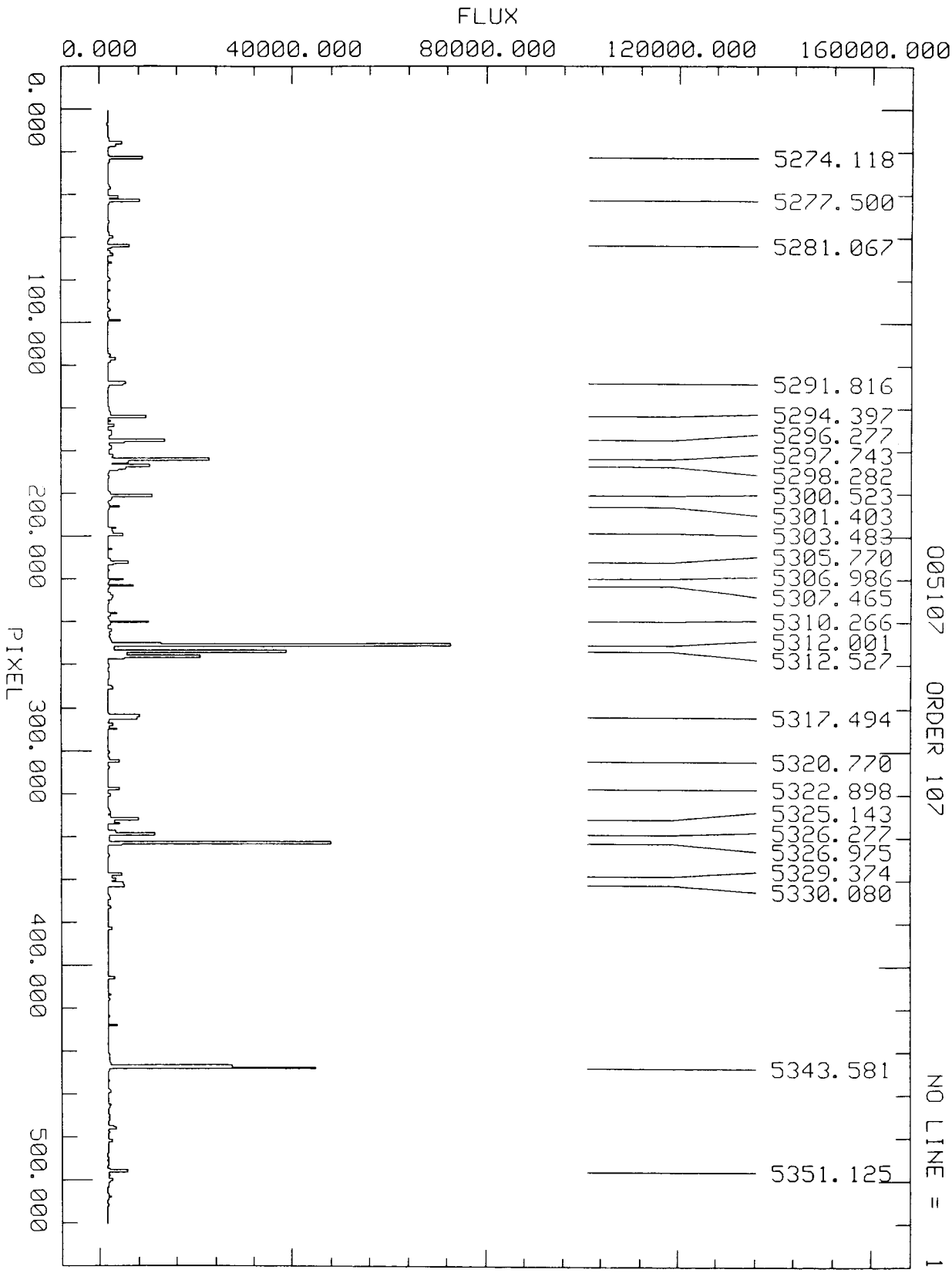
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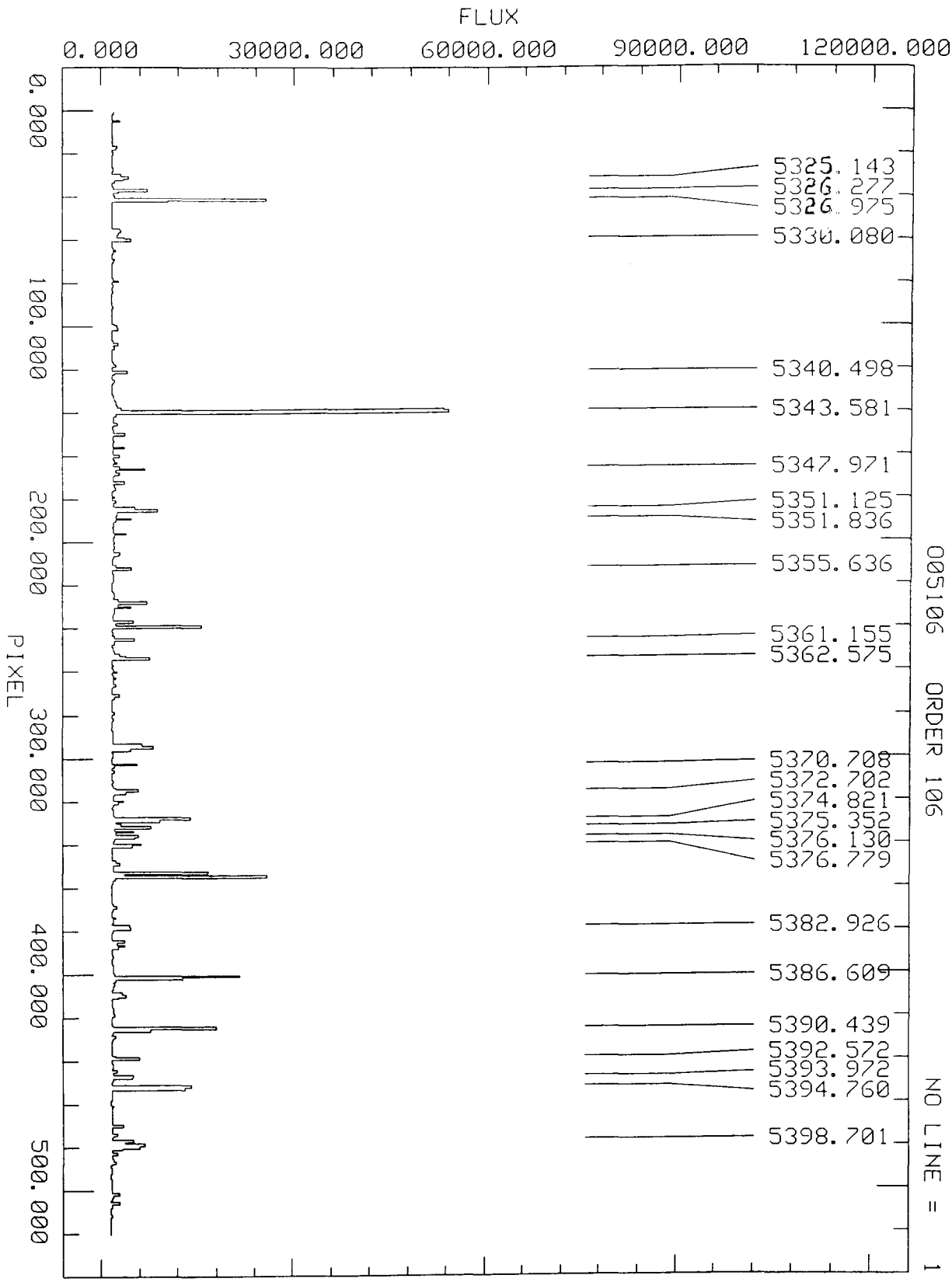
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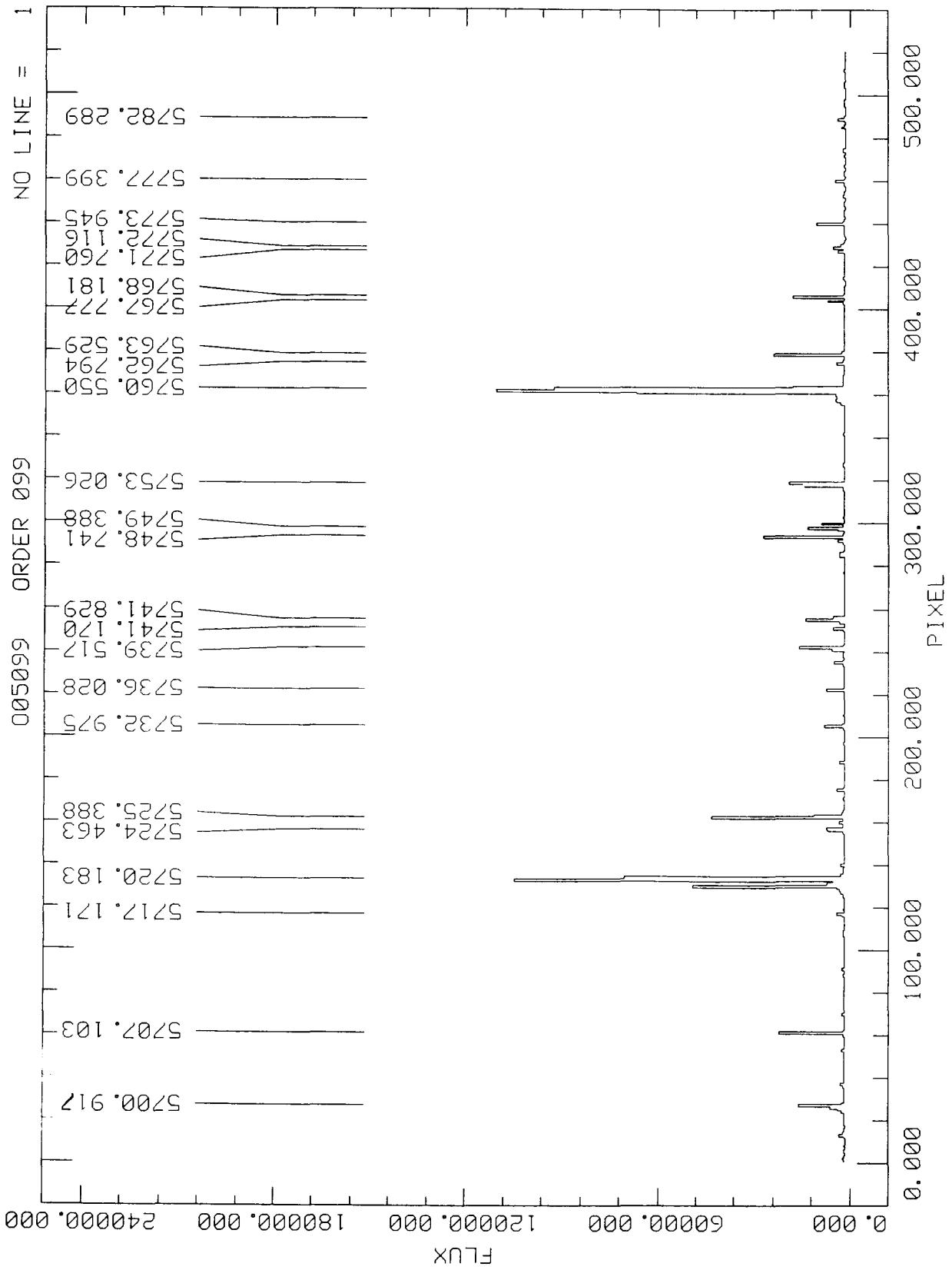
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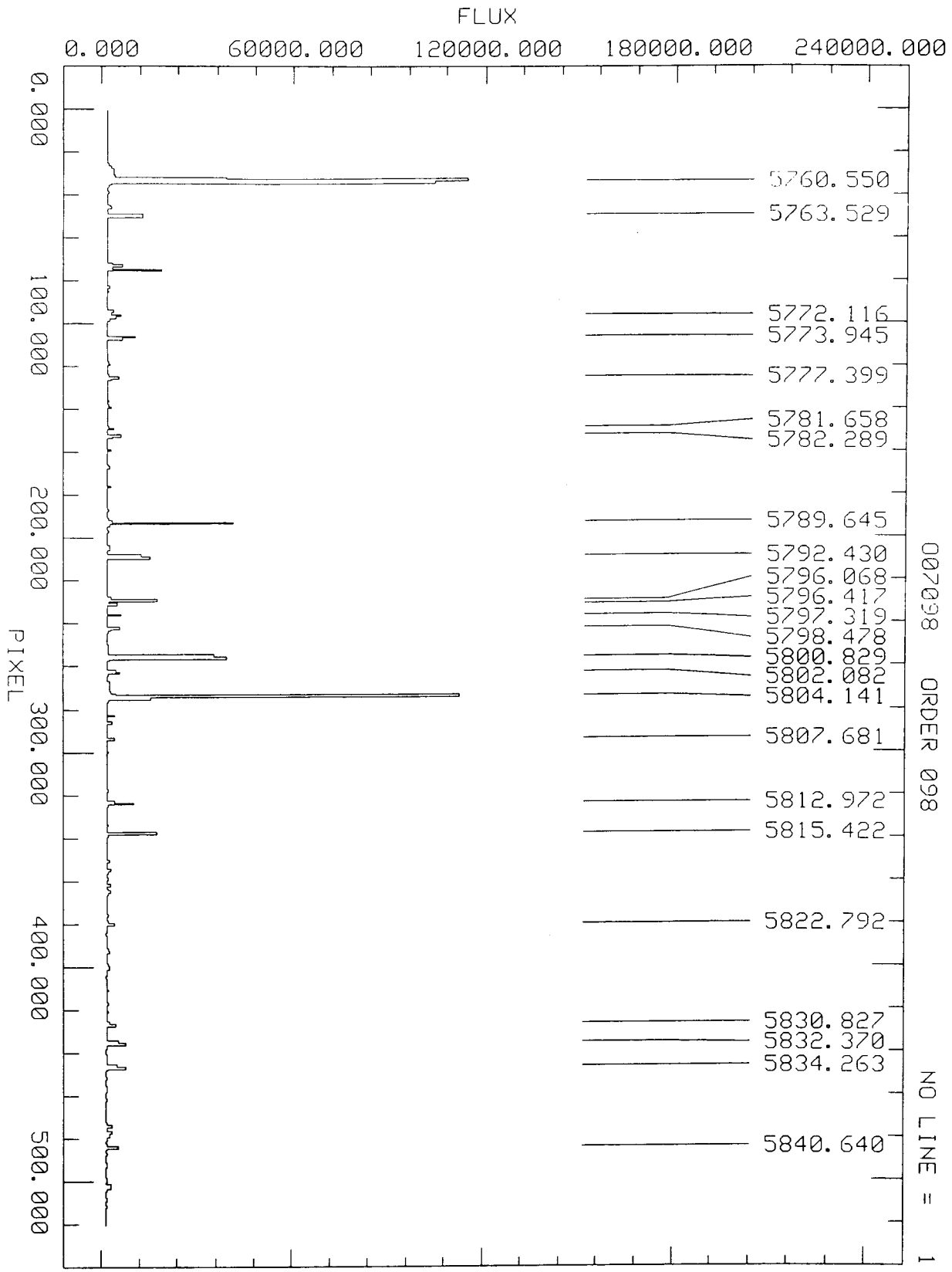
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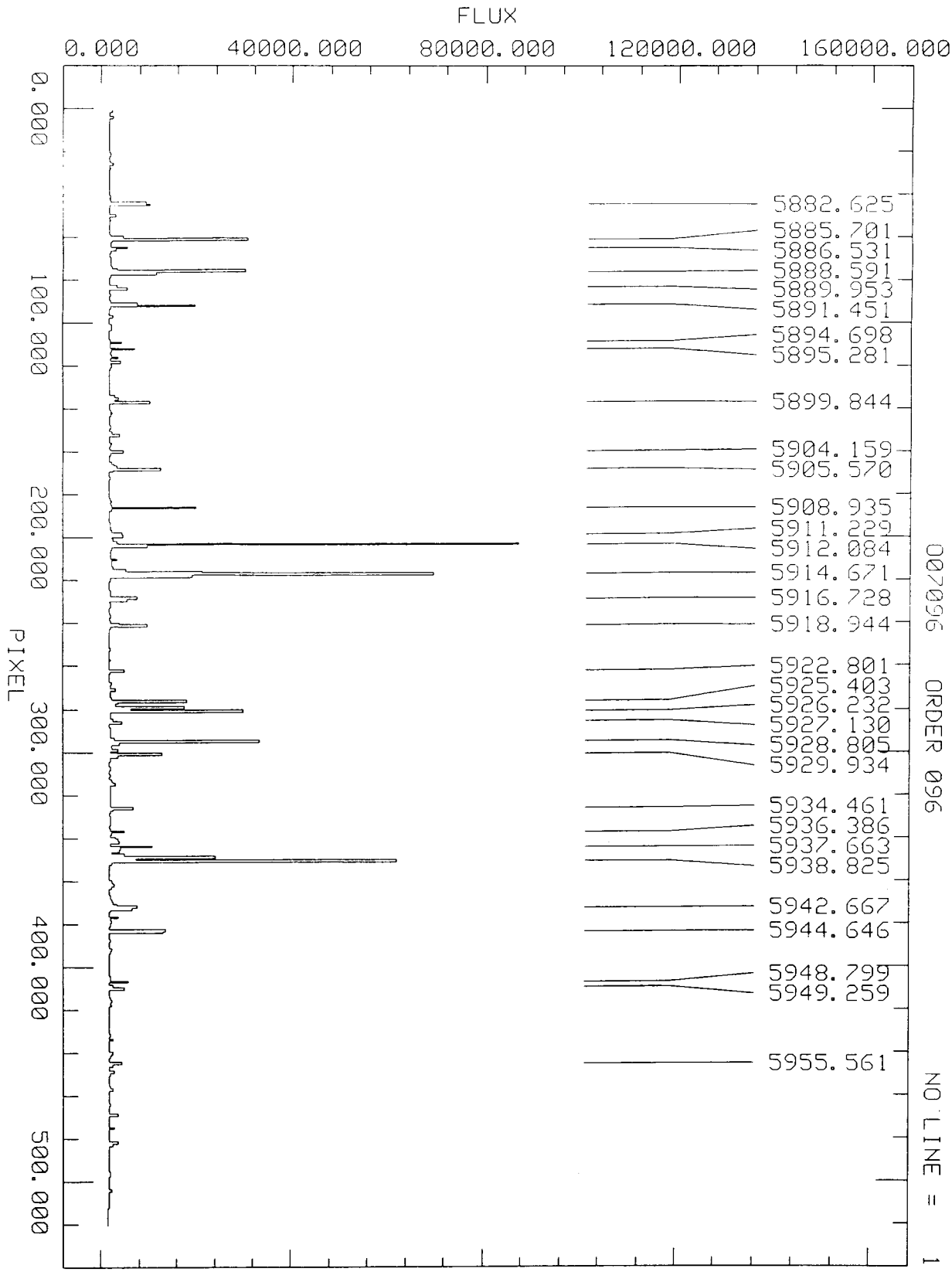
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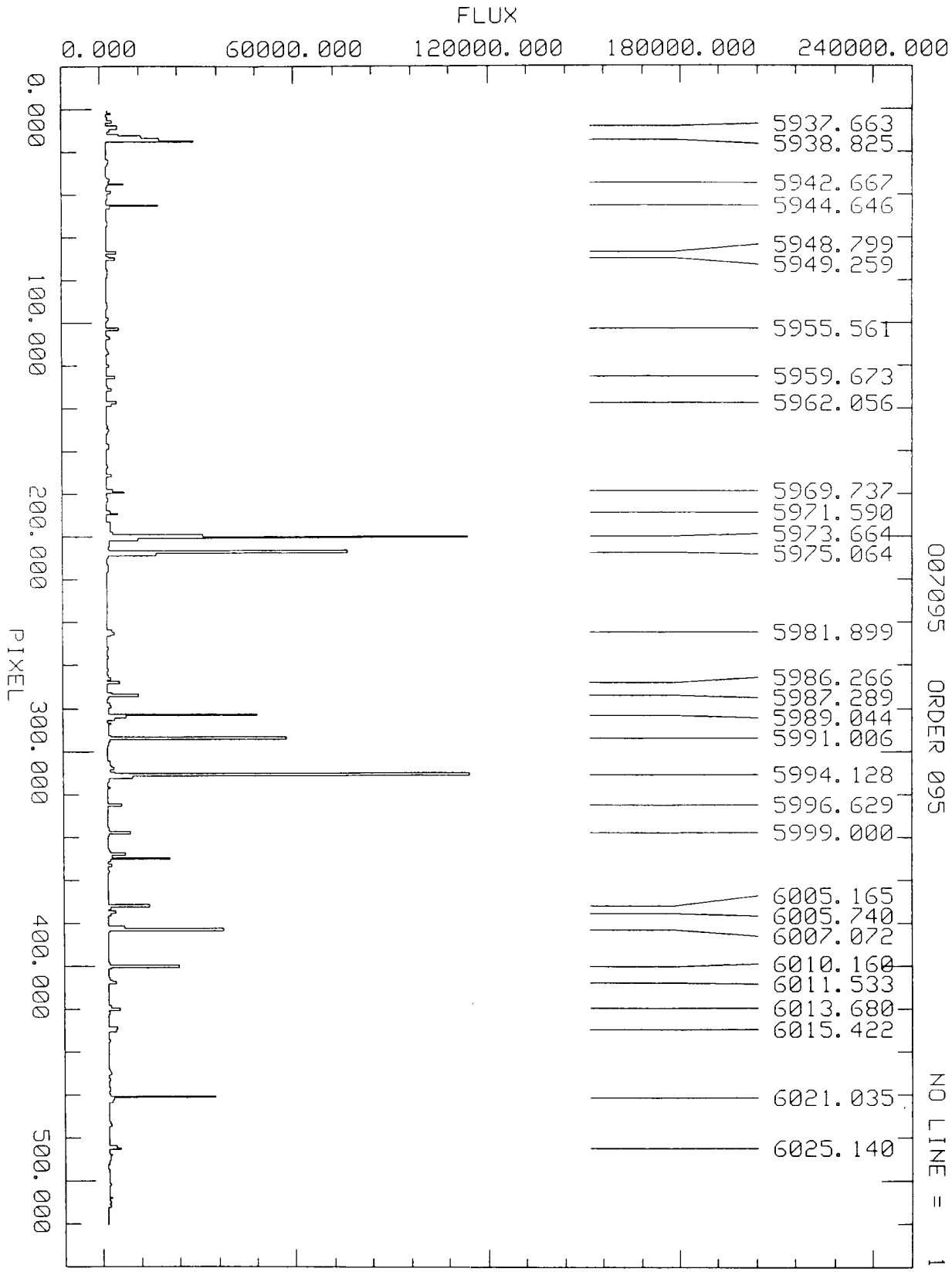
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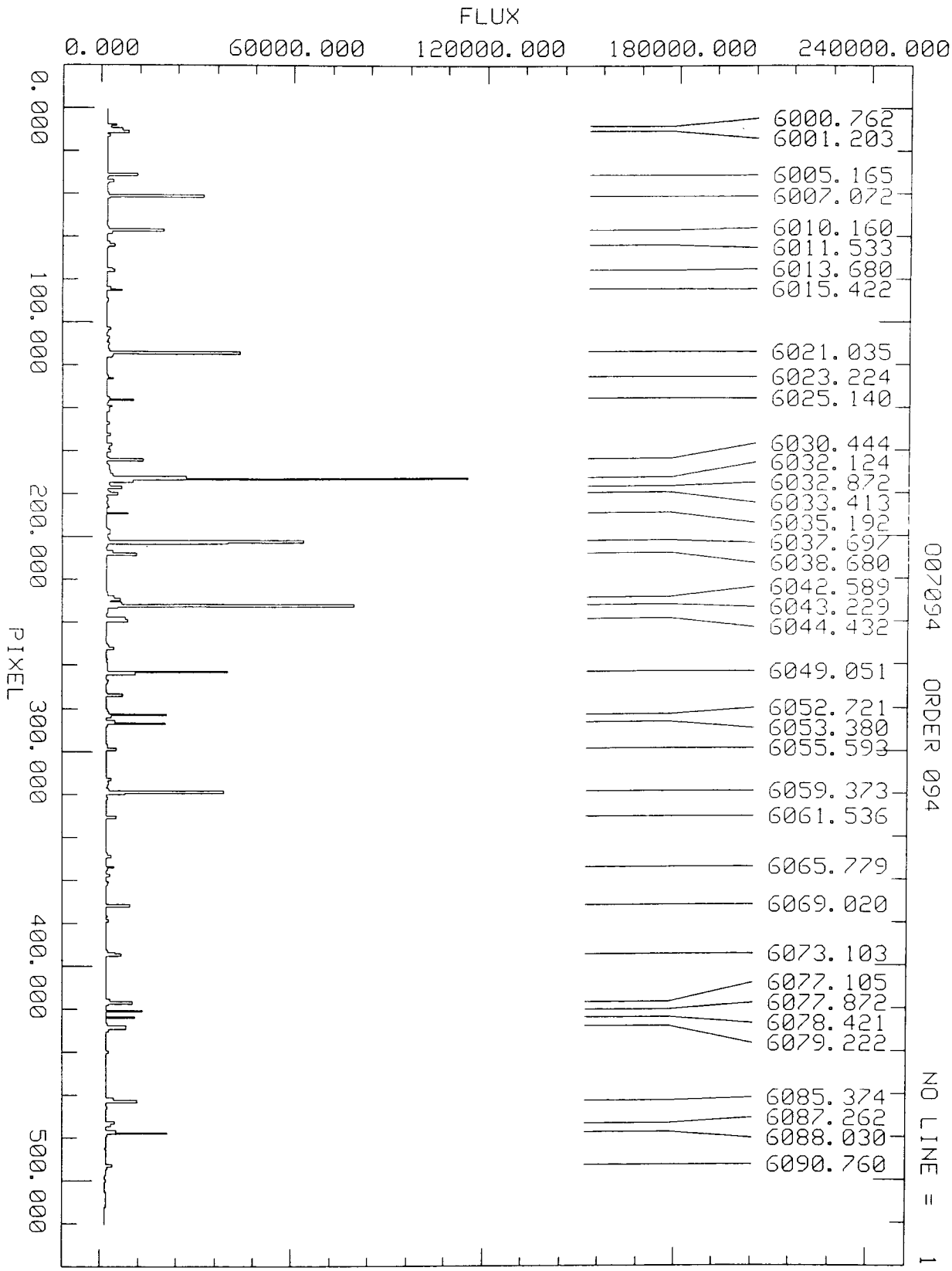
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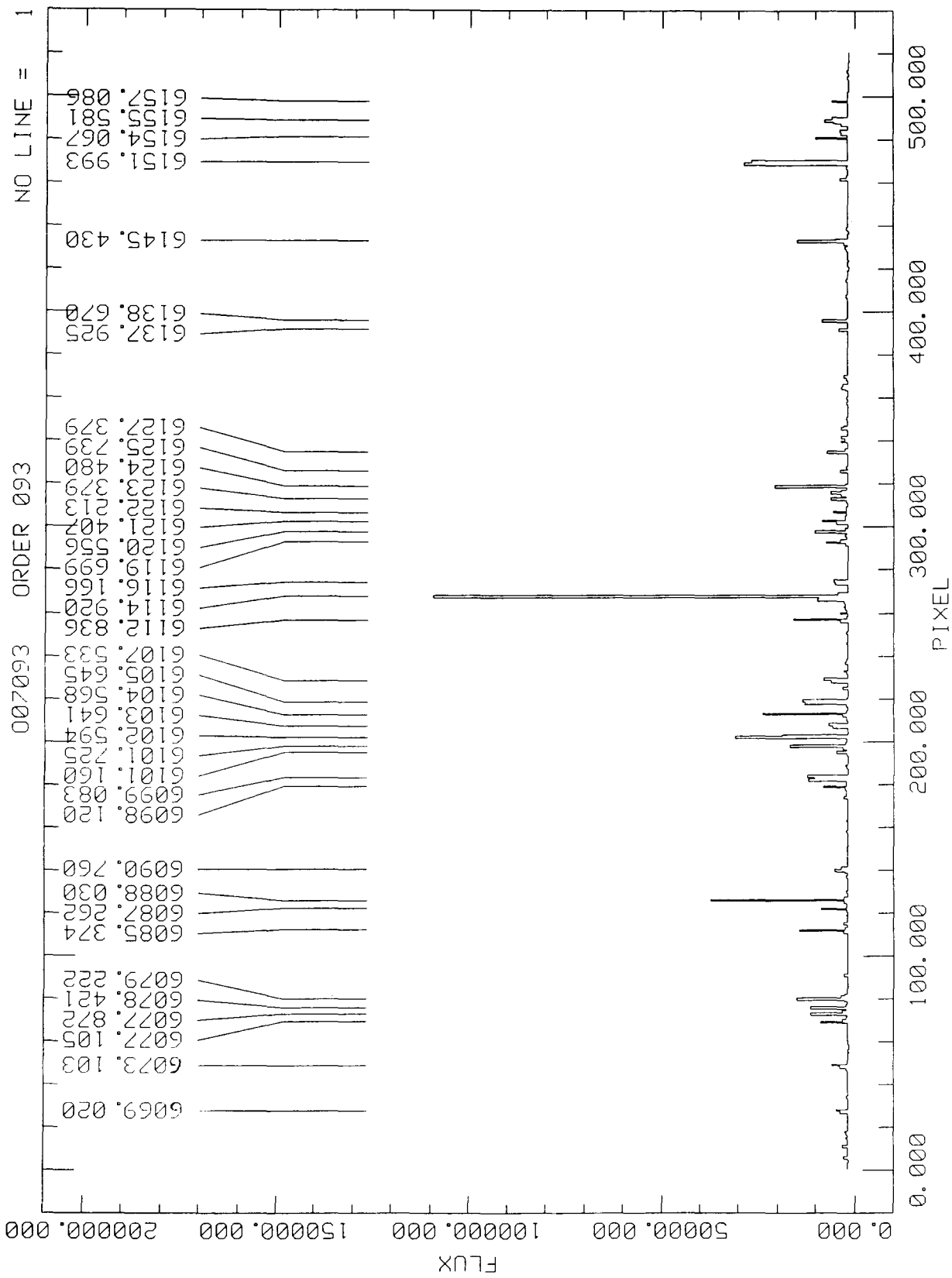
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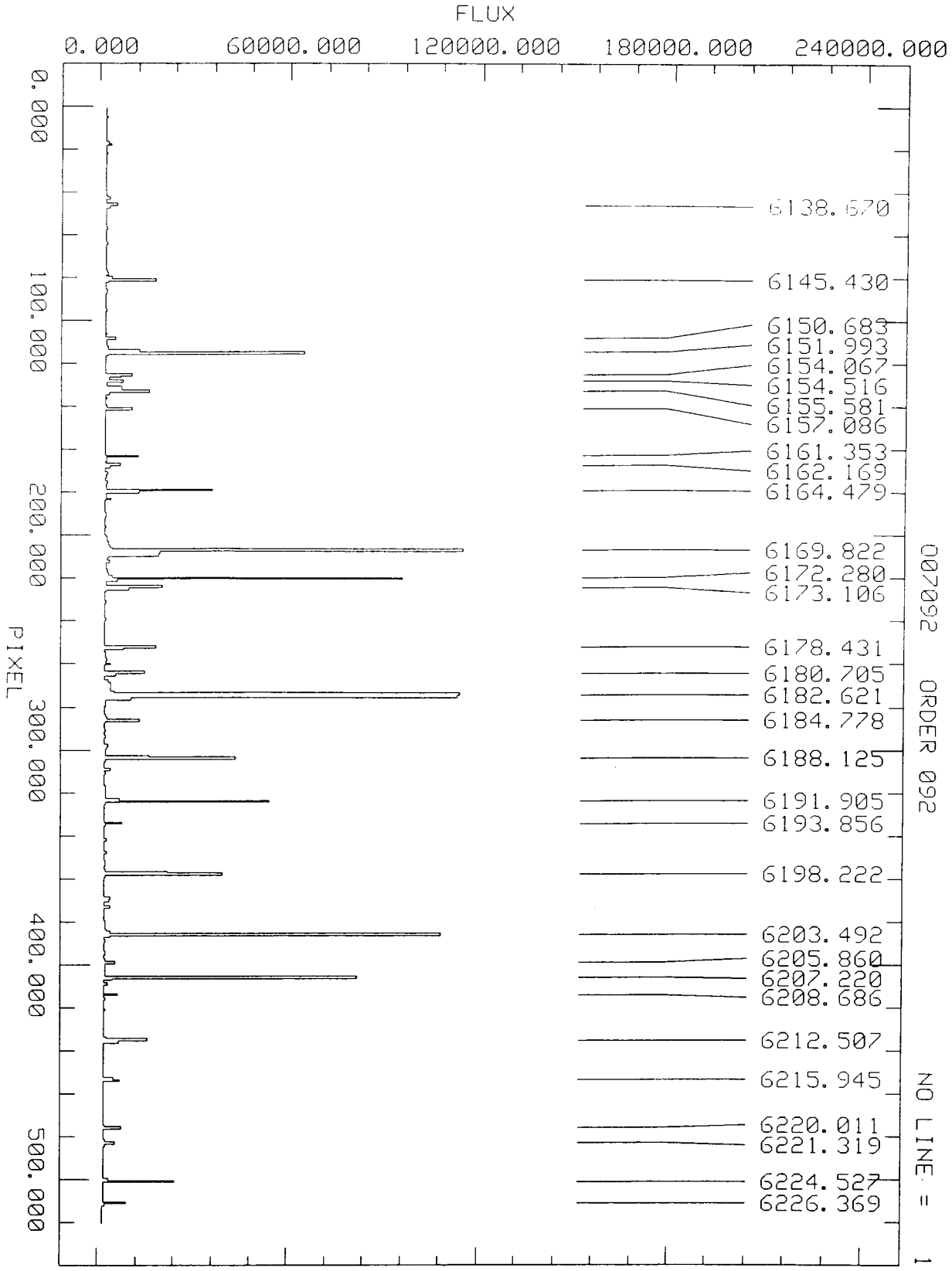
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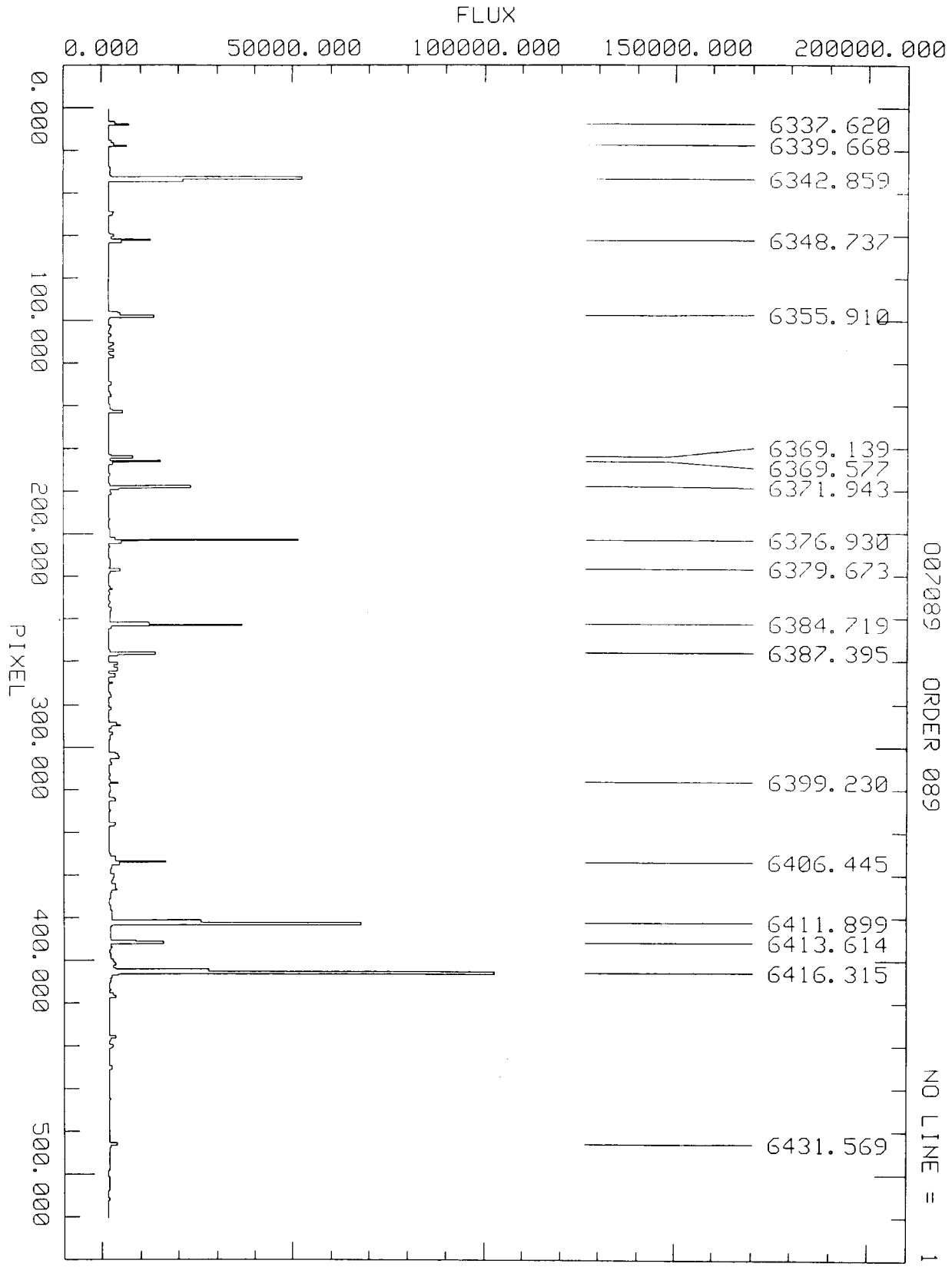
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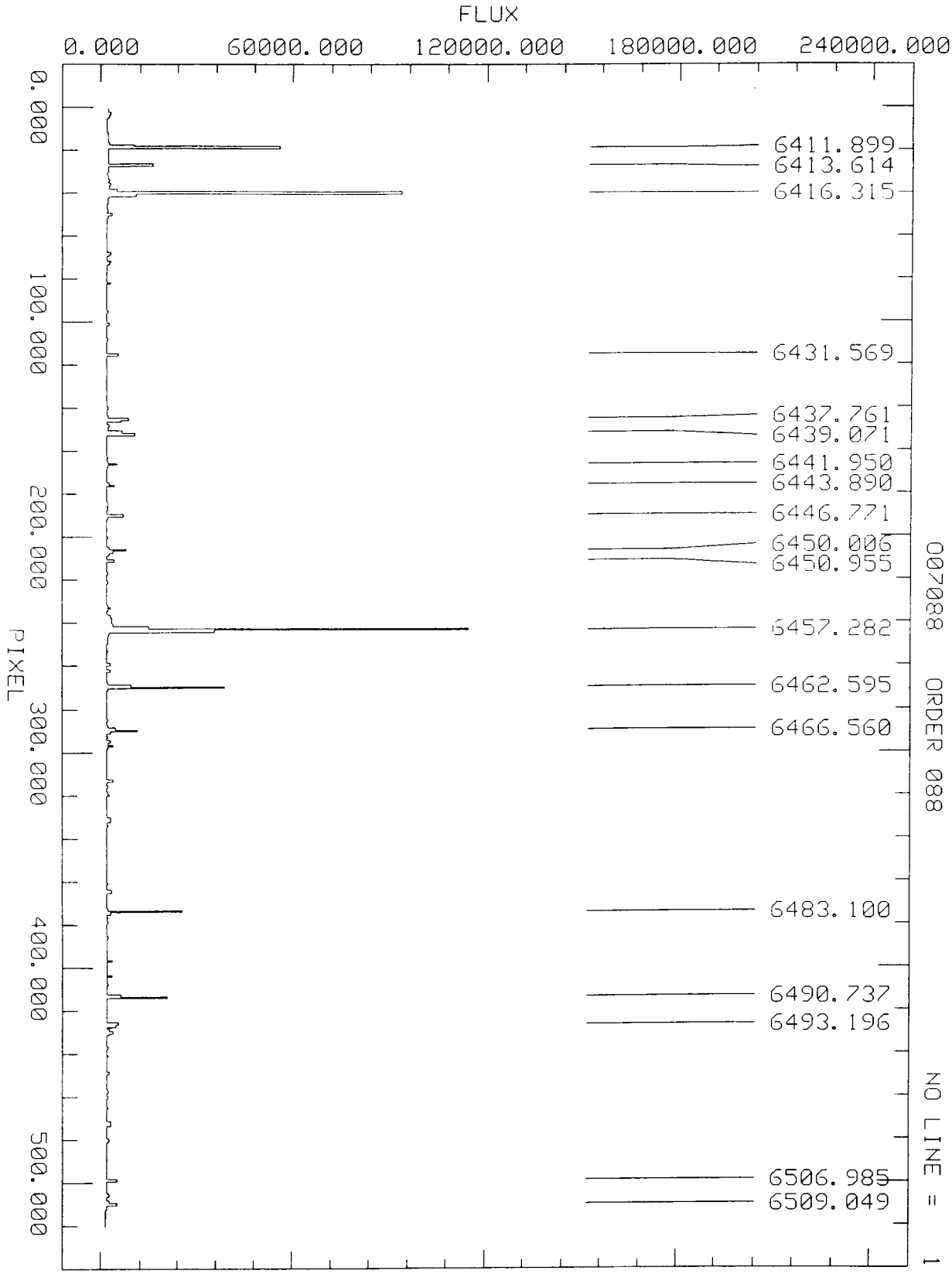
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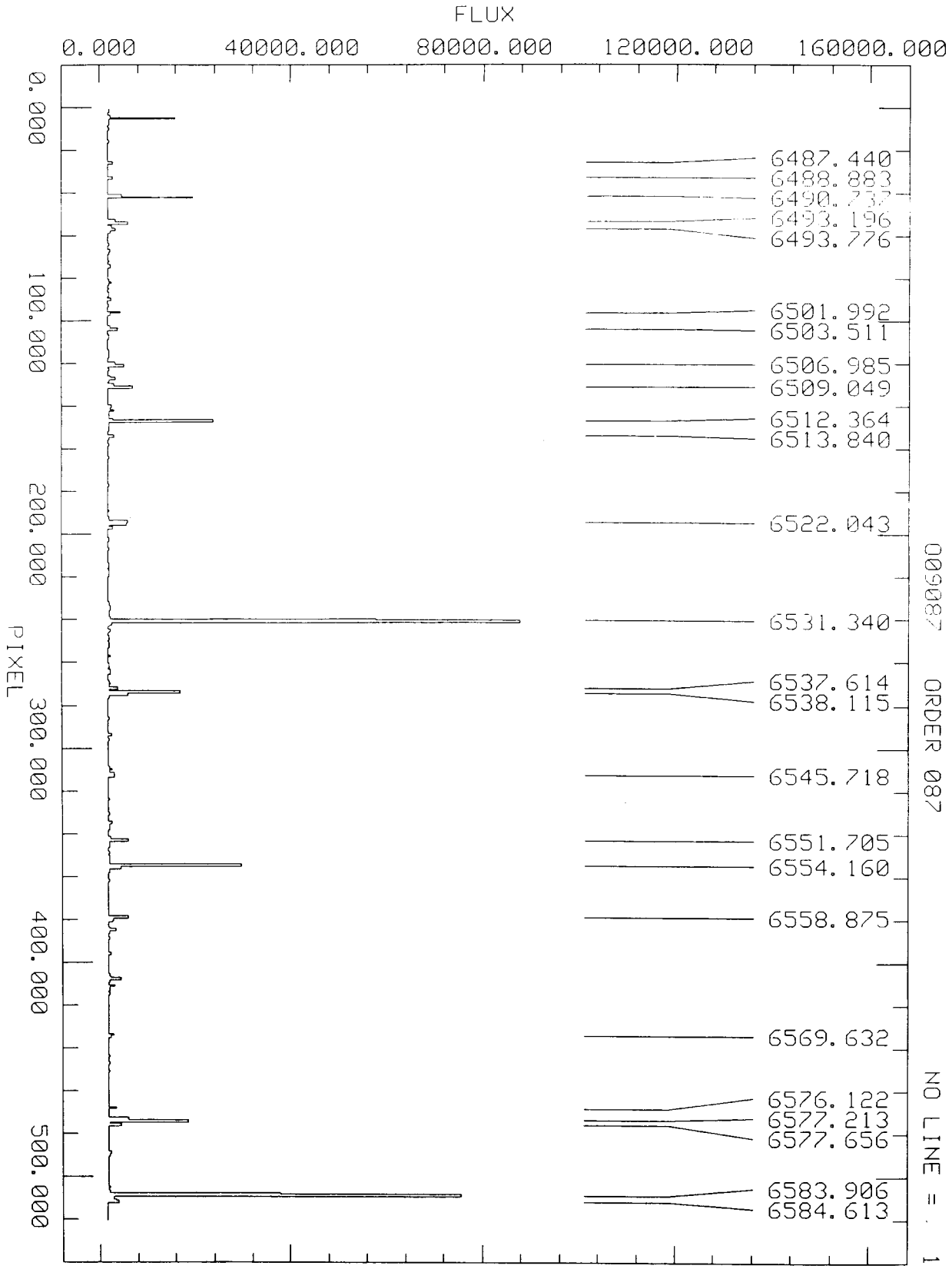
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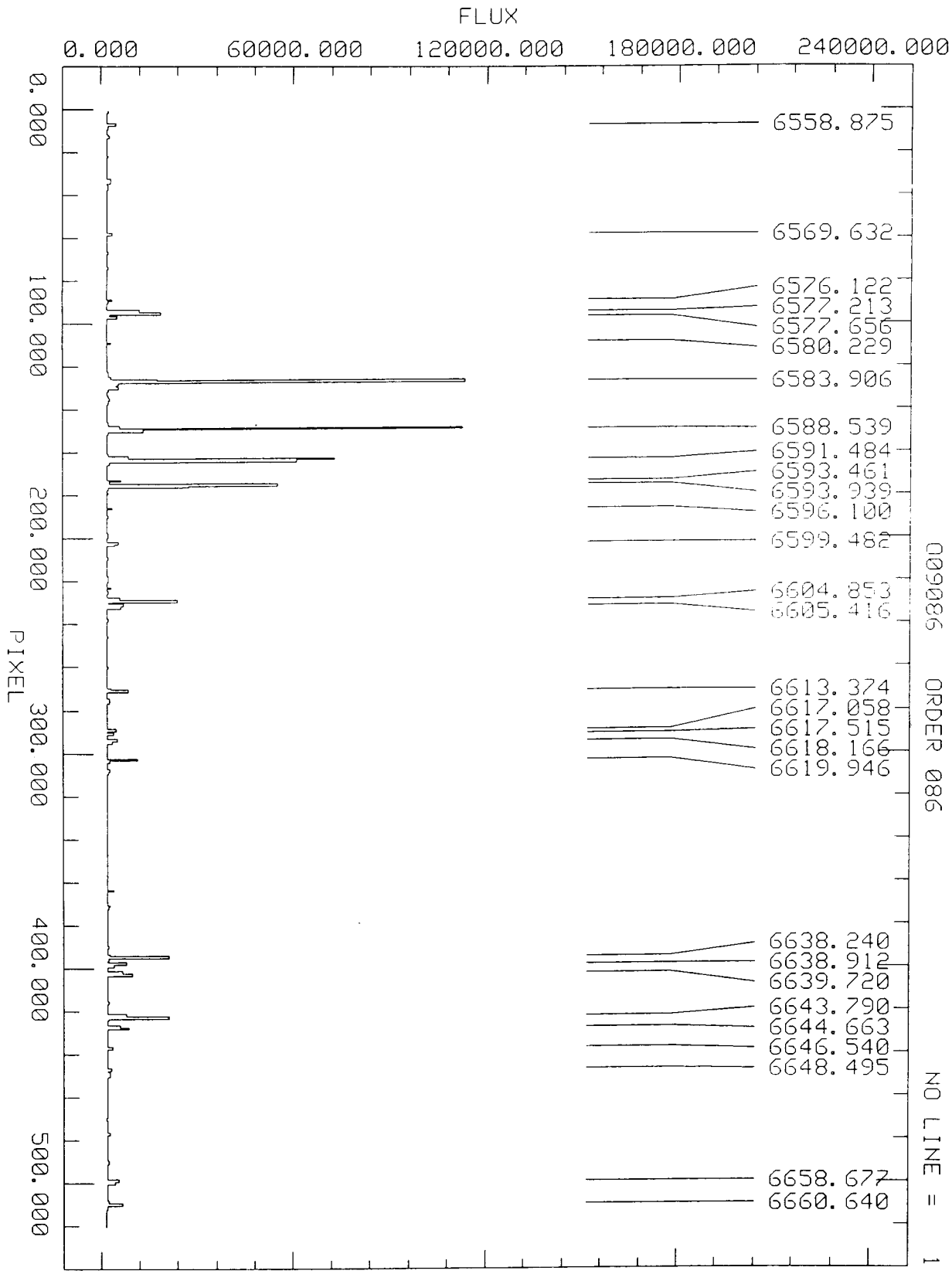
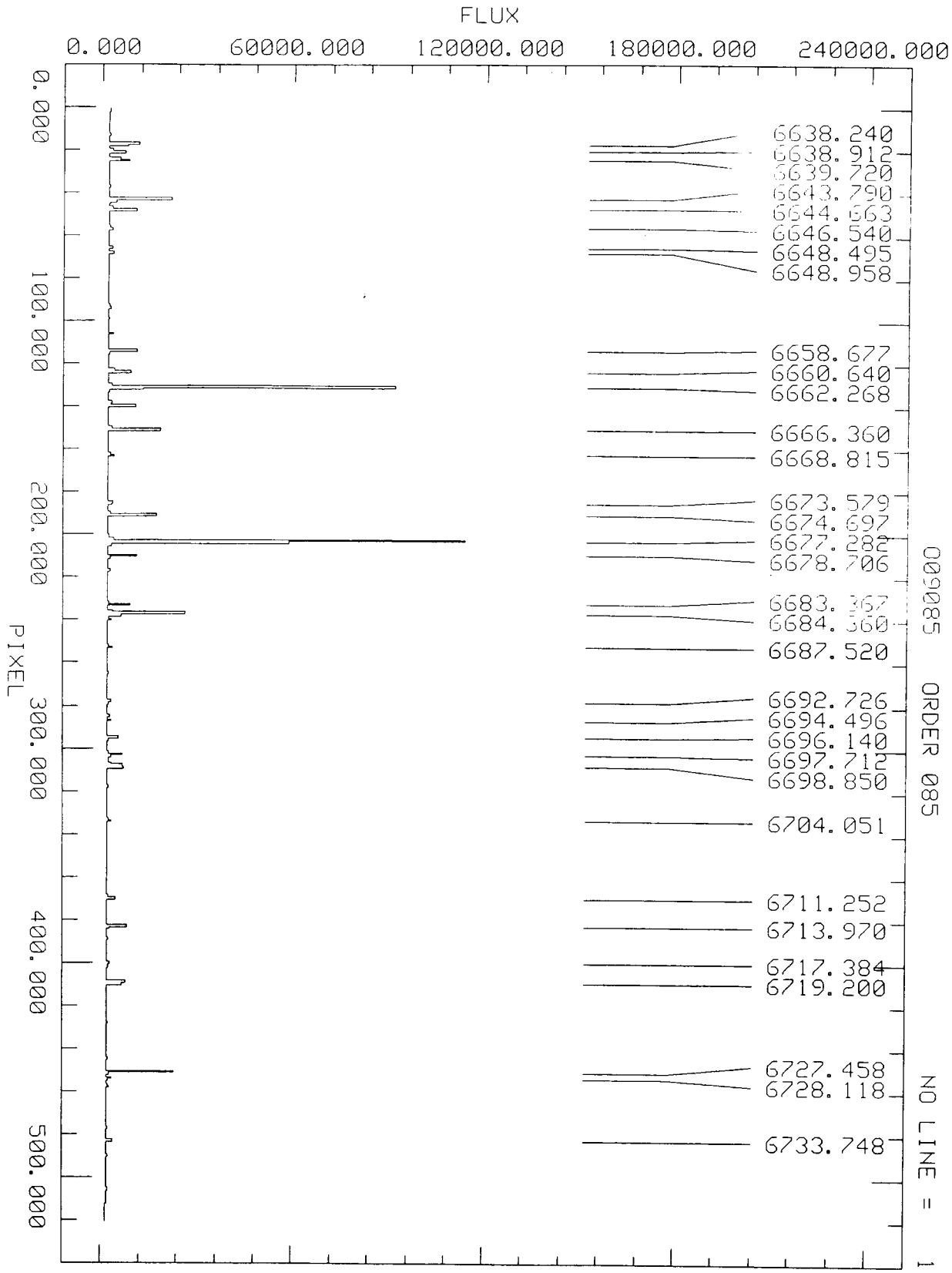
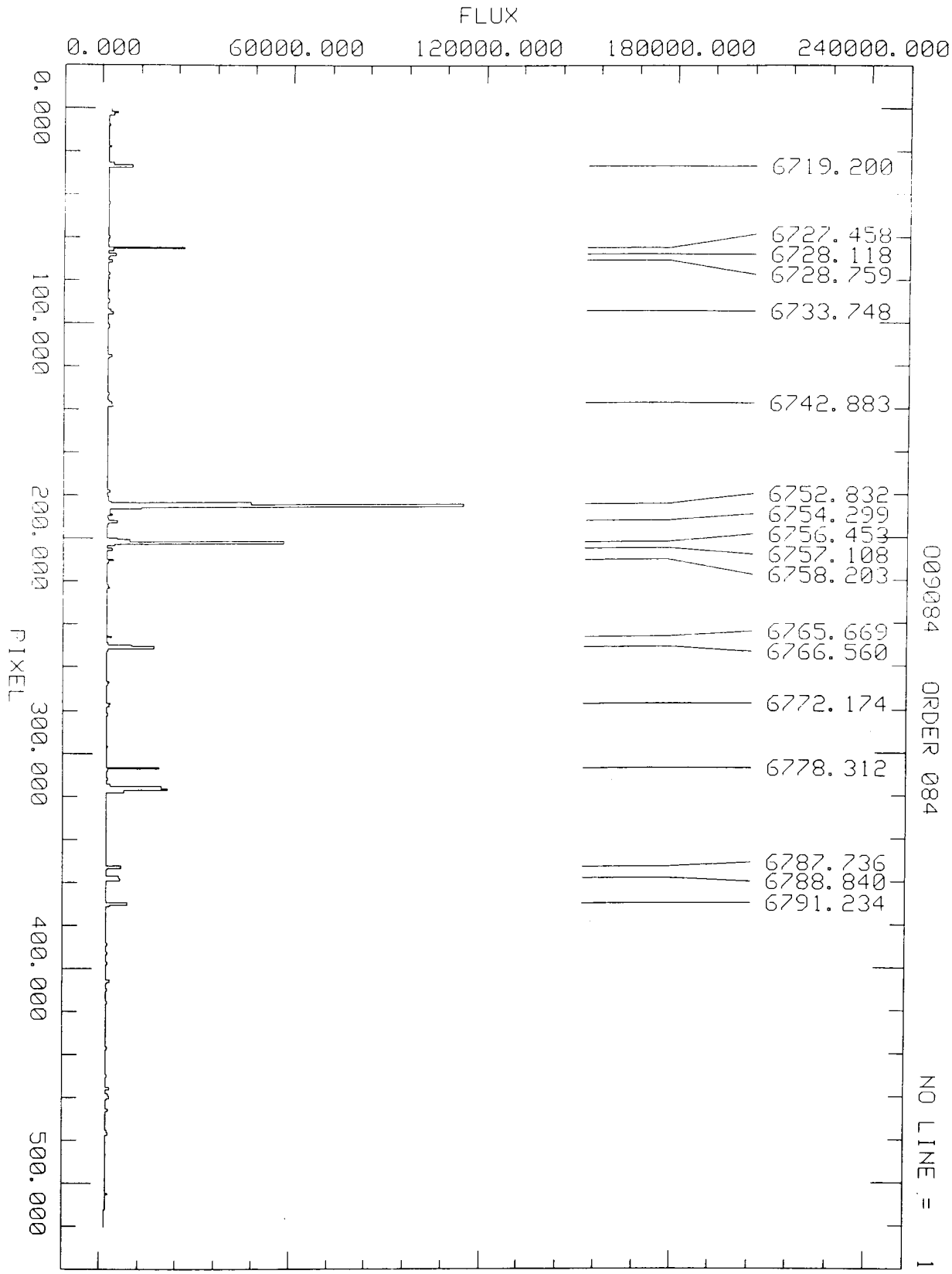
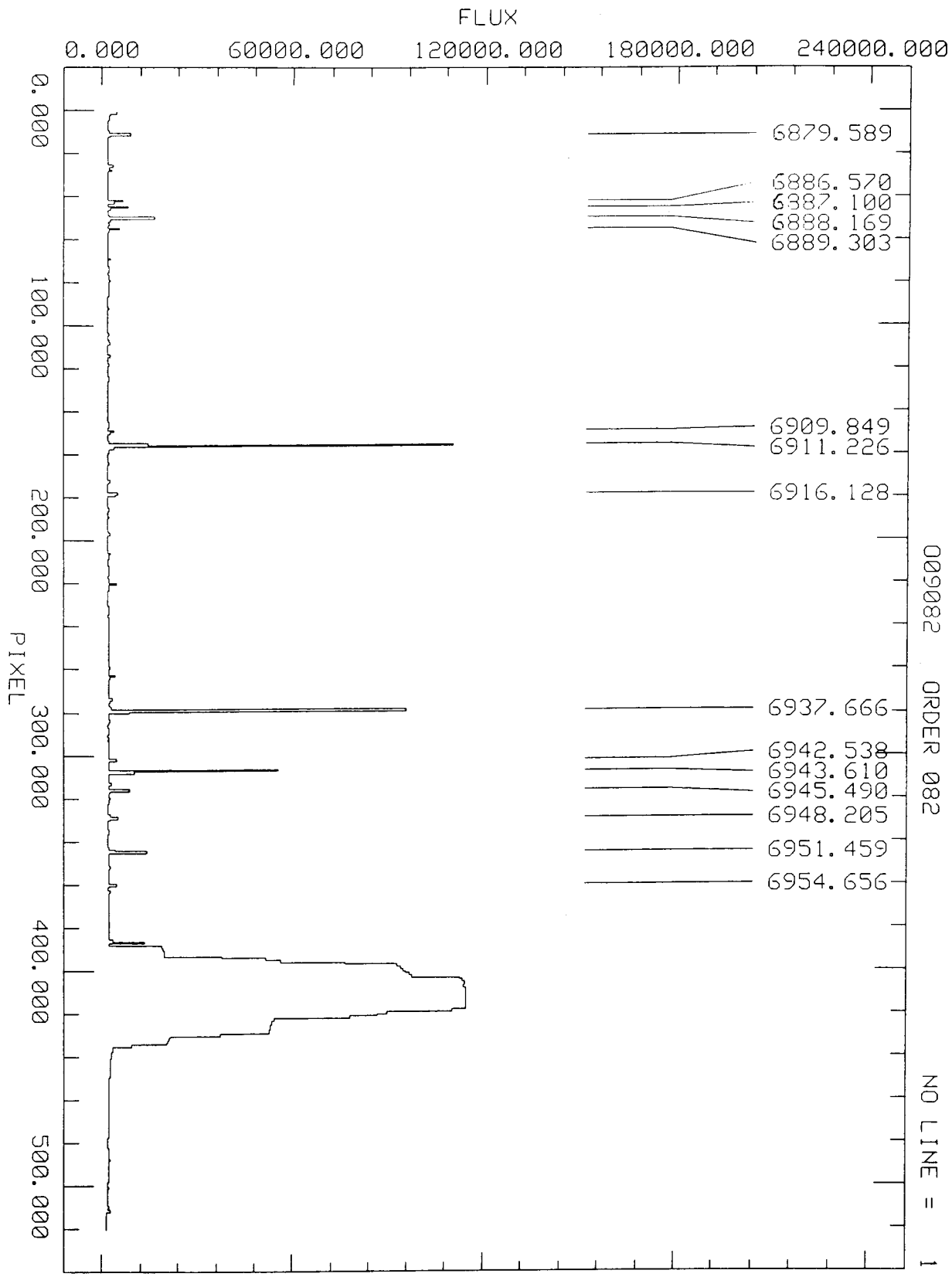
80000.000
120000.000
160000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
6487.440
6488.883
6490.737
6493.196
6493.776
6501.992
6503.511
6506.985
6509.049
6512.364
6513.840
6522.043
6531.340
6537.614
6538.115
6545.718
6551.705
6554.160
6558.875
6569.632
6576.122
6577.213
6577.656
6583.906
6584.613
ORDER 087
NO LINE = 1

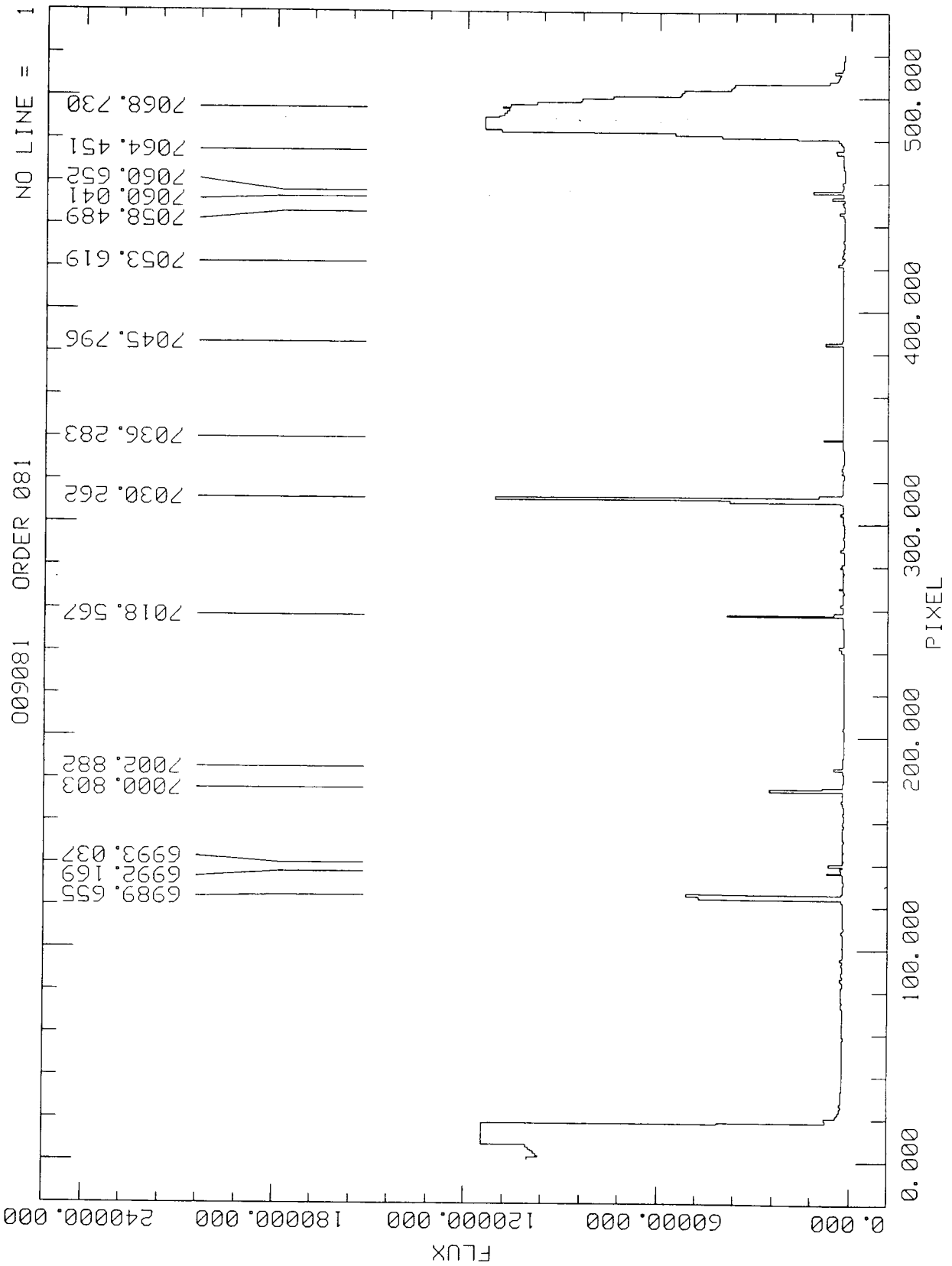

FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
6558.875
6569.632
6576.122
6577.213
6577.656
6580.229
6583.906
6588.539
6591.484
6593.461
6593.939
6596.100
6599.482
6604.853
6605.416
6613.374
6617.058
6617.515
6618.166
6619.946
6638.240
6638.912
6639.720
6643.790
6644.663
6646.540
6648.495
6658.677
6660.640
009086 ORDER 086
NO LINE = 1


FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
6638.240
6638.912
6639.720
6643.790
6644.663
6646.540
6648.495
6648.958
6658.677
6660.640
6662.268
6666.360
6668.815
6673.579
6674.697
6677.282
6678.706
6683.367
6684.360
6687.520
6692.726
6694.496
6696.140
6697.712
6698.850
6704.051
6711.252
6713.970
6717.384
6719.200
6727.458
6728.118
6733.748
009085
ORDER 085
NO LINE = 1

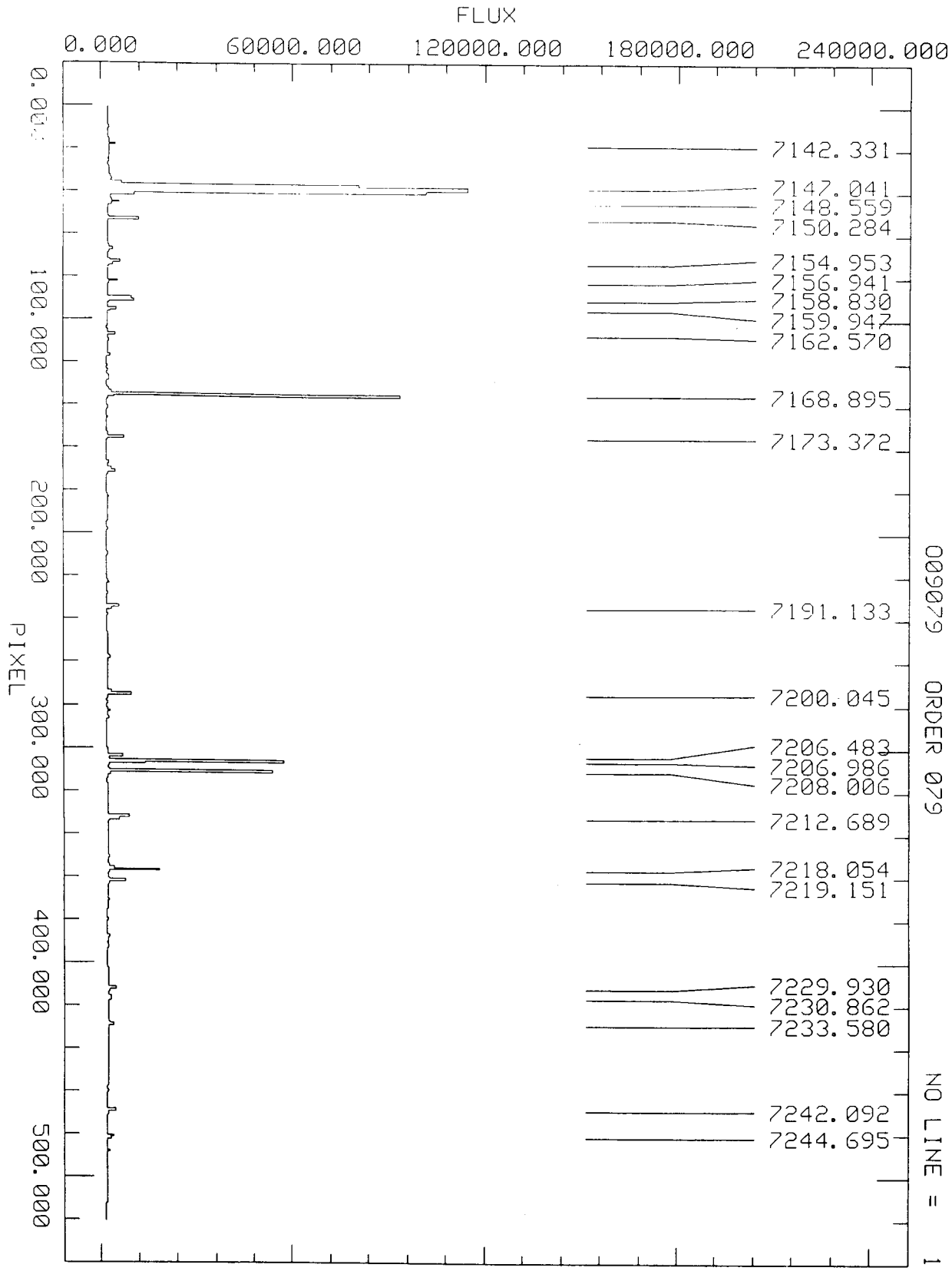

FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
6719.200
6727.458
6728.118
6728.759
6733.748
6742.883
6752.832
6754.299
6756.453
6757.108
6758.203
6765.669
6766.560
6772.174
6778.312
6787.736
6788.840
6791.234
009084 ORDER 084
NO LINE = 1

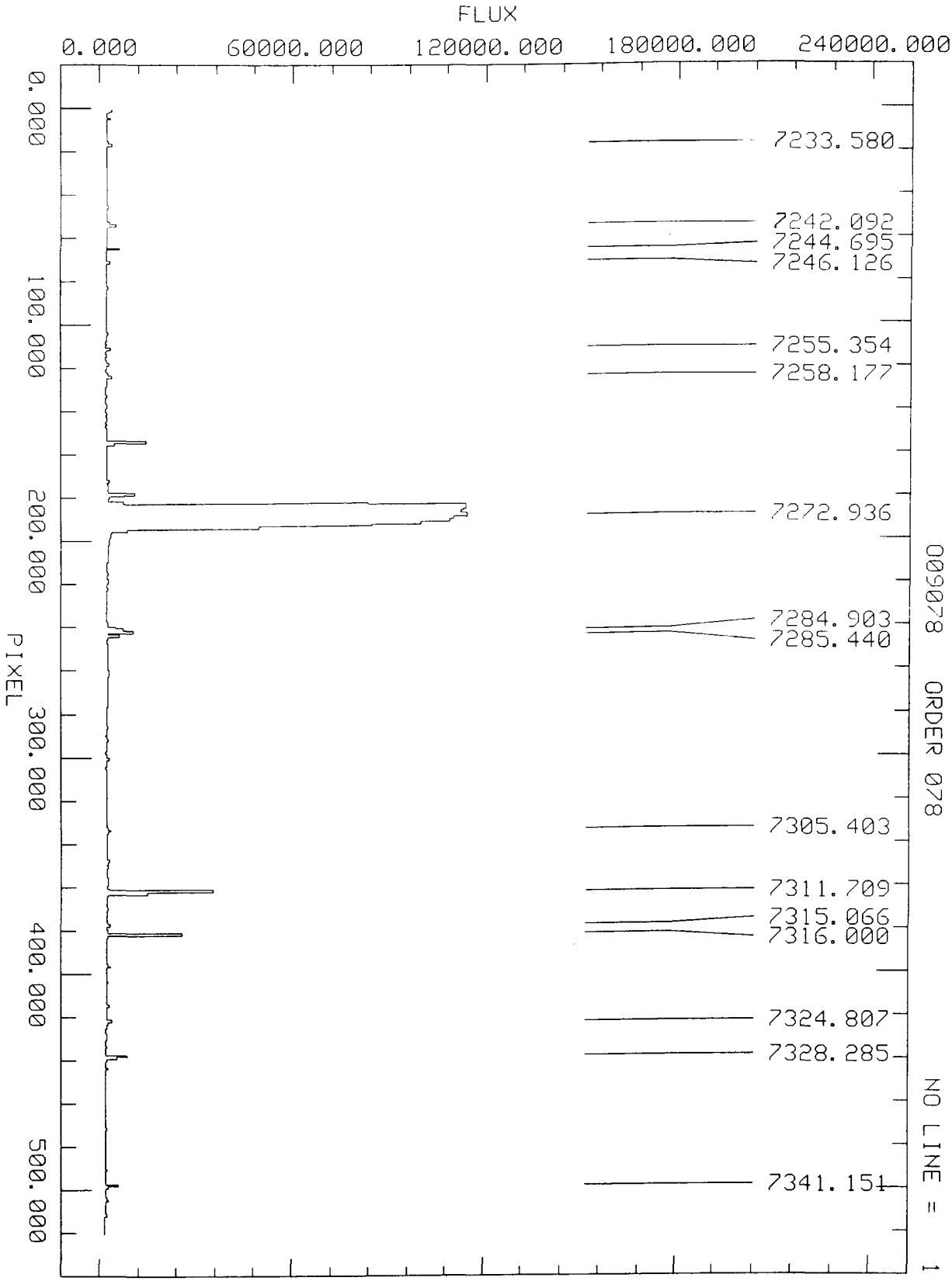
FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
6818.259
6823.507
6824.676
6827.240
6829.035
6834.924
6851.860
6853.522
6854.108
6861.300
6863.520
6866.366
6866.763
6868.450
6871.290
6874.752
6879.589
6882.811
6886.570
6887.100
6888.169
6889.303
009083 ORDER 083
NO LINE = 1

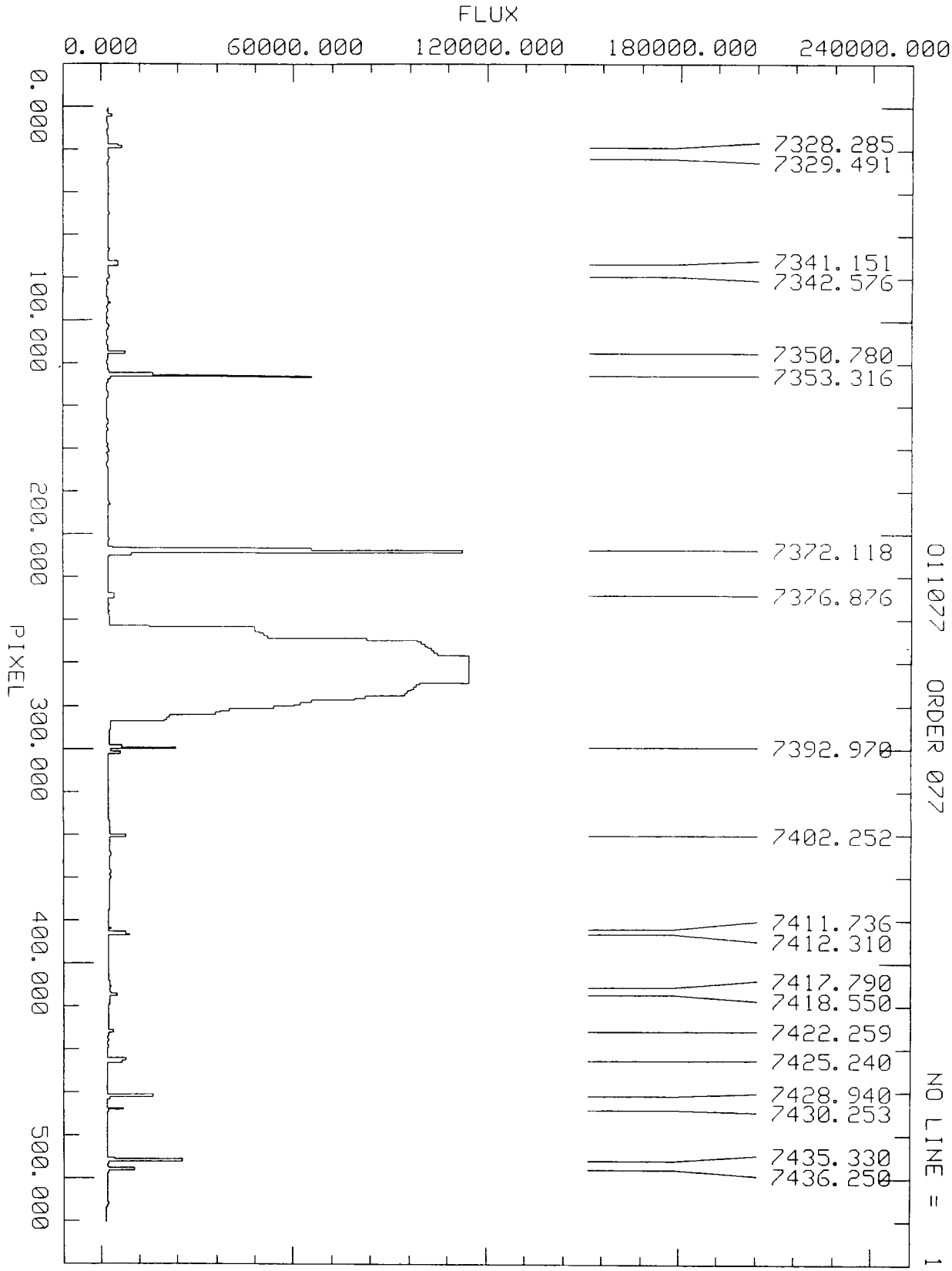

FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
6879.589
6886.570
6887.100
6888.169
6889.303
6909.849
6911.226
6916.128
6937.666
6942.538
6943.610
6945.490
6948.205
6951.459
6954.656
009082 ORDER 082
NO LINE = 1

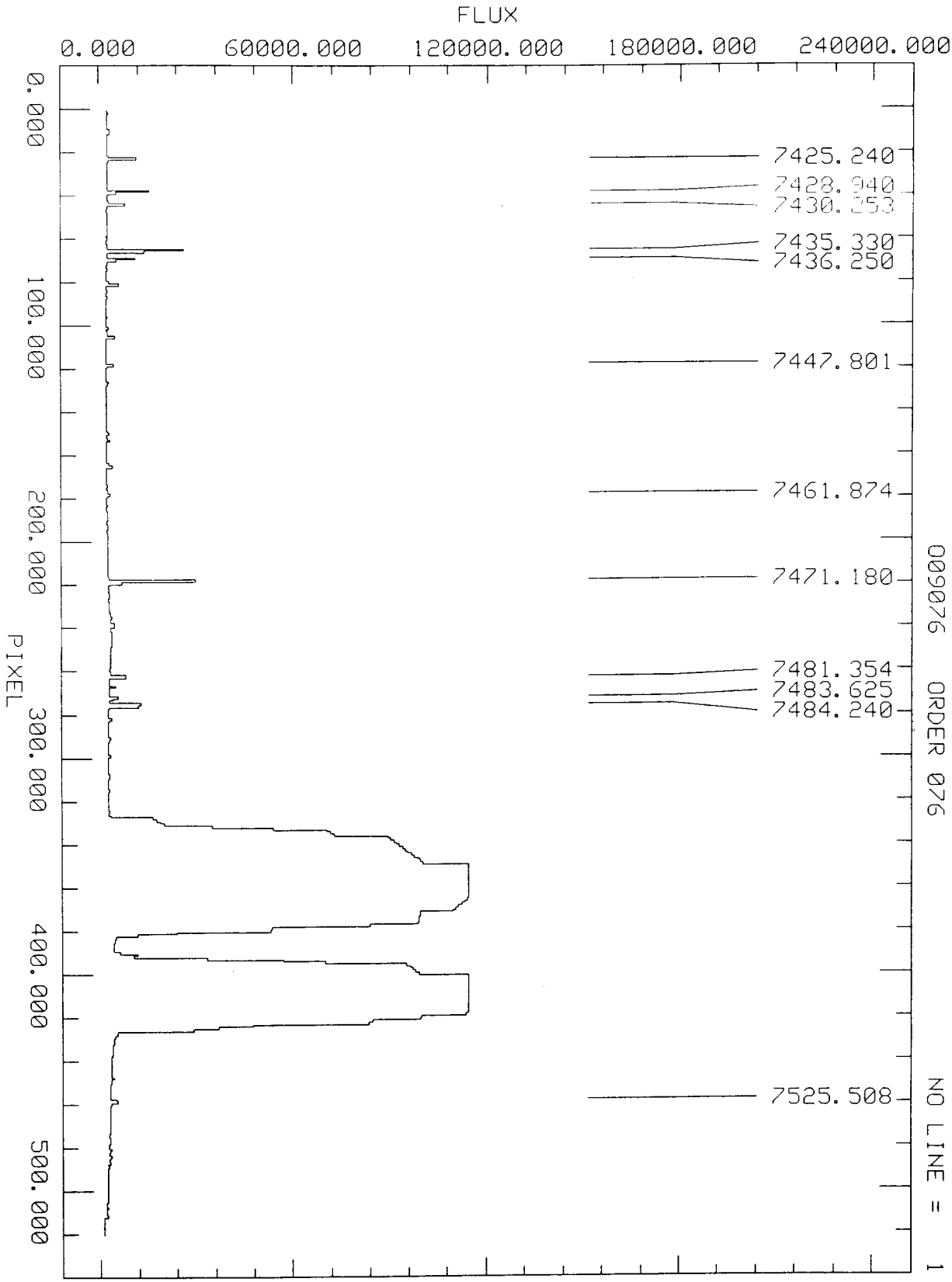

NO LINE = 1
009081 ORDER 081
7068.730
7064.451
7060.652
7060.041
7058.489
7053.619
7045.796
7036.283
7030.262
7018.567
7002.882
7000.803
6993.037
6992.169
6989.655
0.000
60000.000
120000.000
180000.000
240000.000
FLUX
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL

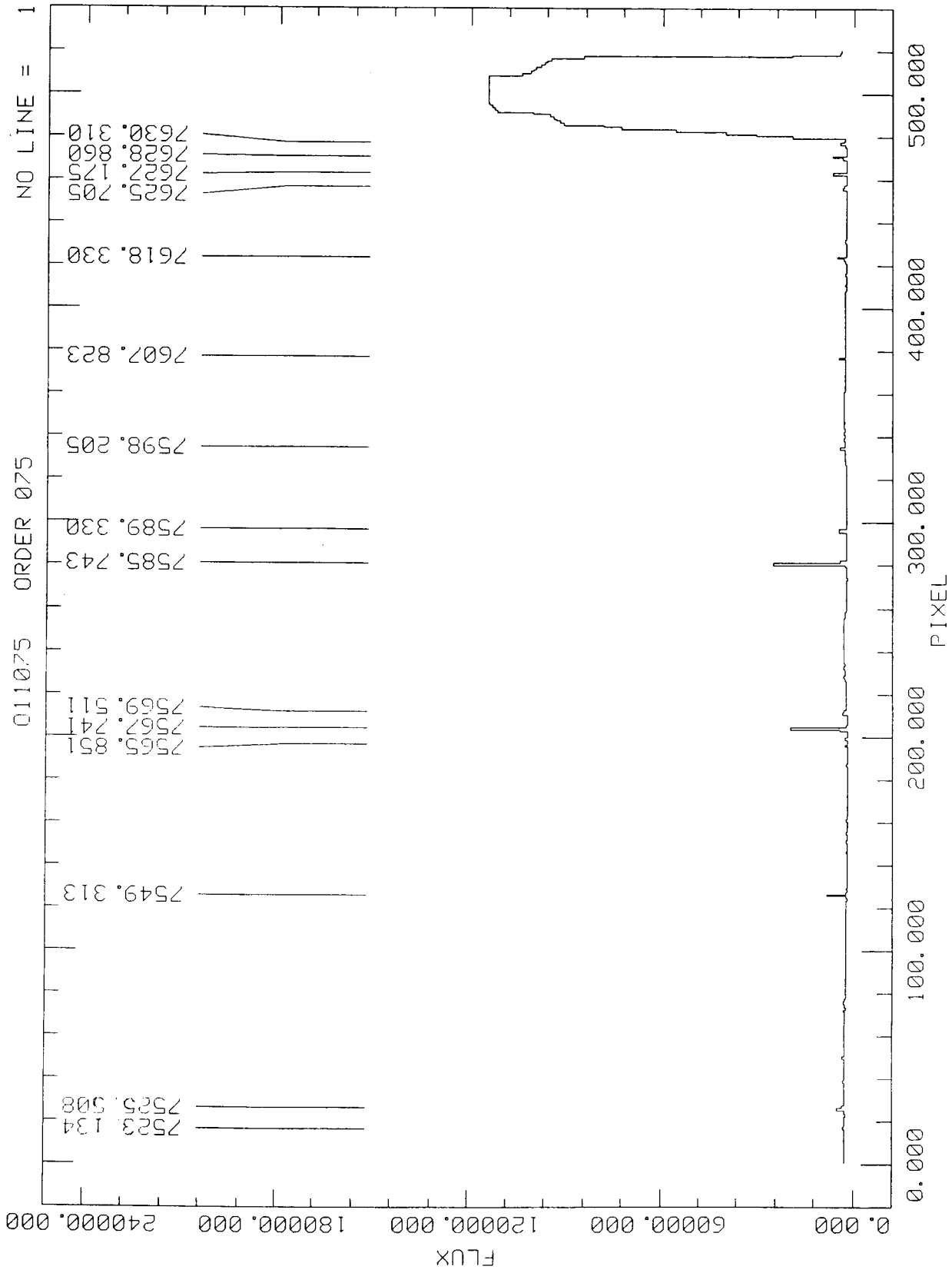
FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
7053.619
7058.489
7060.041
7060.652
7068.730
7072.394
7075.333
7084.169
7086.700
7089.339
7100.514
7107.496
7109.859
7114.398
7122.044
7124.560
7125.800
7130.184
7142.331
7147.041
7148.559
7150.284
7154.953
7156.941
7158.830
7159.947
009080 ORDER 080
NO LINE = 1


FLUX
0.000
60000.000
120000.000
180000.000
240000.000
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
7142.331
7147.041
7148.559
7150.284
7154.953
7156.941
7158.830
7159.942
7162.570
7168.895
7173.372
7191.133
7200.045
7206.483
7206.986
7208.006
7212.689
7218.054
7219.151
7229.930
7230.862
7233.580
7242.092
7244.695
009079 ORDER 079
NO LINE = 1

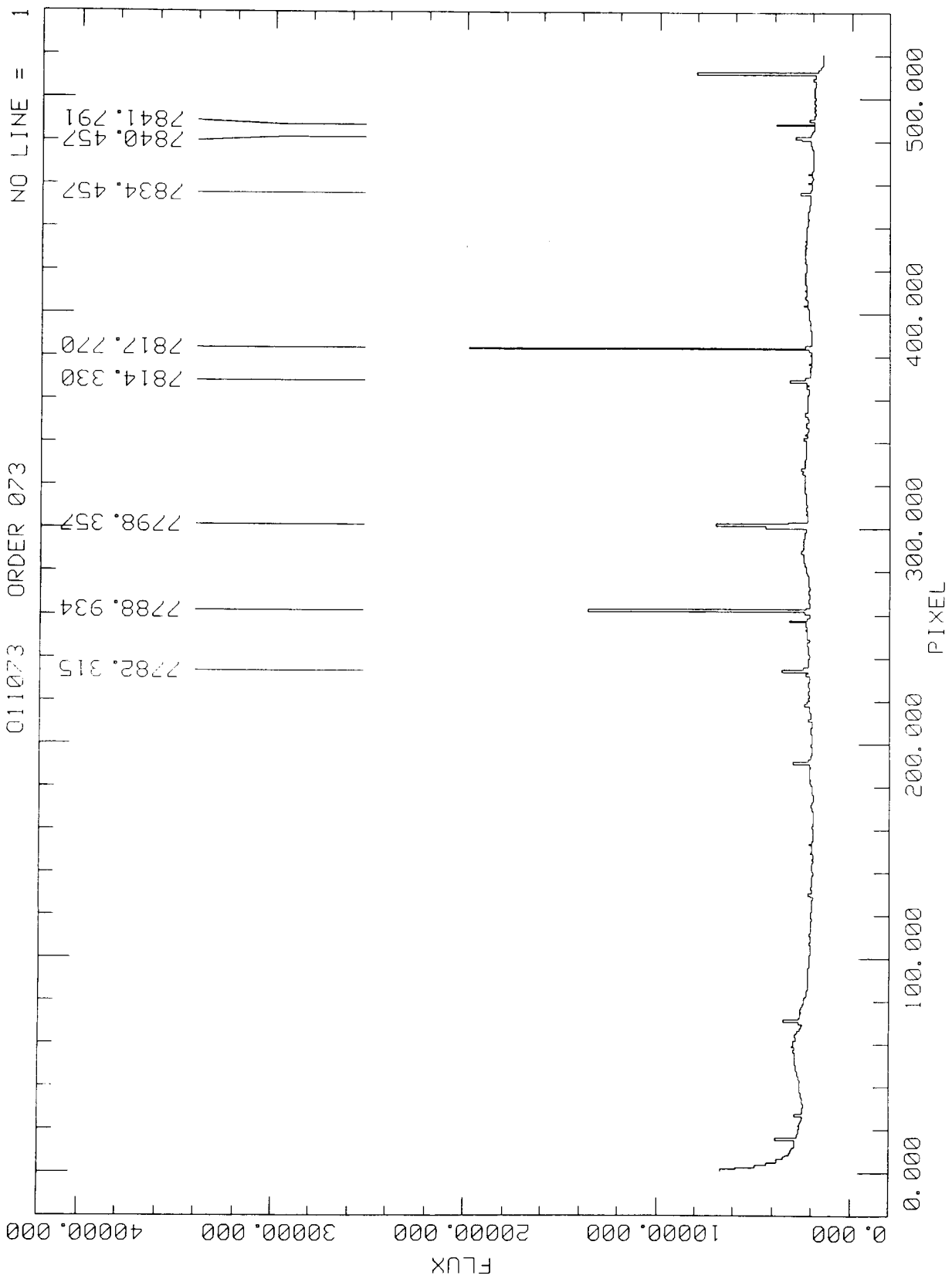

FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
7233.580
7242.092
7244.695
7246.126
7255.354
7258.177
7272.936
7284.903
7285.440
7305.403
7311.709
7315.066
7316.000
7324.807
7328.285
7341.151
009078
ORDER 078
NO LINE = 1


FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
7328.285
7329.491
7341.151
7342.576
7350.780
7353.316
7372.118
7376.876
7392.970
7402.252
7411.736
7412.310
7417.790
7418.550
7422.259
7425.240
7428.940
7430.253
7435.330
7436.250
011077 ORDER 077
NO LINE = 1


FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
7425.240
7428.940
7430.253
7435.330
7436.250
7447.801
7461.874
7471.180
7481.354
7483.625
7484.240
7525.508
009076 ORDER 076
NO LINE = 1


NO LINE = 1
011075 ORDER 075
7630.310
7628.860
7622.175
7625.705
7618.330
7607.823
7598.205
7589.330
7585.743
7569.511
7567.241
7565.851
7549.313
7525.508
7523.134
FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000

FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
7625.705
7627.175
7647.378
7652.320
7653.828
7654.699
7658.324
7660.890
7670.040
7678.125
7685.307
7704.810
7710.269
7713.937
011074 ORDER 074
NO LINE = 1

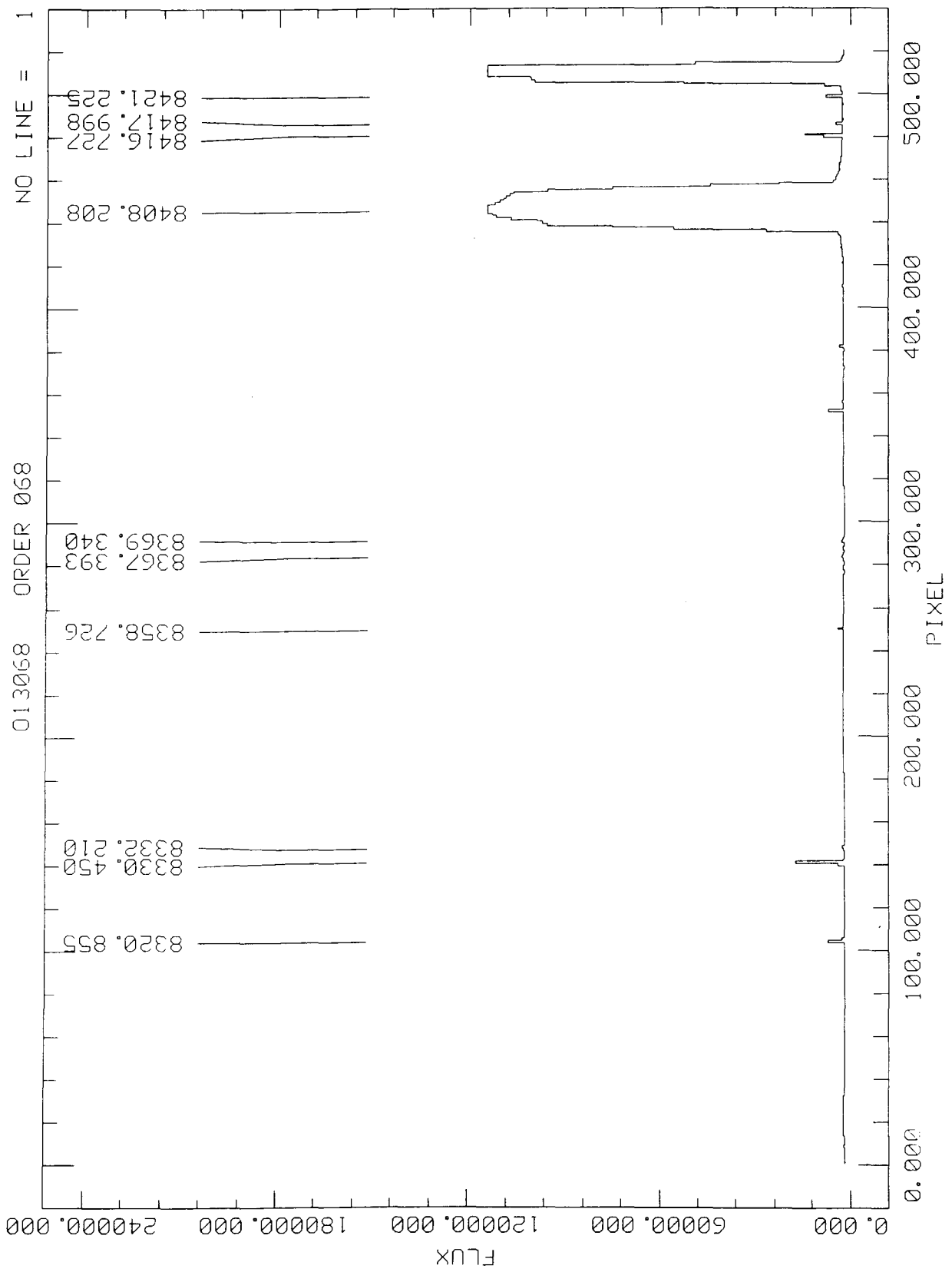

NO LINE = 1
011073 ORDER 073
7841.791
7840.457
7834.457
7817.770
7814.330
7798.357
7788.934
7782.315
FLUX
0.000
10000.000
20000.000
30000.000
40000.000
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL

FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
7840.457
7841.791
7847.539
7861.910
7865.969
7868.200
7886.283
7891.075
7900.320
7916.450
7937.733
7941.726
011072 ORDER 072
NO LINE = 1

FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
7978.973
7987.973
8022.330
8032.431
8037.230
8046.130
8053.307
8062.630
8066.826
011071 ORDER 071
NO LINE = 1

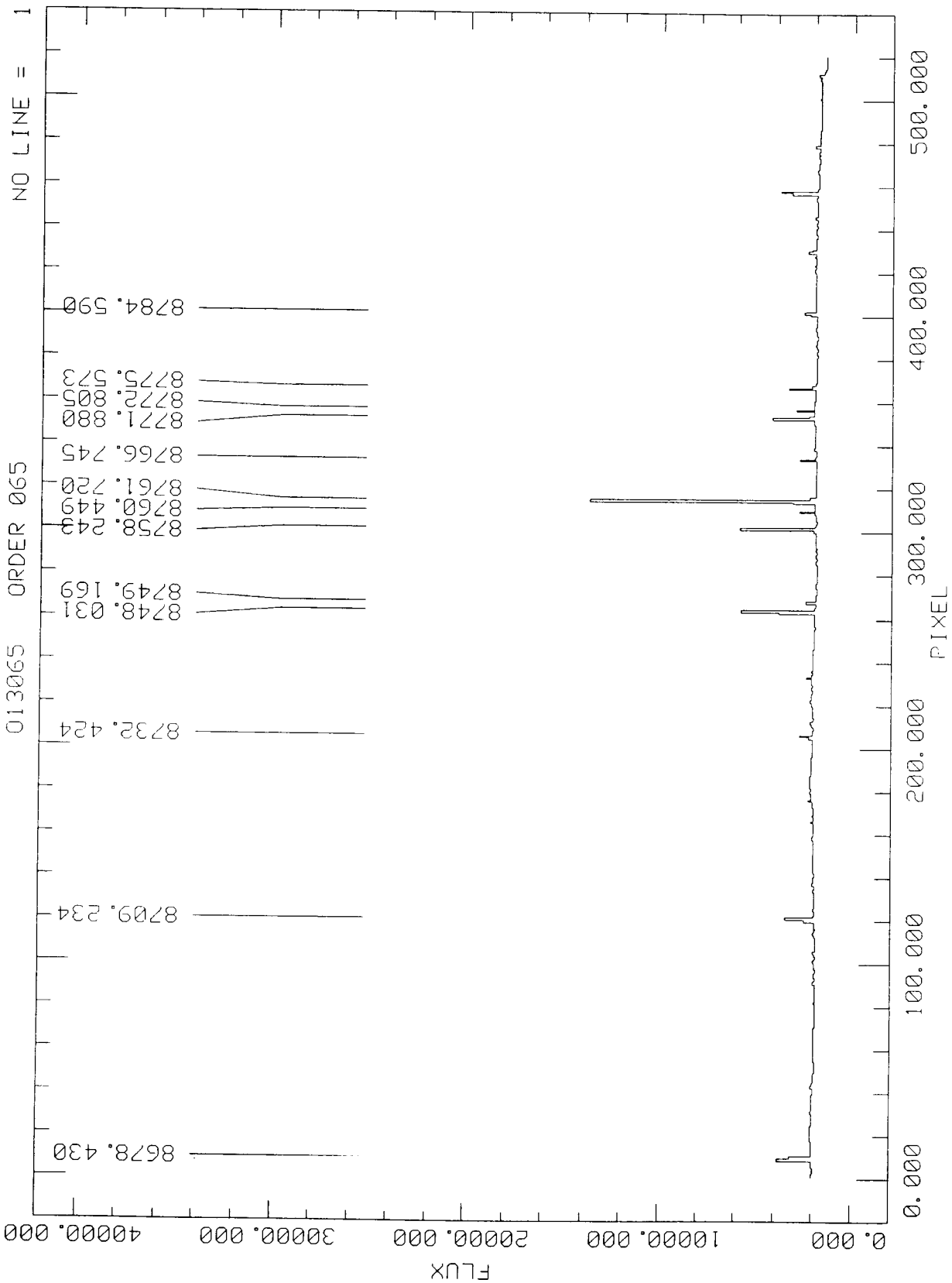
FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
8062.630
8066.826
8075.651
8085.219
8103.692
8122.723
8129.405
8138.475
8143.138
8159.727
8169.786
8178.840
013070 ORDER 070
NO LINE = 1

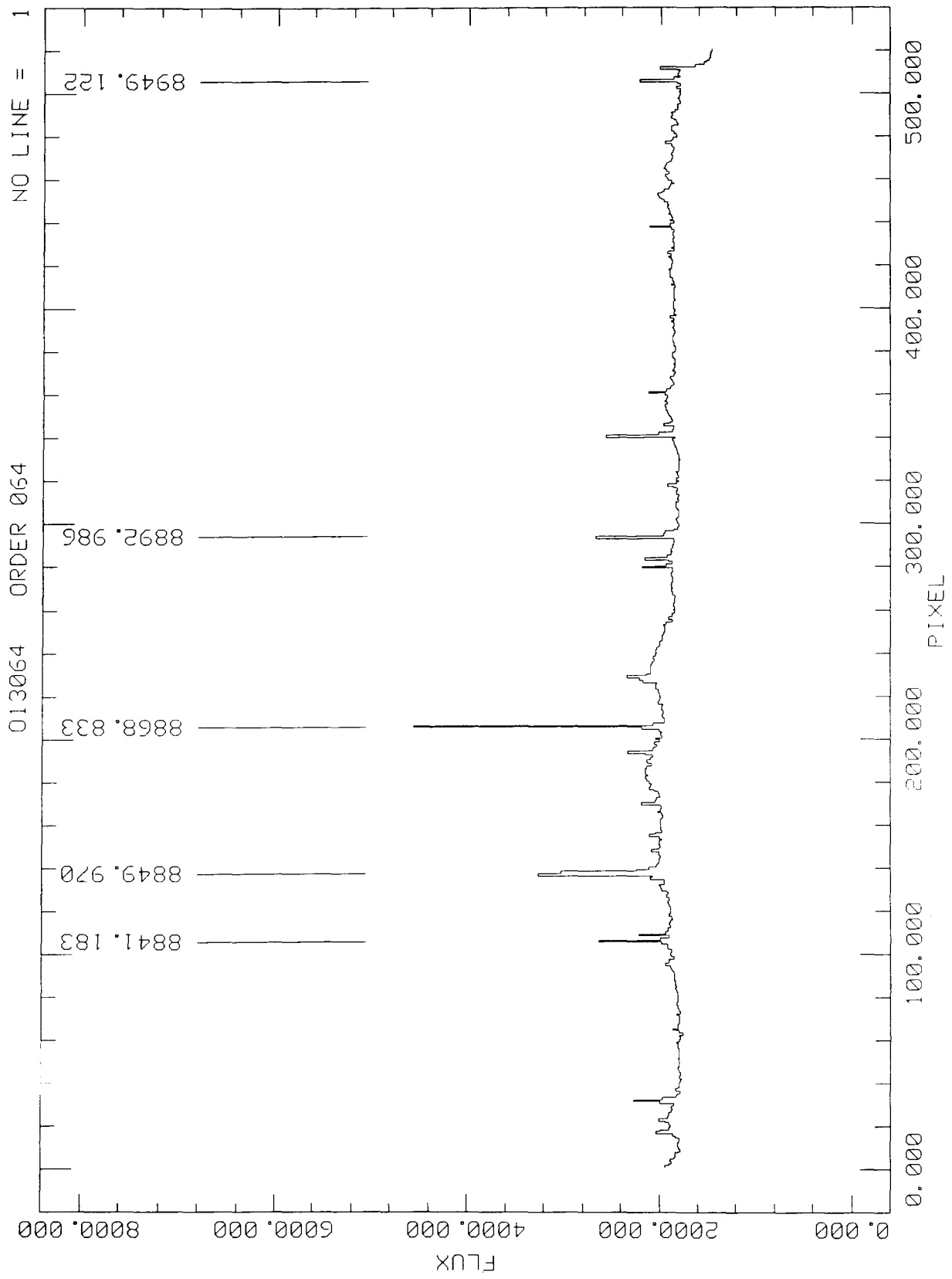
FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
8178.840
8186.911
8203.201
8231.406
8252.393
8254.742
8259.511
8275.626
013069 ORDER 069
NO LINE = 1


NO LINE = 1
013068 ORDER 068
8421.225
8417.998
8416.227
8408.208
8369.340
8367.393
8358.726
8332.210
8330.450
8320.855
FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000

FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
8424.647
8445.487
8446.511
8464.236
8471.826
8478.358
8490.300
8510.624
8516.554
013067 ORDER 067
NO LINE = 1

FLUX
0.000
60000.000
120000.000
180000.000
240000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
8554.944
8573.120
8605.780
8620.470
8639.441
8667.943
8678.430
013066 ORDER 066
NO LINE = 1


013065 ORDER 065
NO LINE = 1
8678.430
8709.234
8732.424
8748.031
8749.169
8758.243
8760.449
8761.720
8766.745
8771.880
8772.805
8775.573
8784.590
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
0.000
10000.000
20000.000
30000.000
40000.000
FLUX


NO LINE = 1
013064 ORDER 064
8949.122
8892.986
8868.833
8849.970
8841.183
FLUX
0.000
2000.000
4000.000
6000.000
8000.000
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL

FLUX
0.000
10000.000
20000.000
30000.000
40000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
8962.190
8967.640
8997.875
9016.590
9017.590
9031.819
9037.893
9045.353
9048.250
9053.485
9063.960
9075.420
013063 ORDER 063
NO LINE = 1

PART 2

52.6 lines/mm echelle

$\lambda\lambda$ 3400 - 4600 Å

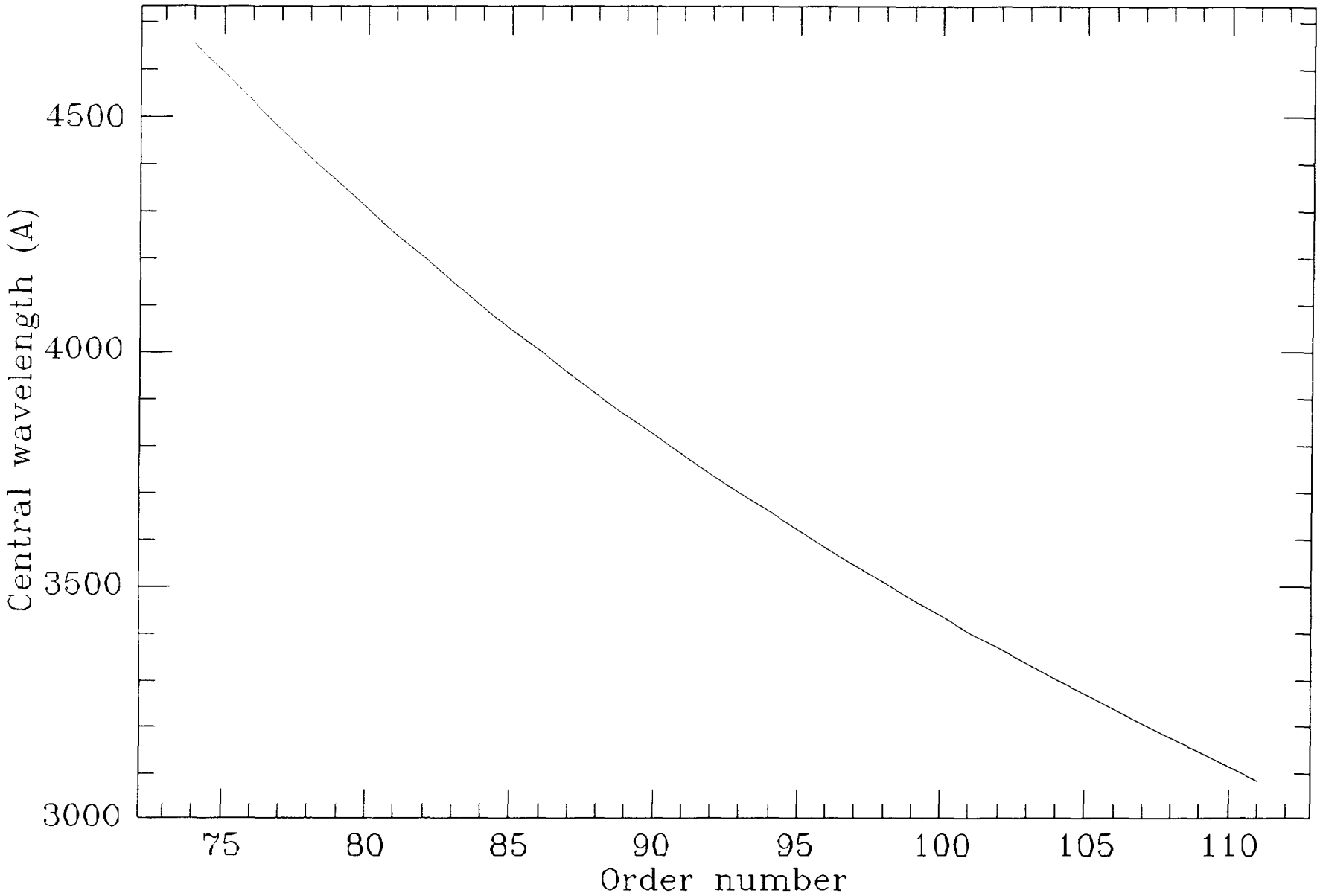

Central wavelength (A)
4500
4000
3500
3000
75
80
85
90
95
100
105
110
Order number

Fig. 11

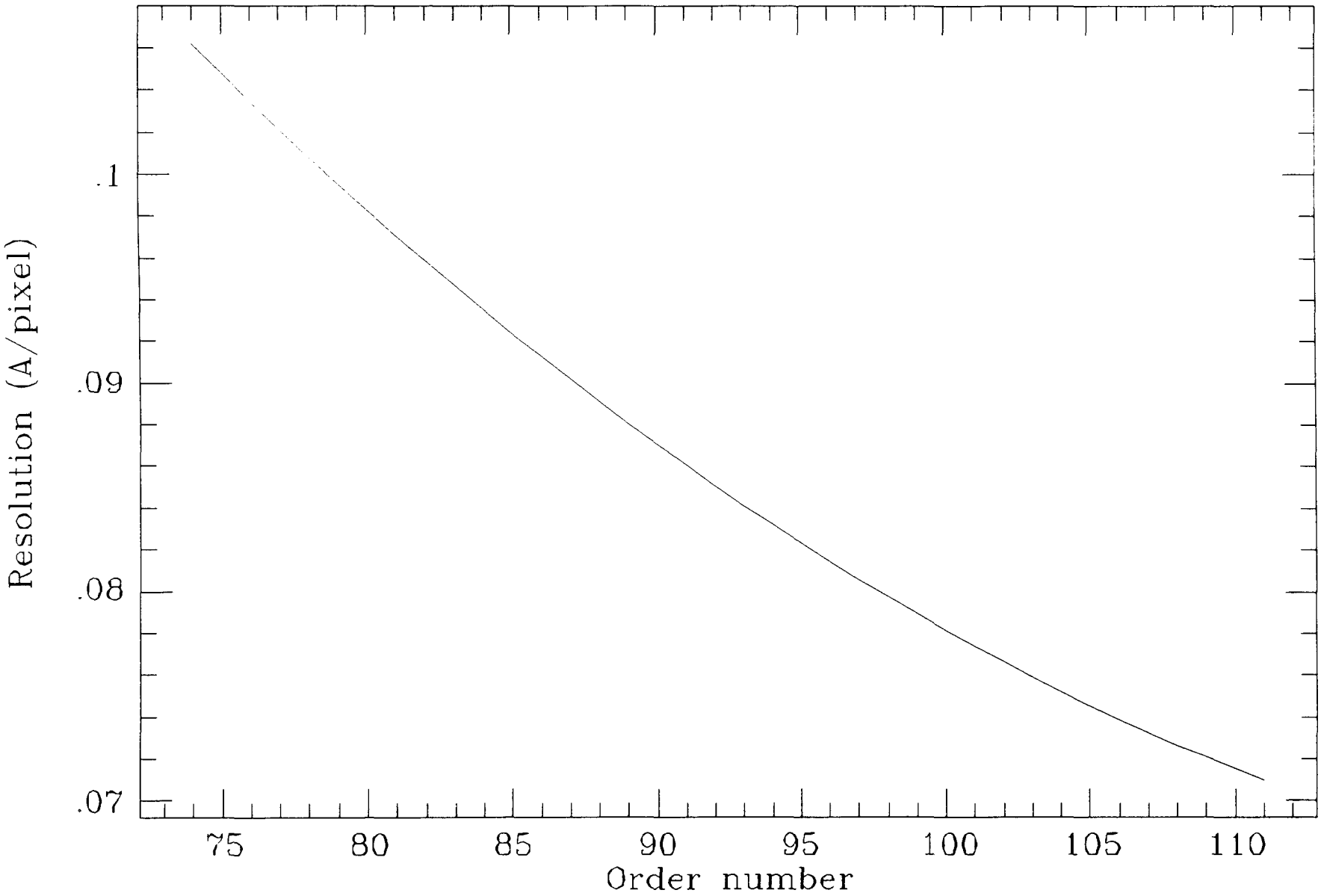

Resolution (A/pixel)
.1
.09
.08
.07
75
80
85
90
95
100
105
110
Order number

Fig. 12

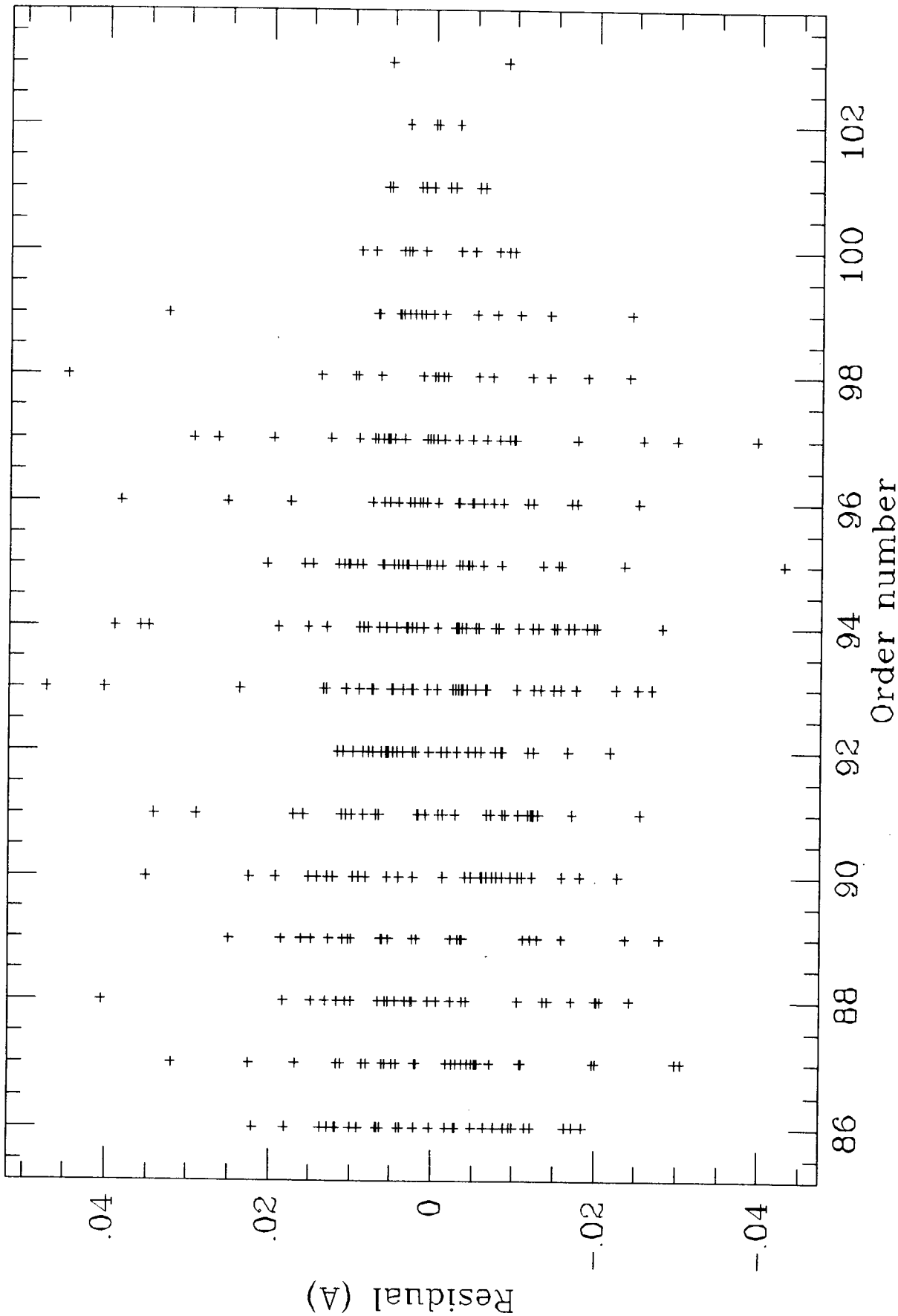


Fig. 13

Order	**Resolution** (Å/pixel)	**Central Wavelength** (Å)
100	0.078± 0.01	3437
95	0.082	3620
90	0.087	3822
85	0.092	4049
80	0.098	4305
75	0.105	4594

Table .2: Resolution for various orders

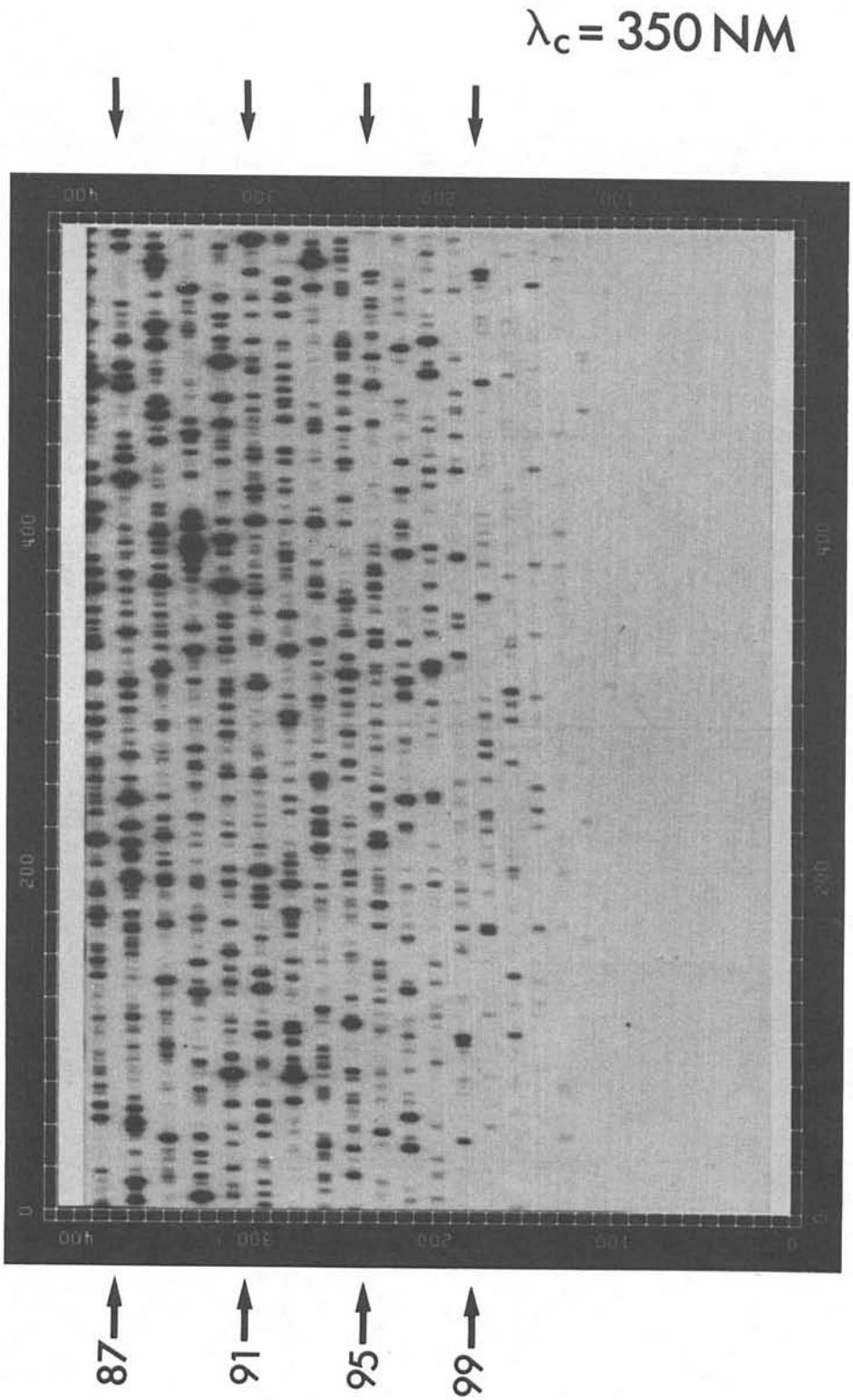


Fig. 14

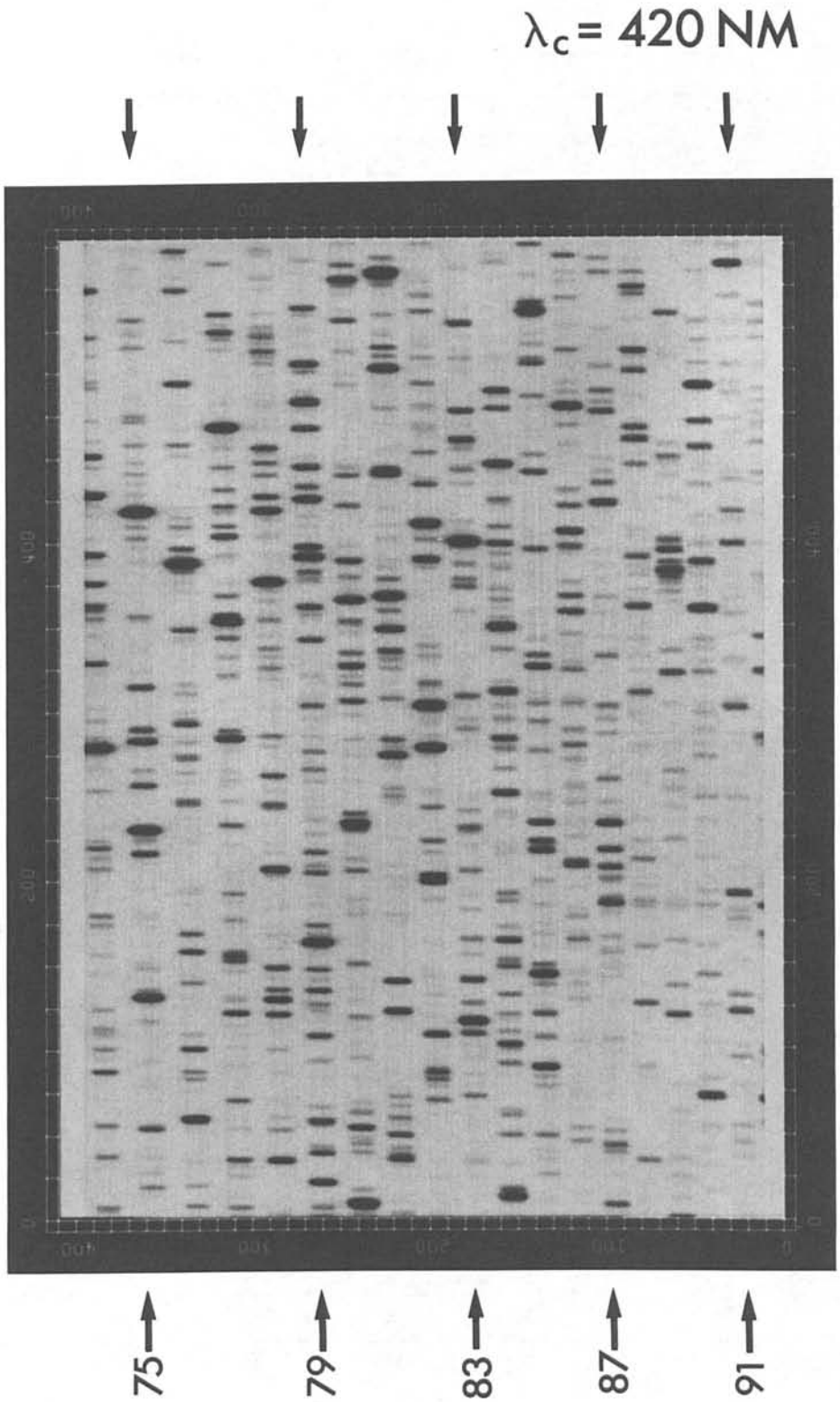
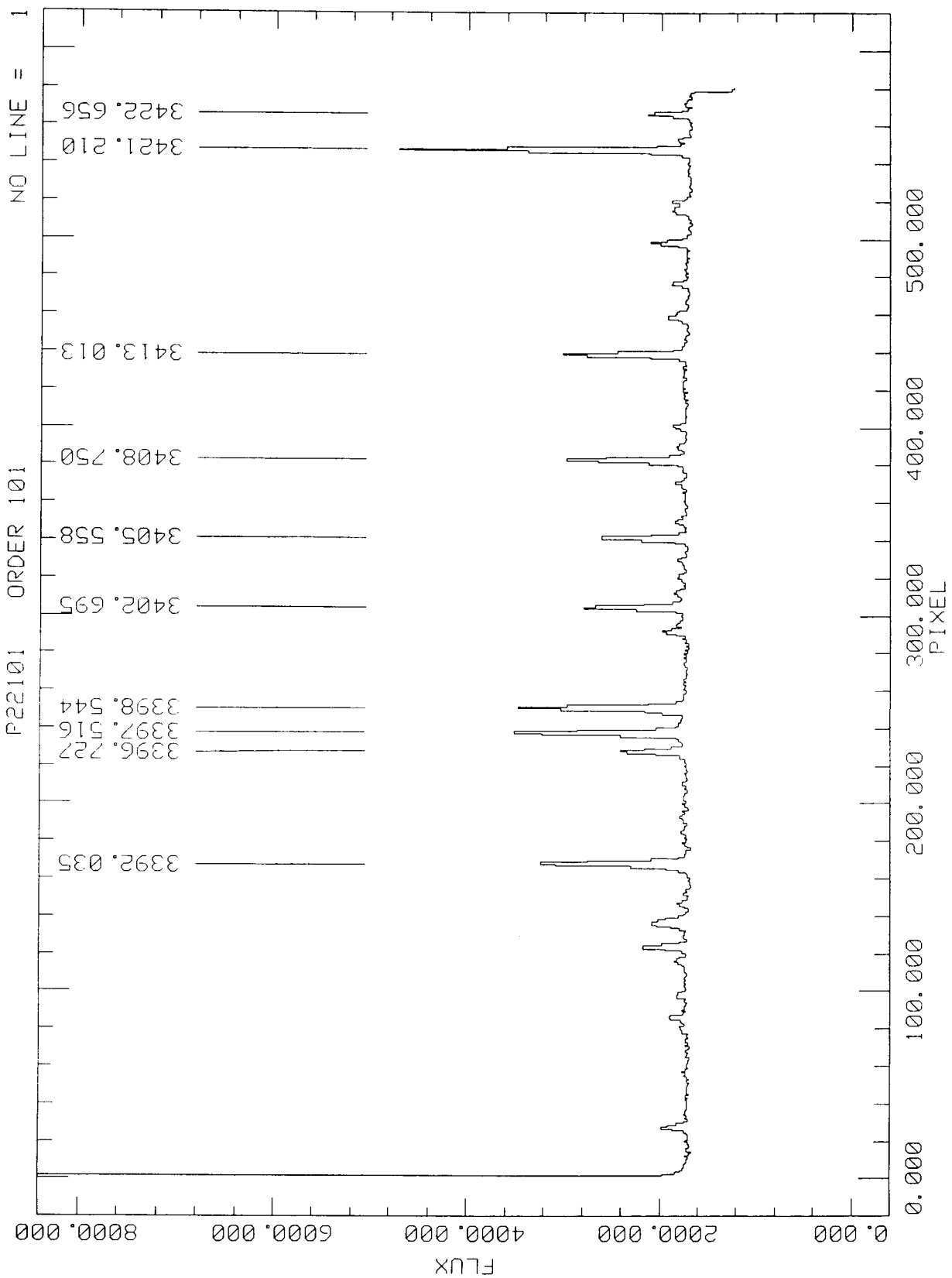
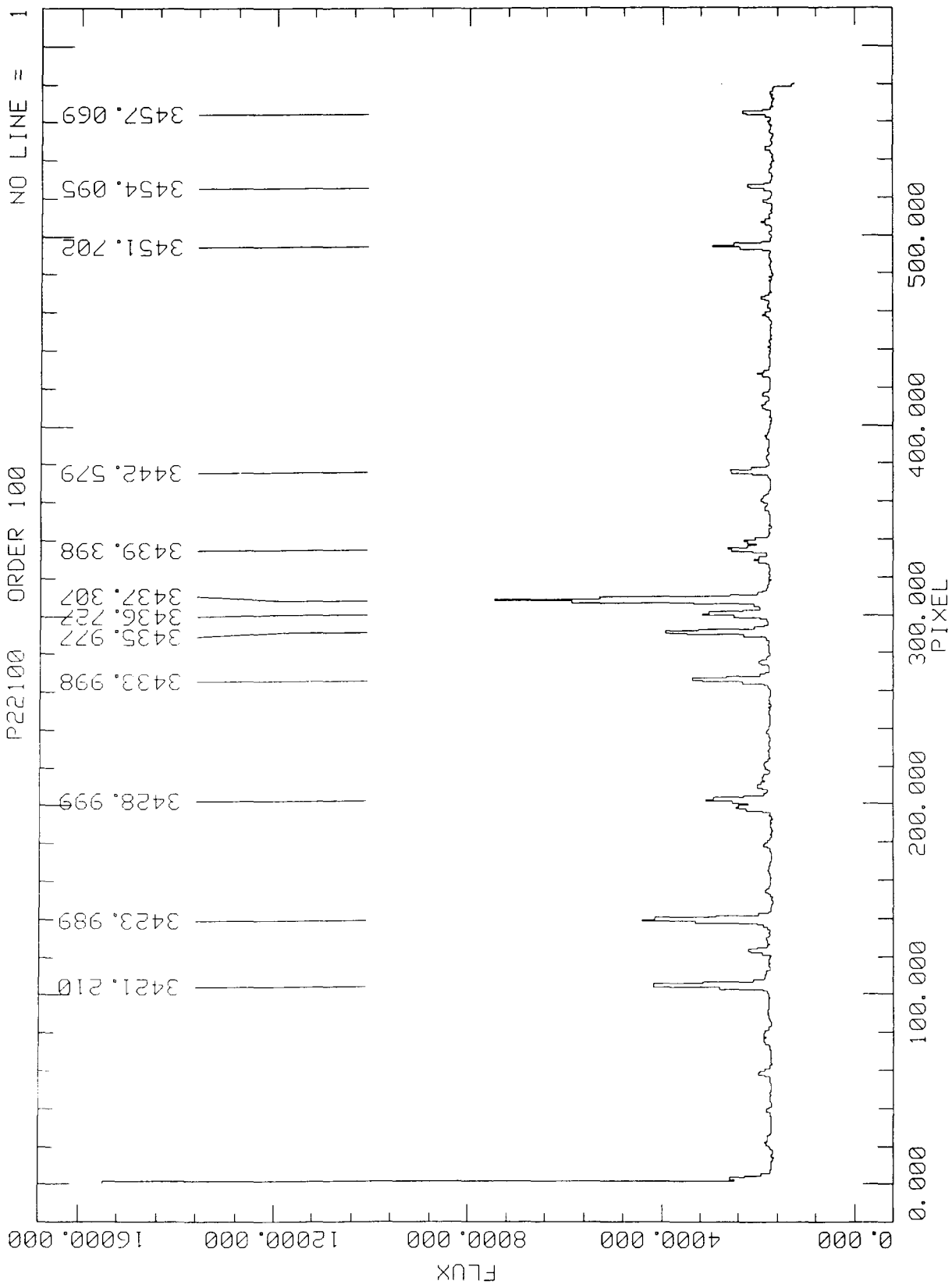
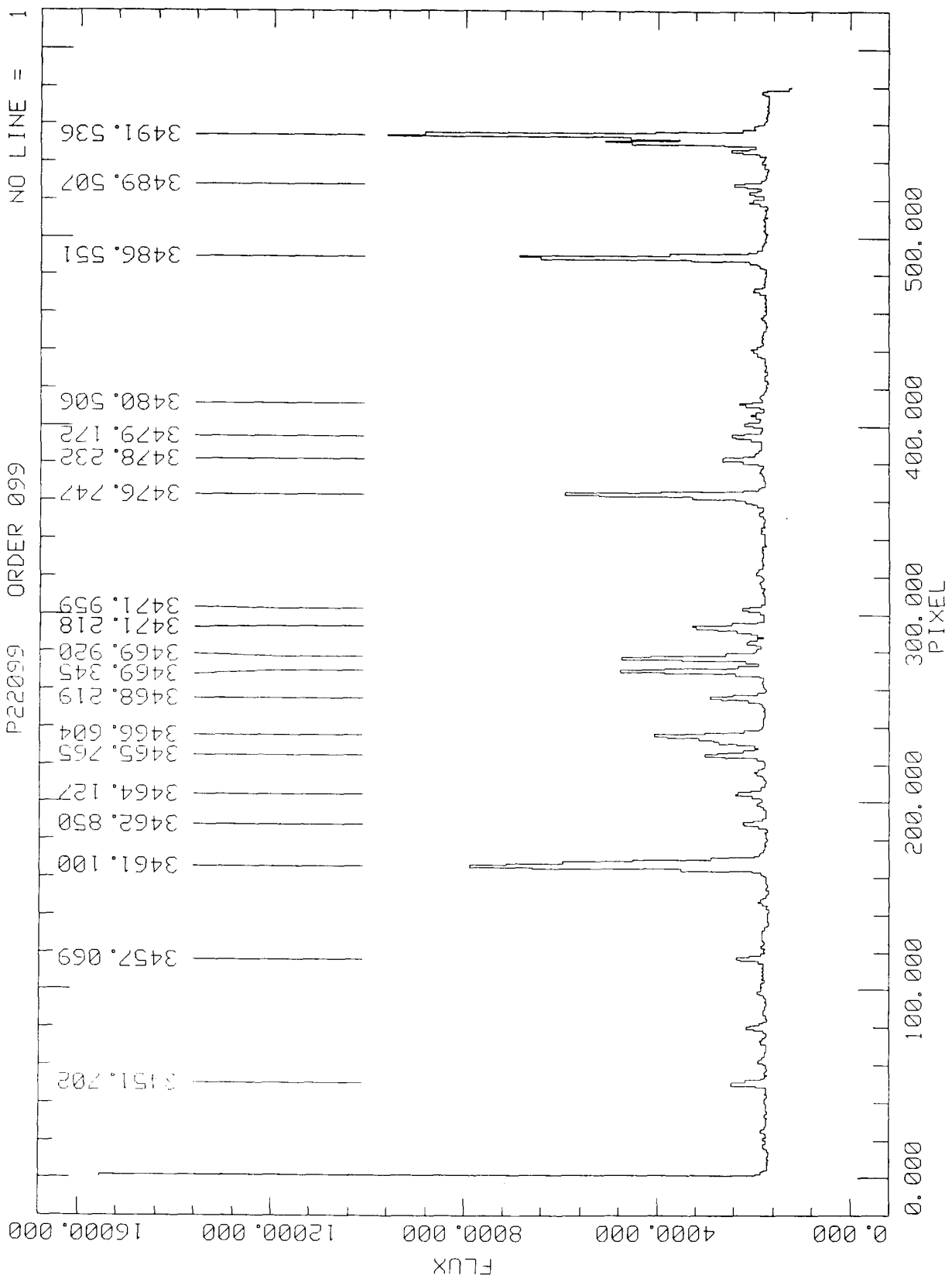


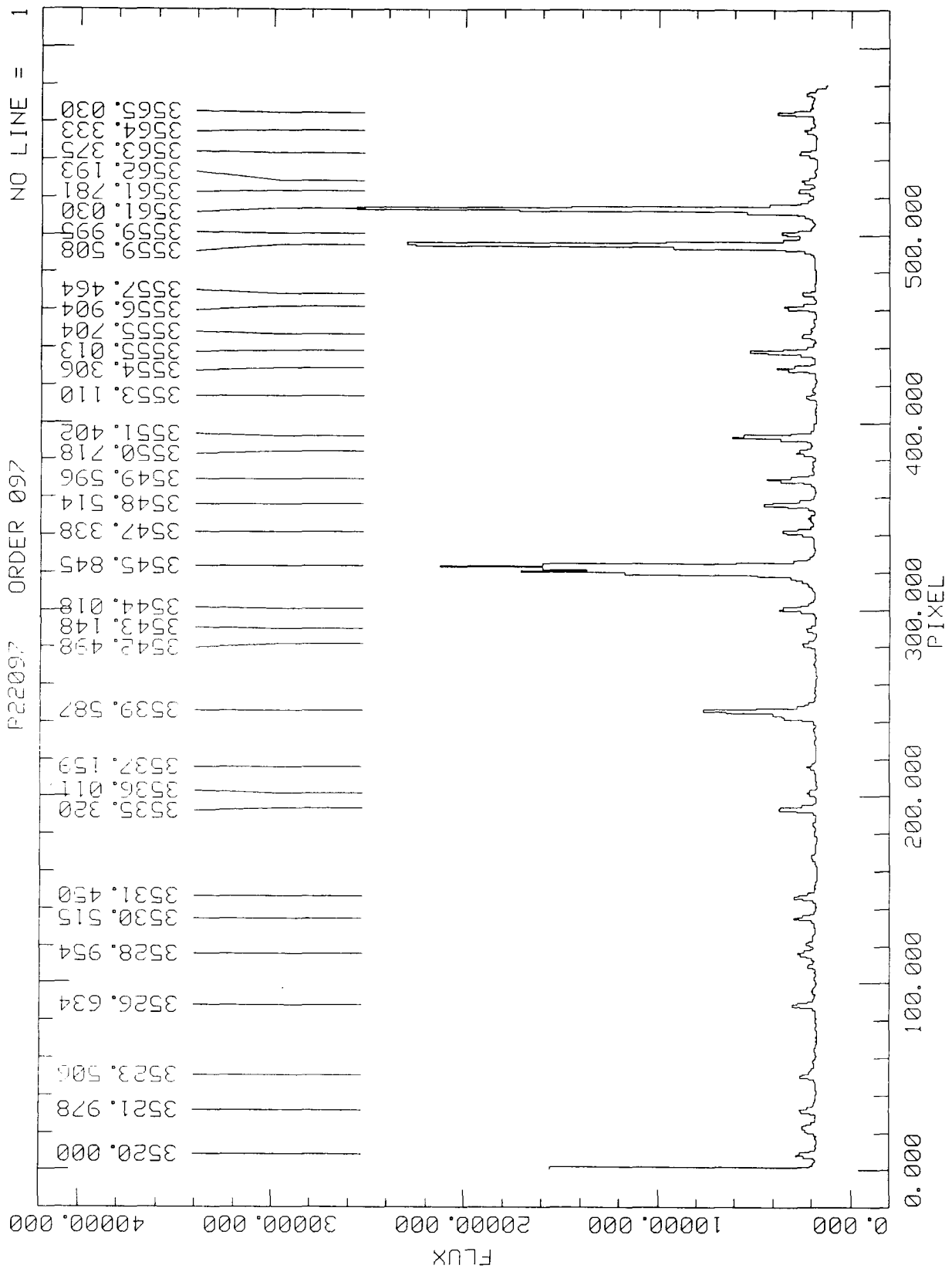
Fig. 15


P22101 ORDER 101
NO LINE = 1
3422.656
3421.210
3413.013
3408.750
3405.558
3402.695
3398.544
3397.516
3396.727
3392.035
0.000
2000.000
4000.000
6000.000
8000.000
FLUX
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL


NO LINE = 1
P22100 ORDER 100
3457.069
3454.095
3451.702
3442.579
3439.398
3437.307
3436.727
3435.977
3433.998
3428.999
3423.989
3421.210
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
0.000
4000.000
8000.000
12000.000
16000.000
FLUX


NO LINE = 1
P22099 ORDER 099
3491.536
3489.507
3486.551
3480.506
3479.172
3478.232
3476.747
3471.959
3471.218
3469.920
3469.345
3468.219
3466.604
3465.765
3464.127
3462.850
3461.100
3457.069
3151.702
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
0.000
4000.000
8000.000
12000.000
16000.000
FLUX

FLUX
0.000
5000.000
10000.000
15000.000
20000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
3486.551
3489.507
3491.536
3495.699
3496.810
3498.009
3498.621
3503.786
3509.779
3511.157
3514.388
3518.404
3520.000
3521.270
3521.978
3523.506
3526.634
P22098 ORDER 098
NO LINE = 1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500.000
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30000.000
40000.000
3520.000
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3523.506
3526.634
3528.954
3530.515
3531.450
3535.320
3536.011
3537.159
3539.587
3542.498
3543.148
3544.018
3545.845
3547.338
3548.514
3549.596
3550.718
3551.402
3553.110
3554.306
3555.013
3555.704
3556.904
3557.464
3559.508
3559.995
3561.030
3561.781
3562.193
3563.375
3564.333
3565.030

FLUX
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10000.000
20000.000
30000.000
40000.000
PIXEL
0.000
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200.000
300.000
400.000
500.000
3556.904
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3563.375
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3565.030
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3569.820
3572.392
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3576.616
3579.457
3581.608
3582.355
3583.102
3584.175
3588.441
3589.360
3589.749
3591.452
3592.779
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3597.495
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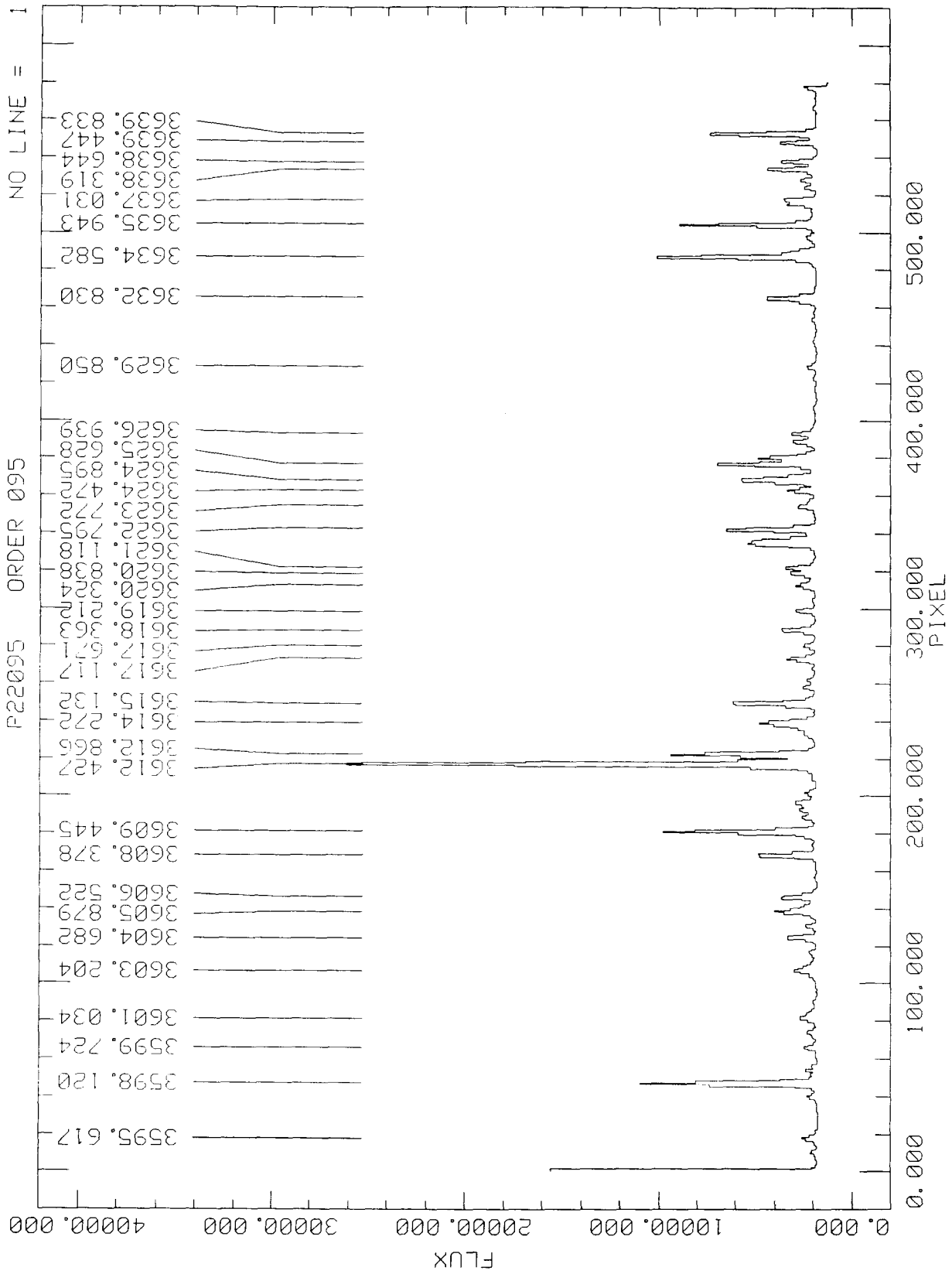
NO LINE = 1
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3604.682
3605.879
3606.522
3608.378
3609.445
3612.427
3612.866
3614.272
3615.132
3617.117
3617.671
3618.363
3619.212
3620.324
3620.838
3621.118
3622.795
3623.272
3624.472
3624.895
3625.628
3626.939
3629.850
3632.830
3634.582
3635.943
3637.031
3638.319
3638.644
3639.447
3639.833
FLUX
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200.000
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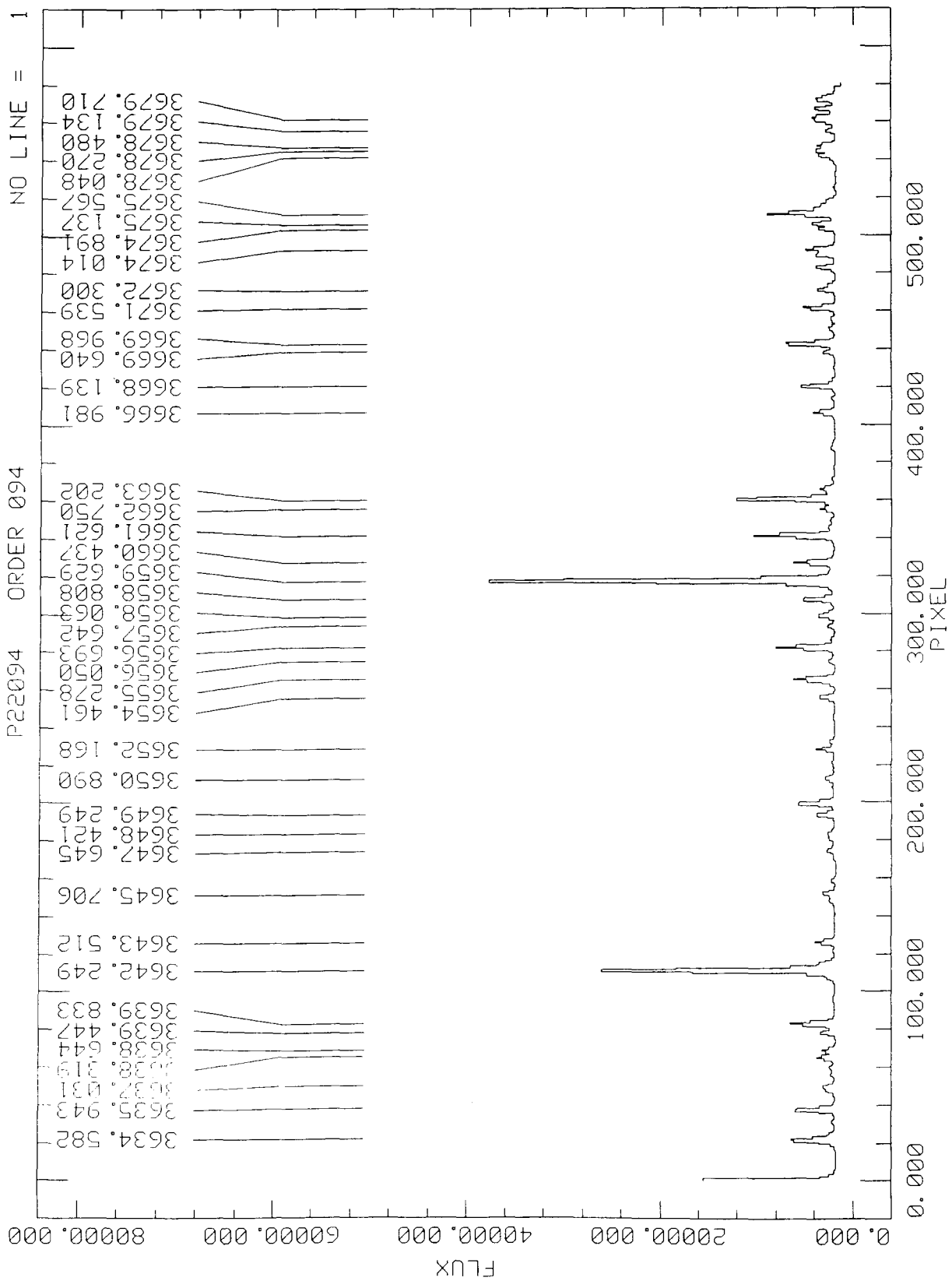
PIXEL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P22094 ORDER 094
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3679.134
3678.480
3678.270
3678.048
3675.567
3675.137
3674.891
3674.014
3672.300
3671.539
3669.968
3669.640
3668.139
3666.981
3663.202
3662.750
3661.621
3660.437
3659.629
3658.808
3658.063
3657.642
3656.693
3656.050
3655.278
3654.461
3652.168
3650.890
3649.249
3648.421
3647.645
3645.706
3643.512
3642.249
3639.833
3639.447
3638.644
3635.943
3634.582
0.000
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500.000
PIXEL
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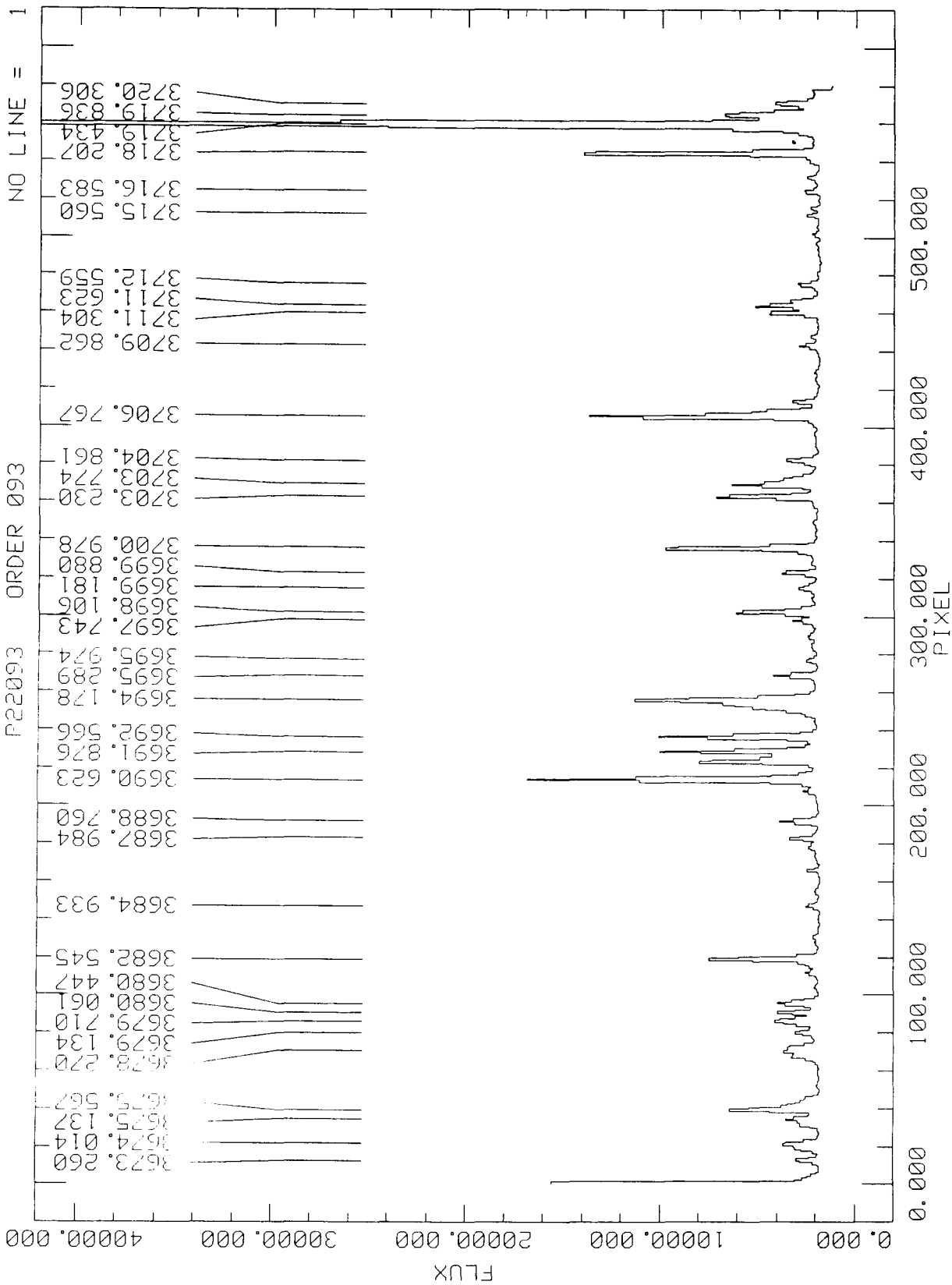
FLUX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3719.434
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3715.560
3712.559
3711.623
3711.304
3709.862
3706.767
3704.861
3703.774
3703.230
3700.978
3699.880
3699.181
3698.106
3697.743
3695.974
3695.289
3694.178
3692.566
3691.876
3690.623
3688.760
3687.984
3684.933
3682.545
3680.447
3680.061
3679.710
3679.134
3678.270
3675.567
3675.137
3674.014
3673.260
FLUX
0.000
10000.000
20000.000
30000.000
40000.000
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL

FLUX
0.000
30000.000
60000.000
90000.000
120000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
3716.583
3718.207
3719.434
3721.825
3723.656
3724.517
3725.393
3726.724
3727.902
3729.309
3730.368
3730.748
3732.985
3733.672
3734.597
3737.512
3737.889
3741.183
3742.923
3745.659
3745.970
3747.539
3749.084
3749.618
3751.022
3752.569
3754.593
3755.212
3756.294
3757.694
3758.467
3759.316
P22092 ORDER 092
NO LINE = 1

FLUX
0.000
20000.000
40000.000
60000.000
80000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
3754.593
3755.212
3756.294
3757.694
3758.462
3759.316
3761.469
3762.933
3765.270
3767.901
3769.585
3770.056
3770.540
3771.370
3772.650
3776.271
3783.012
3783.296
3784.575
3785.600
3789.167
3790.355
3790.794
3792.374
3794.698
3795.385
3797.207
3798.103
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3801.491
P22091 ORDER 091
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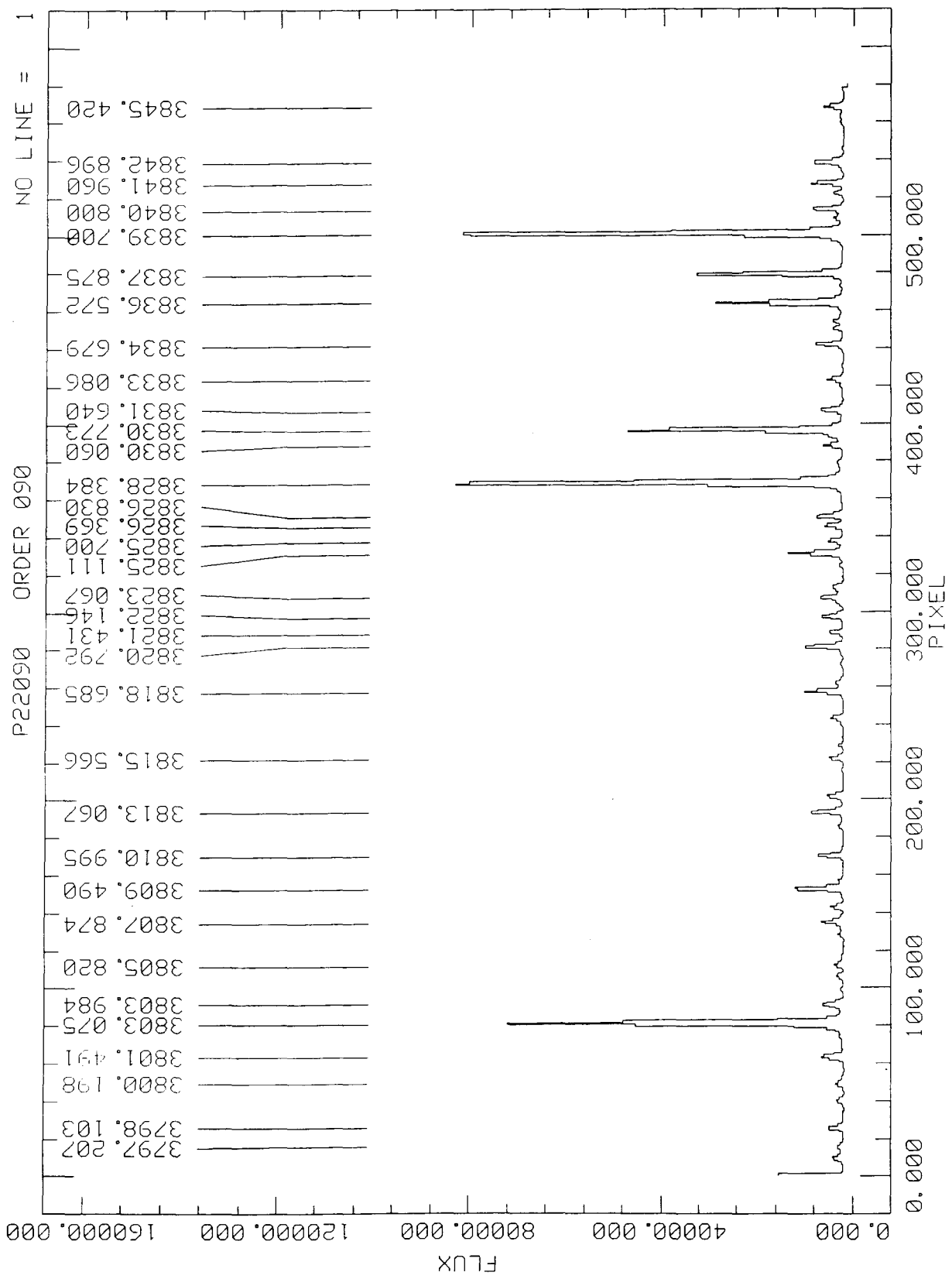
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3837.875
3836.572
3834.679
3833.086
3831.640
3830.773
3830.060
3828.384
3826.830
3826.369
3825.700
3825.111
3823.067
3822.146
3821.431
3820.792
3818.685
3815.566
3813.062
3810.995
3809.490
3807.874
3805.820
3803.984
3803.075
3801.491
3800.198
3798.103
3797.207
FLUX
0.000
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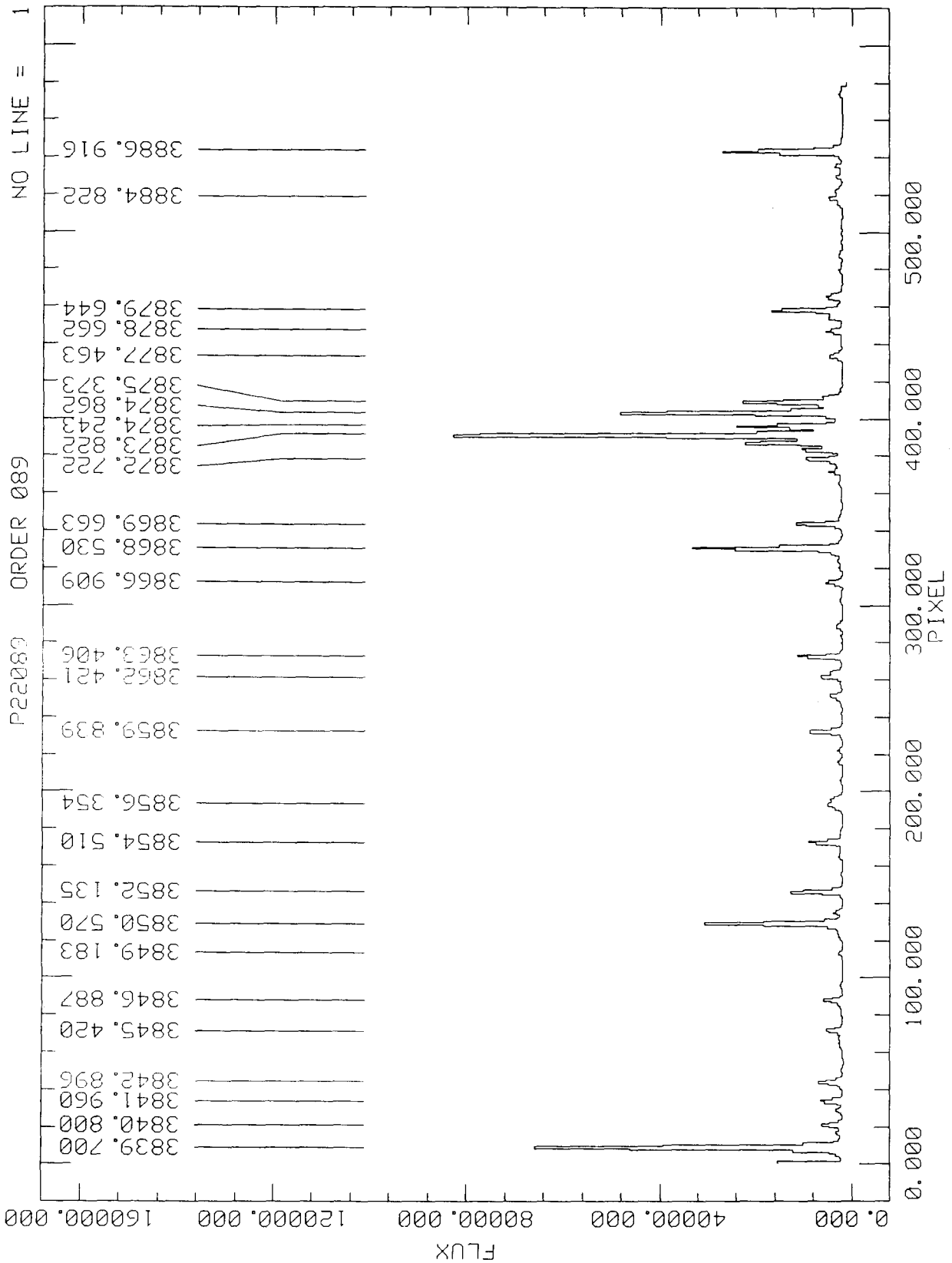
120000.000
160000.000
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL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3879.644
3878.662
3877.463
3875.373
3874.862
3874.243
3873.822
3872.722
3869.663
3868.530
3866.909
3863.406
3862.421
3859.839
3856.354
3854.510
3852.135
3850.570
3849.183
3846.887
3845.420
3842.896
3841.960
3840.800
3839.700
FLUX
0.000
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80000.000
120000.000
160000.000
PIXEL
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100.000
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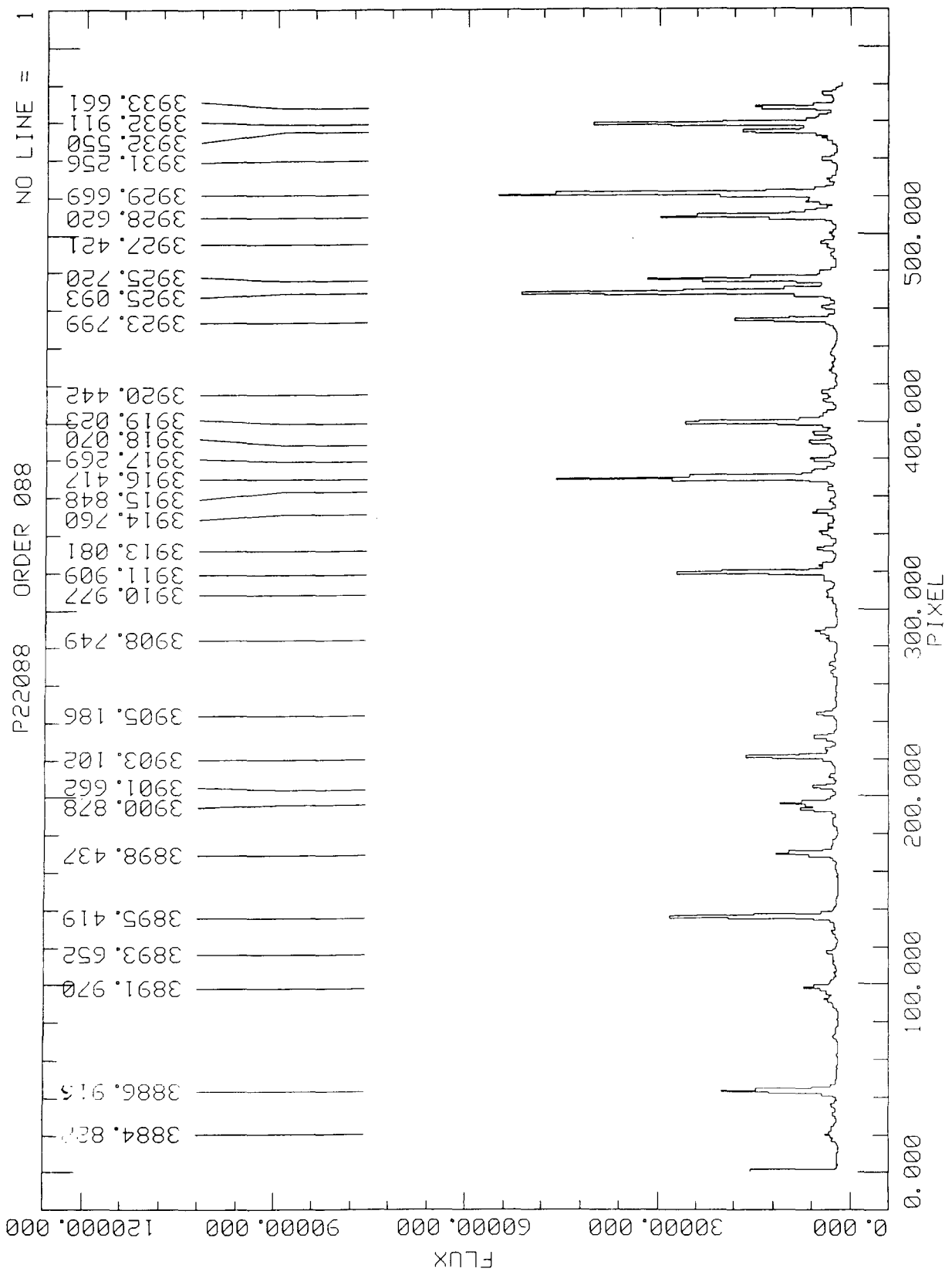
400.000
500.000


NO LINE = 1
P22088 ORDER 088
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3932.550
3931.256
3929.669
3928.620
3927.421
3925.720
3925.093
3923.799
3920.442
3919.023
3918.070
3917.269
3916.417
3915.848
3914.760
3913.081
3911.909
3910.977
3908.749
3905.186
3903.102
3901.662
3900.878
3898.437
3895.419
3893.652
3891.970
3886.915
3884.82?
FLUX
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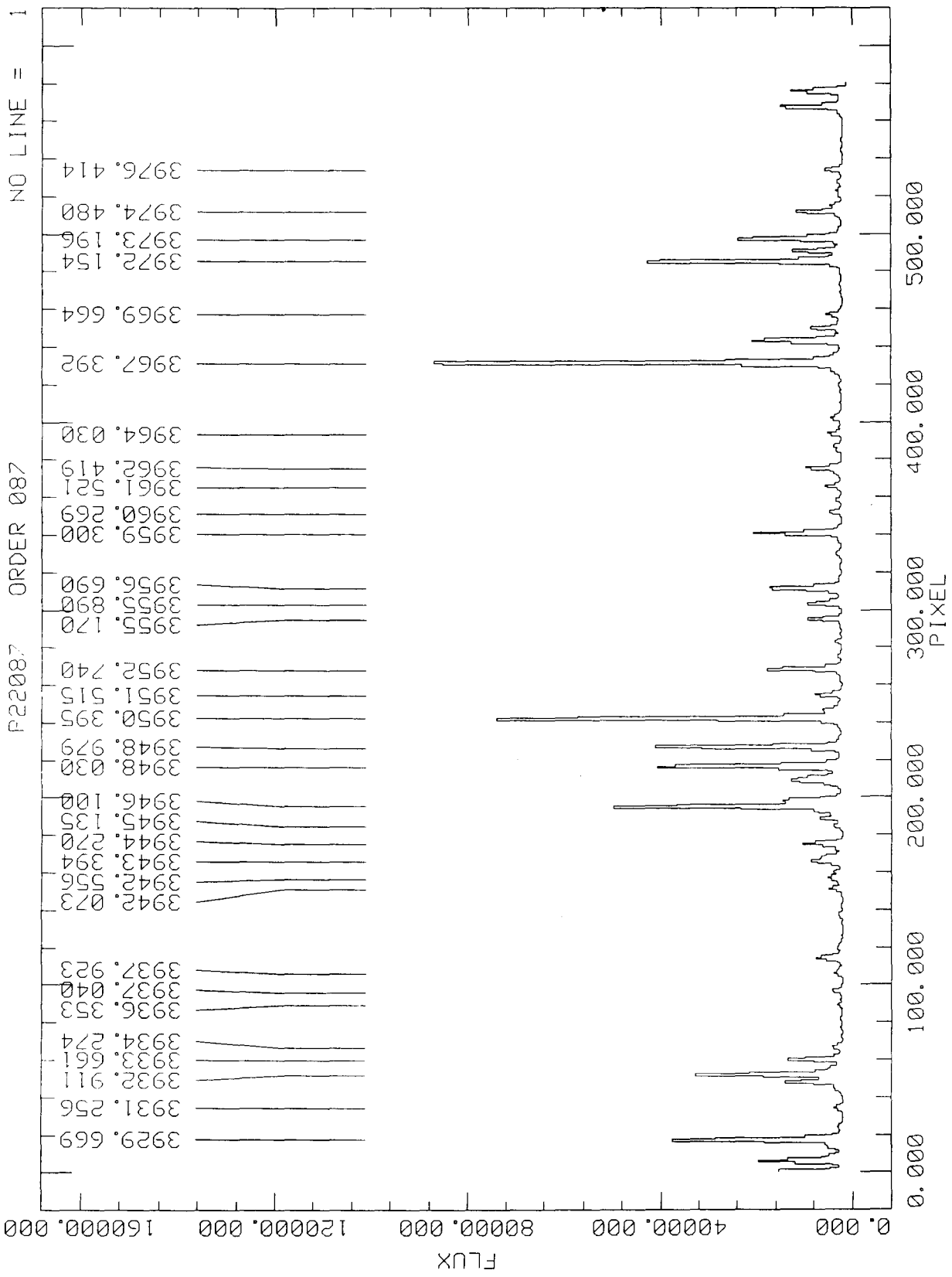
90000.000
120000.000
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL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P220887 ORDER 087
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3973.196
3972.154
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3967.392
3964.030
3962.419
3961.521
3960.269
3959.300
3956.690
3955.890
3955.170
3952.740
3951.515
3950.395
3948.979
3948.030
3946.100
3945.135
3944.270
3943.394
3942.556
3942.073
3937.923
3937.040
3936.353
3934.274
3933.661
3932.911
3931.256
3929.669
0.000
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200.000
300.000
400.000
500.000
PIXEL
0.000
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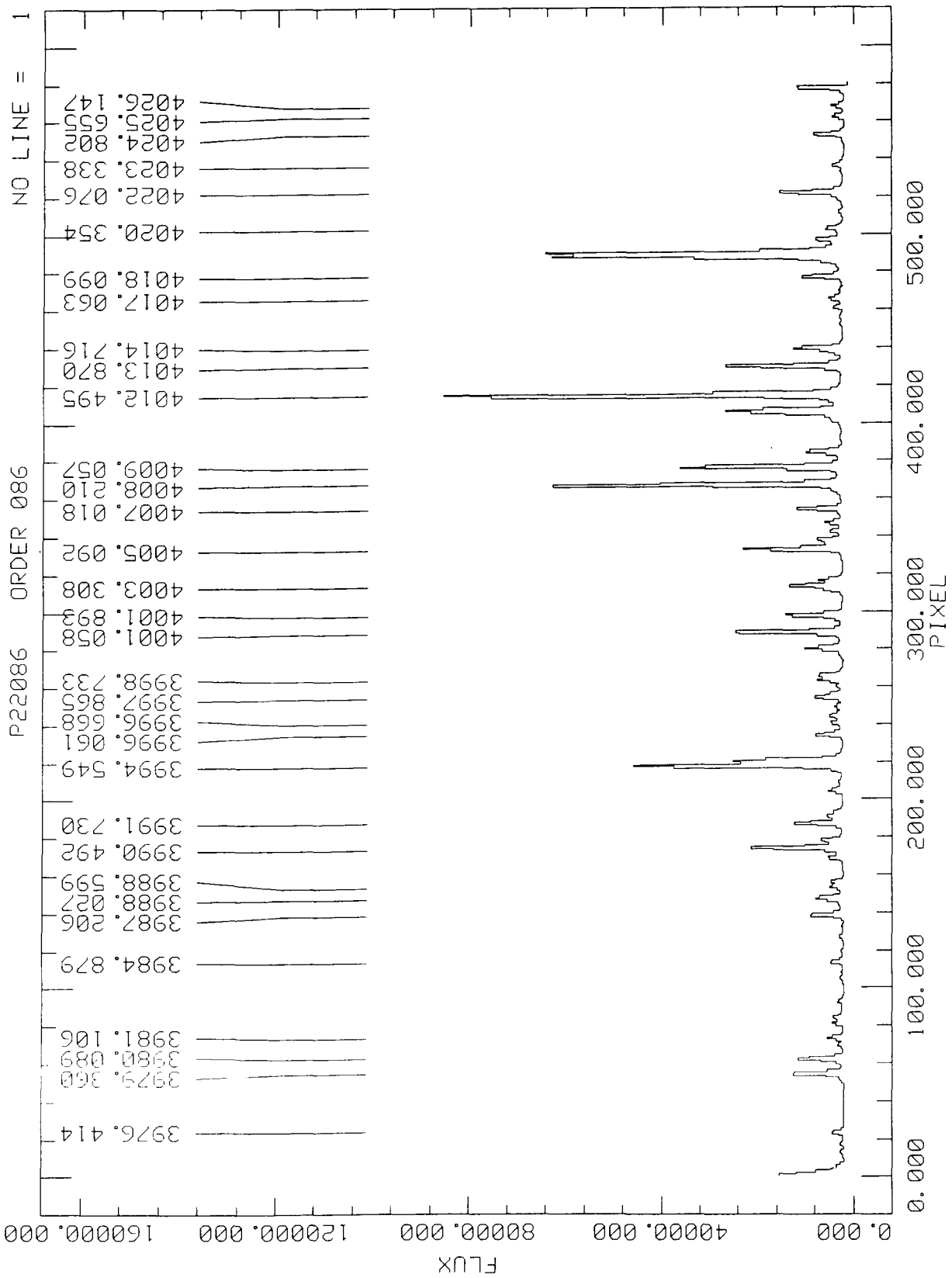
80000.000
120000.000
160000.000
FLUX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3987.206
3988.027
3988.599
3990.492
3991.730
3994.549
3996.061
3996.668
3997.865
3998.733
4001.058
4001.893
4003.308
4005.092
4007.018
4008.210
4009.057
4012.495
4013.870
4014.716
4017.063
4018.099
4020.354
4022.076
4023.338
4024.802
4025.655
4026.147
FLUX
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40000.000
80000.000
120000.000
160000.000
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL

FLUX
0.000
10000.000
20000.000
30000.000
40000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4024.802
4027.009
4029.825
4030.842
4033.862
4036.048
4039.864
4041.203
4042.910
4044.418
4049.944
4050.887
4052.940
4053.527
4059.253
4063.407
4064.331
4067.450
4069.201
4070.238
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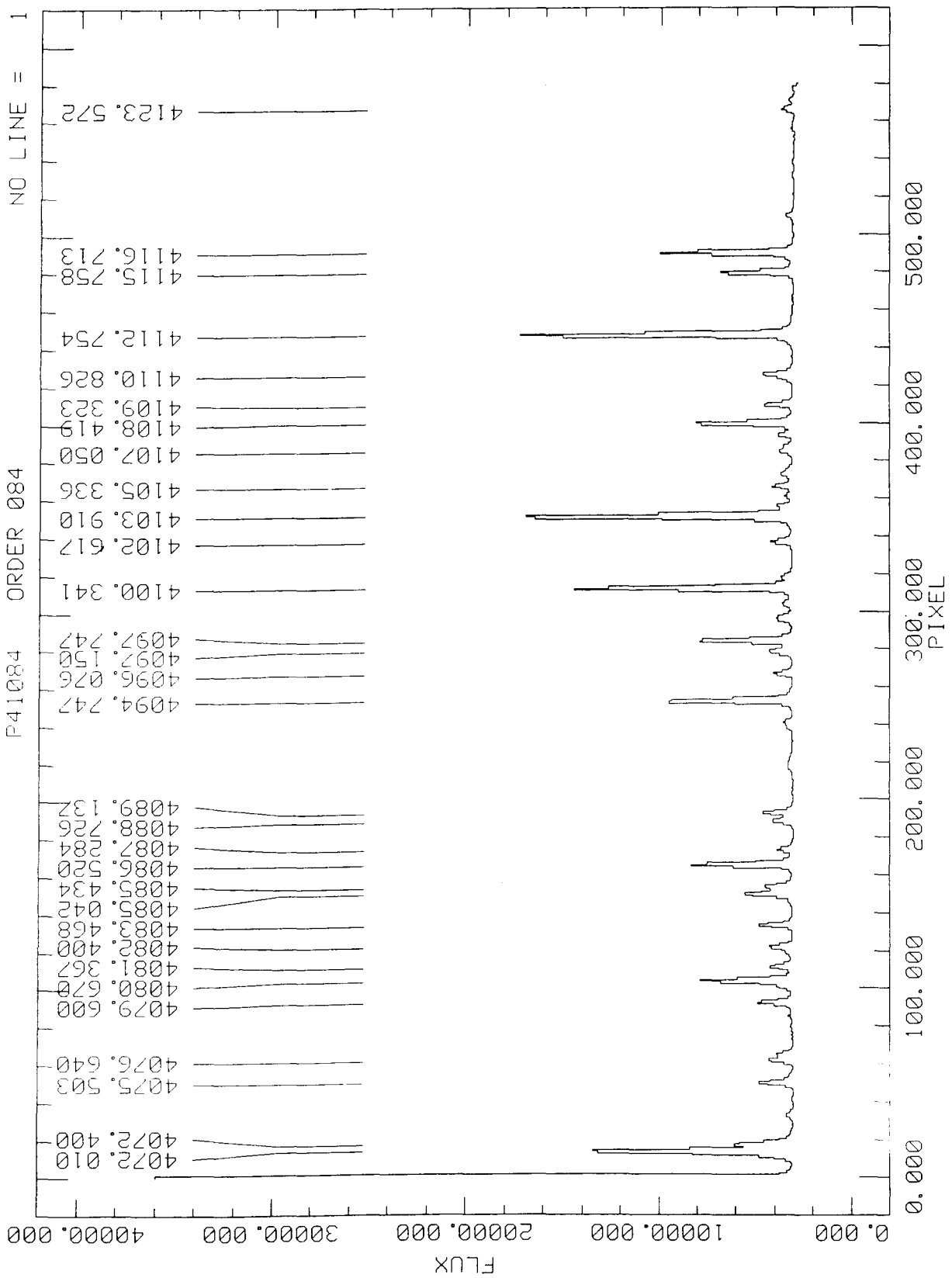
P41085 ORDER 085
NO LINE = 1


P41084 ORDER 084 NO LINE = 1
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4115.758
4112.754
4110.826
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4108.419
4107.050
4105.336
4103.910
4102.617
4100.341
4097.747
4097.150
4096.076
4094.747
4089.132
4088.726
4087.284
4086.520
4085.434
4085.042
4083.468
4082.400
4081.367
4080.670
4079.600
4076.640
4075.503
4072.400
4072.010
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
0.000
10000.000
20000.000
30000.000
40000.000
FLUX

FLUX
0.000
30000.000
60000.000
90000.000
120000.000
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
4127.412
4131.002
4131.730
4132.753
4134.068
4135.480
4136.436
4138.040
4140.235
4142.701
4143.649
4148.181
4149.987
4154.720
4156.110
4156.516
4157.395
4158.590
4161.738
4162.509
4164.179
4165.766
4168.634
4170.533
P41083 ORDER 083
NO LINE = 1

FLUX
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30000.000
60000.000
90000.000
120000.000
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
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4179.252
4179.715
4181.883
4190.712
4192.362
4193.016
4194.936
4198.317
4200.675
4204.041
4208.890
4210.004
4210.923
4213.067
4214.828
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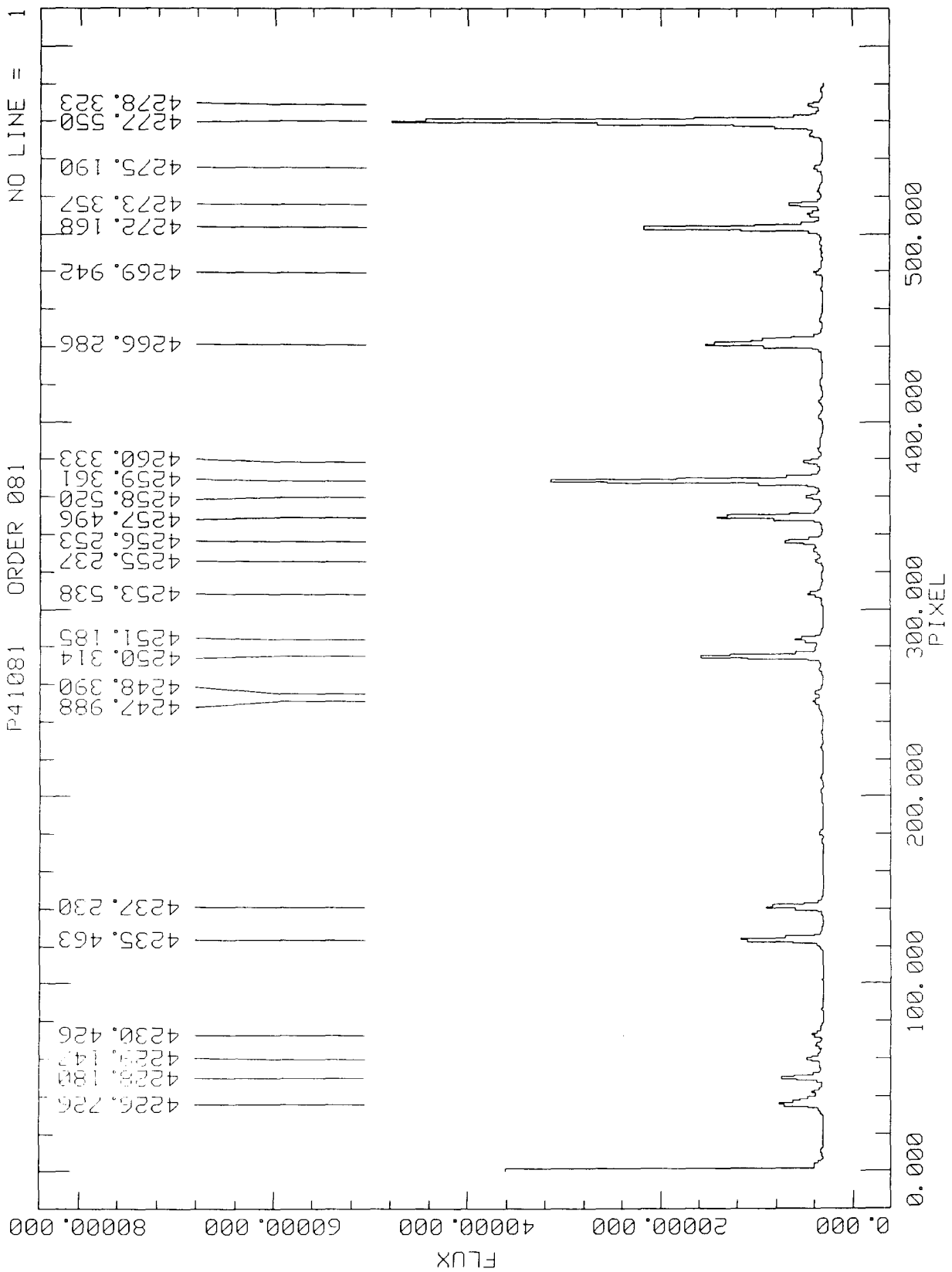
P41082 ORDER 082
NO LINE = 1


P41081 ORDER 081
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4275.190
4273.357
4272.168
4269.942
4266.286
4260.333
4259.361
4258.520
4257.496
4256.2533
4255.2237
4253.538
4251.185
4250.314
4248.390
4247.988
4237.230
4235.463
4230.426
4226.726
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
0.000
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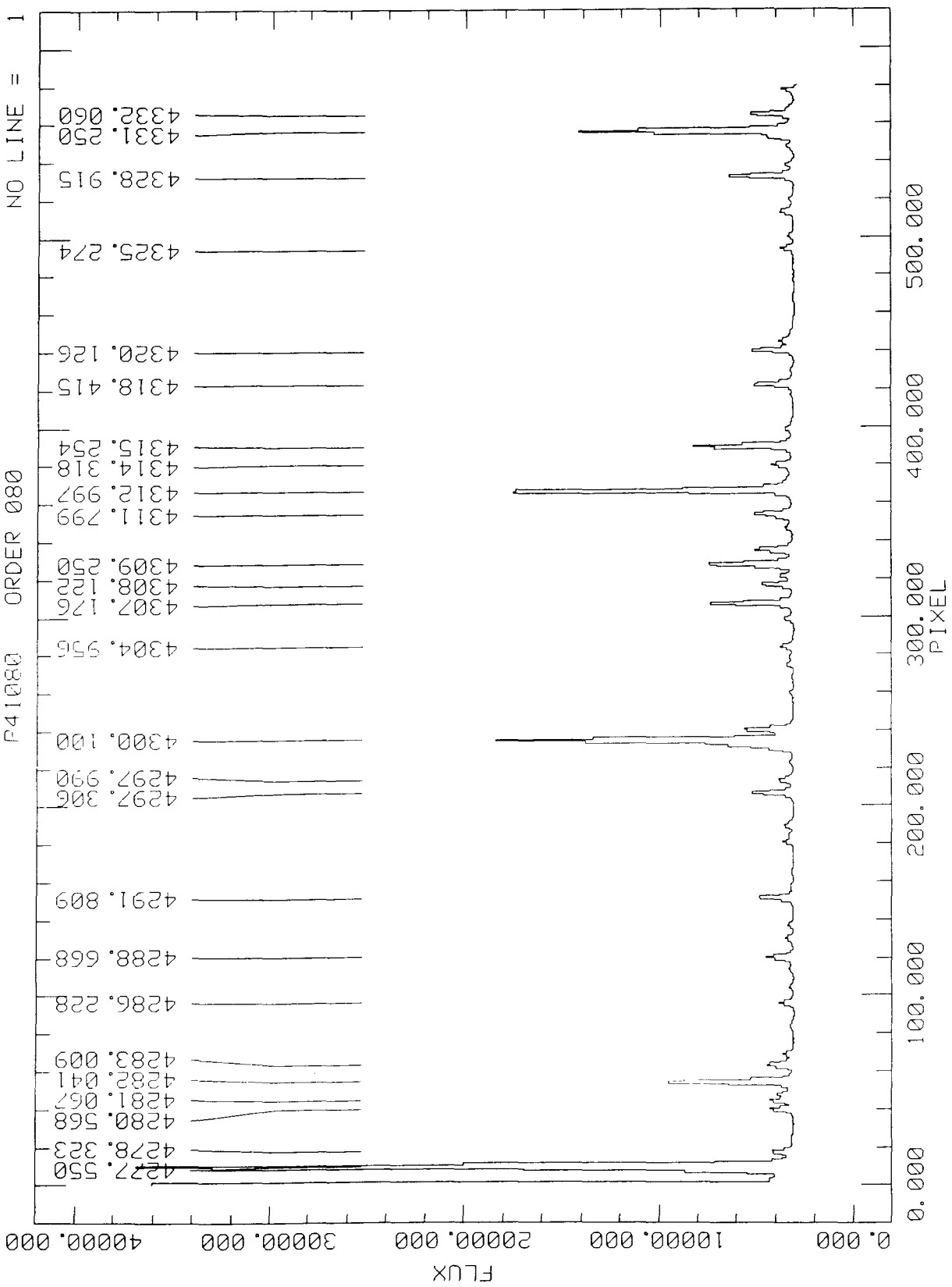
40000.000
60000.000
80000.000
FLUX


NO LINE = 1
P41080 ORDER 080
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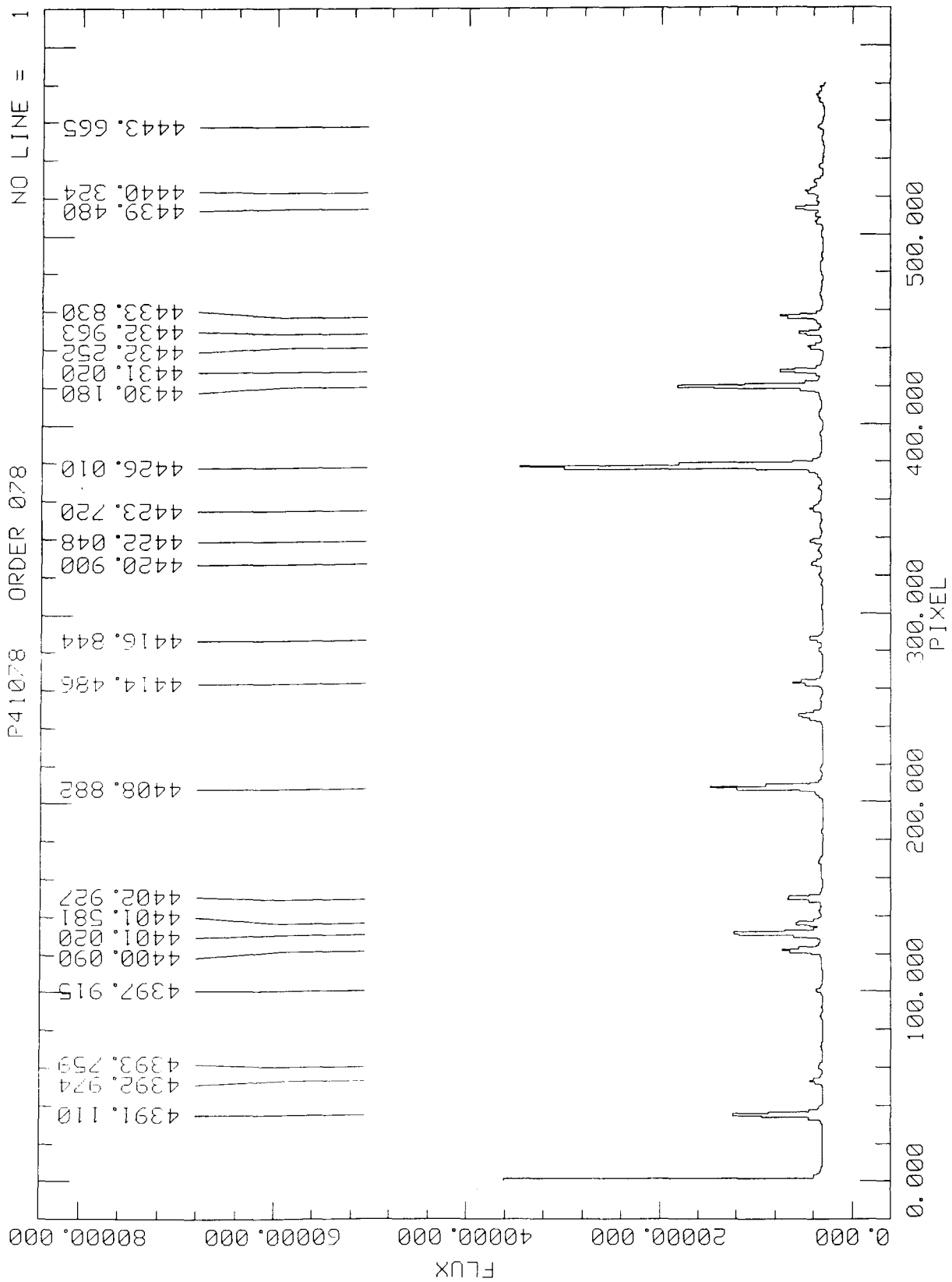
4328.915
4325.274
4320.126
4318.415
4315.254
4314.318
4312.997
4311.799
4309.250
4308.122
4307.176
4304.956
4300.100
4297.990
4297.306
4291.809
4288.668
4286.228
4283.009
4282.041
4281.067
4280.568
4278.323
4277.550
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
0.000
10000.000
20000.000
30000.000
40000.000
FLUX

FLUX
0.000
20000.000
40000.000
60000.000
80000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4332.060
4333.560
4335.337
4337.277
4338.102
4340.895
4342.444
4344.326
4345.167
4346.436
4348.110
4349.072
4352.230
4353.448
4354.482
4358.320
4359.372
4362.070
4365.930
4367.870
4369.875
4370.760
4371.360
4374.124
4374.785
4375.960
4378.176
4381.860
4385.080
4387.787
P41079 ORDER 079
NO LINE = 1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4439.480
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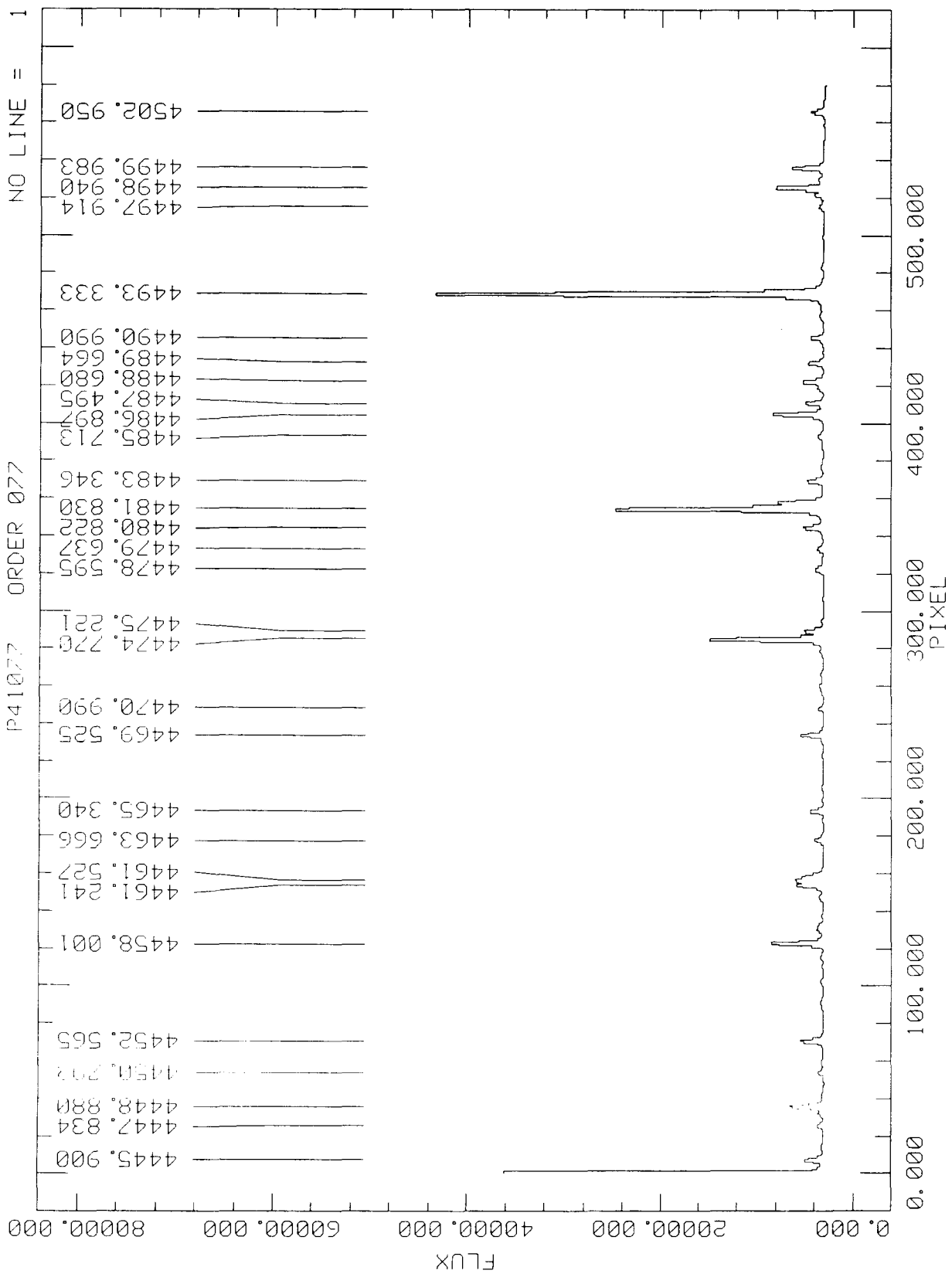
4432.963
4432.255
4431.020
4430.180
4426.010
4423.720
4422.048
4420.900
4416.844
4414.486
4408.882
4402.927
4401.581
4401.020
4400.090
4397.915
4393.759
4392.974
4391.110
FLUX
0.000
20000.000
40000.000
60000.000
80000.000
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL


NO LINE = 1
P41077 ORDER 077
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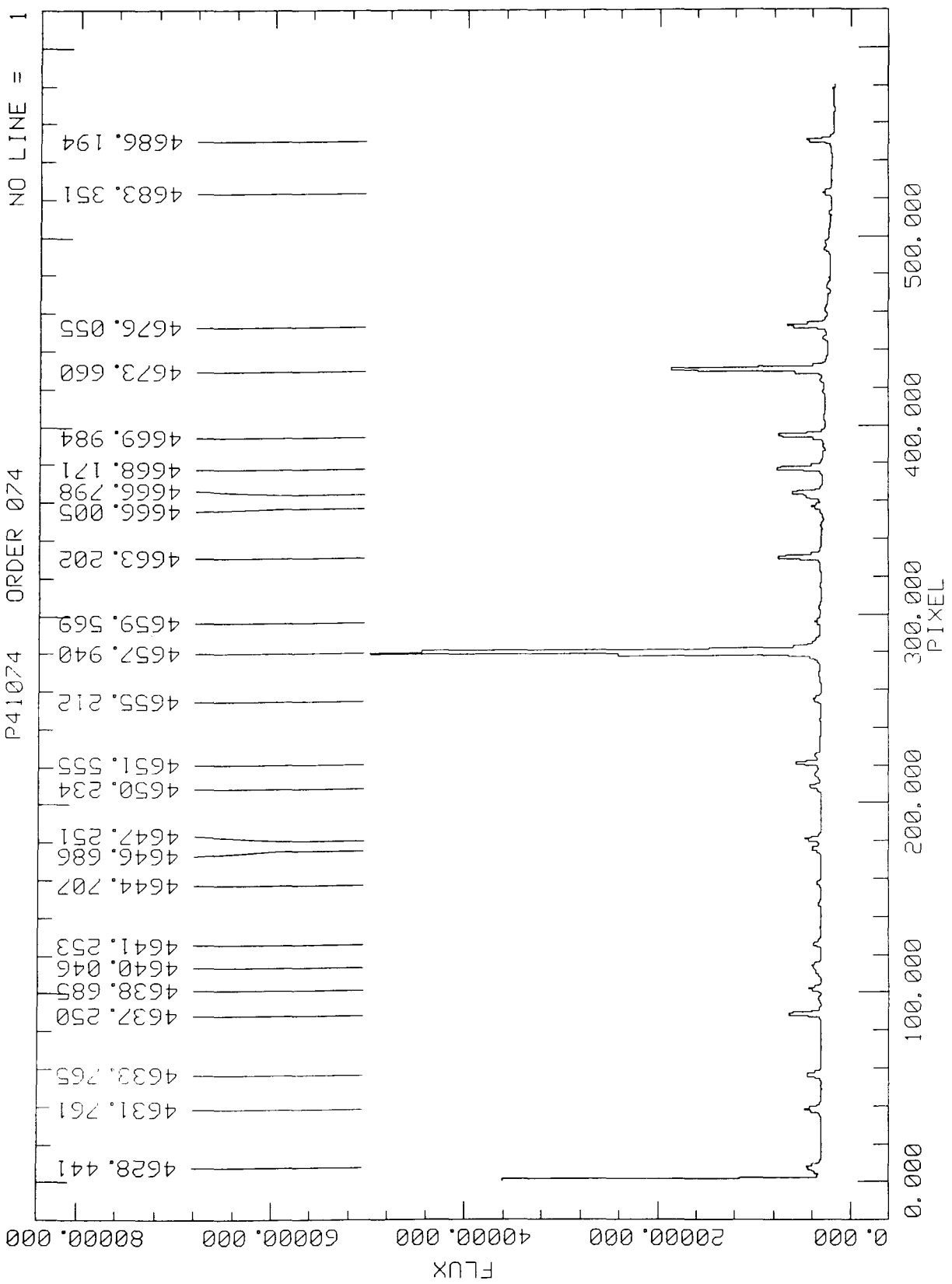
4498.940
4497.914
4493.333
4490.990
4489.664
4488.680
4487.495
4486.897
4485.713
4483.346
4481.830
4480.822
4479.637
4478.595
4475.221
4474.770
4470.990
4469.525
4465.340
4463.666
4461.527
4461.241
4458.001
4452.565
4448.880
4447.834
4445.900
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL
0.000
20000.000
40000.000
60000.000
80000.000
FLUX

FLUX
0.000
30000.000
60000.000
90000.000
120000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4505.216
4506.494
4510.733
4513.223
4513.680
4515.118
4516.064
4519.259
4521.194
4522.323
4530.570
4532.257
4533.304
4534.120
4535.253
4537.144
4540.999
4545.080
4545.915
4547.249
4552.153
4555.812
4558.346
4561.347
P41076 ORDER 076
NO LINE = 1

FLUX
0.000
30000.000
60000.000
90000.000
120000.000
PIXEL
0.000
100.000
200.000
300.000
400.000
500.000
4567.240
4570.972
4577.823
4579.390
4581.173
4588.426
4589.930
4592.666
4593.643
4595.420
4596.097
4598.770
4603.144
4607.934
4609.600
4611.859
4612.543
4613.604
4615.334
4619.479
4621.163
P41075 ORDER 075
NO LINE = 1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4676.055
4673.660
4669.984
4668.171
4666.798
4666.005
4663.202
4659.569
4657.940
4655.212
4651.555
4650.234
4647.251
4646.686
4644.707
4641.253
4640.046
4638.685
4637.250
4633.765
4631.761
4628.441
FLUX
0.000
20000.000
40000.000
60000.000
80000.000
0.000
100.000
200.000
300.000
400.000
500.000
PIXEL

APPENDIX 1

Saturated Lines

Order	Wavelength (Å)	Order	Wavelength (Å)
82	6965.43	74	7723.76
81	6965.43	74	7724.21
81	7067.22	72	7948.18
81	7068.73	71	7948.18
80	7068.73	71	8006.16
79	7147.05	71	8014.79
78	7272.94	70	8103.69
77	7383.98	70	8115.31
76	7503.87	69	8264.53
76	7514.65	68	8408.21
75	7635.10	68	8424.65
74	7635.10	67	8424.65
		67	8521.45

Table .3: Saturated lines in the spectra (31.6 l/mm echelle)

APPENDIX 2

Line Identifications

wavelength	identification	wavelength	identification	wavelength	identification
3325.120	TH II	3414.46	A II	3480.052	TH I
3327.193	TH I	3415.884	TH I	3480.506	A II
3330.477	TH I	3417.497	TH I	3482.761	TH II
3333.129	TH I	3421.210	TH I	3485.212	TH II
3334.604	TH II	3422.656	TH I	3486.551	TH I
3337.870	TH II	3423.989	TH I	3489.507	TH I
3345.880	TH	3428.999	TH I	3491.536	A II
3348.768	TH I	3433.998	TH II	3493.518	TH II
3350.924	A II	3434.727	TH I	3495.699	TH I
3351.228	TH II	3435.977	TH II	3496.810	TH I
3358.602	TH II	3436.727	TH I	3498.009	TH II
3360.998	TH I	3437.307	TH I	3498.621	TH I
3365.338	TH I	3439.398	TH I	3499.986	TH II
3366.517	TH II	3442.579	TH I	3501.866	TH I
3367.713	TH I-II W.M.	3445.217	TH II	3502.779	TH II
3371.796	TH II	3445.744	TH II	3503.786	TH I
3372.823	TH	3446.547	TH I	3507.546	TH
3373.492	TH I	3449.125	TH I-II W.M.	3509.779	A II
3374.975	TH I	3449.644	TH II	3511.157	TH I
3376.436	A II	3451.702	TH I	3511.562	TH II
3378.573	TH II	3454.095	A II	3514.388	A II
3380.859	TH I	3457.069	TH I	3518.404	TH I
3386.500	TH II	3461.100	TH I-I W.M.	3518.886	TH I
3387.920	TH I	3462.850	TH II	3520.00	A II
3388.531	TH II	3464.127	A II	3521.270	A II
3389.550	TH I-II W.M.	3465.765	TH II	3521.914	TH II
3392.035	TH II	3466.604	TH I-I W.M.	3521.978	A II
3396.727	TH I	3468.219	TH II	3523.506	TH I
3397.516	TH I	3469.345	TH I	3526.634	TH I
3398.544	TH I	3469.920	TH II	3528.411	TH I
3401.711	TH I	3471.218	TH I	3528.954	TH II
3402.695	TH II	3471.959	TH I	3530.515	TH I
3405.558	TH I	3476.747	A II	3531.450	TH I
3408.750	TH I	3478.232	A II	3535.320	A II
3410.075	TH I	3479.172	TH II	3536.011	TH I
3413.013	TH I	3479.684	TH I	3537.159	TH II

wavelength	identification	wavelength	identification	wavelength	identification
3539.587	TH II	3582.355	A II	3621.118	TH II
3542.498	TH I	3583.102	TH I	3622.138	A II
3543.148	A II	3584.175	TH I	3622.795	TH I
3544.018	TH I	3588.441	A II	3623.772	TH I
3545.596	A II	3589.360	TH II	3624.472	TH I
3545.845	A II	3589.749	TH I	3624.895	TH II
3547.338	TH I	3590.925	TH I	3625.628	TH II
3548.514	A II	3591.452	TH I	3626.939	TH I
3549.596	TH I	3592.779	TH I	3629.850	TH
3550.718	TH I	3593.882	TH II	3632.683	A I
3551.402	TH I	3594.985	TH I	3632.830	TH I
3553.110	TH II	3595.617	TH I	3634.582	TH I
3554.306	A I	3597.495	TH	3635.943	TH
3555.013	TH I	3598.120	TH I	3636.834	TH
3555.704	TH I	3599.724	TH I	3637.031	A II
3556.904	A II	3600.432	TH I	3638.319	TH I
3557.464	TH II	3601.034	TH II	3638.644	TH I
3559.508	A II	3603.204	TH II	3639.447	TH II
3559.995	TH I-II W.M.	3604.682	TH	3639.833	A II
3561.030	A II	3605.193	TH I	3642.249	TH I
3561.781	TH I	3605.879	A II	3643.512	TH I
3562.193	A II	3606.522	A II	3645.706	TH I
3563.375	TH I	3608.378	TH	3647.645	TH II
3564.333	A II	3609.445	TH II	3648.421	TH II
3565.030	A II	3610.522	TH I-II W.M.	3649.249	TH II
3567.263	TH I	3612.427	TH I	3649.735	TH I
3569.820	TH I	3612.866	TH I	3649.832	A I
3570.357	TH I	3614.272	TH I-I W.M.	3650.766	TH II
3572.392	TH II	3615.132	TH II	3650.890	A II
3573.219	TH II	3615.850	TH I	3652.168	TH II
3575.322	TH II	3617.117	TH II	3654.461	TH I
3576.557	TH I	3617.671	TH I	3655.278	A II
3576.616	A II	3618.363	TH I	3656.050	A II
3579.336	TH II	3619.212	TH I	3656.693	TH I
3579.457	TH	3620.324	TH II	3657.642	TH I
3581.608	A II	3620.838	TH I	3658.063	TH II

wavelength	identification	wavelength	identification	wavelength	identification
3658.808	TH I	3695.289	TH I	3741.183	TH II
3659.629	TH I	3695.974	TH II	3742.923	TH I
3660.437	TH II	3697.743	TH I	3745.659	TH
3661.621	TH I	3698.106	TH I	3745.970	TH I
3662.750	TH I	3699.181	TH	3747.539	TH II
3663.202	TH I	3699.880	TH I	3749.084	TH I
3663.702	TH II	3700.978	TH I	3749.618	TH I
3666.981	TH I	3703.230	TH I	3751.022	TH I
3668.139	TH	3703.774	TH I	3752.569	TH II
3669.640	TH	3704.861	TH I	3754.593	TH II
3669.968	TH I	3706.767	TH I	3755.212	TH I
3671.539	TH I	3709.862	TH II	3756.294	TH I
3672.300	TH I	3711.304	TH II	3757.694	TH I
3673.26	A	3711.623	TH I	3758.467	TH I
3673.793	TH II	3712.559	TH I	3759.316	TH I
3674.014	TH I	3715.560	TH	3761.469	TH I
3674.903	TH I	3716.583	TH	3762.933	TH I
3675.137	TH I	3718.207	A II	3765.27	A
3675.567	TH II	3719.434	TH I	3766.261	TH
3678.048	TH II	3719.836	TH I	3767.901	TH
3678.27	A	3720.306	TH II	3769.585	TH
3678.480	TH I	3721.215	TH I	3770.056	TH I
3679.134	TH	3721.825	TH II	3770.54	A
3679.710	TH II	3723.656	TH II	3771.370	TH I
3680.061	A II	3724.517	A II	3772.650	TH I
3680.447	TH I	3725.393	TH	3776.271	TH I
3682.486	TH I	3726.724	TH II	3780.966	TH I
3682.545	A II	3727.902	TH I	3783.012	TH II
3684.933	TH I	3729.309	A II	3783.296	TH II
3687.984	TH I	3730.368	TH I	3784.575	TH
3688.760	TH II	3730.748	TH II	3785.600	TH II
3690.623	TH I	3732.985	TH I	3789.167	TH I
3691.411	TH I	3733.672	TH I	3790.355	TH
3691.876	TH I	3734.597	TH II	3790.794	TH I
3692.566	TH I	3737.512	TH I	3792.374	TH I
3694.178	TH	3737.889	A II	3794.698	TH I

wavelength	identification	wavelength	identification	wavelength	identification
3795.385	TH II	3849.183	TH	3915.848	TH I
3797.207	TH I	3850.57	A	3916.417	TH I
3798.103	TH I	3852.135	TH I	3917.269	TH I
3800.198	TH I	3854.510	TH II	3918.070	TH
3801.491	TH I-I W.M.	3856.354	TH I	3919.023	TH I
3803.075	TH I	3859.839	TH II	3920.442	TH
3803.984	TH I	3862.421	TH I	3923.799	TH I
3805.820	TH II	3863.406	TH II	3925.093	TH I
3807.874	TH II	3866.909	TH I	3925.72	A II
3809.49	A	3868.53	A	3927.421	TH II
3810.995	TH I	3869.663	TH I	3928.62	A
3813.067	TH II	3872.722	TH II	3929.669	TH II
3815.566	TH I	3873.148	TH I	3931.256	TH II
3818.685	TH I	3873.474	TH I	3932.55	A
3820.792	TH I	3873.822	TH I	3932.911	TH I
3821.431	TH II	3874.243	TH I	3933.661	TH II
3822.146	TH II	3874.862	TH I	3934.274	TH
3823.067	TH I	3875.373	TH I	3936.353	TH
3825.111	TH I-II W.M.	3877.463	TH I	3937.040	TH II
3825.70	A II	3878.662	TH I	3937.923	TH II
3826.369	TH I	3879.644	TH I	3938.614	TH I
3826.83	A	3884.822	TH	3942.073	TH I
3828.384	TH I	3886.916	TH I	3942.556	TH
3830.060	TH I	3891.97	A	3943.394	TH II
3830.773	TH I	3893.652	TH I	3944.27	A
3831.640	TH I	3895.419	TH I	3945.135	TH
3833.086	TH	3898.437	TH I	3946.10	A II
3834.679	A I	3900.878	TH II	3947.331	TH I
3836.572	TH I-I W.M.	3901.662	TH I	3947.504	A I
3837.875	TH I	3903.102	TH I	3948.030	TH I
3839.700	TH I-I W.M.	3905.186	TH II	3948.979	A I
3840.800	TH I	3908.749	TH I	3950.395	TH I
3841.960	TH II	3910.977	TH II	3951.515	TH II
3842.896	TH I	3911.909	TH I	3952.74	A
3845.42	A	3913.081	TH I	3955.170	TH I
3846.887	TH I	3914.76	A	3955.890	TH I

wavelength	identification	wavelength	identification	wavelength	identification
3956.690	TH II	4009.057	TH I	4063.407	TH I
3959.300	TH I	4009.819	TH I	4064.331	TH I
3960.269	TH I	4011.739	TH I	4067.450	TH I
3961.521	TH	4012.495	TH I	4069.201	TH II
3962.419	TH I	4013.87	A	4069.461	TH I
3964.030	TH I	4014.716	TH I	4070.238	TH I
3967.392	TH I	4017.063	TH I	4072.01	A II
3968.467	TH	4018.099	TH I	4072.40	A
3969.002	TH II	4019.129	TH II	4073.856	TH I
3969.664	TH I	4020.354	TH I	4075.503	TH I
3972.154	TH	4022.076	TH I-II W.M.	4076.64	A
3972.639	TH I	4023.338	TH I	4076.96	A
3973.196	TH I	4024.802	TH I	4079.60	A II
3974.48	A	4025.655	TH II	4080.67	A
3976.414	TH II	4026.147	TH II-II W.M.	4081.367	TH I
3979.36	A	4027.009	TH I	4082.40	A
3980.089	TH	4029.657	TH I	4083.468	TH I
3981.106	TH II	4029.825	TH I	4085.042	TH II
3984.879	TH I	4030.292	TH	4085.434	TH I
3987.206	TH I	4030.842	TH I	4086.520	TH II
3988.027	TH	4032.595	TH I	4087.284	TH I
3988.599	TH II	4033.862	TH I-I W.M.	4088.726	TH I
3990.492	TH I	4035.47	A II	4089.137	TH I
3991.730	TH I	4036.048	TH I	4094.747	TH II
3994.549	TH II	4036.565	TH II	4096.076	TH I
3996.061	TH II	4039.864	TH I	4097.15	A II
3996.668	TH I	4041.203	TH II	4097.747	TH I
3997.865	TH II	4042.91	A II	4100.341	TH I
3998.733	TH I	4043.394	TH I	4102.617	TH I
4000.281	TH I	4044.418	A I	4103.91	A
4001.058	TH I	4048.287	TH I	4105.337	TH II-II W.M.
4001.893	TH I	4049.944	TH I	4107.050	TH
4003.308	TH II	4050.887	TH	4107.853	TH I-II W.M.
4005.092	TH I	4052.94	A II	4108.419	TH II
4007.018	TH II	4053.527	TH I	4109.323	TH I
4008.210	TH I	4059.253	TH I	4110.826	TH I

wavelength	identification	wavelength	identification	wavelength	identification
4112.754	TH I	4181.883	A I	4241.094	TH I
4115.759	TH I	4184.137	TH I	4247.988	TH II
4116.713	TH II	4189.561	TH I	4248.390	TH I
4123.572	TH I-II W.M.	4190.712	A I	4250.314	TH I
4127.412	TH	4191.028	A I	4251.185	A I
4128.65	A	4192.362	TH I	4253.538	TH I
4131.002	TH I	4193.016	TH I	4255.237	TH
4131.712	TH I	4194.936	TH I	4255.751	TH I
4131.73	A II	4198.317	A I	4255.797	TH I
4132.753	TH II	4200.675	A I	4256.253	TH I
4134.068	TH I	4201.846	TH II	4257.496	TH I
4135.480	TH I	4204.041	TH I	4258.520	TH I
4136.285	TH I	4208.411	TH I	4259.361	A I
4136.395	TH	4208.890	TH II	4260.333	TH
4136.436	TH	4210.004	TH I-I W.M.	4266.286	A I
4138.040	TH I	4210.923	TH I	4269.942	TH
4140.235	TH II	4213.067	TH I	4272.168	A I
4142.701	TH II	4214.828	TH I	4272.874	TH I
4143.649	TH I	4216.069	TH I	4273.357	TH II
4148.181	TH II	4217.45	A	4274.024	TH II
4149.987	TH II	4218.69	A	4275.19	A
4154.720	TH I	4220.068	TH I-I W.M.	4276.807	TH II
4156.11	A	4222.67	A	4277.314	TH II
4156.516	TH II	4223.440	TH I	4277.55	A II
4157.280	TH	4223.564	TH	4278.323	TH I
4157.395	TH I	4223.593	TH I	4280.568	TH I
4158.590	A I	4226.299	TH I	4281.067	TH II
4161.738	TH I	4226.726	TH II	4281.414	TH II
4162.509	TH I	4227.02	A II	4282.041	TH II
4164.179	A I	4227.387	TH I	4282.90	A
4165.766	TH I	4228.18	A	4283.009	TH
4168.634	TH II	4229.147	TH I	4283.518	TH II
4170.533	TH I	4229.89	A	4286.228	TH I
4178.059	TH II	4230.426	TH I	4288.668	TH I
4179.253	TH I-I W.M.	4235.463	TH I	4291.809	TH I
4179.715	TH II	4237.23	A II	4294.719	TH I

wavelength	identification	wavelength	identification	wavelength	identification
4297.306	TH I	4348.11	A	4408.883	TH I
4297.99	A II	4349.072	TH I	4412.739	TH II
4299.635	TH I	4352.23	A	4412.893	TH
4299.839	TH I	4352.612	TH I	4414.486	TH I
4300.100	A I	4353.448	TH I	4416.237	TH II
4300.66	A II	4354.482	TH I	4416.844	TH I
4304.956	TH I	4358.320	TH I	4420.90	A
4306.366	TH I	4359.372	TH I	4422.048	TH I
4307.176	TH I	4362.07	A II	4423.720	TH I
4308.122	TH I	4363.794	A I	4426.01	A
4308.600	TH I	4365.930	TH I	4430.18	A
4309.25	A II	4367.87	A II	4431.02	A
4309.940	I-II W.M.	4369.494	TH I	4432.252	TH I
4311.799	TH I	4369.875	TH I	4432.963	TH II
4312.997	TH	4370.76	A II	4433.83	A II
4314.319	TH I	4371.36	A I	4438.746	TH I
4315.254	TH I	4374.124	TH I	4439.123	TH II
4318.415	TH II	4374.785	TH II	4439.48	A II
4320.126	TH II	4375.96	A	4440.324	TH I-I W.M.
4325.274	TH I	4378.176	TH I	4440.866	TH II
4328.915	TH I	4379.74	A	4441.608	TH I
4330.843	TH I	4381.402	TH II	4443.665	TH I
4331.25	A	4381.860	TH II	4445.033	TH I
4332.06	A	4384.656	TH I	4445.315	TH I
4333.560	A I	4385.08	A I	4445.901	TH I
4335.337	A I	4387.787	TH I-I W.M.	4447.834	TH II
4335.709	TH II	4391.110	TH II	4448.554	TH II
4337.277	TH I	4392.974	TH I	4448.88	A II
4338.107	TH I	4393.759	TH I	4450.793	TH I
4340.895	TH I	4397.915	TH II	4452.565	TH I
4342.444	TH I	4400.09	A	4458.001	TH I
4343.951	TH II	4401.02	A	4460.53	A
4345.851	TH I	4401.581	TH I	4461.241	TH I
4344.326	TH II	4402.927	TH I	4461.527	TH I
4345.167	A I	4404.91	A	4463.666	TH I
4346.436	TH I	4408.482	TH I	4465.340	TH II

wavelength	identification	wavelength	identification	wavelength	identification
4469.525	TH I	4533.077	TH I	4611.859	TH II
4470.990	TH I	4533.237	TH I	4612.543	TH I
4474.77	A II	4533.304	TH II	4613.604	TH I
4475.221	TH I	4534.120	TH II	4615.024	TH I
4478.595	TH I	4535.254	TH I	4615.334	TH I
4479.637	TH I	4537.144	TH I	4619.479	TH II
4480.822	TH	4537.67	A II	4621.163	TH I
4481.83	A II	4540.999	TH I	4628.298	TH I
4482.169	TH I	4544.514	TH II	4628.441	A I
4483.346	TH I	4545.08	A	4631.761	TH II
4485.713	TH I	4545.915	TH I	4633.765	TH I
4486.897	TH I	4547.249	TH I	4637.25	A II
4487.495	TH II	4547.78	A	4638.685	TH I
4488.312	TH I	4552.153	TH I	4640.046	TH II
4488.680	TH II	4555.812	TH I	4641.253	TH I
4489.664	TH I	4558.346	TH I	4644.707	TH I
4490.99	A II	4561.347	TH I	4646.686	TH I
4493.333	TH I	4563.661	TH I	4647.251	TH I
4497.914	TH I	4567.240	TH I	4650.234	TH I
4498.55	A II	4568.142	TH I	4651.555	TH II
4498.940	TH I	4570.972	TH I	4651.989	TH II
4499.983	TH I	4577.823	TH I	4655.212	TH
4502.95	A	4579.39	A	4657.94	A
4505.216	TH I	4579.827	TH I	4659.570	TH I
4506.494	TH I-I W.M.	4581.173	TH	4663.202	TH I
4510.526	TH II	4588.426	TH I	4666.005	TH II
4510.733	A I	4589.93	A II	4666.798	TH I
4513.223	TH I	4592.666	TH I	4668.171	TH I
4513.680	TH I	4593.643	TH I	4669.984	TH I
4515.118	TH I	4595.420	TH I	4673.660	TH I
4516.064	TH	4596.097	A I	4676.055	TH I
4519.259	TH I	4598.77	A II	4680.237	TH I
4521.194	TH I	4603.144	TH I	4680.646	TH II
4522.323	A I	4607.934	TH I	4683.351	TH I
4530.57	A II	4608.620	TH I	4686.194	TH I
4532.257	TH II	4609.60	A II	4689.251	TH I

wavelength	identification	wavelength	identification	wavelength	identification
4690.622	TH I	4764.346	TH I	4831.597	TH I
4691.635	TH I	4764.89	A	4832.802	TH II
4694.091	TH II	4765.595	TH I	4833.178	TH I
4695.038	TH I	4766.600	TH I	4840.843	TH I
4695.454	TH I	4773.241	TH I	4843.941	TH I
4700.771	TH I	4774.259	TH I-II W.M.	4845.162	TH I
4702.316	A I	4775.794	TH I	4847.90	A
4703.360	A II	4777.191	TH I	4848.362	TH I
4703.989	TH I	4778.294	TH I	4849.140	TH
4705.760	TH II	4779.728	TH I	4850.439	TH II
4706.251	TH II	4782.761	TH II	4852.868	TH
4708.294	TH I	4783.861	TH I	4858.332	TH II
4712.481	TH I	4786.531	TH I	4861.216	TH I
4712.840	TH I	4787.148	TH I	4861.717	TH I
4720.458	TH	4789.386	TH I	4863.172	TH II
4721.276	TH I	4793.244	TH I	4865.477	TH I
4721.620	A	4795.913	TH I	4865.91	A I
4722.088	TH I	4806.07	A	4867.59	A II
4723.438	TH I	4808.133	TH I	4868.881	TH I
4723.784	TH II	4809.614	TH I	4871.289	TH I
4724.772	TH II	4812.375	TH I	4872.917	TH I
4726.91	A	4813.007	TH I	4874.364	TH I
4728.133	TH I	4813.720	TH	4876.260	A
4729.128	TH I	4813.896	TH I	4878.009	TH I
4732.08	A II	4817.020	TH I	4878.733	TH I
4735.93	A	4818.647	TH II	4879.90	A
4739.676	TH I	4819.193	TH I	4881.204	TH I
4740.529	TH II	4820.464	TH I	4882.25	A
4740.952	TH I-I W.M.	4820.884	TH I	4887.947	A I
4742.117	TH I	4821.587	TH I	4889.06	A
4743.687	TH II	4822.854	TH I	4889.490	TH I
4745.337	TH I	4823.606	TH I	4892.760	TH I
4749.200	TH I	4823.996	TH I	4893.445	TH I
4749.971	TH I	4826.700	TH I	4894.955	TH I
4752.414	TH II	4829.797	TH I	4898.459	TH II
4758.128	TH I-I W.M.	4831.121	TH I	4899.240	TH

wavelength	identification	wavelength	identification	wavelength	identification
4902.054	TH I	4989.308	TH I	5069.338	TH I
4902.77	A II	4993.749	TH I	5081.44	A I
4904.75	A II	5002.097	TH I	5085.02	A II
4910.156	TH I	5003.598	TH I	5085.295	TH
4910.793	TH I	5004.127	TH I	5090.55	A II
4911.378	TH I	5009.35	A	5094.106	TH II
4912.529	TH II	5015.889	TH II	5095.064	TH
4919.815	TH II	5017.16	A II	5096.484	TH I
4920.623	TH I	5017.254	TH II	5098.043	TH II
4921.613	TH II	5019.324	TH II	5098.931	TH I
4925.950	TH	5019.806	TH I	5098.97	A
4927.780	TH I	5022.005	TH I	5100.621	TH I
4929.086	TH I	5028.655	TH I	5101.129	TH I
4933.24	A	5029.891	TH I	5111.278	TH I
4933.852	TH II	5039.230	TH I	5113.382	TH II
4936.774	TH I	5041.122	TH I	5115.044	TH I
4937.829	TH I	5044.719	TH I	5118.200	A I
4939.642	TH I	5045.248	TH I	5122.499	TH I
4943.064	TH I	5047.043	TH I	5125.489	TH I
4945.458	TH I	5048.813	A I	5125.950	TH I
4946.663	TH II	5048.936	TH I	5128.489	TH I
4947.575	TH II	5049.796	TH II	5134.746	TH I
4950.251	TH I	5050.784	TH I	5137.473	TH I
4950.626	TH II	5051.888	TH I	5140.773	TH I
4954.660	TH II	5055.347	TH II	5141.81	A I-II
4960.423	TH	5057.986	TH II	5143.267	TH II
4961.726	TH I	5058.361	TH I	5143.916	TH I
4965.12	A	5059.861	TH I	5145.36	A
4965.731	TH I	5061.656	TH I	5148.211	TH II
4968.755	TH II	5062.07	A	5151.612	TH I
4970.063	TH I-II W.M.	5062.932	TH I	5154.243	TH I
4972.177	TH II	5064.602	TH I	5158.604	TH I
4980.186	TH I	5064.945	TH I	5159.620	TH I
4982.487	TH I	5066.135	TH I	5160.710	TH I-II W.M.
4985.372	TH I	5066.773	TH I	5161.539	TH I
4987.147	TH II	5067.973	TH I	5162.284	A I

wavelength	identification	wavelength	identification	wavelength	identification
5163.458	TH I	5231.159	TH I	5320.770	TH II
5165.82	A I	5233.225	TH II	5322.898	TH I
5168.586	TH I	5234.107	TH I	5325.143	TH II
5168.922	TH I	5237.903	TH II	5326.277	TH I
5173.671	TH I	5238.813	TH I	5326.975	TH I
5175.324	TH I	5239.552	TH I	5329.374	TH II
5175.911	TH I	5240.196	TH II	5330.080	TH I
5176.28	A II	5247.196	TH I	5340.498	TH I
5176.403	TH I	5247.654	TH II	5343.581	TH I
5176.961	TH I	5252.786	A I	5347.971	TH I
5177.623	TH I	5254.259	TH I	5351.126	TH I
5183.989	TH II	5258.360	TH I	5351.836	TH I
5184.453	TH I	5260.104	TH I	5355.636	TH I
5186.413	TH I	5261.472	TH I	5358.706	TH I
5187.337	TH I	5266.710	TH I	5359.827	TH I
5187.467	TH II	5269.792	TH I	5360.150	TH I
5187.746	A I	5273.131	TH I	5361.155	TH I
5190.872	TH II	5274.118	TH I	5362.575	TH I
5193.825	TH II	5277.500	TH II	5369.282	TH I
5194.02	A I	5281.068	TH I	5369.447	TH I
5194.457	TH I	5291.816	TH I	5370.709	TH I
5195.813	TH I	5294.397	TH I	5372.702	TH I
5198.800	TH I	5296.278	TH I	5374.822	TH
5199.163	TH I	5297.743	TH I	5375.352	TH II
5203.848	TH	5298.282	TH I	5376.130	TH
5205.152	TH I	5300.523	TH I	5376.780	TH I
5206.495	TH II	5301.404	TH II	5379.110	TH I
5209.724	TH I	5303.483	TH I	5382.927	TH II
5211.230	TH I	5305.77	A II	5384.301	TH I
5213.349	TH I	5306.986	TH I	5386.610	TH I
5216.596	TH II	5307.465	TH II	5388.050	TH I
5218.527	TH II	5310.266	TH II	5390.440	TH I-II W.M.
5219.109	TH I	5312.002	TH I	5392.572	TH II
5220.926	TH I	5312.528	TH I	5393.972	TH I
5221.270	A I	5312.904	TH I	5394.760	TH I
5228.224	TH I	5317.494	TH I	5398.701	TH I

wavelength	identification	wavelength	identification	wavelength	identification
5398.922	TH I	5488.628	TH II	5571.191	TH I
5399.01	A I	5492.643	TH I	5572.465	TH I
5399.174	TH	5493.204	TH I	5573.353	TH I
5400.145	TH I	5494.330	TH I	5576.204	TH I
5402.69	A	5495.872	A I	5577.70	A II
5403.199	TH I	5499.255	TH I	5579.358	TH I
5407.653	TH I	5499.647	TH I	5580.077	TH I
5410.768	TH I	5501.281	TH I	5580.754	TH I
5415.491	TH I-II W.M.	5504.301	TH I	5583.762	TH II
5417.485	TH I	5506.112	A I	5587.026	TH I
5421.346	A I	5507.538	TH I	5588.750	TH
5421.836	TH II	5508.558	TH I	5593.613	TH
5424.008	TH I	5509.993	TH I	5595.063	TH I
5425.678	TH II	5514.873	TH I	5595.846	TH I
5426.407	TH I	5518.989	TH I	5597.46	A I
5431.112	TH I	5524.582	TH I	5599.654	TH I
5434.151	TH I	5524.93	A I	5601.603	TH I
5435.892	TH II	5527.295	TH I	5602.852	TH W.M.
5437.387	TH II	5528.227	TH I	5604.515	TH II
5439.97	A I	5537.130	TH I	5606.386	TH I
5440.601	TH I	5537.556	TH I	5606.732	A I
5443.118	TH II	5538.608	TH I	5609.573	TH I
5443.21	A I	5539.262	TH I	5610.231	TH I
5447.153	TH	5539.910	TH II	5610.104	TH I
5449.478	TH II	5541.581	TH I	5610.680	TH I
5451.650	A I	5542.890	TH I	5612.068	TH I
5452.218	TH I	5548.175	TH I	5615.319	TH I
5457.37	A I	5551.372	TH II	5619.975	TH I
5458.967	TH	5552.623	TH I	5630.297	TH I
5461.735	TH II	5554.07	A	5632.872	TH II
5464.205	TH I	5557.045	TH I	5633.295	TH I
5470.759	TH I	5558.342	TH I	5639.746	TH II
5473.44	A I	5558.702	A I	5641.734	TH I
5474.865	TH II	5559.891	TH I	5645.668	TH I
5479.075	TH I	5564.201	TH II	5646.451	TH I
5484.146	TH II	5567.998	TH I	5648.991	TH I

wavelength	identification	wavelength	identification	wavelength	identification
5650.703	A I	5771.760	TH I	5871.182	TH I
5657.925	TH I	5772.116	A II	5882.625	A I
5659.130	A I	5773.946	TH I	5885.701	TH I
5664.621	TH I	5777.400	TH I	5886.531	TH I
5665.180	TH I	5781.658	TH I	5888.592	A I
5665.628	TH II	5782.289	TH I-I W.M.	5889.953	TH
5667.128	TH I	5789.645	TH I	5891.451	TH I
5674.986	TH I	5792.430	TH I	5894.698	TH I
5677.053	TH I	5796.068	TH I	5895.281	TH I
5679.005	TH I	5796.418	TH II	5899.844	TH I
5681.900	A I	5797.319	TH I	5904.159	TH II
5685.192	TH I	5798.478	TH I	5905.570	TH I
5691.71	A II	5800.829	TH I	5908.935	TH I-I W.M.
5700.458	TH II	5802.082	A I	5911.229	TH I
5700.917	TH II	5804.141	TH I	5912.084	A I
5702.651	TH I	5807.681	TH I	5914.671	TH
5707.103	TH II	5812.972	TH I	5916.728	TH I
5717.171	TH I	5815.422	TH II	5918.944	TH I
5719.623	TH I	5822.793	TH I	5922.802	TH II
5720.183	TH I	5830.827	TH I	5925.403	TH I
5724.253	TH I-I W.M.	5832.370	TH I	5926.232	TH I
5724.463	TH I	5834.263	A I	5927.13	A I
5725.388	TH I	5838.950	TH II	5928.805	A I
5732.975	TH II	5840.640	TH I	5929.480	TH II
5736.029	TH I	5843.807	TH I	5929.934	TH I
5739.517	A I	5845.918	TH I	5934.409	TH I
5741.170	TH II	5852.680	TH I	5934.461	TH I
5741.829	TH I	5853.474	TH I	5936.386	TH I
5748.741	TH I	5854.120	TH I	5937.162	TH
5749.388	TH II	5859.668	TH II	5937.663	TH I
5753.026	TH I	5860.315	A I	5938.825	TH I
5760.550	TH I	5863.718	TH I	5942.668	A I
5762.794	TH I	5866.811	TH I	5944.647	TH I
5763.529	TH I	5868.374	TH I	5948.799	TH I
5767.778	TH I	5869.850	TH I	5949.26	A I
5768.181	TH I	5870.552	TH II	5955.561	TH I

wavelength	identification	wavelength	identification	wavelength	identification
5959.673	TH I	6049.051	TH I	6125.739	TH II
5962.056	TH I	6052.721	A I	6127.38	A I
5969.737	TH I	6053.380	TH I	6129.545	TH I
5971.59	A I	6055.593	TH I	6137.926	TH I
5973.664	TH I	6059.373	A I	6138.67	A II
5975.064	TH I	6061.536	TH I	6145.43	A I
5981.90	A I	6065.779	TH I	6150.683	TH I
5986.266	TH	6069.020	TH I	6151.993	TH I
5987.289	A I	6073.103	TH II	6154.068	TH I
5989.044	TH II	6077.105	TH I	6154.516	TH I
5991.007	TH I	6077.872	TH I	6155.581	TH I
5994.128	TH I	6078.421	TH I	6157.087	TH I
5996.629	TH I	6079.222	TH I	6161.353	TH I
5999.00	A I	6085.374	TH I	6162.170	TH
6000.762	TH I	6087.262	TH II	6164.479	TH I
6001.203	TH I	6088.030	TH I	6169.822	TH I
6005.165	TH I	6090.76	A I	6172.28	A
6005.74	A I	6098.120	TH	6173.106	A I
6007.072	TH I	6099.083	TH II	6178.431	TH I
6010.160	TH I	6101.16	A I	6180.705	TH I
6011.533	TH I	6101.725	TH I	6182.621	TH I
6013.68	A I	6102.594	TH I	6184.778	TH I-II W.M.
6015.422	TH II	6103.56	A II	6188.125	TH I
6021.035	TH I	6103.641	TH II	6191.905	TH I
6023.224	TH I	6104.568	TH I-II W.M.	6193.856	TH I
6025.14	A I	6105.645	A I	6198.222	TH I
6030.445	TH I	6107.533	TH	6203.492	TH I
6032.124	A I	6112.837	TH II	6205.860	TH I
6032.872	TH I	6114.92	A II	6207.220	TH I
6033.413	TH I	6116.166	TH I	6208.686	TH I
6035.192	TH I	6119.699	TH I	6212.507	A I
6037.697	TH I	6120.556	TH II	6215.945	A I
6038.680	TH I	6121.407	TH	6220.011	TH I
6042.589	TH I	6122.214	TH	6221.319	TH I
6043.230	A I	6123.38	A II	6224.527	TH I
6044.432	TH II	6124.480	TH I	6226.369	TH I

wavelength	identification	wavelength	identification	wavelength	identification
6232.974	TH II	6348.737	TH I	6513.84	A I
6234.855	TH I	6355.910	TH I	6522.043	TH I
6240.953	TH I	6369.139	TH I	6531.341	TH I
6243.13	A II	6369.577	A I	6537.614	TH I
6248.40	A I	6371.943	TH I	6538.115	A I
6250.485	TH I	6376.930	TH I	6545.718	TH I
6257.423	TH I	6379.673	TH I	6551.705	TH I
6258.606	TH II	6384.719	A I	6554.160	TH I
6261.064	TH II	6387.395	TH I	6558.875	TH I
6261.418	TH I	6399.23	A II	6569.632	TH II
6266.173	TH II	6406.446	TH I	6576.122	TH I
6271.544	TH I	6411.899	TH I	6577.214	TH I
6274.116	TH II	6413.614	TH I	6577.656	TH II
6274.164	TH I	6416.315	A I	6580.229	TH I
6277.238	TH II	6431.57	A I	6583.906	TH I
6279.166	TH II	6437.761	TH I	6584.613	TH I
6285.278	TH II	6439.071	TH I	6588.539	TH I
6287.255	TH I	6441.95	A	6591.484	TH I
6291.191	TH I	6443.89	A	6593.462	TH I
6293.242	TH I	6446.771	TH I	6593.939	TH I
6296.876	A I	6450.006	TH I	6596.10	A I
6300.916	TH I	6450.955	TH I	6599.482	TH
6303.250	TH I	6457.282	TH I	6604.853	A I
6307.662	A I	6462.595	TH I-II W.M.	6605.416	TH II
6309.14	A I	6466.56	A I	6613.374	TH I
6310.810	TH I	6483.10	A II	6617.058	TH II
6315.775	TH I	6487.441	TH I	6617.515	TH I
6317.182	TH I	6488.883	TH I	6618.166	TH I
6321.820	TH I	6490.737	TH I	6619.946	TH II
6324.45	A	6493.197	TH I	6638.24	A II
6326.367	TH I	6493.777	TH	6638.912	TH I
6327.277	TH I	6501.992	TH I	6639.72	A II
6331.413	TH I	6503.511	TH II	6643.79	A II
6337.620	TH I	6506.986	TH I	6644.663	TH
6339.668	TH I	6509.050	TH I	6646.540	TH II
6342.859	TH I	6512.364	TH I	6648.495	TH II

wavelength	identification	wavelength	identification	wavelength	identification
6648.958	TH II	6772.174	TH I	6942.538	TH I
6658.677	TH I	6778.312	TH I	6943.610	TH I
6660.64	A I	6780.125	TH I	6945.490	TH I
6662.268	TH I	6780.413	TH I	6948.205	TH I
6664.02	A I	6787.736	TH I	6951.46	A I
6666.36	A II	6788.840	TH I	6954.656	TH I
6668.816	TH I	6791.235	TH I	6965.430	A I
6673.579	TH I	6809.100	TH I	6989.655	TH I
6674.697	TH I	6809.509	TH I	6992.17	A I
6677.282	A I	6818.26	A I	6993.037	TH II
6678.706	TH I	6823.508	TH I	7000.803	TH I
6683.367	TH I	6824.677	TH I	7002.883	TH I
6684.36	A II	6827.240	A I	7018.567	TH I
6687.520	TH I	6829.035	TH I	7030.262	A I
6692.726	TH I	6834.924	TH I	7036.283	TH I
6694.496	TH I	6851.86	A I	7045.797	TH II
6696.140	TH I	6853.523	TH I	7053.619	TH II
6697.712	TH I	6854.109	TH I	7058.489	TH I
6698.85	A I	6861.30	A II	7060.041	TH I
6704.051	TH	6863.52	A II	7060.653	TH I
6711.252	TH I	6866.366	TH I	7064.451	TH I
6713.970	TH I	6866.763	TH I	7067.217	A I
6717.385	TH I	6868.450	TH I	7068.73	A I
6719.20	A I	6871.290	A I	7072.394	TH I
6727.458	TH I	6874.753	TH I	7075.333	TH II
6728.118	TH I	6879.59	A I	7084.169	TH I
6728.759	TH I	6882.811	TH I	7086.70	A I
6733.748	TH I	6886.408	TH I	7089.339	TH II
6742.884	TH I	6886.57	A II	7100.514	TH II
6752.832	A I	6887.10	A I	7107.496	A I
6754.30	A I	6888.17	A I	7109.860	TH I
6756.453	TH I	6889.303	TH II	7114.398	TH I
6757.109	TH I	6909.849	TH II	7122.044	TH
6758.203	TH I	6911.226	TH I	7124.560	TH I
6765.669	TH I	6916.128	TH II	7125.80	A I
6766.56	A I	6937.666	A I	7130.184	TH I

wavelength	identification	wavelength	identification	wavelength	identification
7132.10	TH I	7298.143	TH I	7484.24	A I
7142.331	TH I	7305.404	TH II	7487.973	TH I
7147.041	A I	7308.641	TH I	7489.614	TH I
7148.559	TH I	7311.71	A I	7503.867	A I
7150.284	TH I	7315.066	TH I	7510.42	A I
7154.762	TH I	7316.00	A I	7511.349	TH II
7154.953	TH I	7324.807	TH I	7511.790	TH I
7156.941	TH I	7328.285	TH I	7514.651	A I
7158.83	A I	7329.491	TH I	7523.134	TH I
7159.947	TH I	7335.577	TH II	7525.508	TH II
7162.57	A I	7341.151	TH I	7549.313	TH I
7168.895	TH I	7342.576	TH I	7565.851	TH I
7173.372	TH I	7350.78	A I	7567.741	TH I
7191.133	TH II	7353.316	A I	7569.511	TH I
7200.045	TH I	7372.118	A I	7585.743	TH I-I W.M.
7206.483	TH I	7376.877	TH I	7589.33	A II
7206.986	A I	7383.980	A I	7598.205	TH I
7208.006	TH I	7392.97	A I	7607.823	TH I
7212.689	TH I	7402.252	TH I	7618.33	A I
7218.054	TH I	7411.736	TH I	7625.705	TH I
7219.151	TH I	7412.31	A I	7627.175	TH I
7229.93	A I	7417.790	TH I	7628.86	A I
7230.862	TH I	7418.550	TH I	7630.310	TH I
7233.58	A II	7421.827	TH I	7635.105	A I
7242.092	TH I	7422.26	A I	7647.379	TH I
7244.696	TH I	7425.24	A I	7652.320	TH I
7246.127	TH	7428.940	TH I	7653.828	TH I
7255.354	TH I	7430.253	TH I	7654.699	TH I
7256.986	TH I	7435.33	A I	7658.324	TH I
7258.177	TH I	7436.25	A I	7660.890	TH I
7270.66	A I	7447.801	TH I-I W.M.	7670.04	A I
7272.936	A I	7455.208	TH I	7678.126	TH I
7284.903	TH I	7461.874	TH	7685.307	TH II
7285.44	A I	7471.18	A I	7697.924	TH I
7288.98	TH	7481.354	TH I	7704.81	A I
7296.265	TH I	7483.625	TH I	7710.269	TH I

wavelength	identification	wavelength	identification	wavelength	identification
7713.937	TH I	8079.68	A I	8471.826	TH I
7724.206	A I	8085.219	TH I	8478.358	TH I
7731.738	TH I	8093.623	TH I	8490.30	A I
7782.316	TH	8103.692	A I	8510.624	TH I
7788.934	TH I	8115.311	A I	8516.554	TH I
7798.358	TH I	8122.723	TH I	8521.441	A I
7814.33	A I	8129.405	TH I	8554.944	TH I
7817.770	TH I	8138.475	TH I	8573.120	TH I
7834.457	TH II	8143.138	TH I	8605.78	A I
7840.457	TH I	8159.727	TH I	8620.47	A I
7841.791	TH I	8169.786	TH I	8639.441	TH I
7847.539	TH I	8178.840	A	8667.943	TH I
7861.91	A I	8186.911	TH I	8678.43	A I
7865.969	TH I	8202.147	TH	8709.234	TH I
7868.20	A I	8203.201	TH II	8732.424	TH I
7886.283	TH I	8231.406	TH I	8748.031	TH I
7891.075	A I	8252.393	TH I	8749.169	TH
7900.320	TH I	8254.742	TH I	8758.243	TH I
7916.45	A I	8259.511	TH I	8760.449	TH I
7937.733	TH I	8263.924	TH I	8761.72	A I
7941.726	TH I	8264.521	A I	8766.745	TH I
7948.175	A I	8275.626	TH I	8771.88	A II
7978.973	TH I	8320.855	TH I	8772.805	TH I
7987.973	TH I	8330.450	TH I	8775.573	TH I
8006.156	A I	8332.21	A I	8784.59	A I
8014.786	A I	8358.726	TH I	8841.183	TH I
8022.201	TH I	8367.393	TH I	8849.97	A I
8022.330	TH I	8369.340	TH I	8852.791	TH I
8032.431	TH I	8408.208	A I	8868.833	TH I
8037.23	A I	8416.727	TH I	8892.986	TH I
8046.13	A I	8417.998	TH I	8949.122	TH I
8053.307	A I	8421.225	TH I	8962.19	A I
8062.630	TH I	8424.647	A I	8967.640	TH I
8066.826	TH I	8445.487	TH I	8997.876	TH I
8068.742	TH I	8446.511	TH I	9016.590	TH I
8075.652	TH I	8464.236	TH I	9017.59	A II

wavelength	identification
9031.819	TH I
9037.893	TH I
9045.353	TH I
9048.250	TH I
9053.485	TH II
9063.960	TH I
9075.42	A I
9122.966	A I
9194.68	A I
9224.498	TH I
9291.58	A I
9354.218	A I