ING LA PALMA TECHNICAL NOTE NO. 84

Maps of Standard arc-lamps for the WHT ISIS

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This note gives line lists and identification maps for some of the arc lamps available to ISIS (Intermediate dispersion Spectrograph and Imaging System) on the William Herschel Telescope at the Roque de Los Muchachos Observatory on the island of La Palma.

Dave Carter used the IPCS II (which at the time had an RCA CCD chip as its backend detector) and the holographic grating (2400 lines per mm) to obtain data at high dispersion (0.08Å per pixel). The lamps used were copper-argon and copper-neon. Table I gives information for the wavelength ranges, rms values for the goodness-of-fit of the measured values of the lines compared with their laboratory wavelengths, and other details about each series of CCD frames.

For the lower dispersion maps the GEC5 detector was used with the 600 lines per mm grating, giving a dispersion of 0.73Å per pixel. Information for these frames is given in Table II. A second order filter was not used as it was thought that, once identified, the second order lines could prove useful.

Steve Unger investigated some iron arc lamps instead of the more commonly used copper-argon lamps for the wavelength region around 3250Å, where the strong copper I lines occur which can cause problems when photon counting detectors are used. To avoid exceeding the maximum count rate he used neutral density filters. Their values are given in the column NDF in Table III. Three lamps were tested, iron-argon and iron-neon, and also copper-argon as a comparison. IPCS II was used with a GEC chip as the backend detector and the 600 lines per mm grating. As can be seen from the maps the iron-neon arc has many lines of similar intensity in this region, which make it well-suited to a photon counting device.

After investigation of various publications of tables of wavelengths of spectral lines in the relevant regions, it was found that the data in 'Tables of Spectral Lines of Neutral and Ionized Atoms' gave the most comprehensive data set, and the best fit to the measured values, so these were adopted. Other tables tried are listed at the end of this note.

Comparisons were made with Norlen's values for the argon wavelengths as these are used in Figaro. Good agreement was found for the stronger lines (ie within .002Å, though there were some discrepancies for the weaker (.02Å for a few lines). When the IPCS was used together with the RCA chip there was found to be no significant improvement of fit of wavelength to pixel value by going above a third order polynomial. For the IPCS with the GEC chip a fifth order polynomial gave a significantly improved fit. For each of the 7 configurations described in Tables I, II and III, line lists of the laboratory wavelengths used are given, followed by maps of these lines with identifications (in crowded regions only selected lines are identified).

Jim Lewis kindly allowed the use of his program which converts the FITS format data from signed integer word to real and corrects for the 16 bit problem. The Figaro package was used for extracting the data, identifying the lines and giving an rms for the fitting of the wavelengths. Figaro was also used for producing most of the maps. It was not used for the lower dispersion maps at the red end of the spectrum, where it was necessary to distinguish between the first and second-order lines. The wavelengths are given to one tenth of an Ångstrom and second order lines are indicated by placing brackets around the value for the wavelength. Blended lines are also indicated by values in brackets but for these the wavelength is only given to an integer value. An asterisk indicates that the first order line is weak compared with the second order line at the similar position. The figures given in brackets after the wavelengths in the line lists are the relative strengths of the lines given in the publication used. They have only been included for lines which are probably blends, which were not used in the line fitting.

Aluminium and manganese lines were found in the copper-neon lamp at high dispersion. These are identified in the line lists with an exclamation mark, and on the maps with brackets.

Please send any comments or queries via e-mail to CAVAD::JES.

References

The publication used was:

Tables of Spectral Lines of Neutral and Ionised Atoms, **1968**, Striganov, A.R. & Sventitskii, N.S., IFI/PLENUM New York-London.

Other publications consulted were:

Tables of Spectral Lines, **1970**, Zaidel, A.N., Prokof'ev, V.K., Raiskii, S.M., Slavnyi, V.A. & Shreider, E.Ya. IFI/PLENUM New York-London.

Wavelengths and Energy Levels of Ar I and Ar II in the region of 3400 – 9800 Angstroms. **1973**, Norlen, G., *Physica Scripta*, 8, 249.

MIT Wavelength Tables, Vol 2. **1982**, Prepared by Phelps, F.M., The MIT Press, Cambridge, Massachusetts. London, England.

Line Spectra of the Elements, Handbook of Chemistry and Physics, eds. Weast, R.C. & Astle, M.J., Section E205, 62nd Edition, **1982**, CRC Press. Boca Raton, Florida.

TABLE I

IPCS with RCA chip and the 2400 line per mm grating
Dispersion 0.08 Angstroms per pixel
Slit width 120 microns

Copper neon lamp:

Wavelength Range	Exp secs	RMS cubic	RMS quintic	No. of lines	
2990–3170	500	0.016	0.010	13	(1 line is aluminium)
3195–3350	300	0.012	0.009	15	
3305–3320	200	0.016	0.016	27	
3470–3670	200	0.017	0.012	16	
3630–3830	200	0.017	0.015	15	
3795–3965	200	0.017		6	(3 lines are aluminium)
3960–4155	300	0.018	0.009	9	(1 aluminium, 4 manganese)
4135–4295	300	0.023	0.015	14	
4265–4470	300	0.020	0.019	20	
4425–4620	300	0.017	0.012	17	
4590–4760	300	0.008	0.007	17	
4750–4945	300	0.013	0.009	20	
4920–5100	200	0.018	0.013	15	
5080–5240	200	0.009	0.007	24	
5230–5425	200	0.015	0.012	18	
5395–5580	300	0.012	0.008	12	
5555–5720	200	0.012	0.009	10	
5715–5885	200	0.019	0.014	9	
5880–6050	200	0.014	0.011	15	

Copper argon lamp:

Wavelength Range	Exp secs	RMS cubic	RMS quintic	No. of lines
3085–3295	600	0.018	0.015	13
3150–3355	600	0.015	0.015	15
3315–3520	400	0.013	0.010	18
3470–3665	300	0.011	0.007	24
3630–3820	300	0.013	0.009	23
3795–3995	300	0.012	0.011	30
3945–4135	340	0.010	0.006	20
4130–4285	200	0.007	0.007	19
4270–4465	200	0.007	0.005	25
4430–4630	200	0.014	0.009	20
4585–4770	200	0.007	0.006	14
4750–4945	200	0.014	0.005	15
4920–5095	200	0.012	0.006	15
5070–5265	200	0.015	0.012	19
5240–5425	400	0.026	0.023	30
5390–5585	200	0.020	0.017	24
5555–5740	200	0.019	0.015	21
5735–5890	300	0.011	0.008	13
5880–6055	200	0.014	0.012	20

TABLE II

GEC CCD chip with 600 lines per mm grating
Dispersion 0.73 Angstroms per pixel
Slit width 120 microns

Copper neon lamp:

Wavelength Range	Exp secs	RMS cubic	RMS quintic	No. of 1st order lines	No. of 2nd order lines
4835–5535	100	0.020	0.018	17	
5660–6315	100	0.032	0.027	20	
6215–7035	50	0.034	0.026	14	
6925–7545	10	0.039	0.031	12	
7730–8370	5	0.029	0.020	11	
8360–9150	10	0.039	0.038	16	
9145–9670	20	0.038	0.032	17	
9805–10470	100	0.043	0.039	1	15
10405–11180	100	0.042	0.045	4	8

Copper argon lamp:

Wavelength Range	Exp secs	RMS cubic	RMS quintic	No. of 1st order lines	No. of 2nd order lines
4800–5610	300	0.043	0.039	19	
5570–6310	5	0.037	0.034	31	
6210–7035	5	0.045	0.032	21	
6935–7705	5	0.030	0.025	24	
7630–8430	20	0.045	0.038	15	
8330–9125	50	0.043	0.026	14	
9065–9785	100	0.039	0.037	13	
9755–10480	300	0.093	0.091	6	12
10470–11215	300	0.055	0.047	4	8

TABLE III

IPCS with GEC chip and 600 line per mm grating
Dispersion 0.44 Angstroms per pixel
Slit width 200 microns

Lamp	Wavelength Range	Exp secs	RMS cubic	RMS quintic	No. of 1st order lines	NDF
Iron argon	3305–4330	1800	0.110	0.057	36	0.8
Copper argon	3335–4280	1800	0.107	0.052	35	0.6
Iron neon	3315–4330	600	0.156	0.061	51	1.8

Copper Argon lines: 2400 line grating, IPCS with RCA CCD

3088.209 Ar II
3093.403 Ar II (10)
3093.989 Cu I (1500)
3104.359 Ar II
3139.015 Ar II (12)
3139.257 Ar II (4)
3153.782 Ar II (4)
3154.289 Ar II (2)
3161.369 Ar II (7)
3161.456 Ar II (8)
3169.667 Ar II
3181.038 Ar II
3194.229 Ar II (9)
3194.598 Ar II (4)
3203.66 Ar I (10)
3204.318 Ar II (9)
3204.996 Ar II (8)
3236.809 Ar II
3243.689 Ar II
3247.54 Cu I (10000)
3247.481 Ar II (3)
3249.801 Ar II
3257.585 Ar I
3263.572 Ar II (12)
3263.78 Ar I (3)
3273.316 Ar II (6)
3273.957 Cu I (10000)
3281.703 Ar II
3293.641 Ar II (10)
3293.921 Ar II (9)
3307.229 Ar II
3319.345 Ar I
3325.501 Ar I
3336.20 Ar III
3344.79 Ar III
3350.933 Ar II
3373.482 Ar I
3376.443 Ar II
3388.365 Ar I (20)
3388.533 Ar II (10)
3393.752 Ar I
3406.18 Ar I
3414.46 Ar II
3421.615 Ar II
3442.58 Ar I
3454.098 Ar II (12)
3454.944 Ar I (20)
3461.078 Ar I
3464.132 Ar II
3465.787 Ar II (4)
3466.343 Ar II (8)
3476.747 Ar II
3478.236 Ar II
3491.243 Ar II (20)
3491.538 Ar II (25)
3499.481 Ar II
3509.783 Ar II
3514.388 Ar II
3519.996 Ar II
3521.263 Ar II (12)
3521.977 Ar II (4)
3535.319 Ar II
3545.597 Ar II (18)
3545.842 Ar II (18)
3548.519 Ar II
3554.306 Ar I
3556.906 Ar II
3559.508 Ar II
3561.031 Ar II
3567.657 Ar I
3572.296 Ar I
3576.611 Ar II
3581.608 Ar II
3582.362 Ar II
3588.448 Ar II
3605.883 Ar II (12)
3606.522 Ar I (1000)
3622.140 Ar II
3632.684 Ar I
3639.830 Ar II
3649.833 Ar I
3655.281 Ar II (12)
3656.051 Ar (10)
3659.530 Ar I (100)
3660.439 Ar II (10)
3678.274 Ar II
3680.064 Ar II
3682.547 Ar II
3718.208 Ar II
3720.428 Ar II
3724.521 Ar II
3729.310 Ar II
3737.893 Ar II
3763.504 Ar II
3765.269 Ar II
3766.118 Ar II
3780.841 Ar II
3786.383 Ar II
3796.599 Ar II
3799.381 Ar II
3803.172 Ar II
3809.456 Ar II
3819.017 Ar II
3825.676 Ar II
3826.807 Ar II
3834.679 Ar I
3841.518 Ar II
3845.406 Ar II
3850.578 Ar II
3868.524 Ar II
3872.143 Ar II
3875.264 Ar II (12)
3876.080 Ar I (10)
3880.335 Ar II
3891.400 Ar II (12)
3891.984 Ar II (15)
3894.660 Ar I
3900.624 Ar II
3911.572 Ar II
3914.768 Ar II
3925.722 Ar II
3928.629 Ar II
3931.235 Ar II
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4035.459 Ar II
4038.807 Ar II
4042.896 Ar II
4044.418 Ar I
4052.923 Ar II
4054.525 Ar I
4072.006 Ar II (25)
4072.385 Ar II (12)
4076.638 Ar II (12)
4076.939 Ar II (9)
4079.582 Ar II
4080.645 Ar II (6)
4080.686 Ar II (4)
4082.383 Ar II
4097.138 Ar II
4103.913 Ar II
4131.730 Ar II
4156.090 Ar II
4158.590 Ar I
4164.180 Ar I
4181.884 Ar I
4190.714 Ar I (600)
4191.029 Ar I (1200)
4198.318 Ar I
4200.674 Ar I
4217.433 Ar II
4218.667 Ar II
4222.640 Ar II
4226.607 Ar II (5)
4226.988 Ar II (10)
4228.162 Ar II
4229.872 Ar II
4237.223 Ar II
4251.185 Ar I
4259.362 Ar I
4266.286 Ar I (1200)
4266.528 Ar II (25)
4272.169 Ar I
4277.524 Ar II
4282.896 Ar II
4300.101 Ar I (1200)
4300.650 Ar II (12)
4309.09 Ar II (8)
4309.236 Ar II (9)
4331.199 Ar II (25)
4332.031 Ar II (15)
4333.561 Ar I (1000)
4335.338 Ar I (800)
4337.070 Ar II
4345.167 Ar I

Copper Argon lines: 2400 line grating, IPCS with GEC CCD

4348.063 Ar II	4942.915 Ar II	5495.877 Ar I
4352.204 Ar II	4956.750 Ar I	5506.115 Ar I
4362.065 Ar II	4965.073 Ar II	5524.960 Ar I
4367.829 Ar II (10)	4972.157 Ar	5528.960 Ar I
4367.87 Ar I (10)	4989.948 Ar I	5534.45 Ar I
4370.751 Ar II	5009.334 Ar II	5554.050 Ar II
4371.329 Ar II	5017.160 Ar II (20)	5558.703 Ar I (500)
4375.948 Ar II	5017.629 Ar II (10)	5559.62 Ar I (200)
4379.667 Ar II (20)	5048.813 Ar I	5572.543 Ar I
4379.879 Ar II (5)	5054.178 Ar I	5577.689 Ar II
4385.058 Ar II	5060.079 Ar I	5581.83 Ar I
4400.099 Ar II (18)	5062.036 Ar II	5588.721 Ar I
4400.988 Ar II (20)	5073.076 Ar I	5597.478 Ar I
4426.005 Ar II	5087.085 Ar I	5606.734 Ar I
4430.192 Ar II (20)	5090.496 Ar II	5618.010 Ar I
4431.004 Ar II (15)	5104.74 Ar I	5623.778 Ar I
4433.841 Ar II	5118.206 Ar I	5635.575 Ar I
4439.463 Ar II (7)	5125.765 Ar II	5637.29 Ar I
4439.878 Ar II (4)	5141.790 Ar II (20)	5641.34 Ar I
4440.122 Ar II (4)	5141.81 Ar I (20)	5648.66 Ar I
4448.459 Ar II (3)	5145.319 Ar II	5650.705 Ar I
4448.881 Ar II (8)	5151.394 Ar I	5659.128 Ar I
4460.53 Ar I (10)	5162.286 Ar I	5672.952 Ar
4460.560 Ar II (12)	5165.774 Ar II	5681.901 Ar I
4474.759 Ar II	5177.540 Ar I	5689.64 Ar I (200)
4481.81 Ar II	5187.751 Ar I	5689.91 Ar I (200)
4490.988 Ar II	5210.492 Ar I	5691.650 Ar II
4502.931 Ar II	5214.774 Ar I	5700.874 Ar I
4510.733 Ar I	5221.273 Ar I	5712.48 Ar I
4522.324 Ar I	5241.091 Ar I	5738.416 Ar I
4530.553 Ar II	5252.789 Ar I	5739.521 Ar I
4545.045 Ar II	5254.471 Ar I	5772.116 Ar I (100)
4563.751 Ar II (7)	5264.783 Ar II	5772.326 Ar II (5)
4564.415 Ar II (7)	5280.40 Ar I	5774.00 Ar I
4564.82 Ar I (4)	5283.43 Ar I	5783.541 Ar I
4579.346 Ar II	5286.071 Ar I (60)	5789.477 Ar I
4589.896 Ar II	5286.895 Ar II (15)	5790.39 Ar I
4596.097 Ar I	5290.00 Ar I	5802.081 Ar I
4598.760 Ar II	5305.690 Ar II	5812.746 Ar II
4609.560 Ar II	5309.517 Ar I	5834.266 Ar I
4628.441 Ar I	5317.726 Ar I	5860.312 Ar I
4637.233 Ar II	5345.81 Ar I	5870.26 Ar I (2)
4657.893 Ar II	5347.412 Ar I	5870.443 Ar II (4)
4702.316 Ar I	5358.363 Ar II	5882.625 Ar I
4721.594 Ar II	5373.495 Ar I	5888.585 Ar I
4726.859 Ar II	5387.37 Ar I	5912.086 Ar I
4732.056 Ar II	5389.10 Ar I	5916.58 Ar I
4735.905 Ar II	5393.971 Ar I	5928.812 Ar I
4752.940 Ar I	5397.522 Ar II	5940.86 Ar I
4764.862 Ar II	5402.604 Ar II	5942.672 Ar I
4768.675 Ar I	5407.348 Ar II	5949.259 Ar I
4792.090 Ar II	5410.475 Ar I	5968.31 Ar I
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4835.97 Ar I	5439.990 Ar I	5987.302 Ar I
4836.697 Ar I	5442.22 Ar I	5994.66 Ar I
4847.815 Ar II	5443.21 Ar I	5998.999 Ar I
4865.919 Ar II	5451.654 Ar I	6005.725 Ar I
4876.262 Ar I	5454.307 Ar II	6013.679 Ar I
4879.860 Ar II	5457.41 Ar I (200)	6025.151 Ar I
4887.947 Ar I	5457.75 Ar I (10)	6032.129 Ar I
4889.033 Ar II	5467.162 Ar I	6043.225 Ar I
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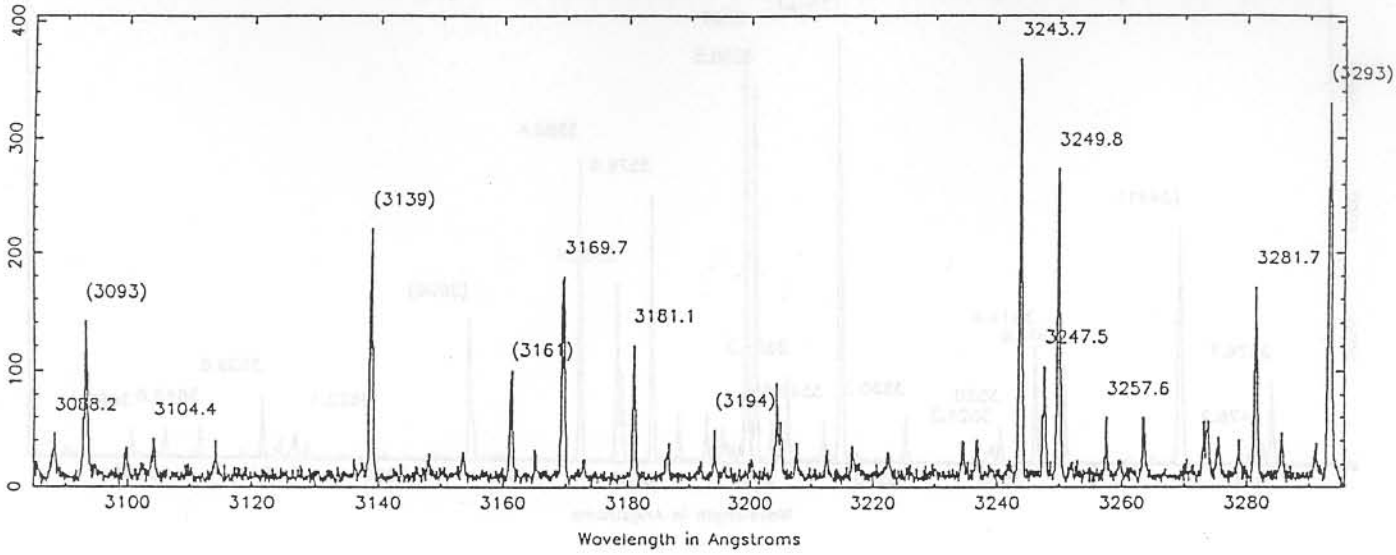
Cu-Ar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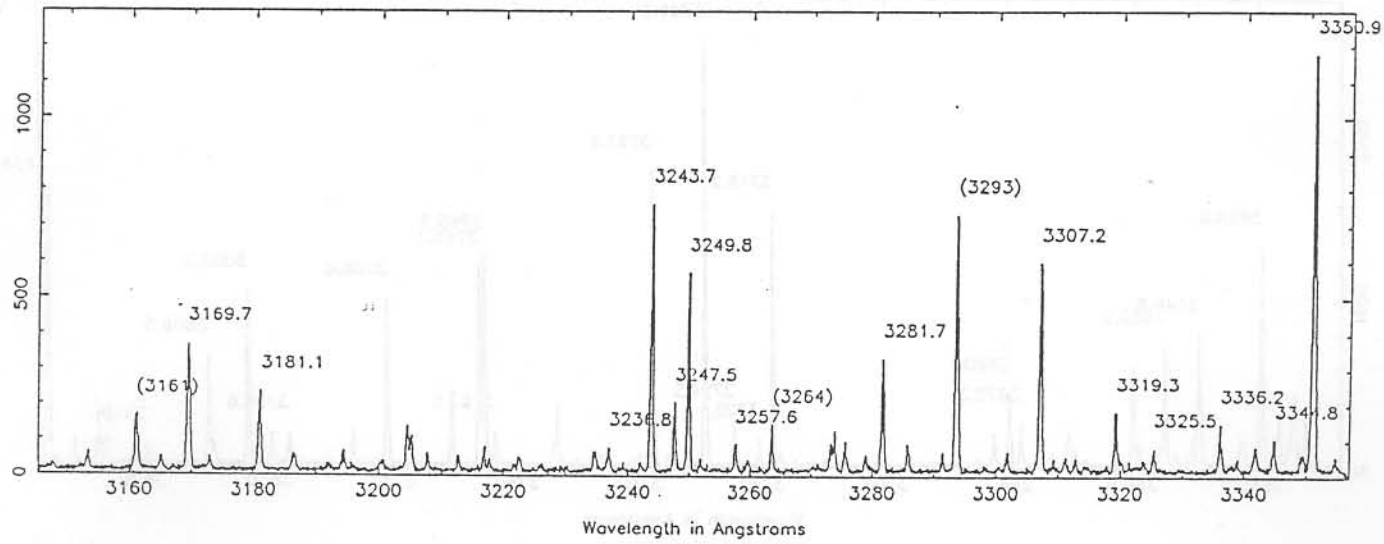
Wavelength in Angstroms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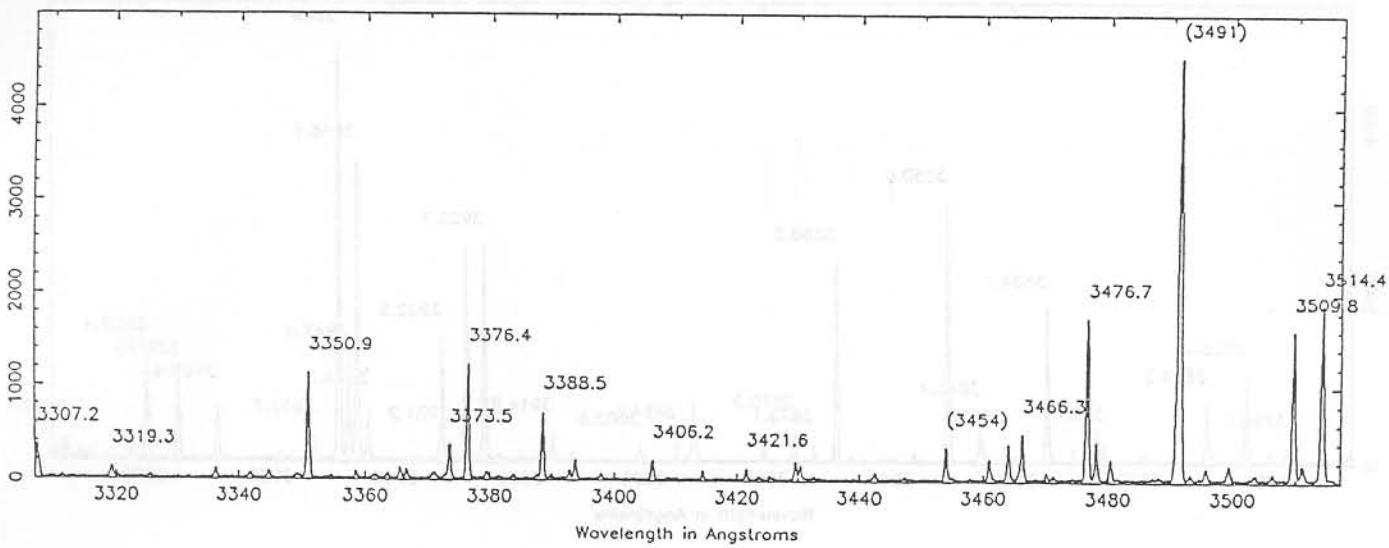
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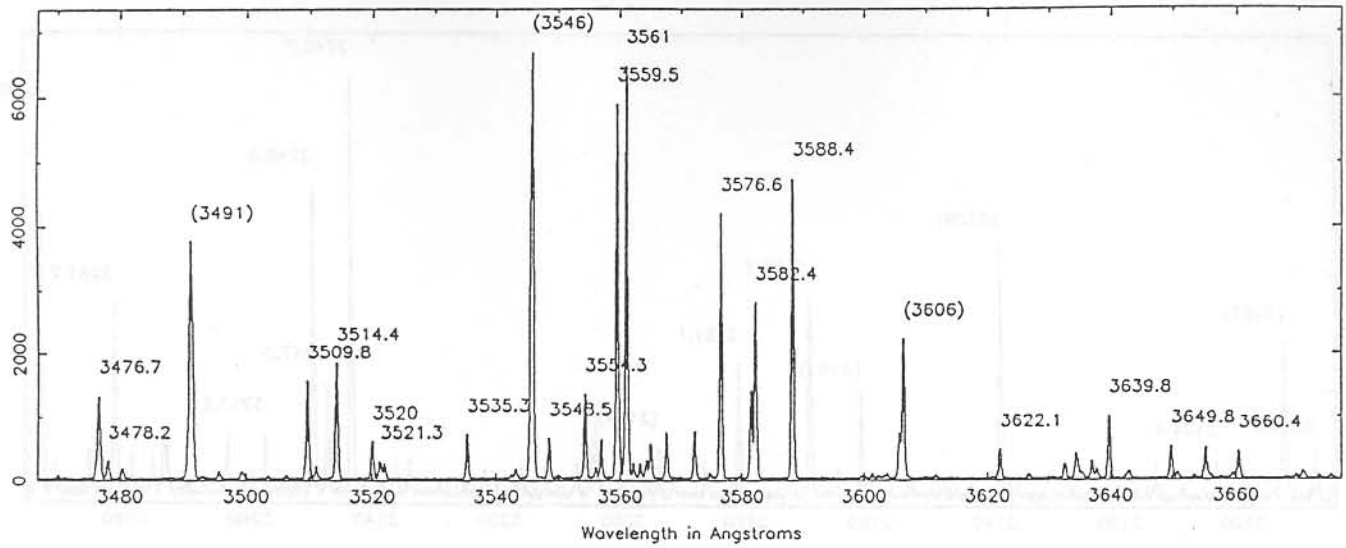
Wavelength in Angstroms

Cu-Ar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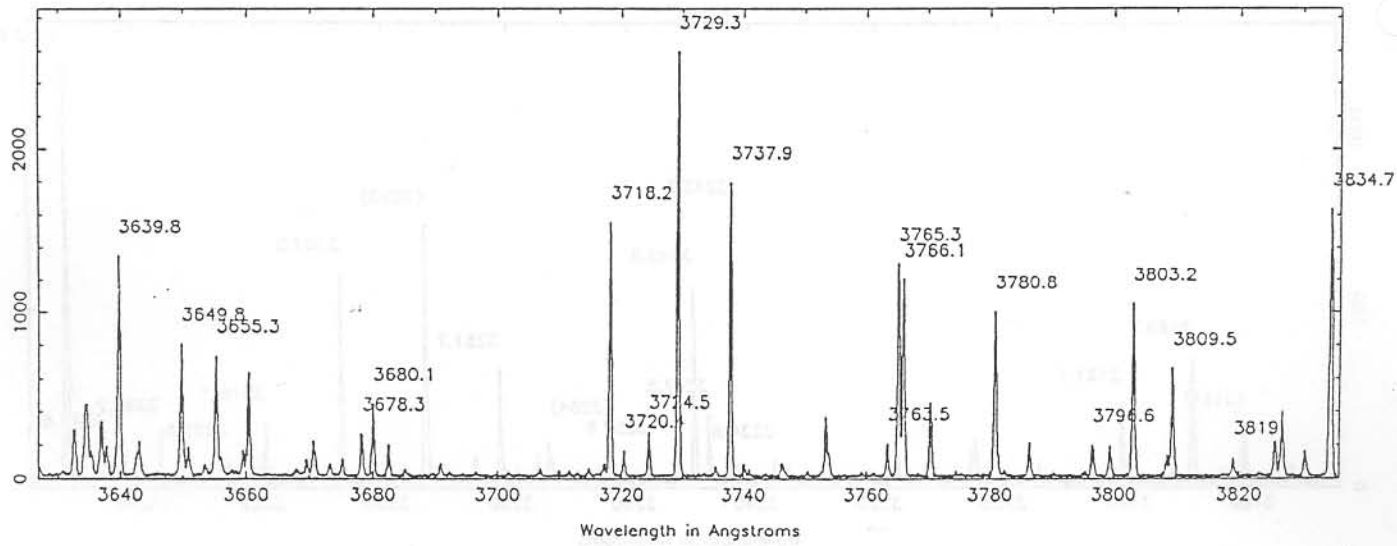
Wavelength in Angstroms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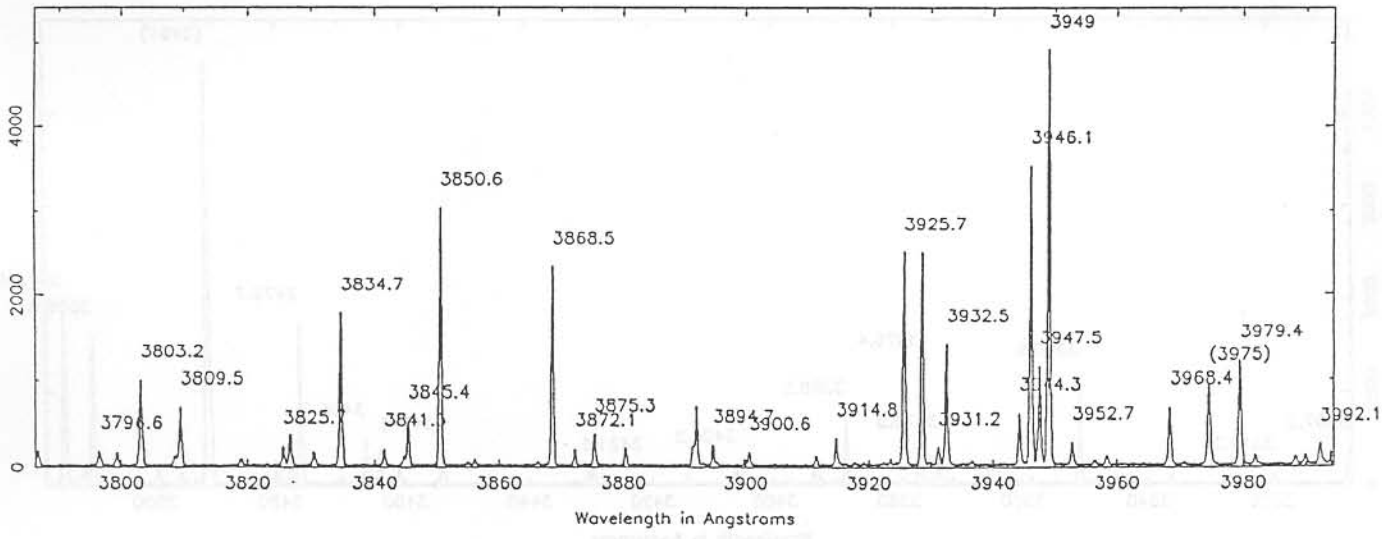
Wavelength in Angstroms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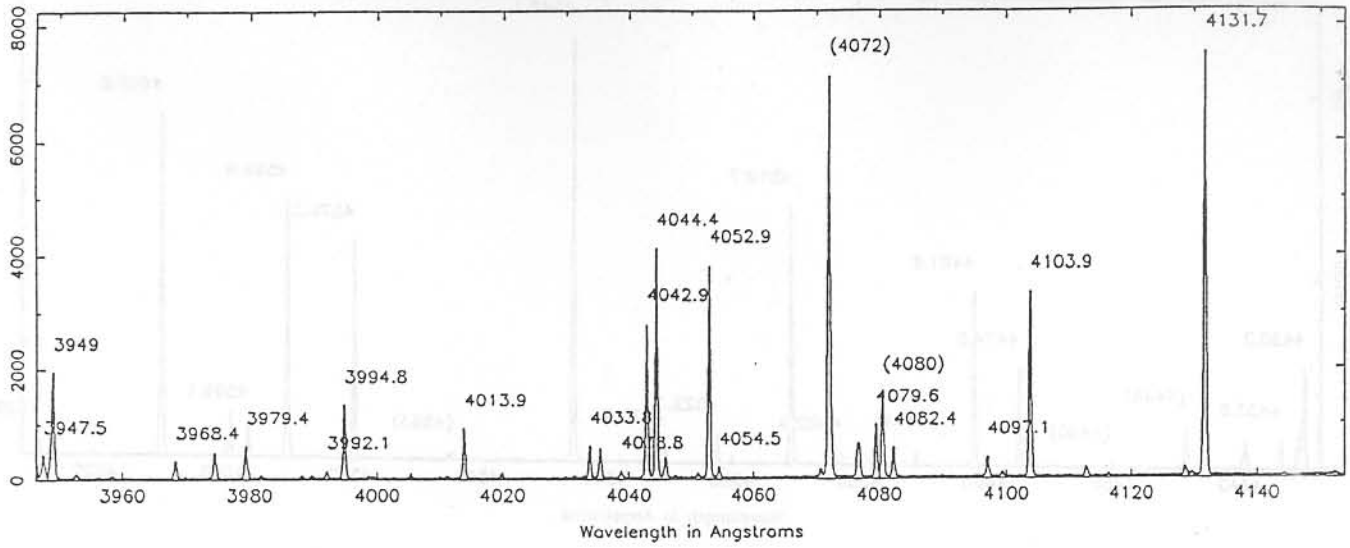
Wavelength in Angstroms

Cu-Ar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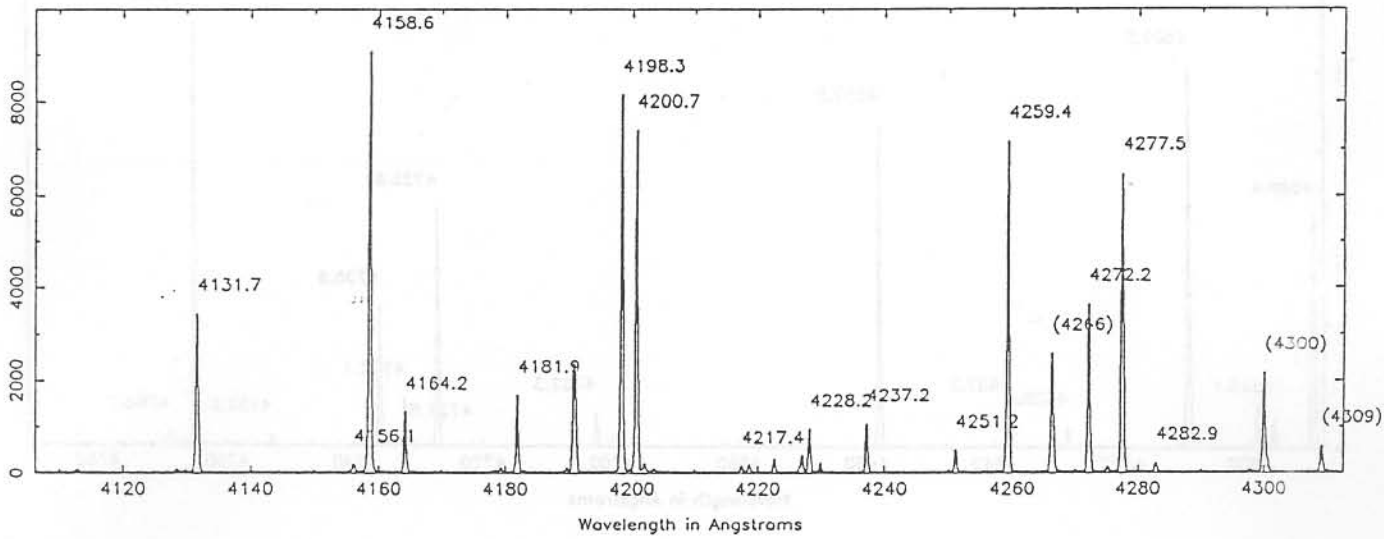
Wavelength in Angstroms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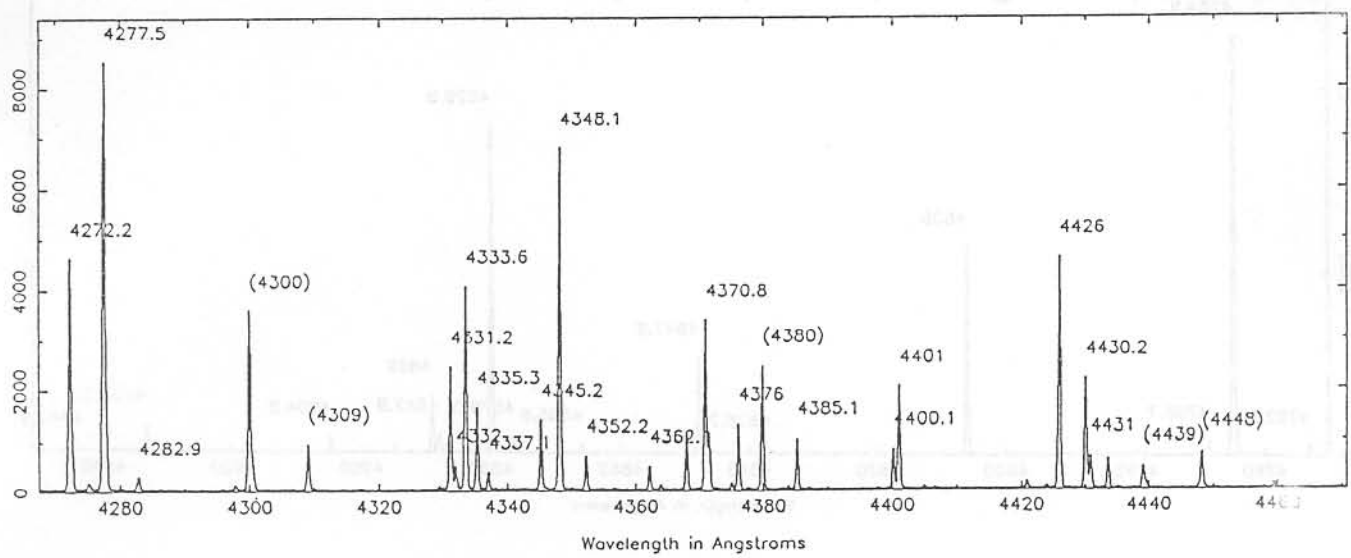
(4309)
4217.4
Wavelength in Angstroms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(4448)
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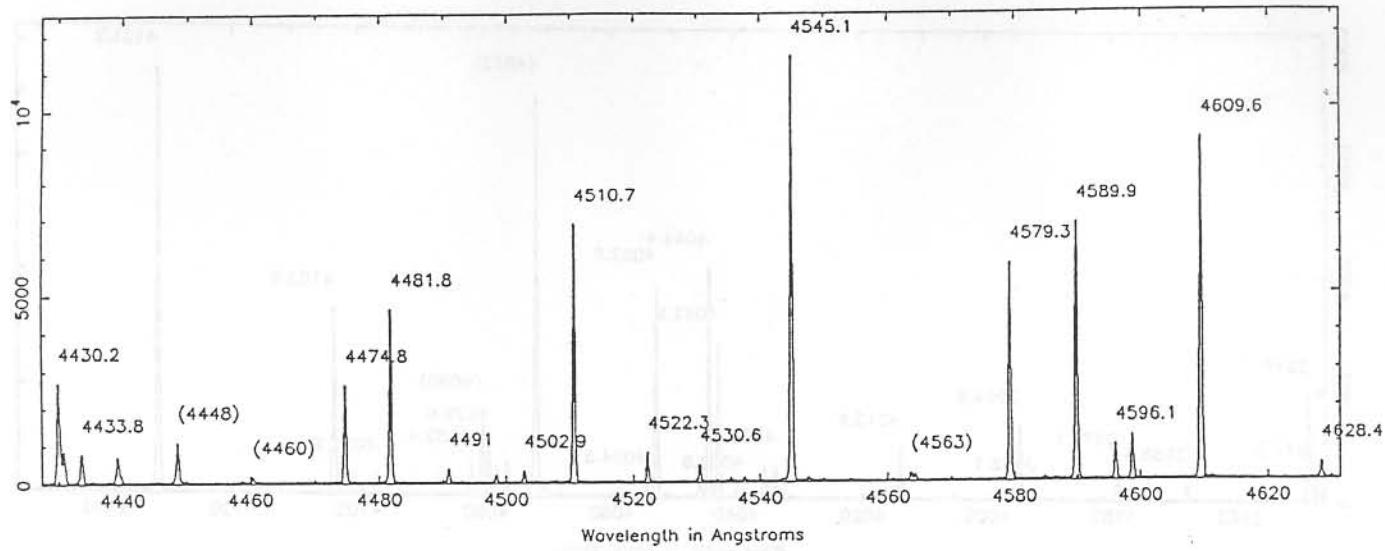
Wavelength in Angstroms

Cu-Ar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4596.1
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(4448)
(4460)
4491
4502.9
4522.3
4530.6
(4563)
4628.4
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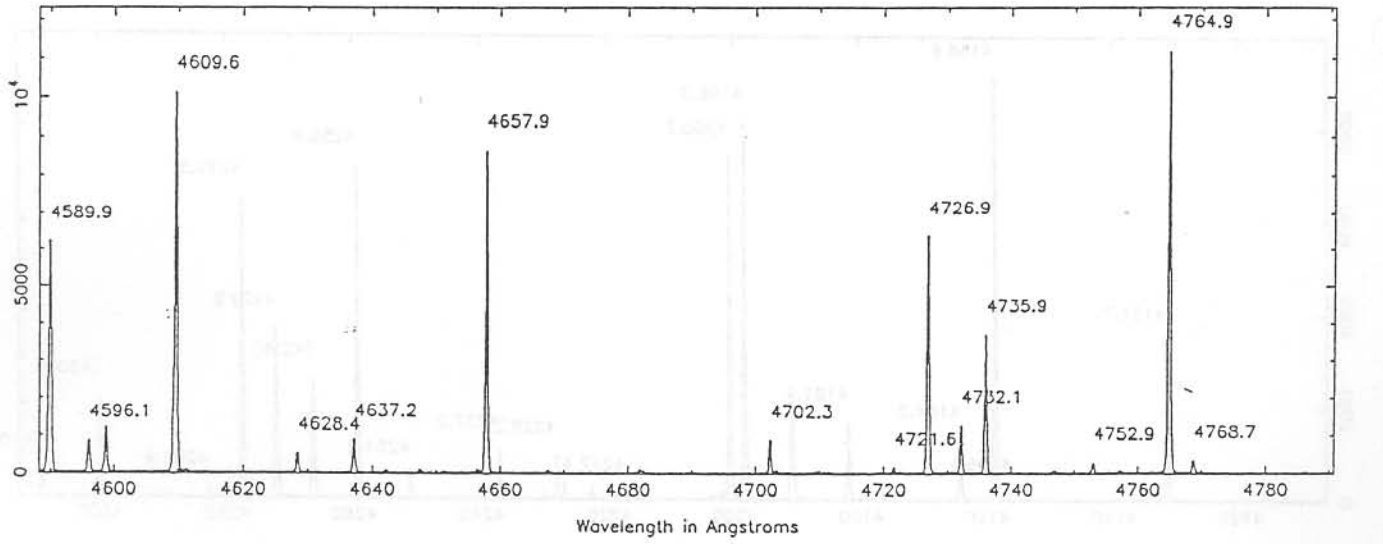
4620
Wavelength in Angstroms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4721.6
4752.9
4768.7
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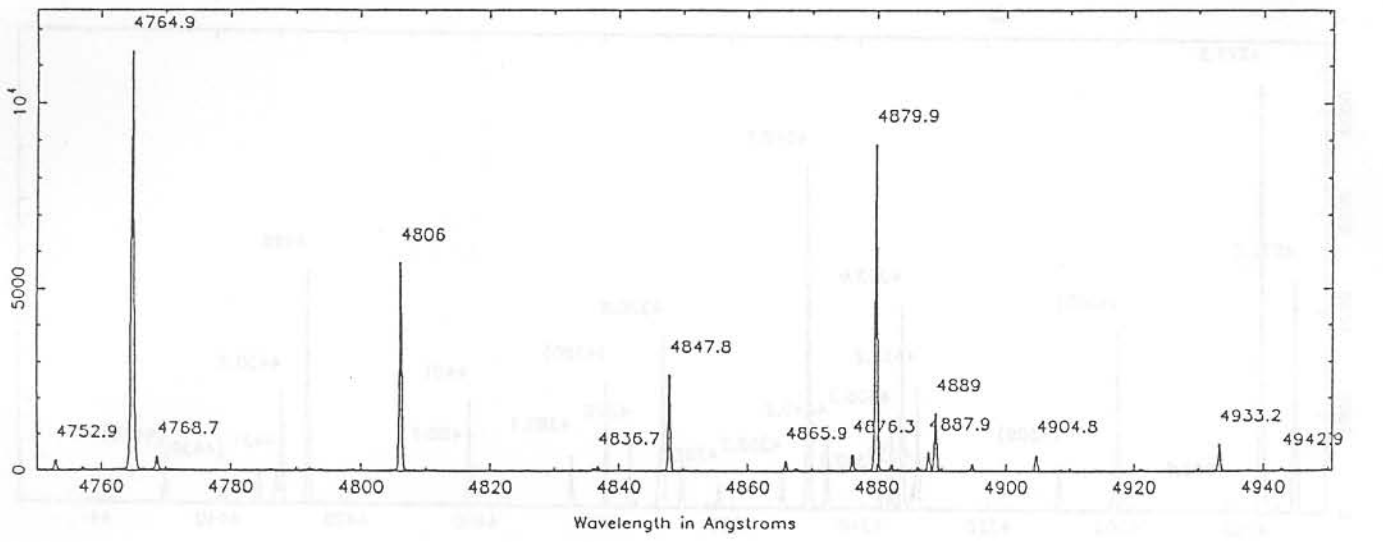
Wavelength in Angstroms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4933.2
10⁴
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4920
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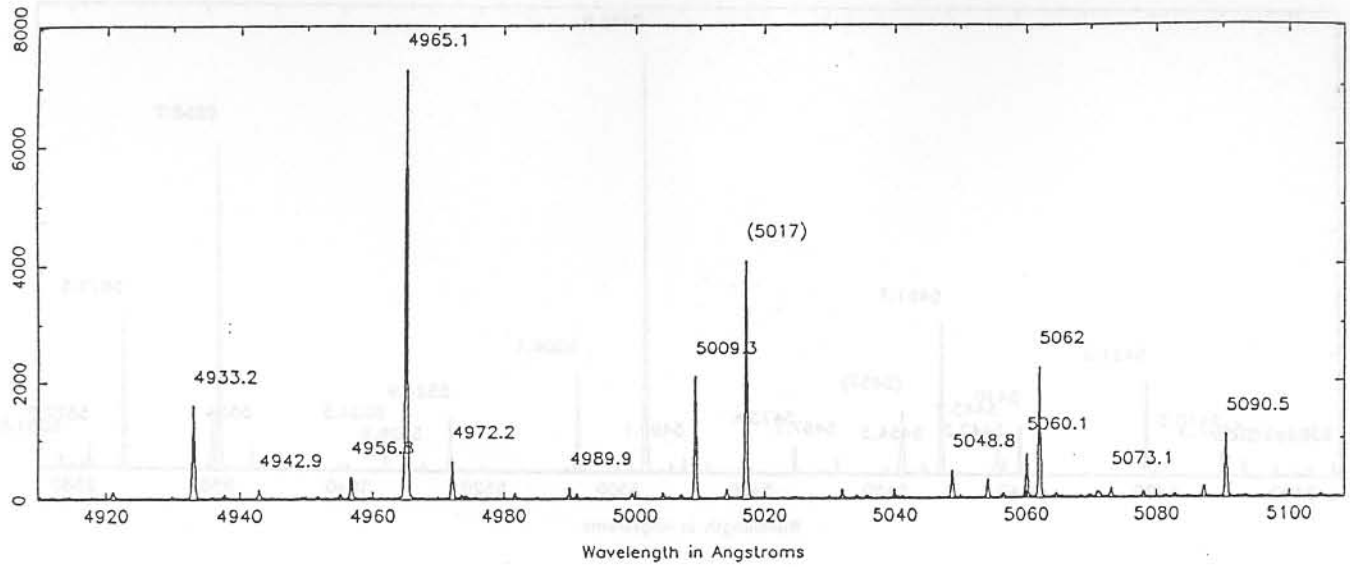
Wavelength in Angstroms

Cu-Ar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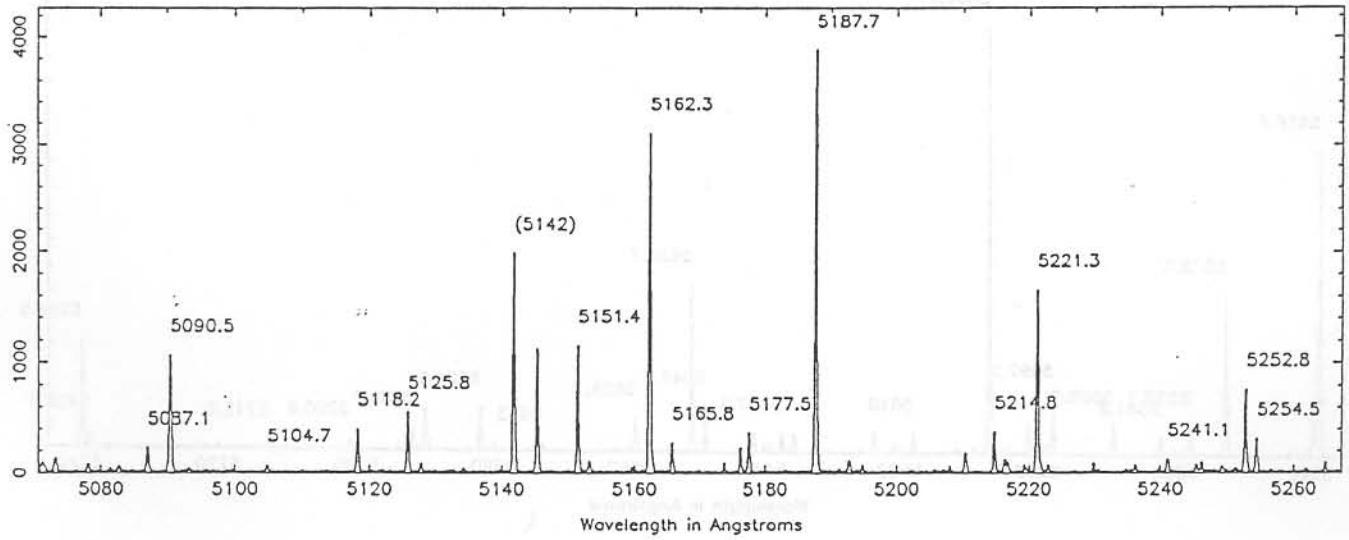
Wavelength in Angstroms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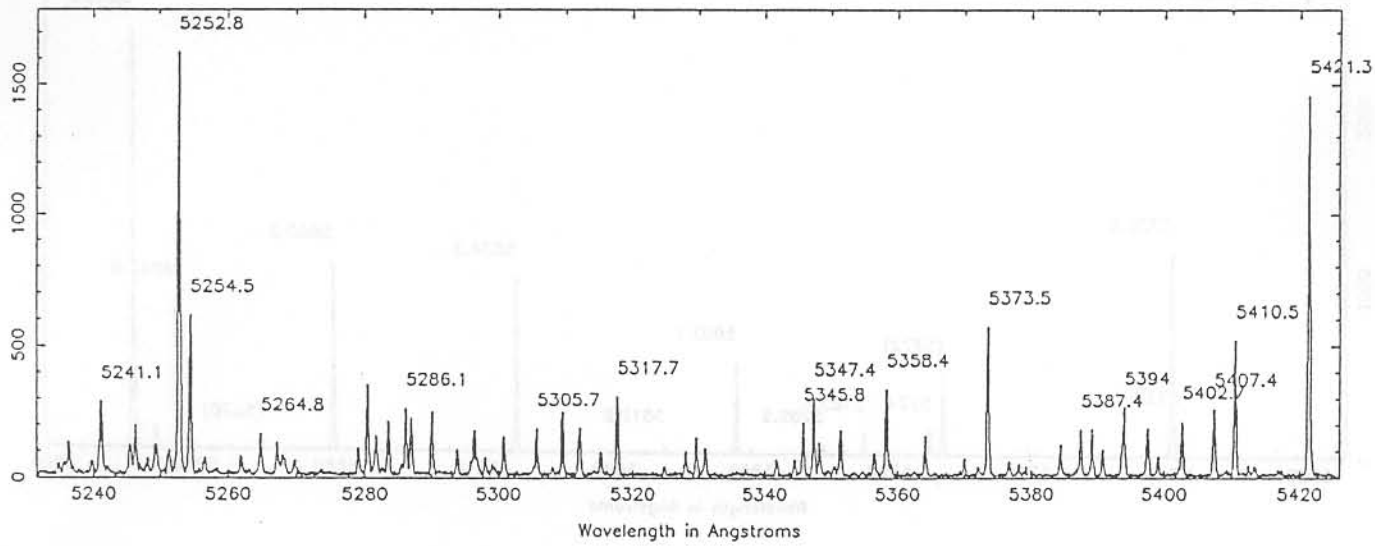
Wavelength in Angstroms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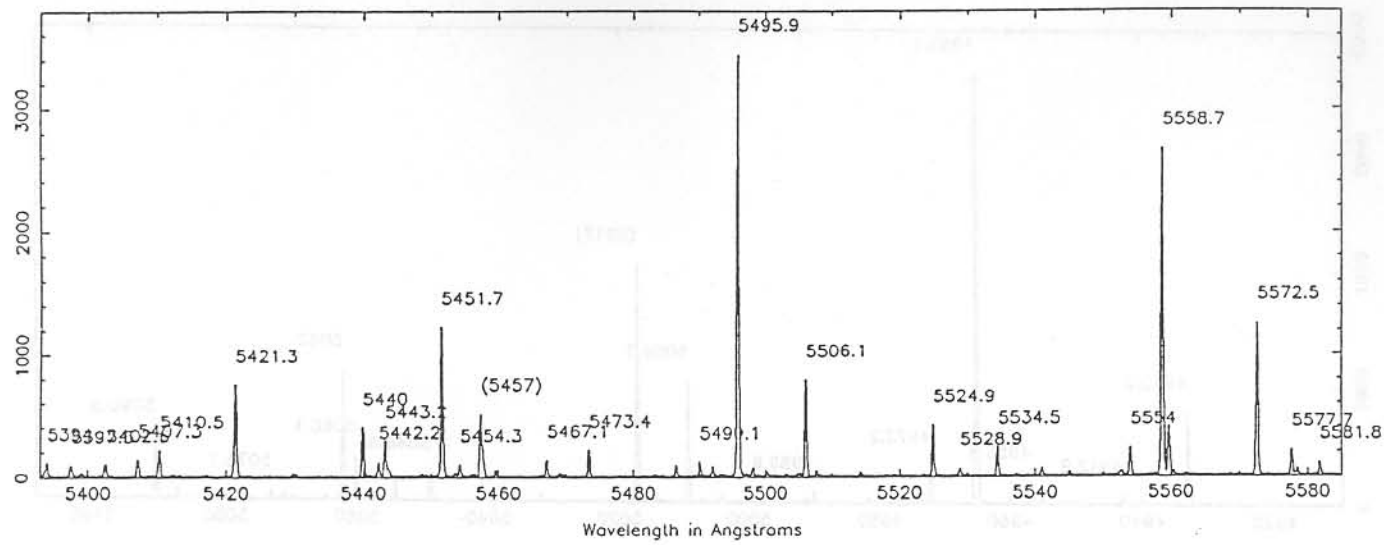
Wavelength in Angstroms

Cu-Ar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5581.8
5440
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5442.2
5454.3
5467.1
5473.4
5490.1
5410.5
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2000
1000
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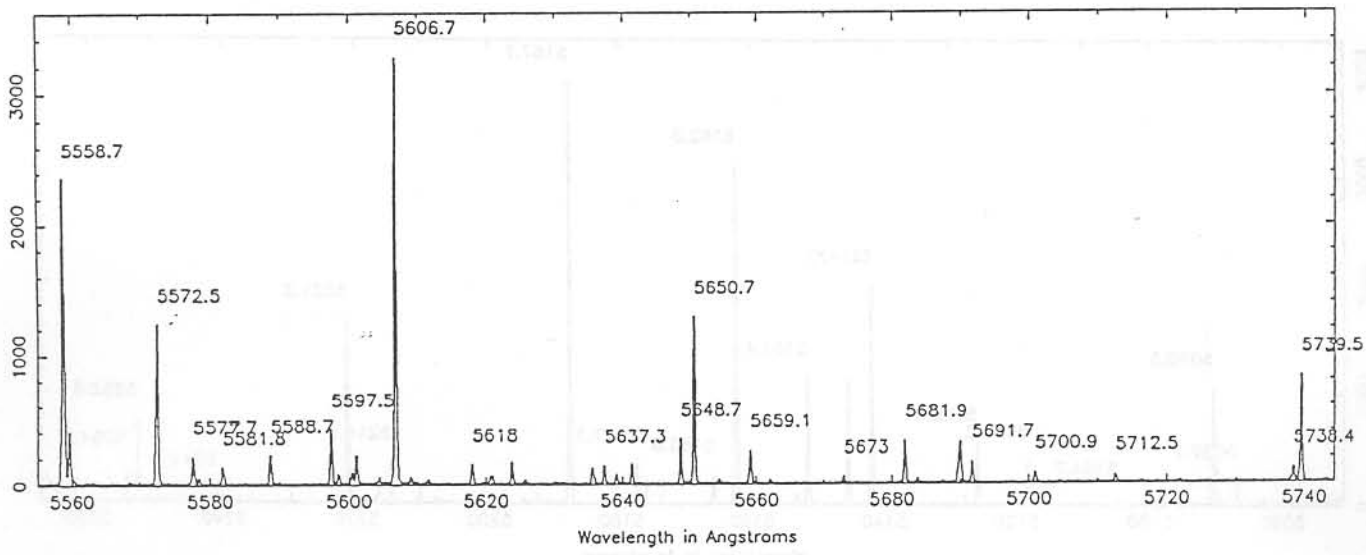
5400
5420
5440
5460
5480
5500
5520
5540
5560
5580
Wavelength in Angstroms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5577.7
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5581.8
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5637.3
5648.7
5659.1
5673
5681.9
5691.7
5700.9
5712.5
5738.4
3000
2000
1000
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5580
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5620
5640
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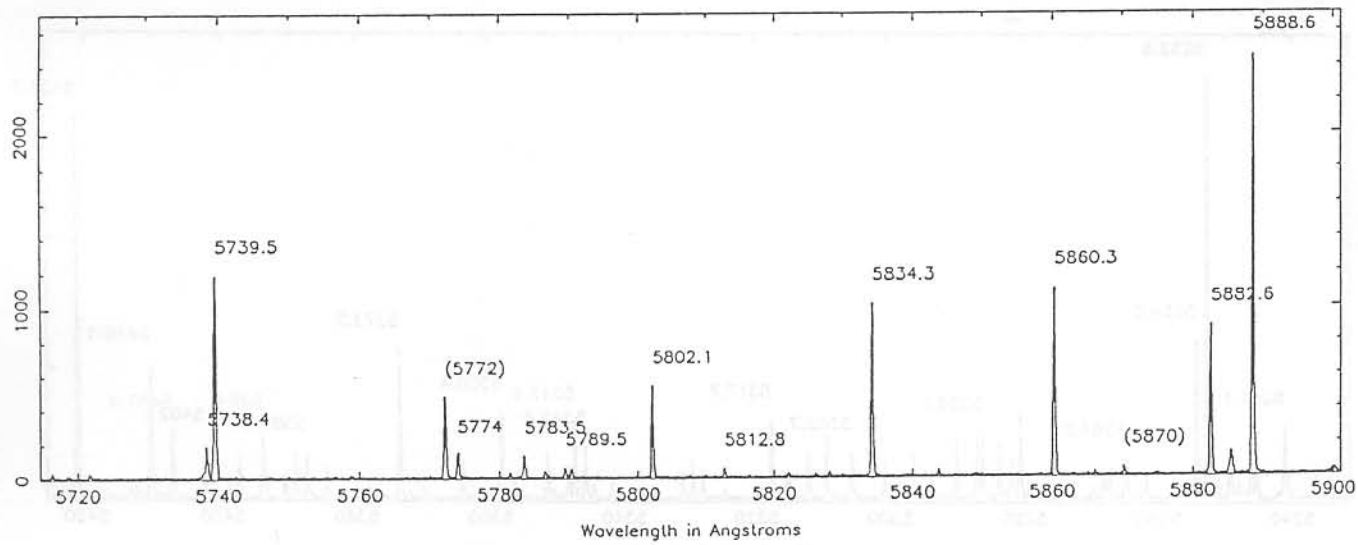
5680
5700
5720
5740
Wavelength in Angstroms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5860.3
5882.6
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5802.1
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5774
5783.5
5789.5
5812.8
(5870)
2000
1000
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5760
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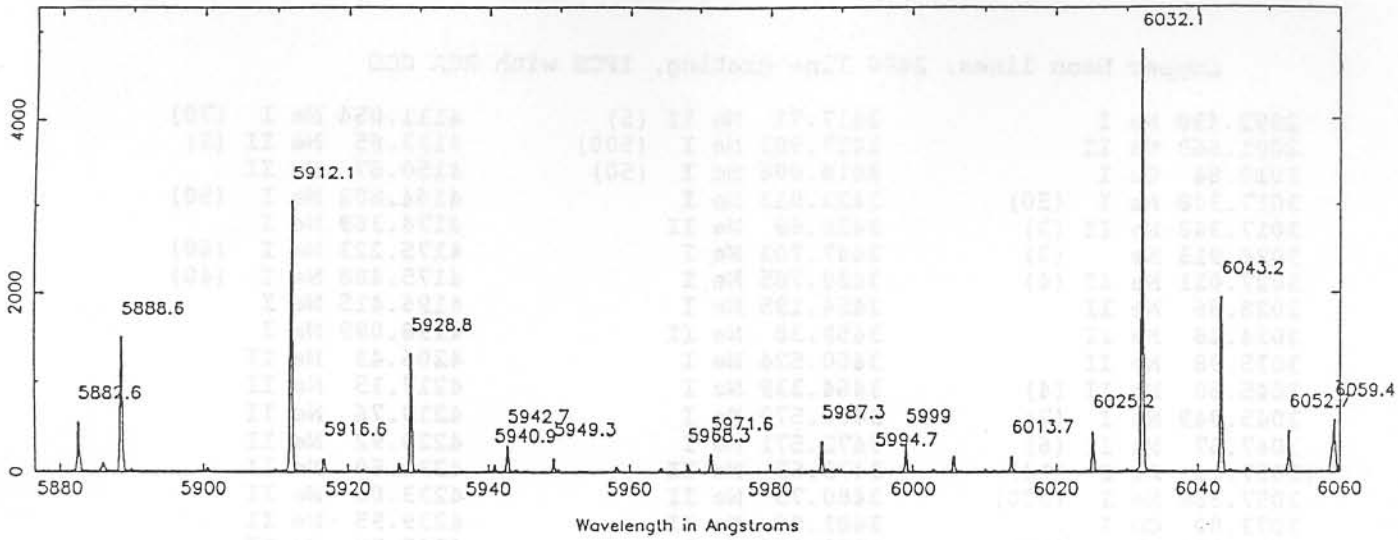
5800
5820
5840
5860
5880
5900
Wavelength in Angstroms

Cu-Ar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5999
5994.7
6013.7
6025.2
6052.7
6059.4
4000
2000
0
5880
5900
5920
5940
5960
5980
6000
6020
6040
6060
Wavelength in Angstroms

Copper Neon lines: 2400 line grating, IPCS with RCA CCD

2992.438	Ne I		3417.71	Ne II	(5)	4131.054	Ne I	(70)
3001.663	Ne II		3417.903	Ne I	(500)	4133.65	Ne II	(3)
3010.84	Cu I		3418.006	Ne I	(50)	4150.67	Ne II	
3017.348	Ne I	(50)	3423.913	Ne I		4164.802	Ne I	(50)
3017.348	Ne II	(3)	3428.69	Ne II		4174.369	Ne I	
3026.913	Ne	(3)	3447.703	Ne I		4175.223	Ne I	(60)
3027.011	Ne II	(4)	3450.765	Ne I		4175.488	Ne I	(40)
3028.86	Ne II		3454.195	Ne I		4196.415	Ne I	
3034.48	Ne II		3459.38	Ne II		4198.099	Ne I	
3035.98	Ne II		3460.524	Ne I		4206.43	Ne II	
3045.58	Ne II	(4)	3464.339	Ne I		4217.15	Ne II	
3045.949	Ne I	(7)	3466.579	Ne I		4219.76	Ne II	
3047.57	Ne II	(6)	3472.571	Ne I		4220.92	Ne II	
!3057.14	Al I	(14)	3479.53	Ne II		4231.60	Ne II	
3057.388	Ne I	(300)	3480.75	Ne II		4233.86	Ne II	
3073.80	Cu I		3481.96	Ne II		4239.95	Ne II	
!3082.153	Al I	(24)	3498.064	Ne I		4242.20	Ne II	
3088.23	Ne II		3501.216	Ne I		4250.68	Ne II	
!3092.710	Al I	(26)	3510.721	Ne I		4257.25	Ne II	(1)
!3092.839	Al I	(20)	3515.191	Ne I		4257.82	Ne II	(3)
3092.91	Ne II	(2)	3520.472	Ne I		4268.009	Ne I	
3093.99	Cu I	(1500)	3530.383	Cu I		4269.724	Ne I	
3094.01	Ne II	(4)	3542.28	Ne II	(2)	4274.656	Ne I	
3095.10	Ne II		3542.90	Ne II	(7)	4275.560	Ne I	
3118.02	Ne II	(4)	3557.84	Ne II		4290.40	Ne II	
3126.11	Cu I	(1400)	3565.84	Ne II		4306.262	Ne I	
3126.199	Ne I		3568.53	Ne II		4321.492	Ne I	(2)
3141.35	Ne II		3574.23	Ne II	(0)	4322.26	Ne I	(2)
3164.46	Ne II	(3)	3574.64	Ne II	(5)	4322.66	Ne II	(1)
3165.70	Ne II	(4)	3593.526	Ne I	(500)	4334.125	Ne I	
3194.10	Cu I	(1500)	3593.640	Ne I	(300)	4339.78	Ne II	
3194.61	Ne II	(4)	3600.169	Ne I		4345.479	Ne I	(2)
3198.62	Ne II		3609.179	Ne I		4345.762	Ne I	(1)
3218.21	Ne II		3633.665	Ne I		4346.036	Ne I	(15)
3224.82	Ne II		3643.89	Ne II		4346.12	Ne II	(1)
3229.50	Ne II	(3)	3664.112	Ne II		4369.77	Ne II	
3230.16	Ne II	(5)	3682.243	Ne I		4377.95	Ne II	
3232.38	Ne II		3685.736	Ne I		4379.50	Ne II	
3247.54	Cu I		3694.197	Ne II		4391.94	Ne II	
3273.96	Cu I		3701.225	Ne I	(40)	4397.94	Ne II	
3279.816	Cu I		3701.81	Ne II	(4)	4409.30	Ne II	(7)
3297.74	Ne II		3709.64	Ne II		4409.620	Ne I	(20)
3309.78	Ne II		3713.084	Ne II		4412.285	Ne I	(20)
3319.75	Ne II		3727.08	Ne II		4412.54	Ne II	(2)
3323.75	Ne II		3734.94	Ne II		4413.20	Ne II	(4)
3327.16	Ne II		3751.26	Ne II		4422.519	Ne I	
3329.20	Ne II		3766.29	Ne II		4424.81	Ne I	
3334.87	Ne II		3777.16	Ne II		4425.400	Ne I	
3337.845	Cu I		3800.02	Ne II		4428.54	Ne II	
3344.43	Ne II	(5)	3818.44	Ne II		4429.60	Ne II	
3345.49	Ne II	(3)	3829.77	Ne II		4430.90	Ne II	
3345.88	Ne II	(1)	!3900.68	Al II		4431.67	Ne II	(0.7)
3355.05	Ne II		!3944.006	Al I		4432.26	Ne II	(0.7)
3360.63	Ne II		!3961.520	Al I		4432.526	Ne I	(1.3)
3367.20	Ne II		4022.657	Cu I		4433.724	Ne I	
3369.808	Ne I	(500)	!4030.76	Mn I		4442.67	Ne II	
3369.908	Ne I	(700)	!4033.07	Mn I		4457.05	Ne II	
3378.28	Ne II		!4034.49	Mn I		4460.175	Ne I	
3388.46	Ne II		!4041.36	Mn I		4468.91	Ne II	
3392.78	Ne II		4062.64	Cu I	(2000)	4480.36	Cu I	(1.3)
3404.77	Ne II		4062.90	Ne II	(3)	4480.823	Ne I	(1.2)
3406.88	Ne II		4098.77	Ne II		4483.190	Ne I	
3416.87	Ne II	(4)	4130.512	Ne I	(20)	4488.093	Ne I	

Copper Neon lines: 2400 line grating, IPCS with RCA CCD

4491.771	Ne I	(80)	4837.312	Ne I		5326.396	Ne I	
4491.838	Ne I	(50)	4852.655	Ne I		5330.778	Ne I	
4498.94	Ne II	(5)	4863.079	Ne I		5333.323	Ne I	
4499.000	Ne I	(2)	4864.351	Ne I		5341.094	Ne I	
4508.21	Ne II		4865.505	Ne I		5343.283	Ne I	
4511.29	Ne II	(2)	4884.917	Ne I		5349.204	Ne I	
4511.37	Ne II	(4)	4892.090	Ne I	(500)	5355.176	Ne I	(150)
4511.509	Ne I	(20)	4892.228	Ne I	(10)	5355.422	Ne I	(150)
4522.70	Ne II		4899.013	Ne I		5360.012	Ne I	(150)
4530.785	Cu I		4928.235	Ne I		5360.442	Ne I	(35)
4536.312	Ne I		4930.944	Ne I		5372.311	Ne I	
4537.684	Ne I	(300)	4939.046	Ne I		5374.977	Ne I	
4537.754	Ne I	(1000)	4944.990	Ne I		5383.250	Ne I	
4538.293	Ne I	(300)	4955.382	Ne I		5400.562	Ne I	
4540.380	Ne I		4957.033	Ne I	(1000)	5412.649	Ne I	
4569.06	Ne II		4957.122	Ne I	(150)	5418.558	Ne I	
4575.062	Ne I	(300)	4973.538	Ne I		5420.155	Ne I	
4575.858	Ne I	(20)	4974.760	Ne I		5433.651	Ne I	
4582.035	Ne I	(150)	4994.930	Ne I		5447.120	Ne I	
4582.105	Ne I	(15)	5005.159	Ne I		5448.508	Ne I	
4582.450	Ne I	(150)	5011.003	Ne I		5494.416	Ne I	
4582.556	Ne I	(15)	5022.870	Ne I		5533.678	Ne I	
4582.980	Ne I	(5)	5031.350	Ne I		5538.651	Ne I	
4588.13	Ne II		5035.989	Ne I		5559.087	Ne I	
4593.243	Ne I		5037.751	Ne I		5562.441	Ne I	(150)
4614.391	Ne I		5052.930	Ne I		5562.769	Ne I	(500)
4615.98	Ne II		5074.062	Ne I	(3)	5563.047	Ne I	(75)
4617.837	Ne I		5074.200	Ne I	(35)	5576.049	Ne I	
4627.799	Ne I	(2)	5076.581	Ne I		5589.378	Ne I	
4627.85	Ne II	(3)	5080.385	Ne I		5652.566	Ne I	
4628.311	Ne I	(150)	5099.042	Ne I		5656.030	Ne I	
4628.460	Ne I	(30)	5104.701	Ne I		5656.659	Ne I	
4645.416	Ne I		5105.54	Cu I		5662.549	Ne I	
4649.904	Ne I		5113.672	Ne I		5689.816	Ne I	
4651.124	Cu I		5116.503	Ne I		5715.339	Ne I	
4656.394	Ne I		5122.257	Ne I	(150)	5718.899	Ne I	(150)
4661.104	Ne I		5122.337	Ne I	(150)	5719.225	Ne I	(500)
4667.356	Ne I		5143.266	Ne I		5719.532	Ne I	(75)
4670.884	Ne I		5144.938	Ne I	(500)	5748.298	Ne I	(500)
4687.671	Ne I		5145.011	Ne I	(500)	5748.650	Ne I	(70)
4702.526	Ne I		5150.077	Ne I		5760.588	Ne I	
4704.395	Ne I		5151.961	Ne I		5764.419	Ne I	
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4710.067	Ne I		5154.427	Ne I		5804.450	Ne I	(500)
4712.066	Ne I		5156.667	Ne I		5820.156	Ne I	
4715.347	Ne I		5158.902	Ne I		5852.488	Ne I	
4721.536	Ne I		5163.474	Ne I		5872.129	Ne I	(75)
4725.145	Ne I		5188.612	Ne I		5872.828	Ne I	(500)
4749.575	Ne I		5191.322	Ne I		5881.895	Ne I	
4752.732	Ne I		5193.130	Ne	(150)	5902.462	Ne I	
4758.728	Ne I		5193.224	Ne I	(150)	5906.429	Ne I	
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4790.22	Ne I		5208.865	Ne I		5918.907	Ne I	
4800.111	Ne I		5210.567	Ne I		5944.834	Ne I	
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4810.634	Ne I	(100)	5218.202	Cu I		5965.471	Ne I	
4817.639	Ne I		5222.351	Ne I		5974.627	Ne I	(500)
4818.789	Ne I		5234.028	Ne I		5975.534	Ne I	(600)
4821.924	Ne I		5274.039	Ne I		5987.907	Ne I	
4823.174	Ne I		5280.085	Ne I		5991.653	Ne I	
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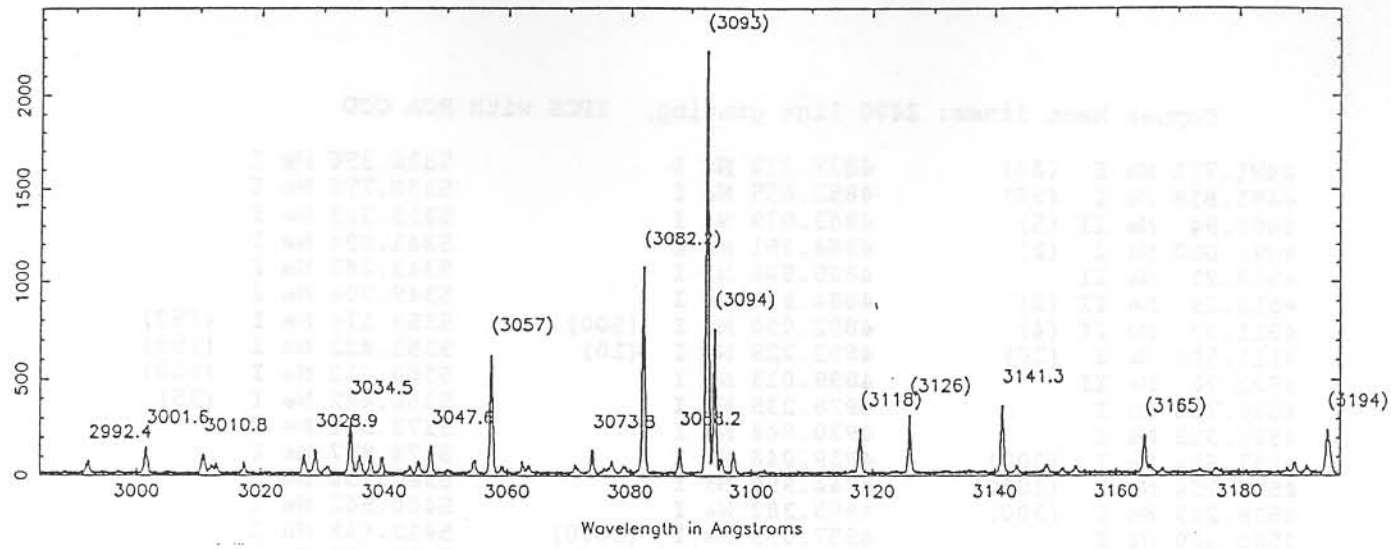
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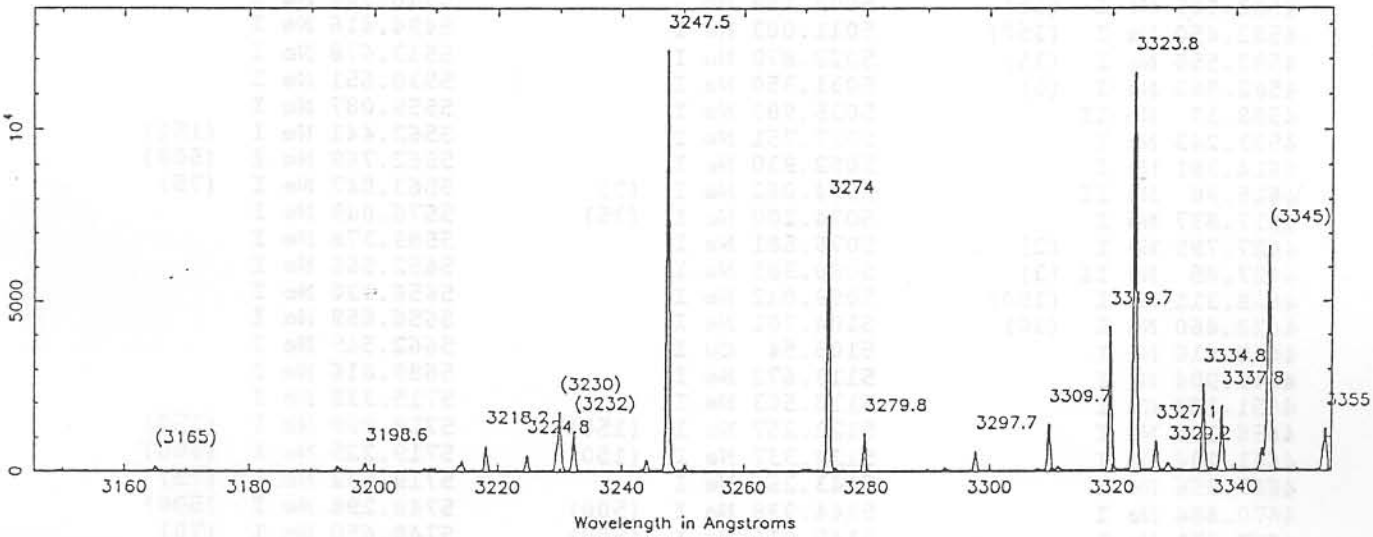
3088.2
(3118)
(3126)
3141.3
(3165)
(3194)
Wavelength in Angstroms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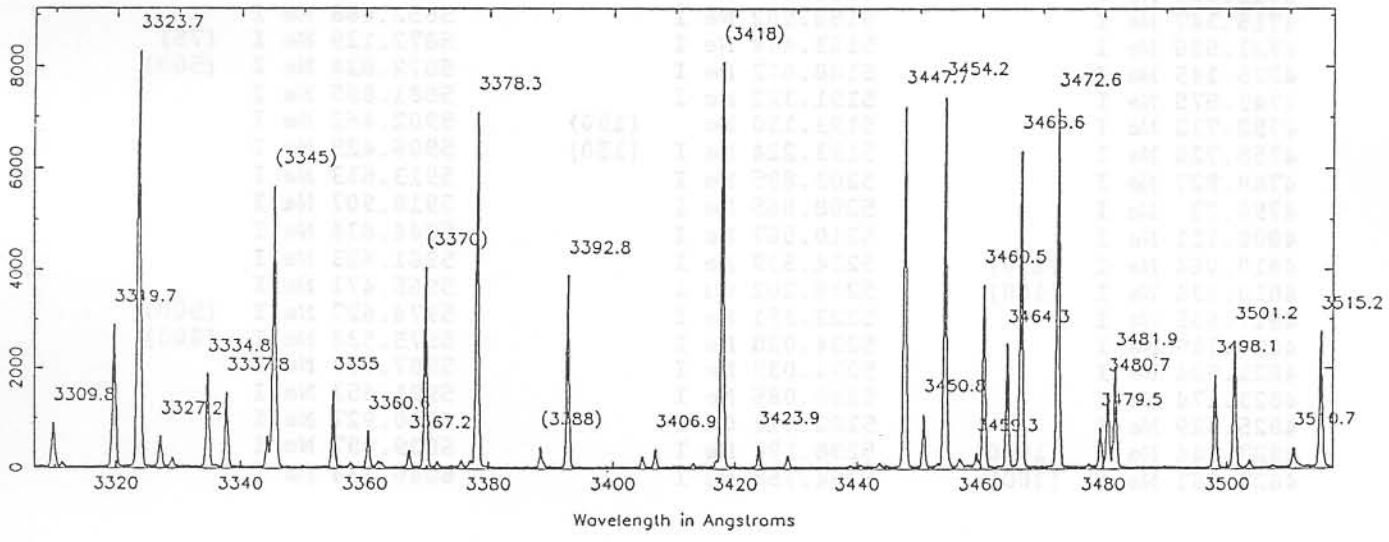
Wavelength in Angstroms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3367.2
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3481.9
3480.7
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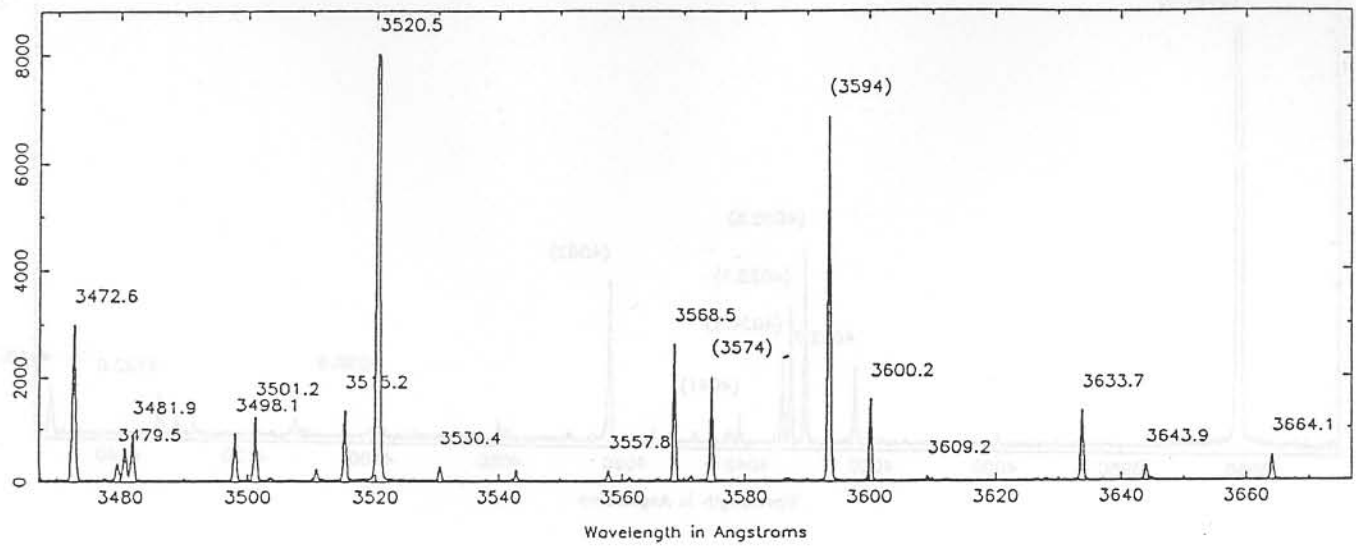
Wavelength in Angstroms

Cu-Ne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3568.5
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3479.5
3530.4
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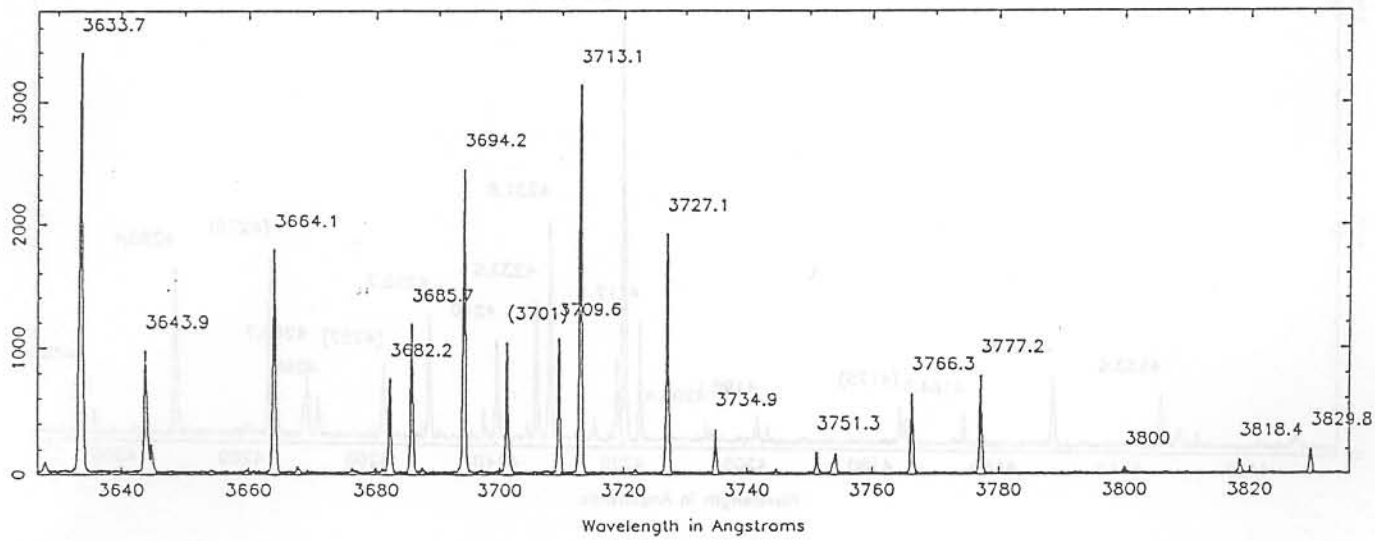
3609.2
3643.9
3664.1
Wavelength in Angstroms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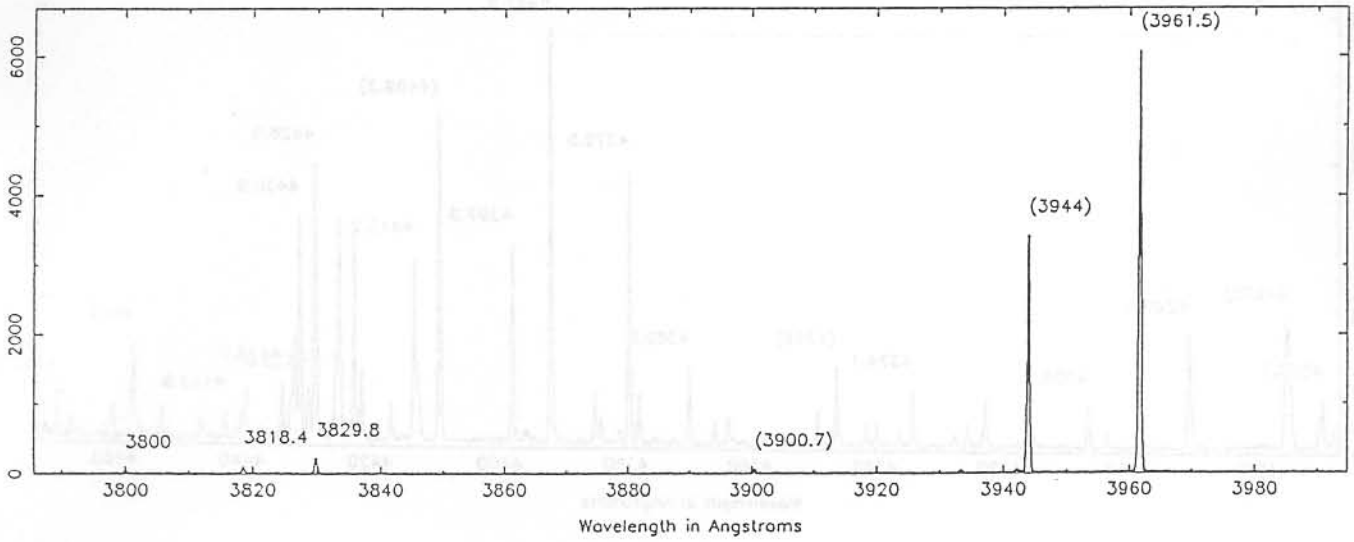
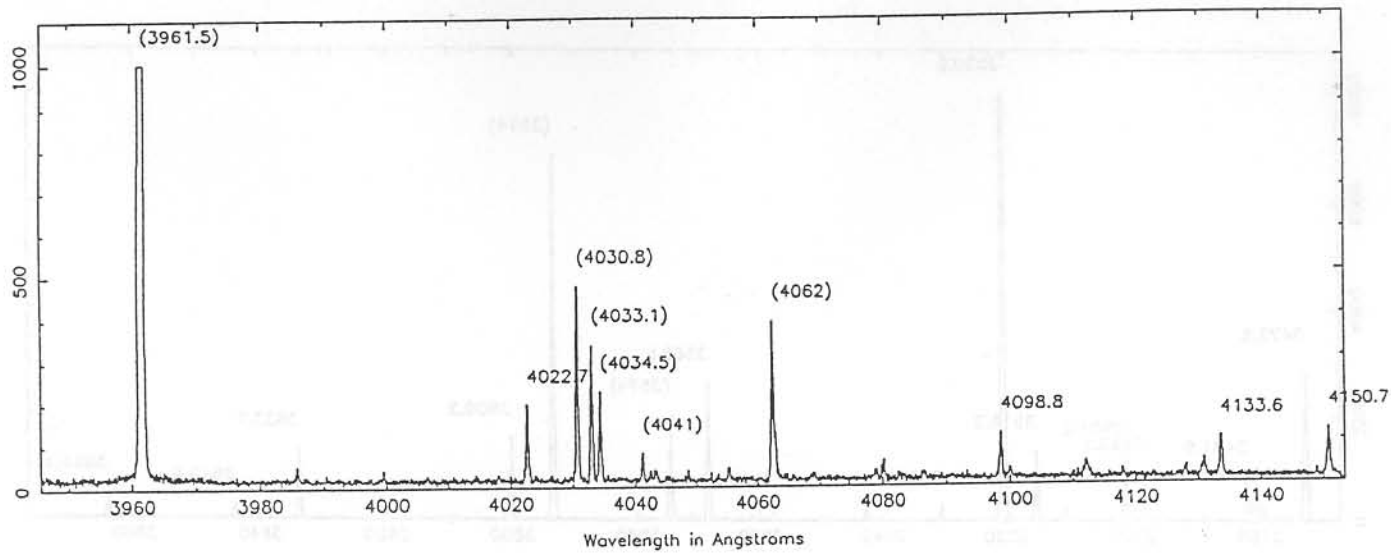
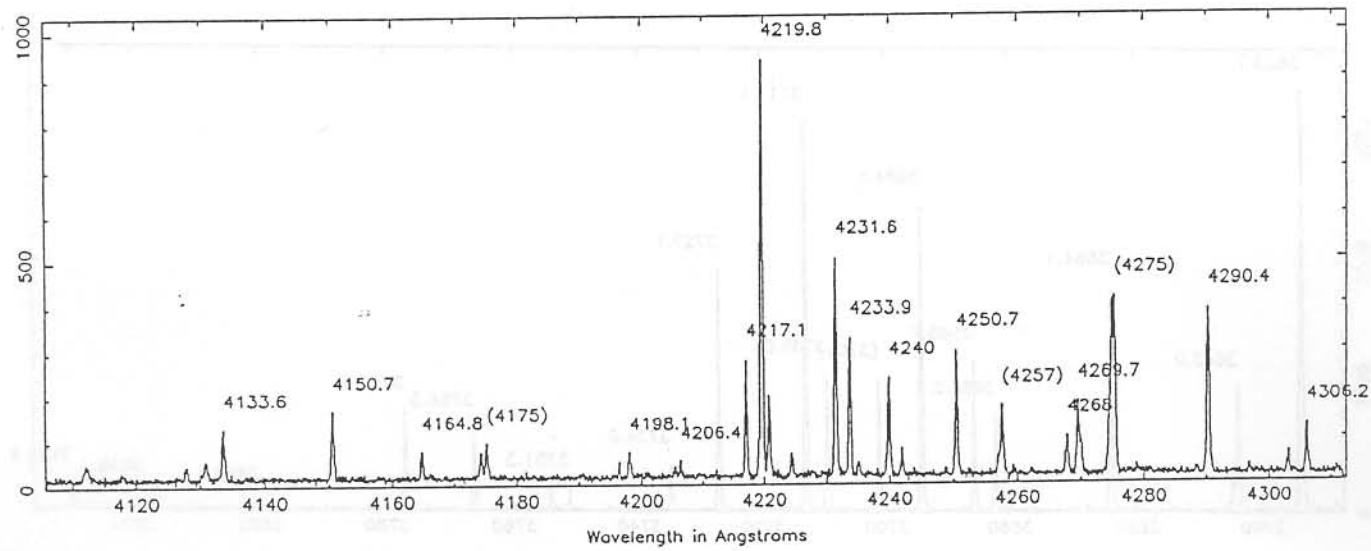
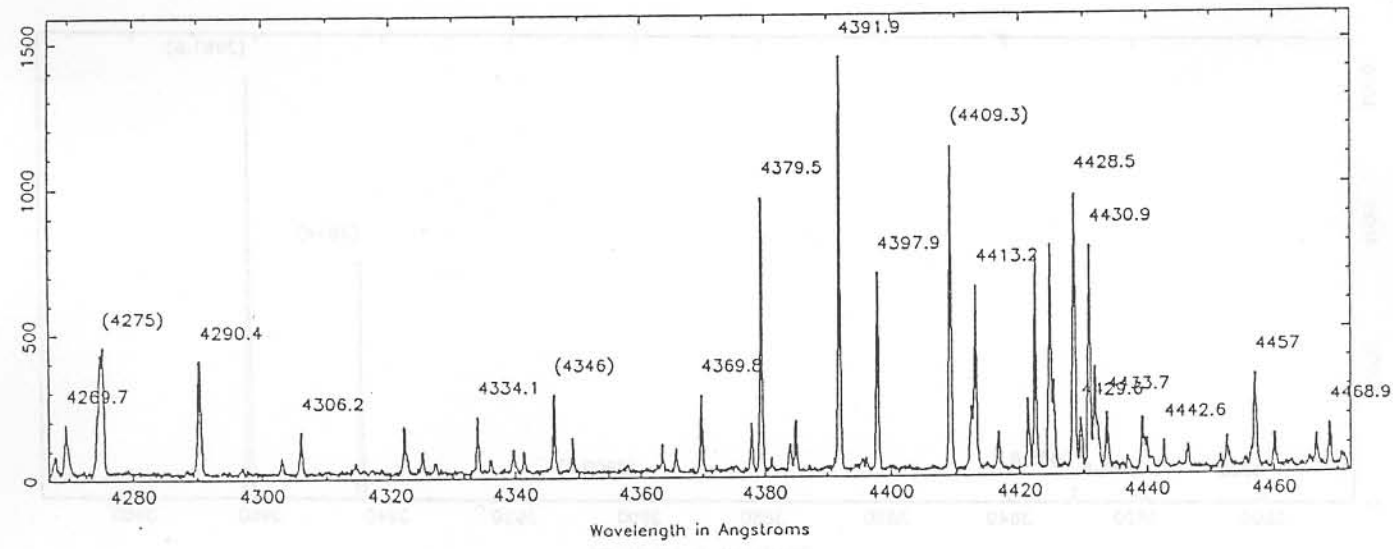
3664.1
3727.1
3685.7
3643.9
(3701)
3709.6
3682.2
3766.3
3777.2
3734.9
3751.3
3800
3818.4
3829.8
Wavelength in Angstroms


(3961.5)
(3944)
3800
3818.4
3829.8
(3900.7)
Wavelength in Angstroms

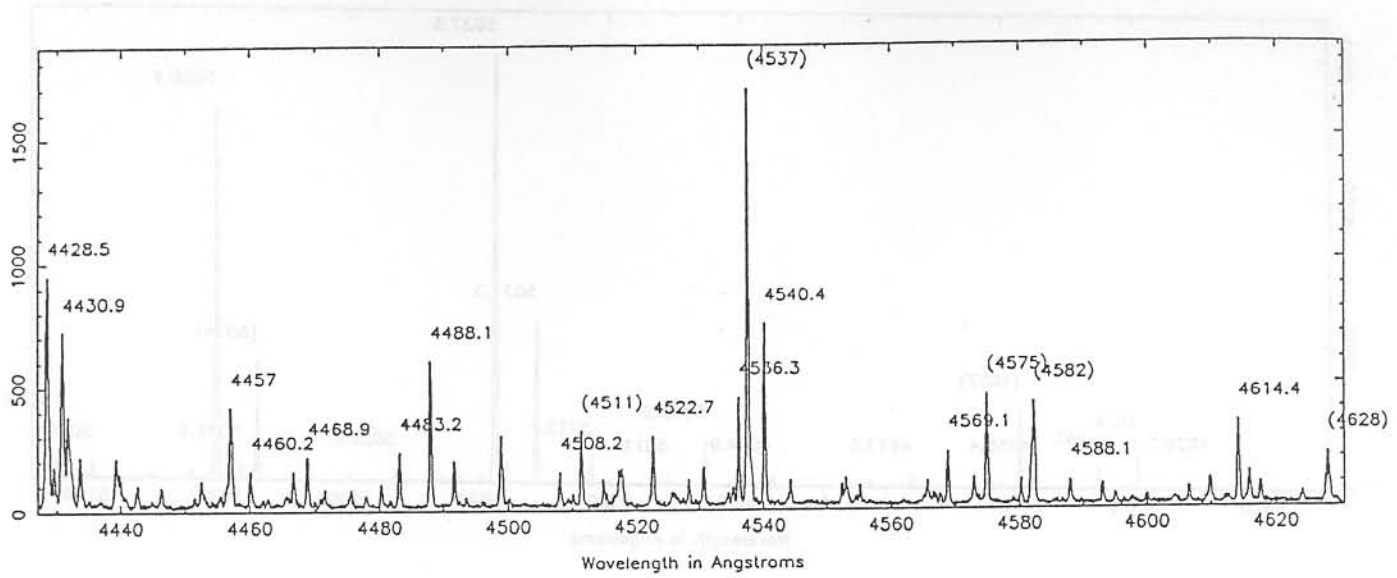
Cu-Ne

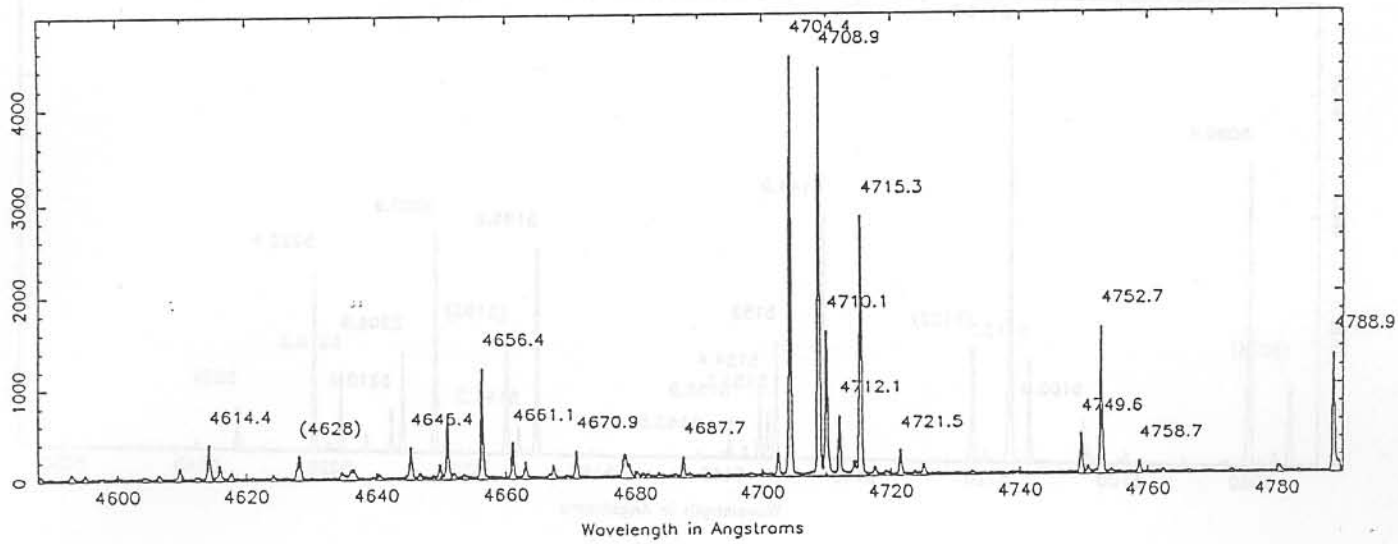

(3961.5)
(4030.8)
(4033.1)
(4034.5)
4022.7
(4041)
(4062)
4098.8
4133.6
4150.7
1000
500
0
3960
3980
4000
4020
4040
4060
4080
4100
4120
4140
Wavelength in Angstroms

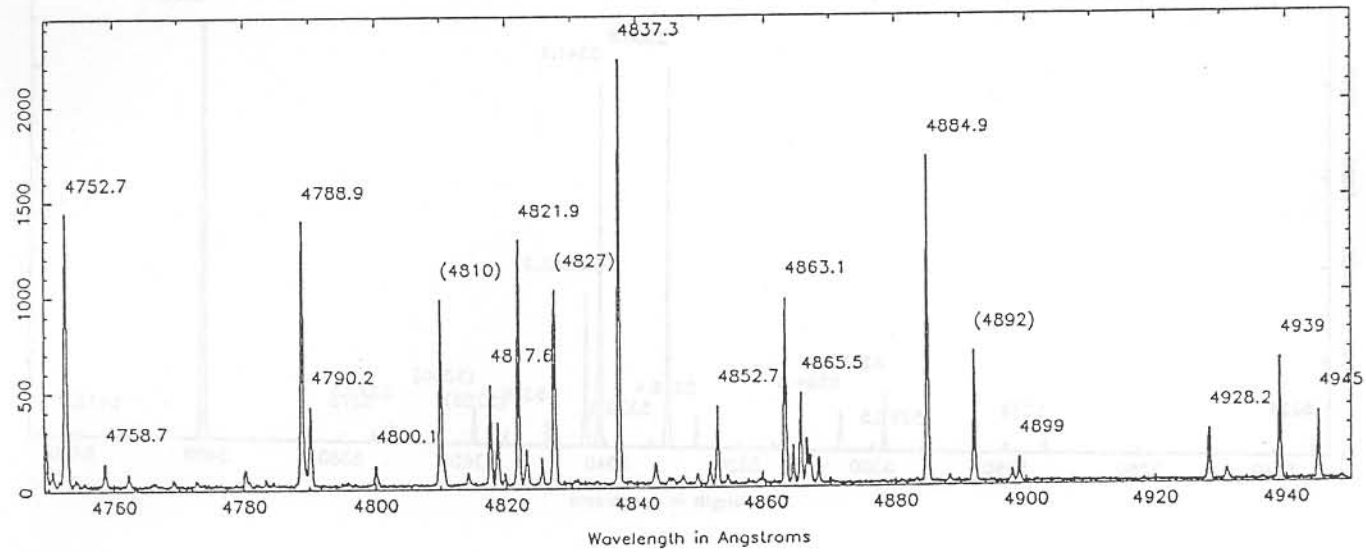

4219.8
4231.6
4233.9
4217.1
4240
4250.7
(4275)
4290.4
(4257)
4269.7
4268
4306.2
4133.6
4150.7
4164.8
(4175)
4198.1
4206.4
1000
500
0
4120
4140
4160
4180
4200
4220
4240
4260
4280
4300
Wavelength in Angstroms

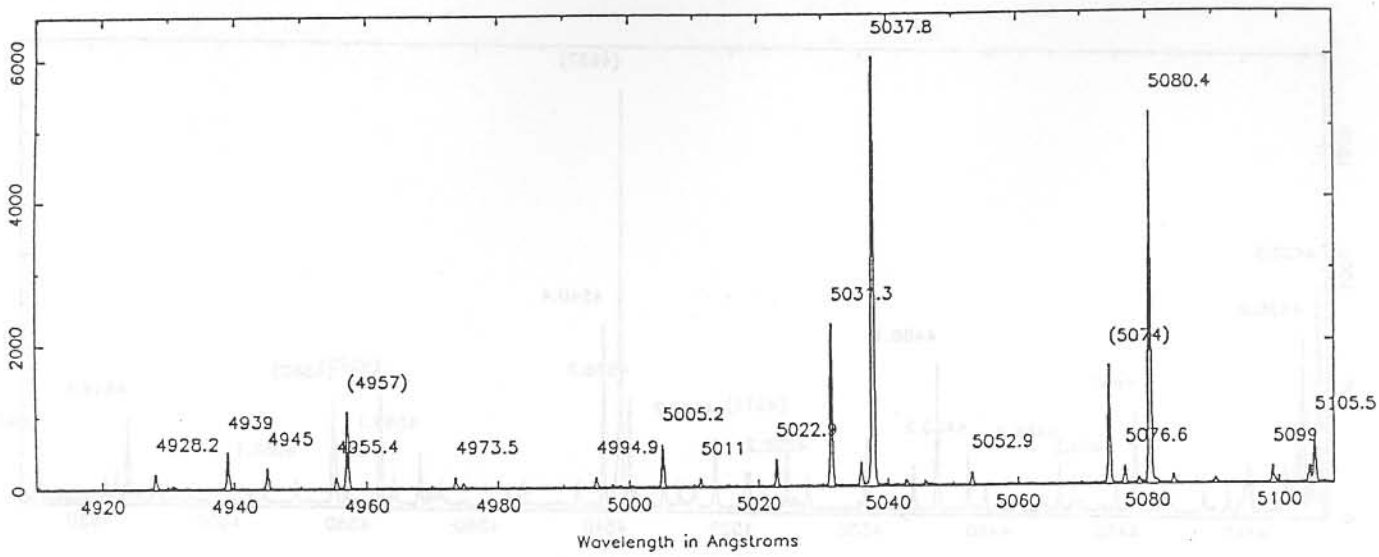

4391.9
(4409.3)
4379.5
4428.5
4430.9
4397.9
4413.2
(4275)
4290.4
4457
4269.7
4306.2
4334.1
(4346)
4369.8
4442.6
4468.9
1500
1000
500
0
4280
4300
4320
4340
4360
4380
4400
4420
4440
4460
Wavelength in Angstroms

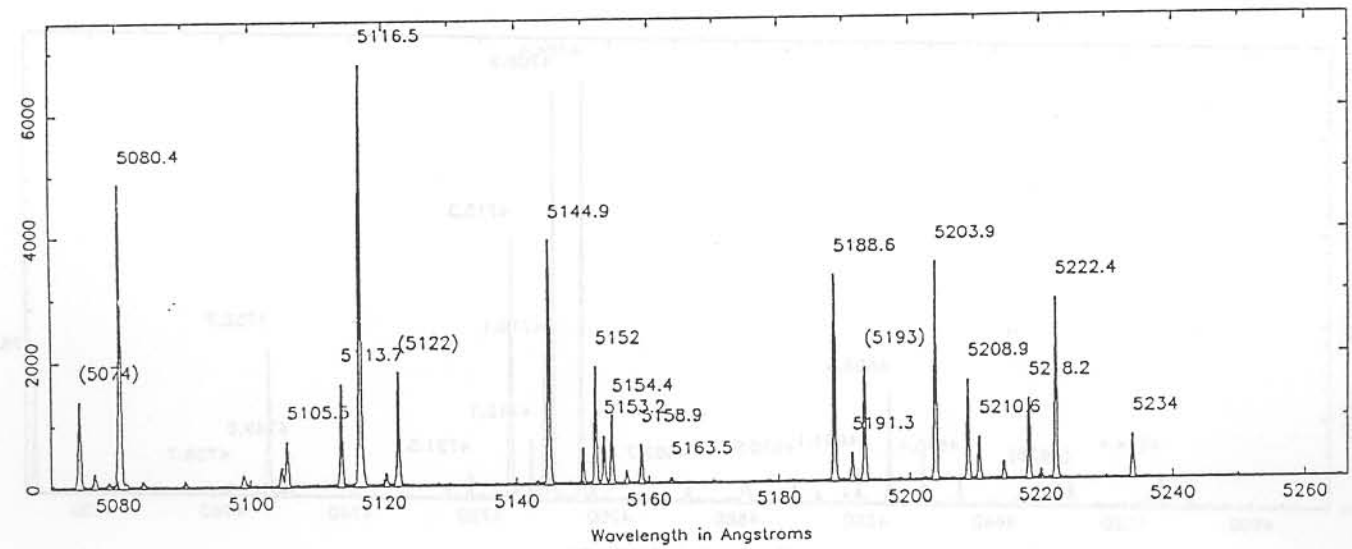
Cu-Ne

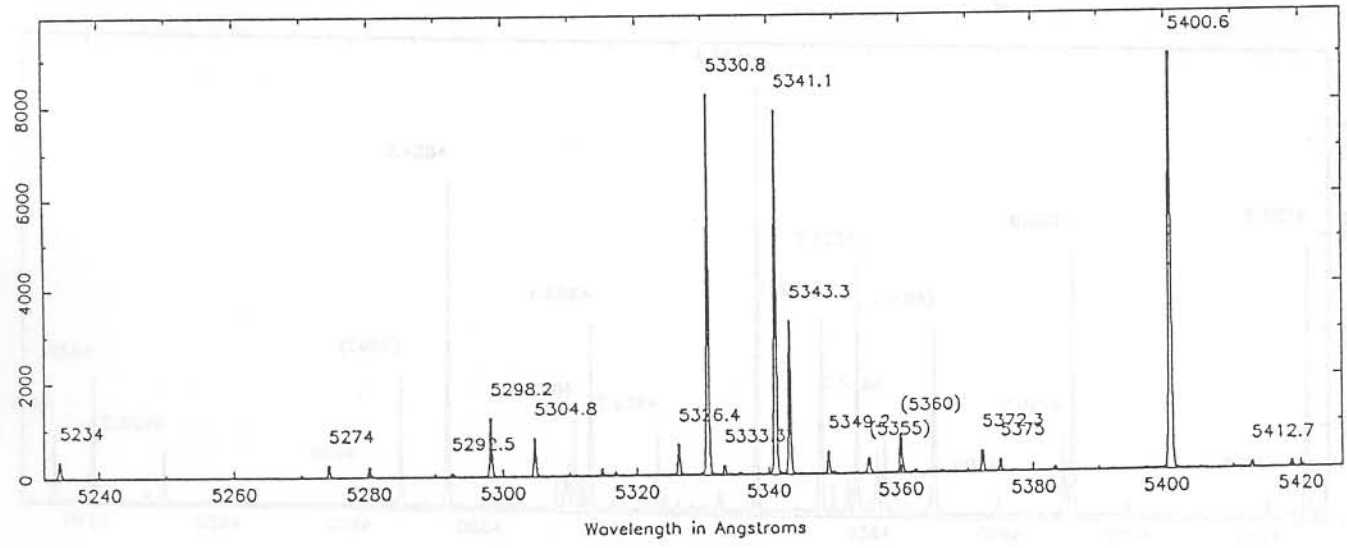

(4537)
4428.5
4430.9
4488.1
4540.4
4457
4536.3
(4575)
(4582)
4614.4
(4511)
4522.7
4569.1
(4628)
4460.2
4468.9
4483.2
4508.2
4588.1
0
500
1000
1500
4440
4460
4480
4500
4520
4540
4560
4580
4600
4620
Wavelength in Angstroms


4704.4
4708.9
4715.3
4710.1
4752.7
4788.9
4656.4
4712.1
4614.4
(4628)
4646.4
4661.1
4670.9
4687.7
4721.5
4749.6
4758.7
0
1000
2000
3000
4000
4600
4620
4640
4660
4680
4700
4720
4740
4760
4780
Wavelength in Angstroms

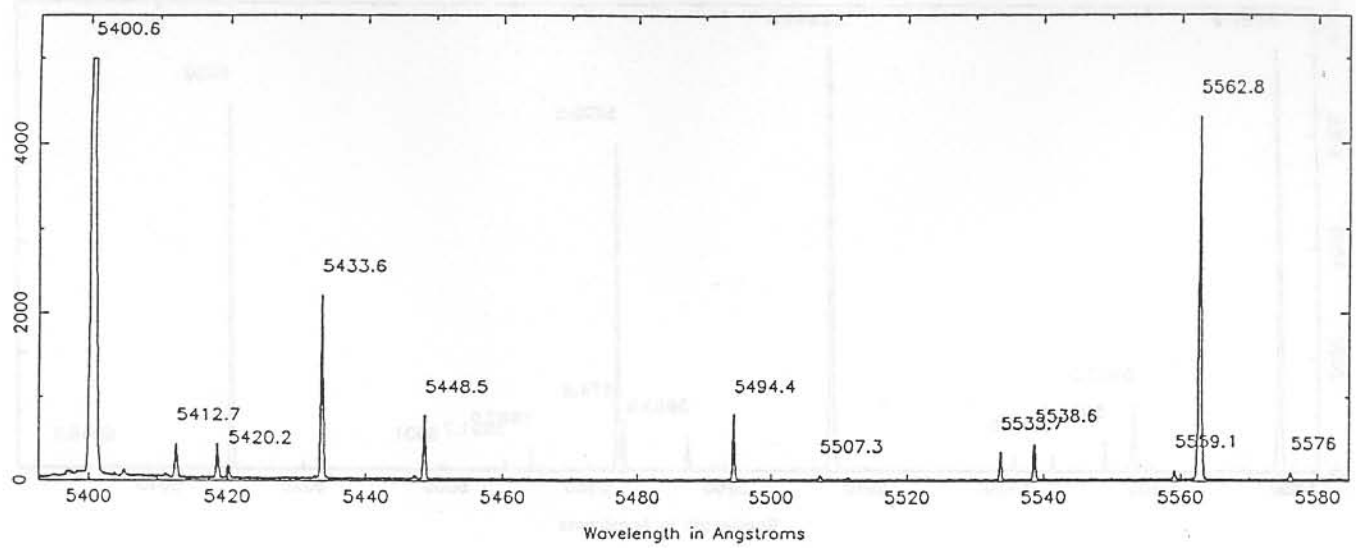

4837.3
4884.9
4752.7
4788.9
4821.9
(4810)
(4827)
4863.1
(4892)
4939
4790.2
4817.6
4852.7
4865.5
4928.2
4945
4758.7
4800.1
4899
0
500
1000
1500
2000
4760
4780
4800
4820
4840
4860
4880
4900
4920
4940
Wavelength in Angstroms

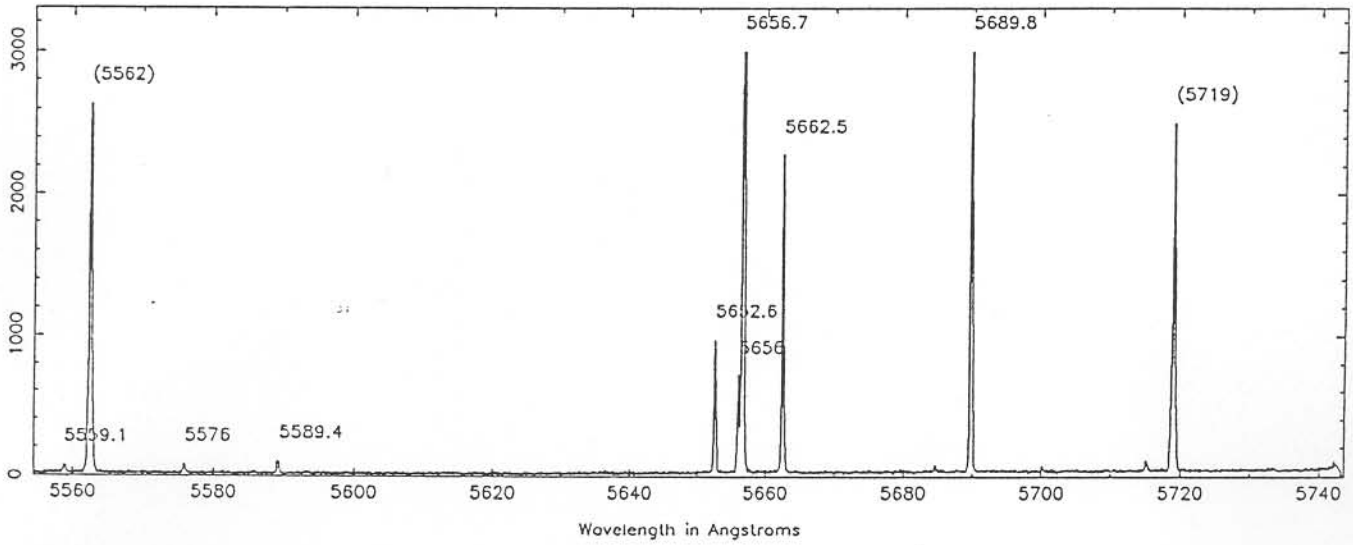

5037.8
5080.4
5037.3
(5074)
(4957)
5005.2
5105.5
4939
4928.2
4945
4955.4
4973.5
4994.9
5011
5022.9
5052.9
5076.6
5099
0
2000
4000
6000
4920
4940
4960
4980
5000
5020
5040
5060
5080
5100
Wavelength in Angstroms

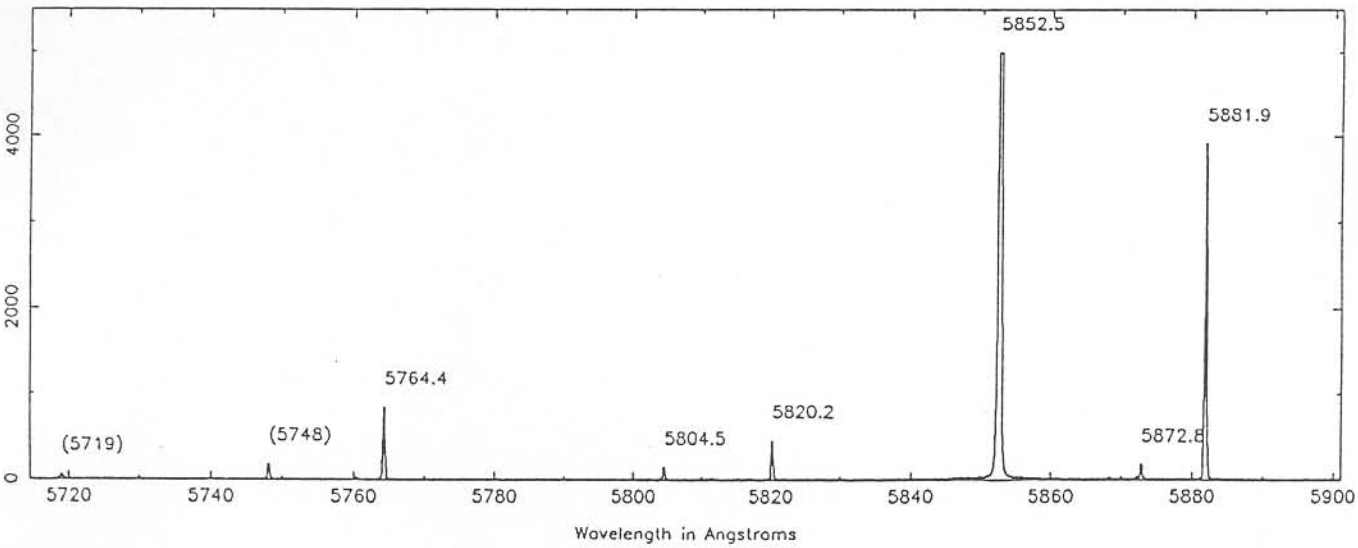

5116.5
5080.4
5144.9
5188.6
5203.9
5222.4
(5074)
(5122)
5152
(5193)
5208.9
5154.4
5153.2
5158.9
5105.5
5191.3
5210.6
5234
5163.5
0
2000
4000
6000
5080
5100
5120
5140
5160
5180
5200
5220
5240
5260
Wavelength in Angstroms


5400.6
5330.8
5341.1
5343.3
5298.2
5304.8
5234
5274
5326.4
(5360)
5372.3
5412.7
0
2000
4000
6000
8000
5240
5260
5280
5300
5320
5340
5360
5380
5400
5420
Wavelength in Angstroms

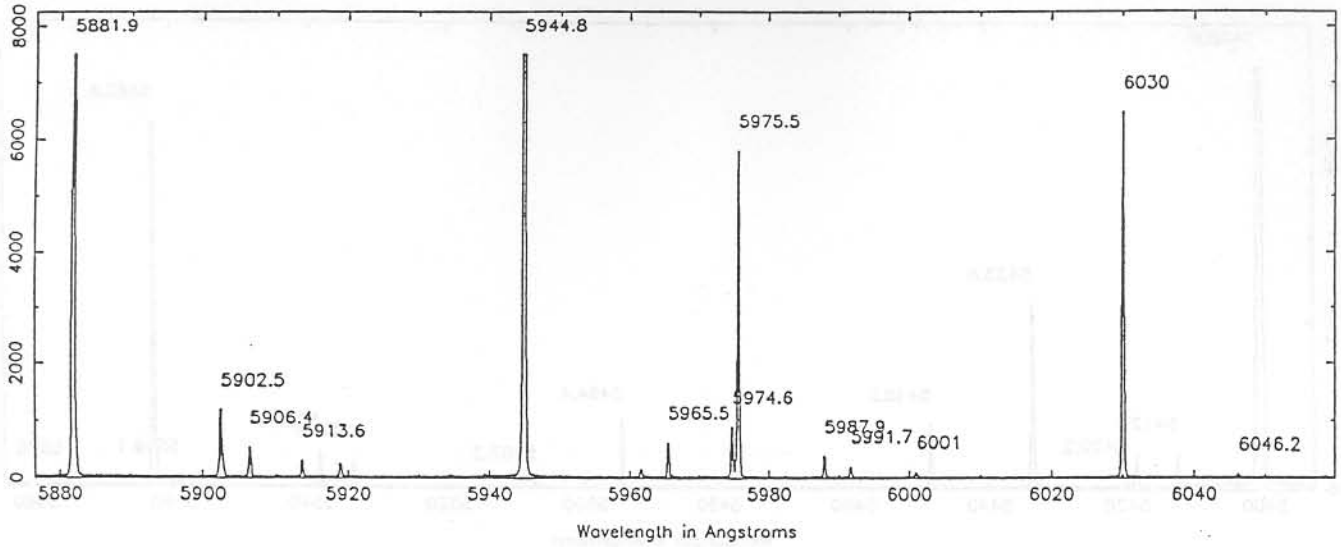
Cu-Ne


5400.6
5562.8
5433.6
5448.5
5494.4
5412.7
5420.2
5507.3
5538.6
5559.1
5576
0
2000
4000
5400
5420
5440
5460
5480
5500
5520
5540
5560
5580
Wavelength in Angstroms


5656.7
5689.8
(5562)
(5719)
5662.5
5559.1
5576
5589.4
0
1000
2000
3000
5560
5580
5600
5620
5640
5660
5680
5700
5720
5740
Wavelength in Angstroms


5852.5
5881.9
5764.4
(5719)
(5748)
5804.5
5820.2
5872.8
0
2000
4000
5720
5740
5760
5780
5800
5820
5840
5860
5880
5900
Wavelength in Angstroms

Cu-Ne

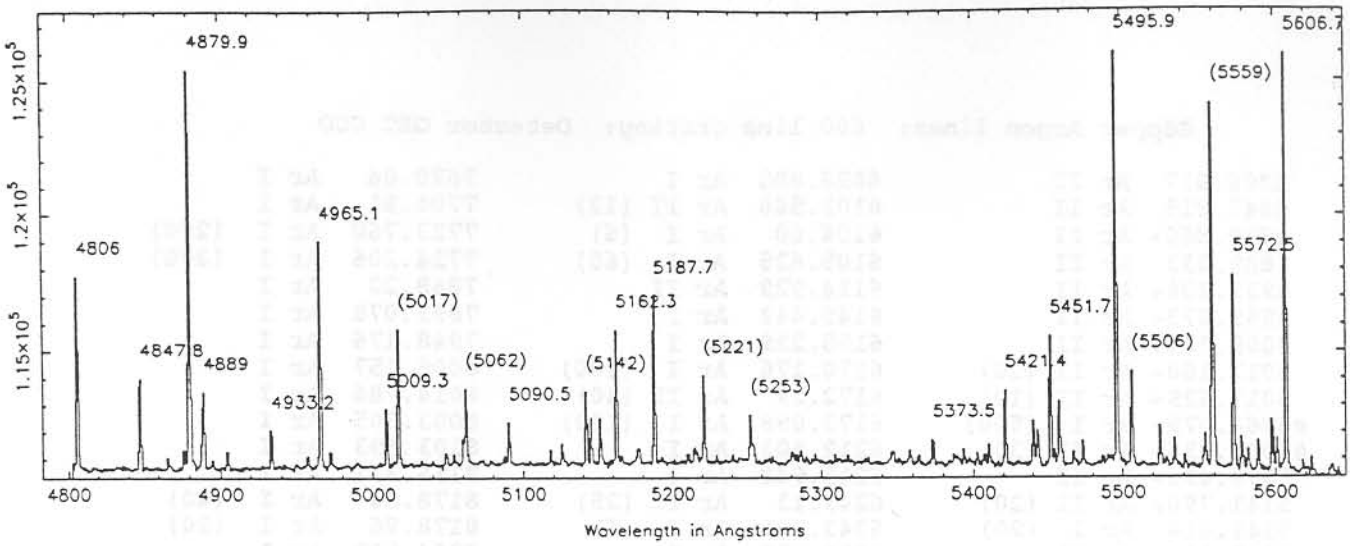

5881.9
5944.8
6030
5975.5
5902.5
5906.4
5913.6
5965.5
5974.6
5987.9
5991.7
6001
6046.2
8000
6000
4000
2000
0
5880
5900
5920
5940
5960
5980
6000
6020
6040
Wavelength in Angstroms

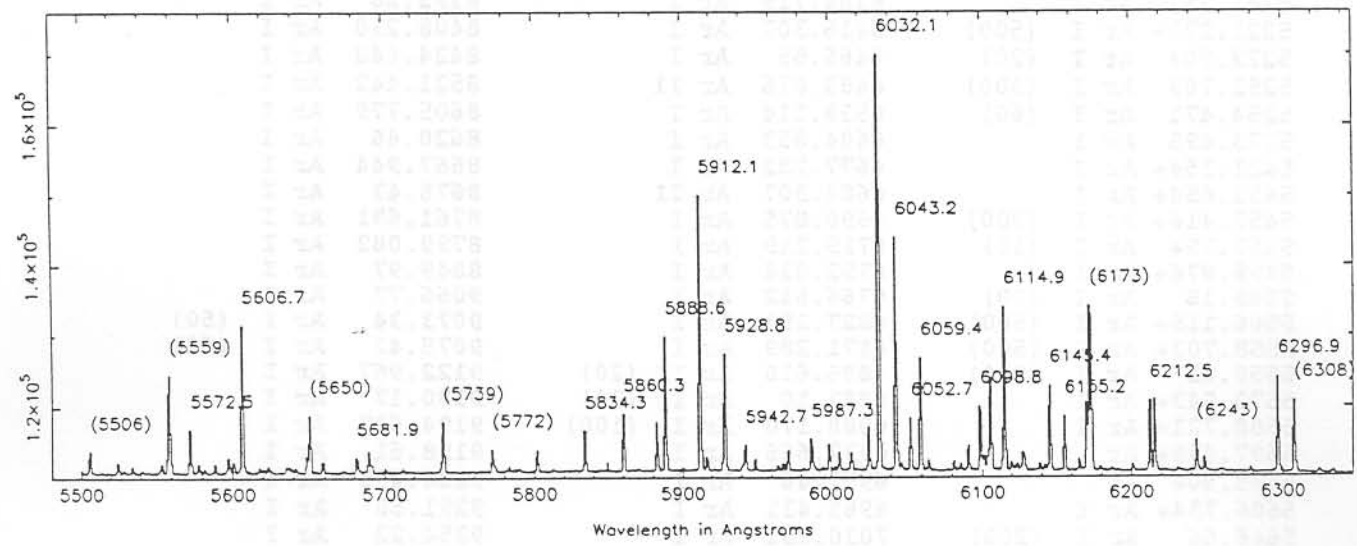
Copper Argon lines: 600 line grating: Detector GEC CCD

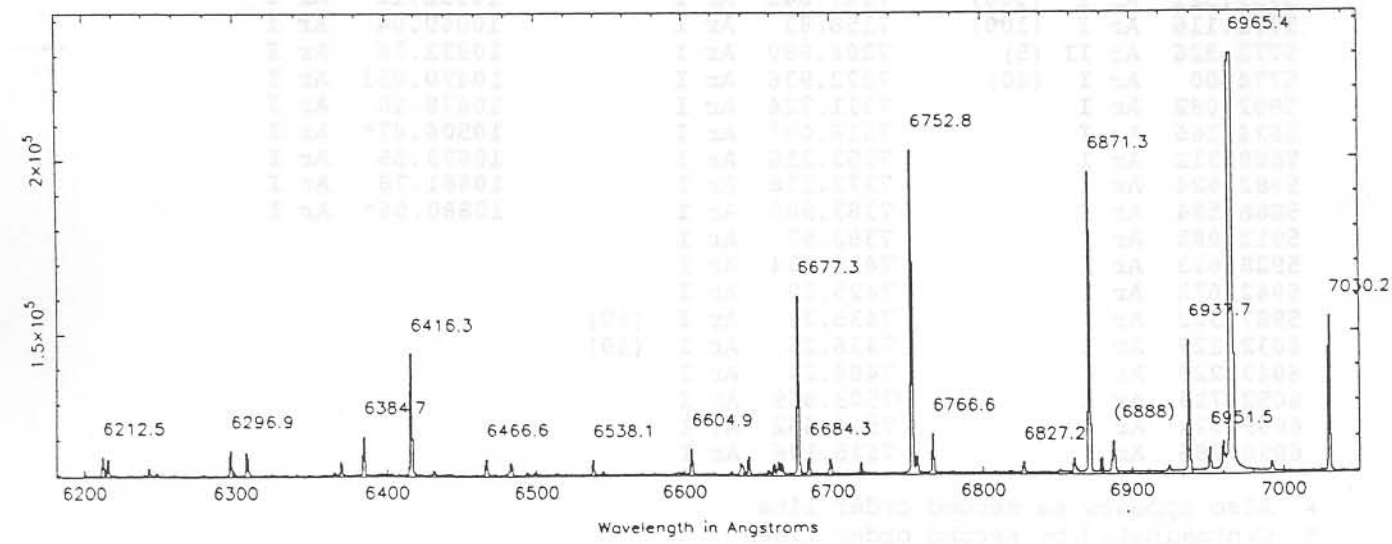
4806.017	Ar II		6098.805	Ar I		7670.04	Ar I	
4847.815	Ar II		6103.546	Ar II	(12)	7704.81	Ar I	
4879.860+	Ar II		6104.60	Ar I	(6)	7723.760	Ar I	(200)
4889.033	Ar II		6105.635	Ar I	(60)	7724.206	Ar I	(200)
4933.206+	Ar II		6114.929	Ar II		7868.20	Ar I	
4965.073+	Ar II		6145.443	Ar I		7891.078	Ar I	
5009.334+	Ar II		6155.239	Ar I		7948.176	Ar I	
5017.160+	Ar II	(20)	6170.176	Ar I	(100)	8006.157	Ar I	
5017.629+	Ar II	(10)	6172.29	Ar II	(40)	8014.786	Ar I	
#5060.079+	Ar I	(500)	6173.098	Ar I	(100)	8053.305	Ar I	
#5062.036+	Ar II	(30)	6212.503	Ar I		8103.693	Ar I	
5090.496+	Ar II		6215.942	Ar I		8115.311	Ar I	
5141.790+	Ar II	(20)	6243.13	Ar II	(25)	8178.84	Ar I	(40)
5141.81+	Ar I	(20)	6243.396	Ar I	(6)	8178.96	Ar I	(20)
5145.319+	Ar II		6296.876	Ar I		8264.522	Ar I	
5151.394+	Ar I		6307.66	Ar I	(30)	8332.21	Ar I	
5162.285+	Ar I		6309.14	Ar I	(8)	8384.73	Ar I	
5187.751+	Ar I		6384.719	Ar I		8392.28	Ar I	
5221.273+	Ar I	(500)	6416.307	Ar I		8408.210	Ar I	
5222.90+	Ar I	(20)	6466.55	Ar I		8424.648	Ar I	
5252.789	Ar I	(300)	6483.076	Ar II		8521.442	Ar I	
5254.471	Ar I	(60)	6538.114	Ar I		8605.779	Ar I	
5373.495	Ar I		6604.853	Ar I		8620.46	Ar I	
5421.354+	Ar I		6677.282	Ar I		8667.944	Ar I	
5451.654+	Ar I		6684.307	Ar II		8678.43	Ar I	
5457.416+	Ar I	(200)	6698.875	Ar I		8761.691	Ar I	
5457.75+	Ar I	(10)	6719.219	Ar I		8799.082	Ar I	
5495.876+	Ar I		6752.834	Ar I		8849.97	Ar I	
5505.18	Ar I	(10)	6766.612	Ar I		9066.77	Ar I	
5506.115+	Ar I	(500)	6827.253	Ar I		9073.34	Ar I	(50)
5558.703+	Ar I	(500)	6871.289	Ar I		9075.42	Ar I	(60)
5559.62	Ar I	(200)	6886.618	Ar II	(20)	9122.967	Ar I	
5572.543+	Ar I		6887.10	Ar I	(20)	9180.17	Ar I	
5588.721+	Ar I		6888.170	Ar I	(100)	9194.637	Ar I	
5597.478+	Ar		6937.666	Ar I		9198.61	Ar I	
5598.50+	Ar		6951.46	Ar I		9224.495	Ar I	
5606.734+	Ar I		6965.431	Ar I		9291.58	Ar I	
5648.66	Ar I	(200)	7030.251	Ar I		9354.22	Ar I	
5650.704	Ar I	(1500)	7067.218	Ar I	(400)	9459.09	Ar I	
5659.127	Ar I		7068.73	Ar I	(30)	9657.784	Ar I	
5681.901	Ar I		7107.478	Ar I		9784.501	Ar I	
5738.416	Ar I	(20)	7125.825	Ar I		10029.70	Ar I	
5739.521	Ar I	(500)	7147.042	Ar I		10052.10	Ar I	
5772.116	Ar I	(100)	7158.83	Ar I		10069.04	Ar I	
5772.326	Ar II	(5)	7206.980	Ar I		10332.76	Ar I	
5774.00	Ar I	(40)	7272.936	Ar I		10470.051	Ar I	
5802.082	Ar I		7311.724	Ar I		10478.10	Ar I	
5834.266	Ar I		7316.007	Ar I		10506.47*	Ar I	
5860.312	Ar I		7353.316	Ar I		10673.55	Ar I	
5882.624	Ar I		7372.118	Ar I		10681.78	Ar I	
5888.584	Ar I		7383.980	Ar I		10880.96*	Ar I	
5912.085	Ar I		7392.97	Ar I				
5928.813	Ar I		7412.334	Ar I				
5942.672	Ar I		7425.29	Ar I				
5987.302	Ar I		7435.33	Ar I	(30)			
6032.129	Ar I		7436.25	Ar I	(10)			
6043.225	Ar I		7484.24	Ar I				
6052.723	Ar I		7503.869	Ar I				
6059.372	Ar I		7514.652	Ar I				
6090.786	Ar I		7635.106	Ar I				

\+ Also appears as second order line
* Contaminated by second order lines
\# Blend in first order but not in second

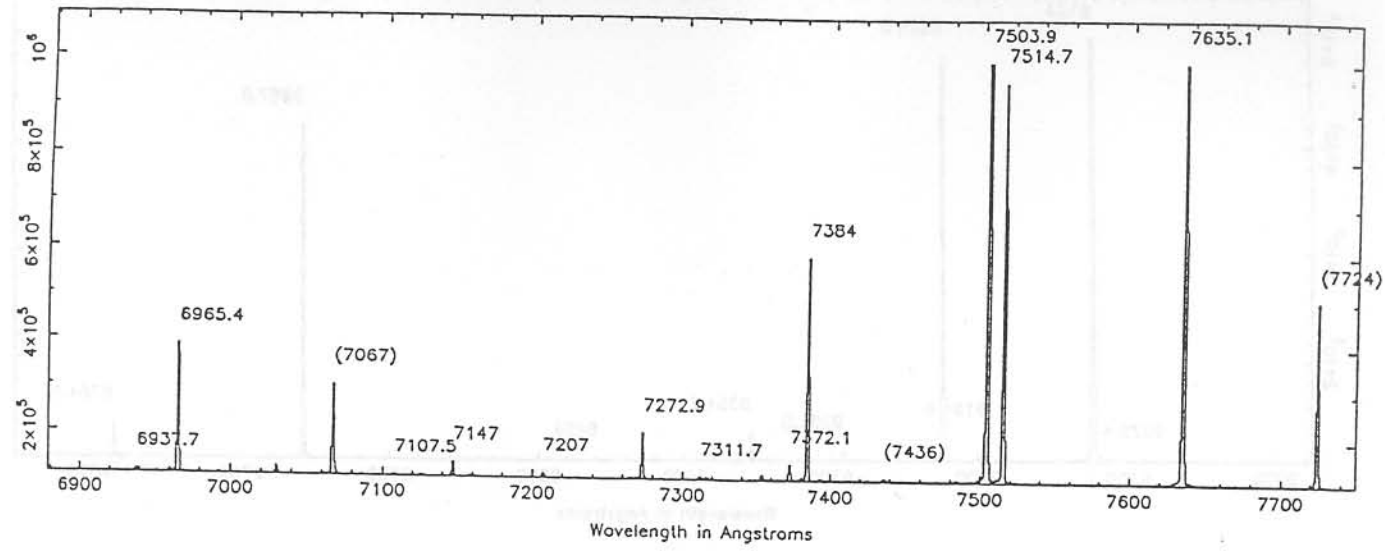
Cu-Ar

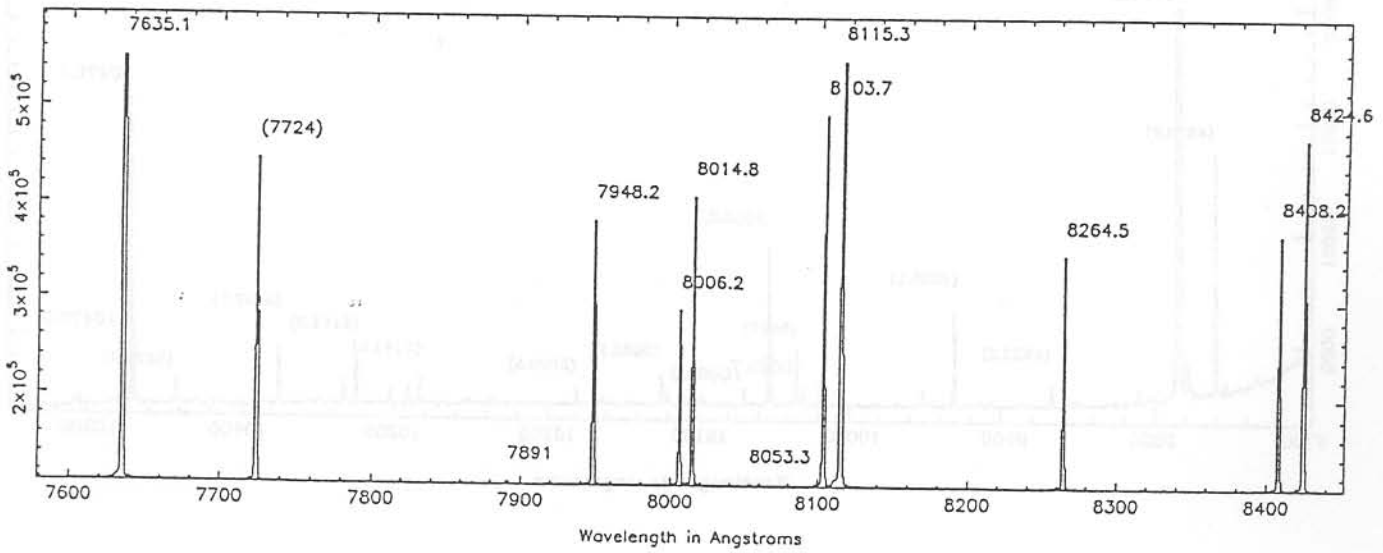

4879.9
5495.9
5606.7
(5559)
4965.1
4806
5572.5
5187.7
(5017)
5162.3
5451.7
4847.8
4889
(5062)
(5142)
(5221)
(5506)
5009.3
5421.4
5090.5
(5253)
4933.2
5373.5
1.25×10^5
1.2×10^5
1.15×10^5
4800
4900
5000
5100
5200
5300
5400
5500
5600
Wavelength in Angstroms

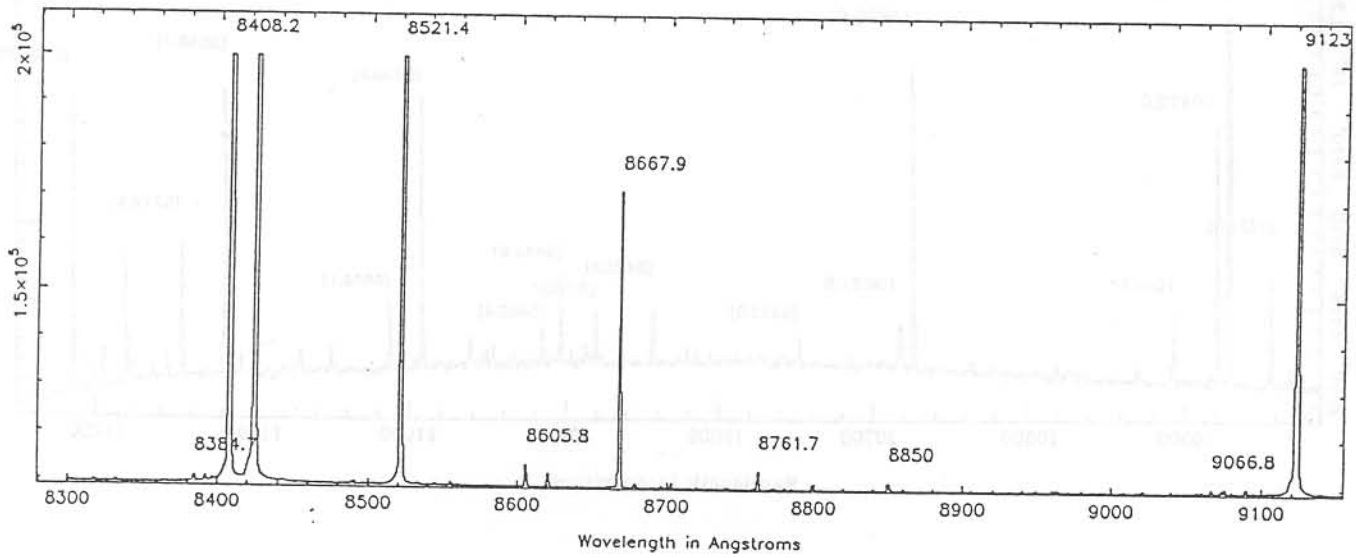

6032.1
5912.1
6043.2
5606.7
6114.9
(6173)
5888.6
5928.8
6059.4
(5559)
6145.4
6296.9
(6308)
6212.5
5572.5
(5650)
(5739)
5860.3
6098.8
6155.2
5834.3
6052.7
(5506)
5681.9
(5772)
5942.7
5987.3
(6243)
1.6×10^5
1.4×10^5
1.2×10^5
5500
5600
5700
5800
5900
6000
6100
6200
6300
Wavelength in Angstroms


6965.4
6752.8
6871.3
6677.3
7030.2
6937.7
6416.3
6766.6
6212.5
6296.9
6384.7
6466.6
6538.1
6604.9
6684.3
6827.2
(6888)
6951.5
2×10^5
1.5×10^5
6200
6300
6400
6500
6600
6700
6800
6900
7000
Wavelength in Angstroms

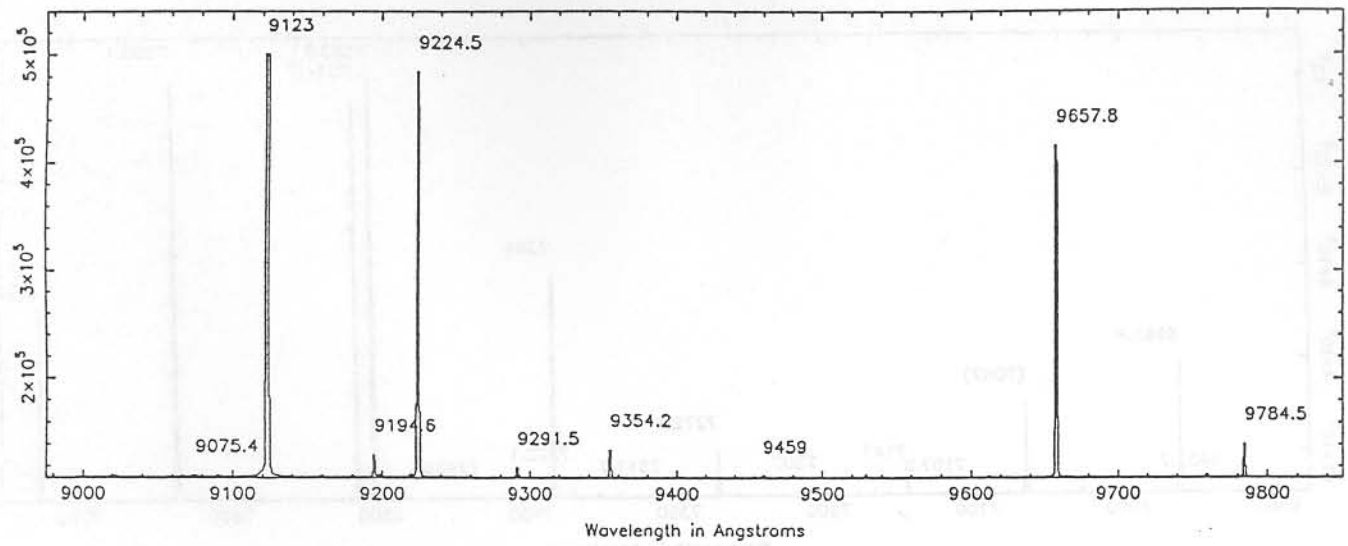
Cu-Ar

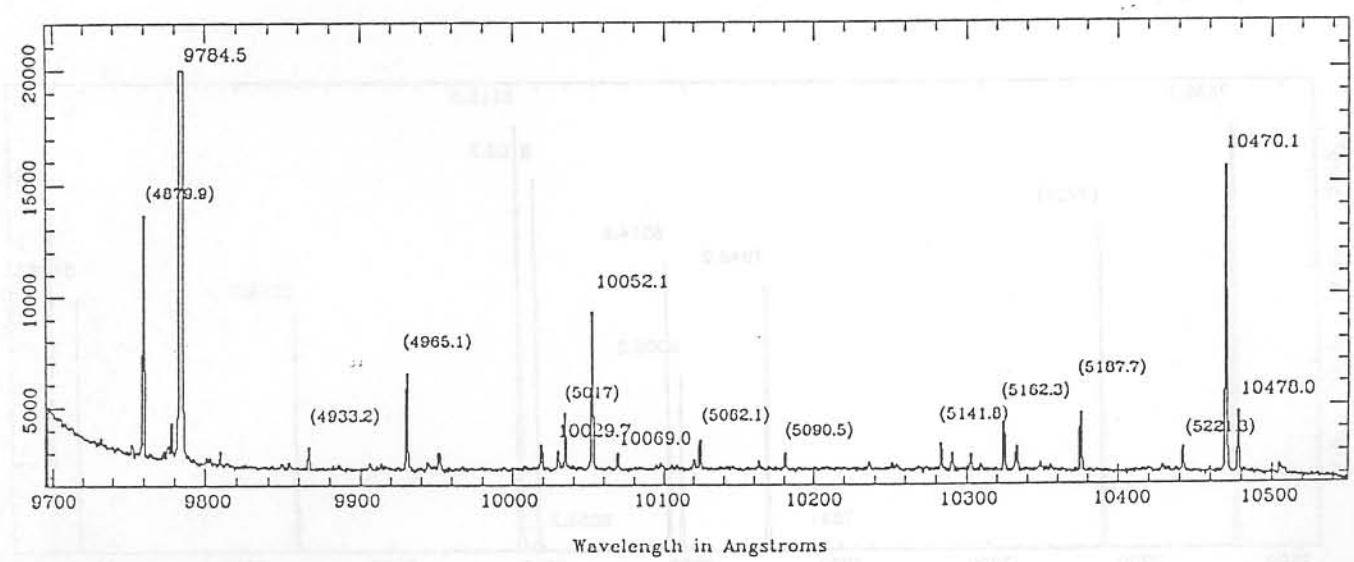

7503.9
7514.7
7635.1
7384
(7724)
6965.4
(7067)
7272.9
6937.7
7107.5
7147
7207
7311.7
7372.1
(7436)
6900
7000
7100
7200
7300
7400
7500
7600
7700
Wavelength in Angstroms

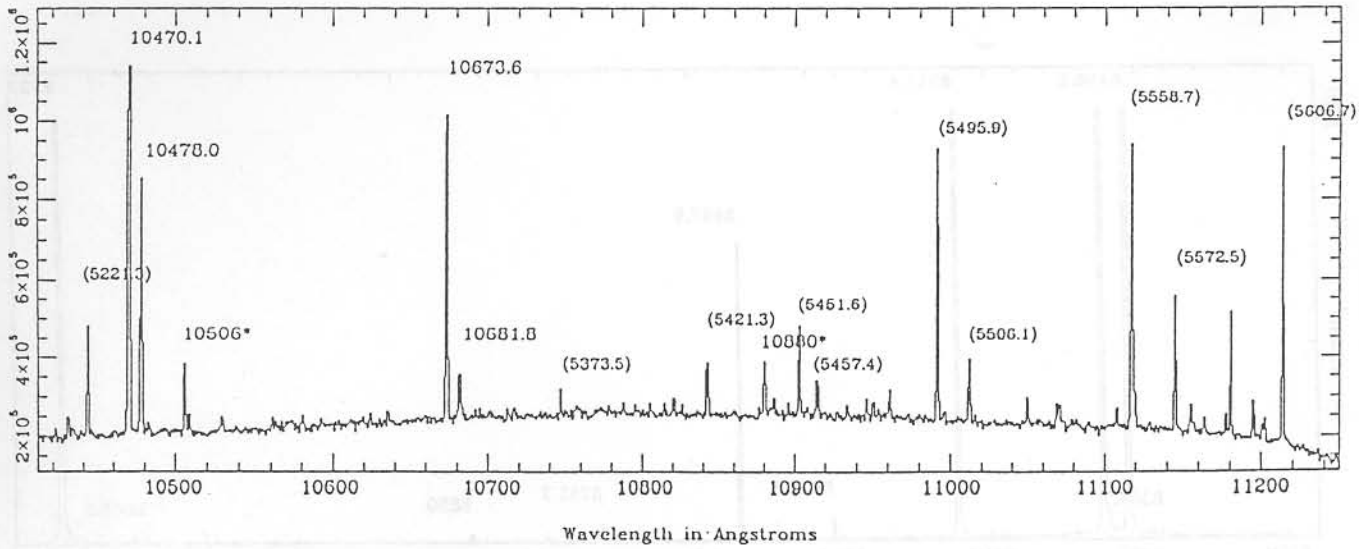

7635.1
8115.3
(7724)
8014.8
7948.2
8264.5
8006.2
7891
8053.3
7600
7700
7800
7900
8000
8100
8200
8300
8400
Wavelength in Angstroms


8408.2
8521.4
9123
8667.9
8384.7
8605.8
8761.7
8850
9066.8
8300
8400
8500
8600
8700
8800
8900
9000
9100
Wavelength in Angstroms

Cu-Ar


9123
9224.5
9657.8
9784.5
9075.4
9194.6
9291.5
9354.2
9459
Wavelength in Angstroms

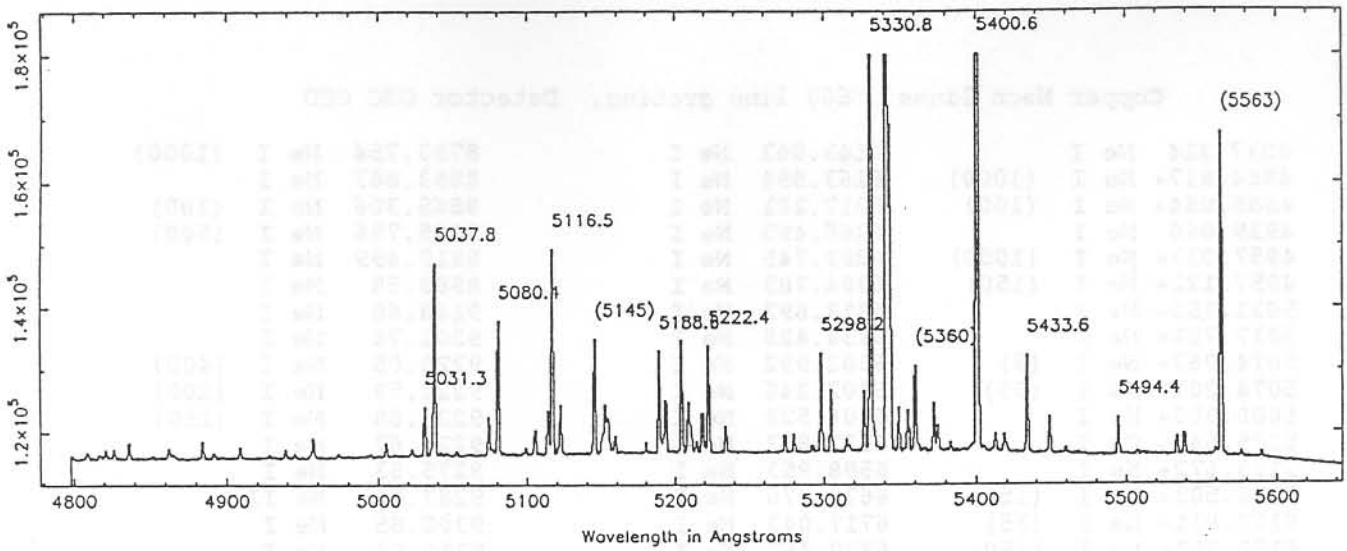

9784.5
10470.1
(4879.9)
10052.1
(4965.1)
(5187.7)
(5162.3)
10478.0
(4933.2)
(5017)
(5062.1)
(5141.0)
10029.7
10069.0
(5090.5)
Wavelength in Angstroms


10470.1
10673.6
(5558.7)
(5495.9)
10478.0
(5572.5)
(5451.6)
(5421.3)
10506*
10681.8
10880*
(5373.5)
(5457.4)
(5506.1)
Wavelength in Angstroms

Copper Neon lines. 600 line grating. Detector GEC CCD

4837.314	Ne I		6143.063	Ne I		8783.754	Ne I	(1000)
4884.917+	Ne I	(1000)	6163.594	Ne I		8853.867	Ne I	
4885.084+	Ne I	(100)	6217.281	Ne I		8865.306	Ne I	(100)
4939.046	Ne I		6266.495	Ne I		8865.756	Ne I	(500)
4957.033+	Ne I	(1000)	6293.745	Ne I		8919.499	Ne I	
4957.122+	Ne I	(150)	6304.789	Ne I		8988.58	Ne I	
5031.350+	Ne I		6313.692	Ne I		9148.68	Ne I	
5037.751+	Ne I		6334.428	Ne I		9201.76	Ne I	
5074.062+	Ne I	(3)	6382.992	Ne I		9220.05	Ne I	(400)
5074.201+	Ne I	(35)	6402.246	Ne I		9221.59	Ne I	(200)
5080.385+	Ne I		6506.528	Ne I		9221.88	Ne I	(150)
5105.541+	Cu I		6532.882	Ne I		9226.67	Ne I	
5113.672+	Ne I		6598.953	Ne I		9275.53	Ne I	
5116.503+	Ne I	(150)	6678.276	Ne I		9287.56	Ne II	
5117.011+	Ne I	(35)	6717.043	Ne I		9300.85	Ne I	
5122.257+	Ne I	(150)	6929.467	Ne I		9310.58	Ne I	
5122.337+	Ne I	(150)	7024.050	Ne I		9313.98	Ne I	
5144.938+	Ne I	(500)	7032.413	Ne I		9326.52	Ne I	
5145.011+	Ne I	(500)	7051.294	Ne I		9373.28	Ne I	
5145.122+	Ne I	(35)	7059.107	Ne I		9425.38	Ne I	
5153.235*	Cu I	(2000)	7173.939	Ne I		9459.21	Ne I	
5154.427*	Ne I	(50)	7245.167	Ne I		9486.68	Ne I	
5188.612+	Ne I		7438.899	Ne I		9534.167	Ne I	
5203.895+	Ne I		7472.438	Ne I		9547.40	Ne I	
5218.202+	Cu I		7488.871	Ne I		9577.01	Ne II	
5222.351+	Ne I		7535.774	Ne I		9665.424	Ne I	
5234.028+	Ne I		7544.044	Ne I		9808.86	Ne I	
5298.190+	Ne I		7724.628	Ne I		9915.13#	Ne I	
5304.758+	Ne I		7833.06	Ne I		10210.73#	Ne I	
5326.396+	Ne I		7839.06	Ne I		10295.40	Ne I	
5330.778+	Ne I		7936.995	Ne I		10562.43	Ne I	
5341.094+	Ne I	(1000)	7943.181	Ne I		10798.12*	Ne I	
5343.284+	Ne I	(600)	8082.458	Ne I		10844.54	Ne I	
5360.012+	Ne I	(150)	8118.549	Ne I		11143.09	Ne I	
5360.442+	Ne I	(35)	8128.908	Ne I		11177.59	Ne I	
5400.562+	Ne I		8136.406	Ne I				
5433.651+	Ne I		8259.379	Ne I				
5448.508+	Ne I		8266.079	Ne I	(200)			
5494.416+	Ne I		8267.117	Ne I	(80)			
5533.679	Ne I		8300.326	Ne I	(600)			
5562.441+	Ne I	(150)	8301.54	Ne I	(150)			
5562.766+	Ne I	(500)	8365.749	Ne I				
5563.047+	Ne I	(75)	8376.41	Ne I	(200)			
5656.659	Ne I		8377.606	Ne I	(800)			
5662.549	Ne I		8417.161	Ne I	(100)			
5689.816	Ne I		8418.427	Ne I	(400)			
5719.225	Ne I		8463.357	Ne I				
5764.419	Ne I		8495.359	Ne I				
5804.449	Ne I		8571.353	Ne I				
5852.488	Ne I		8591.259	Ne I				
5881.895	Ne I		8634.647	Ne I				
5944.834	Ne I		8647.04	Ne I				
5974.627	Ne I	(500)	8654.384	Ne I	(1500)			
5975.534	Ne I	(600)	8654.521	Ne I	(400)			
5987.907	Ne I		8679.490	Ne I				
6029.997	Ne I		8681.922	Ne I				
6046.135	Ne I		8704.113	Ne I				
6074.338	Ne I		8771.659	Ne I				
6096.163	Ne I		8780.622	Ne I	(1200)			
6118.027	Ne I		8782.014	Ne I	(50)			

+ Also appears as second order line
# Contaminated by second order line
* In wing of strong second order line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(5145)
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(5360)
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5031.3
5494.4
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1.4×10^5
1.6×10^5
1.8×10^5
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4900
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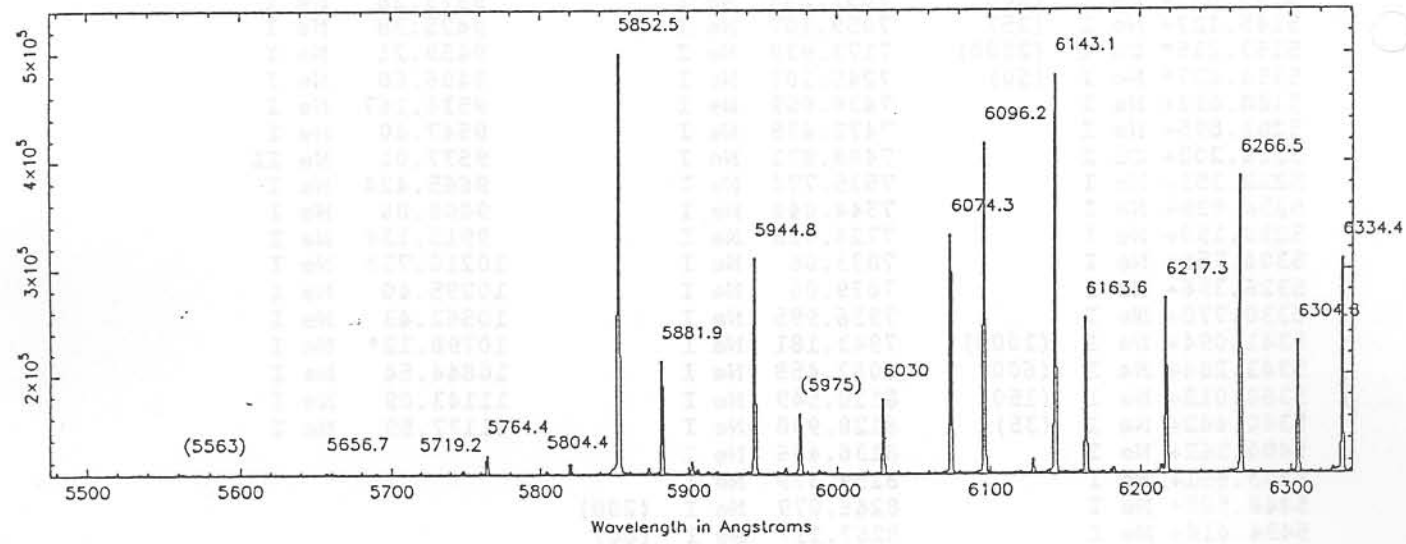
5200
5300
5400
5500
5600
Wavelength in Angstroms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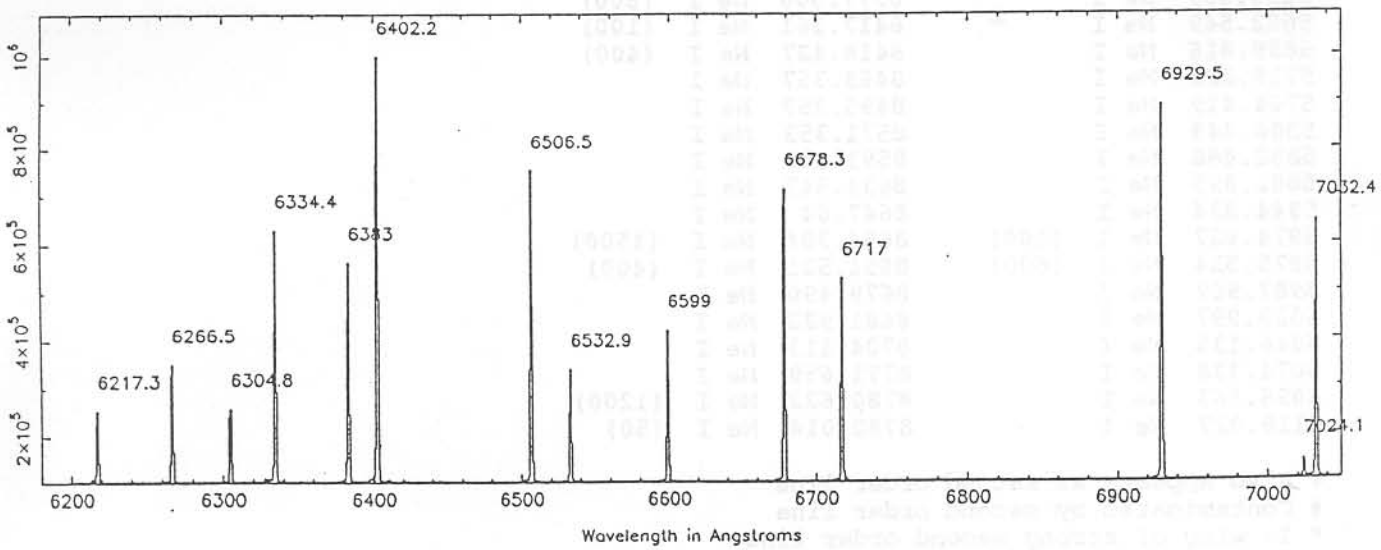
6096.2
6266.5
6074.3
5944.8
6334.4
6217.3
6163.6
6304.8
5881.9
6030
(5975)
(5563)
5656.7
5719.2
5764.4
5804.4
2×10^5
3×10^5
4×10^5
5×10^5
5500
5600
5700
5800
5900
6000
6100
6200
6300
Wavelength in Angstroms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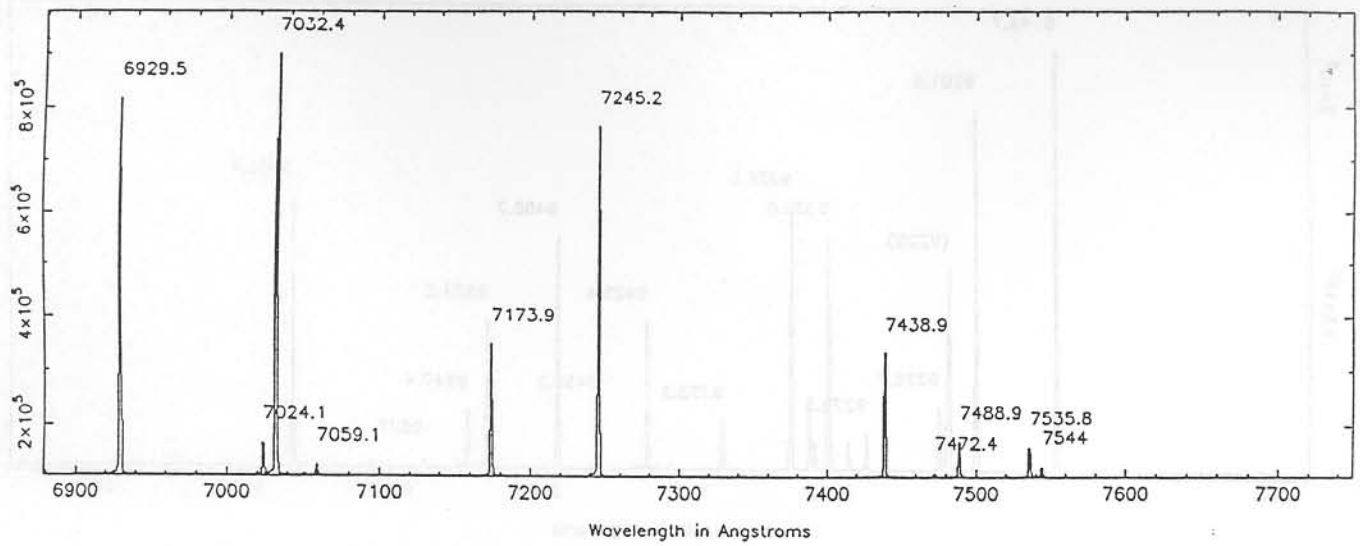
6334.4
6383
6717
6599
6266.5
6532.9
6217.3
6304.8
7024.1
2×10^5
4×10^5
6×10^5
8×10^5
10^6
6200
6300
6400
6500
6600
6700
6800
6900
7000
Wavelength in Angstroms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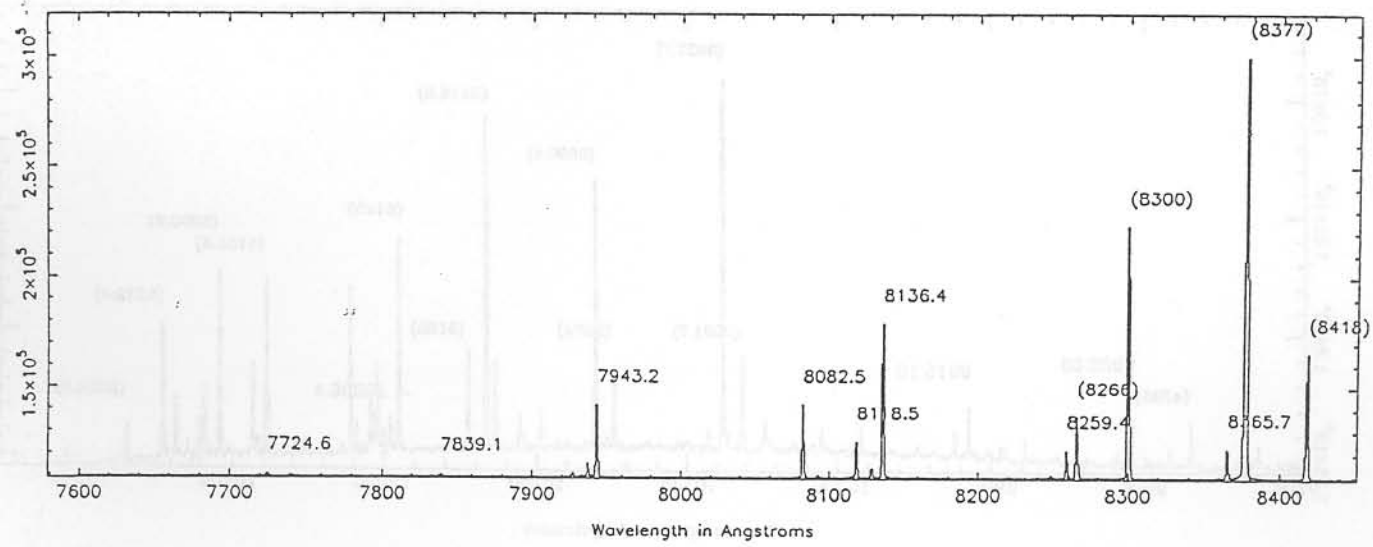
7438.9
7024.1
7059.1
7488.9
7535.8
7472.4
7544
2×10^5
4×10^5
6×10^5
8×10^5
6900
7000
7100
7200
7300
7400
7500
7600
7700
Wavelength in Angstroms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(8418)
7943.2
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(8266)
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7724.6
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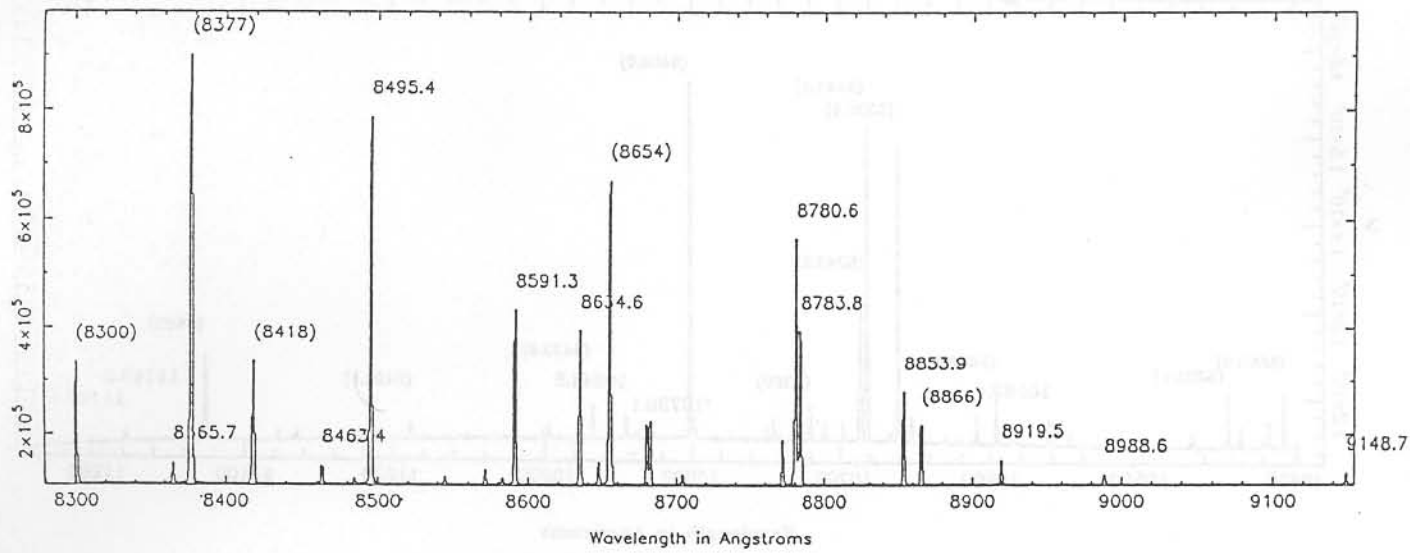
2×10^5
2.5×10^5
3×10^5
7600
7700
7800
7900
8000
8100
8200
8300
8400
Wavelength in Angstroms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(8654)
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8591.3
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(8300)
(8418)
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(8866)
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8988.6
2×10^5
4×10^5
6×10^5
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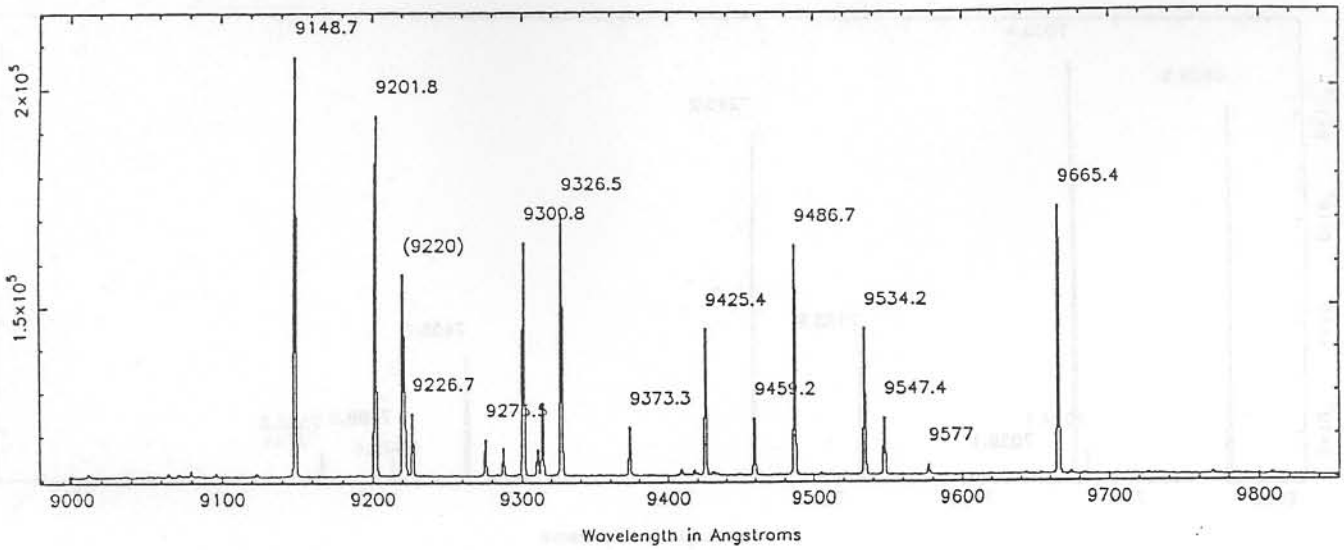
8500
8600
8700
8800
8900
9000
9100
Wavelength in Angstroms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9326.5
9300.8
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9665.4
9486.7
9425.4
9534.2
9226.7
9373.3
9459.2
9547.4
9577
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1.5×10^5
9000
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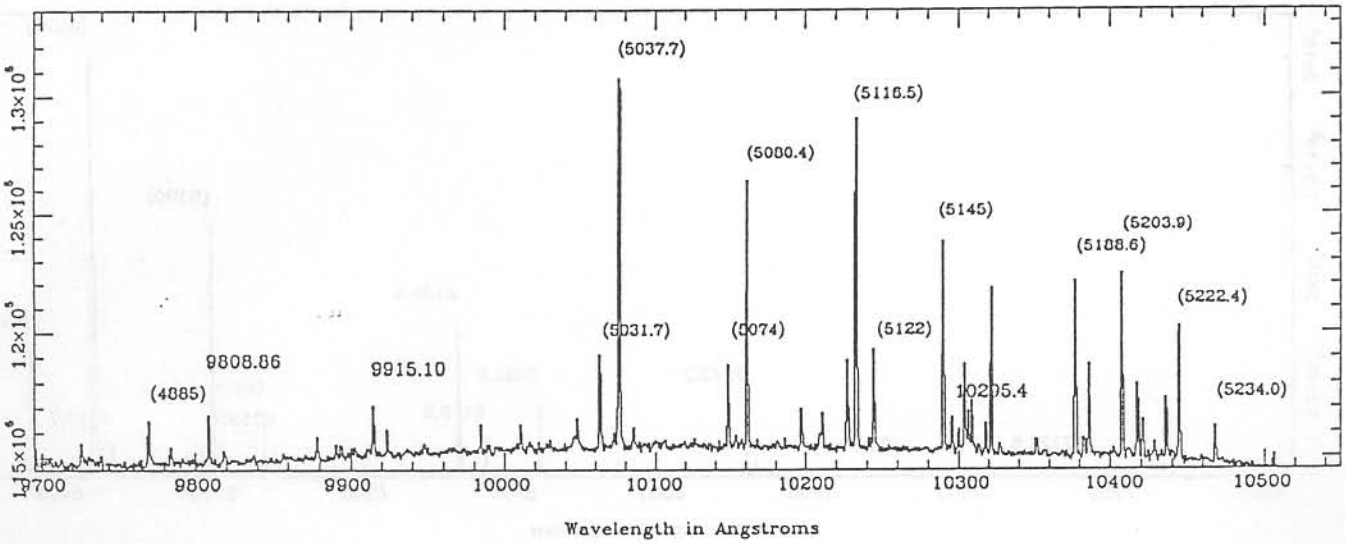
9200
9300
9400
9500
9600
9700
9800
Wavelength in Angstroms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(5203.9)
(5108.6)
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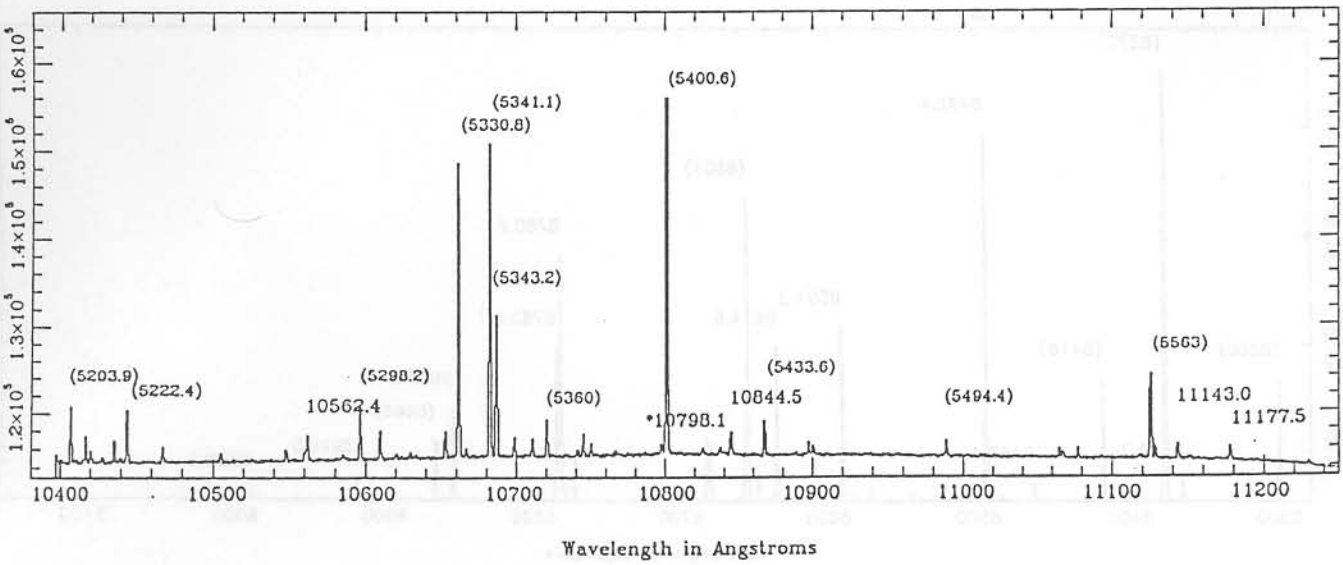
(5031.7)
(5074)
(5122)
9808.86
9915.10
(4885)
10205.4
(5234.0)
1.3×10^5
1.25×10^5
1.2×10^5
9700
9800
9900
10000
10100
10200
10300
10400
10500
Wavelength in Angstroms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(5298.2)
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(5563)
10562.4
(5360)
10844.5
(5494.4)
11143.0
*10798.1
11177.5
1.6×10^5
1.5×10^5
1.4×10^5
1.3×10^5
1.2×10^5
10400
10500
10600
10700
10800
10900
11000
11100
11200
Wavelength in Angstroms

Iron Neon lines. 600 line grating.
Detector IPCS II with GEC CCD

3297.74	Ne II	(7)	3664.112	Ne II		4206.43	Ne II	(2)
3298.133	Fe I	(6)	3682.242	Ne I		4206.698	Fe I	(3)
3309.78	Ne II		3685.735	Ne I		4216.185	Fe I	(8)
3319.75	Ne II		3694.197	Ne II		4217.15	Ne I	(3)
3323.75	Ne II		3701.225	Ne I	(40)	4217.555	Fe I	(7)
3334.87	Ne II		3701.81	Ne II	(4)	4219.76	Ne II	
3344.43	Ne II	(5)	3705.567	Fe I		4250.125	Fe I	(25)
3345.49	Ne II	(3)	3709.248	Fe I	(75)	4250.68	Ne II	(4)
3369.549	Fe I	(8)	3709.64	Ne II	(7)	4250.790	Fe I	(25)
3369.808	Ne I	(500)	3713.084	Ne II		4260.479	Fe I	
3369.908	Ne I	(700)	3719.936	Fe I		4271.159	Fe I	(20)
3370.785	Fe I	(10)	3722.564	Fe I		4271.763	Fe I	(35)
3378.28	Ne II		3726.925	Fe I	(6)	4307.905	Fe I	
3392.78	Ne II		3727.08	Ne II	(9)	4325.764	Fe I	
3416.87	Ne II	(4)	3727.621	Fe I	(50)			
3417.71	Ne II	(5)	3734.866	Fe I	(300)			
3417.903	Ne I	(500)	3734.94	Ne II	(7)			
3418.007	Ne I	(50)	3737.13	Fe I				
3440.606	Fe I	(150)	3745.562	Fe I	(100)			
3440.989	Fe I	(75)	3745.901	Fe I	(40)			
3447.702	Ne I		3748.264	Fe I	(60)			
3454.194	Ne I		3749.487	Fe I	(200)			
3460.524	Ne I		3758.235	Fe I				
3464.338	Ne I	(100)	3777.16	Ne II				
3465.862	Fe I	(60)	3815.843	Fe I				
3466.578	Ne I	(200)	3820.427	Fe I				
3472.571	Ne I		3834.224	Fe I				
3480.75	Ne II	(2)	3840.439	Fe I	(80)			
3481.96	Ne II	(6)	3841.05	Fe I	(80)			
3490.574	Fe I		3856.373	Fe I				
3497.108	Fe I	(10)	3859.913	Fe I				
3497.842	Fe I	(40)	3878.021	Fe I	(60)			
3498.063	Ne I	(100)	3878.574	Fe I	(100)			
3501.215	Ne I		3886.283	Fe I				
3515.190	Ne I		3895.658	Fe I				
3520.471	Ne I	(1000)	3899.709	Fe I				
3521.263	Fe I	(25)	3920.260	Fe I				
3542.28	Ne I	(2)	3922.913	Fe I				
3542.90	Ne I	(7)	3927.922	Fe I				
3568.53	Ne II		3930.298	Fe I				
3574.64	Ne II		3969.259	Fe I				
3581.19	Fe I		4005.244	Fe I				
3593.526	Ne I	(500)	4045.815	Fe I				
3593.640	Ne I	(300)	4063.596	Fe I				
3608.861	Fe I		4071.740	Fe I				
3618.769	Fe I		4143.417	Fe I	(15)			
3631.465	Fe I	(125)	4143.870	Fe I	(30)			
3633.664	Ne I	(100)	4198.309	Fe I	(20)			
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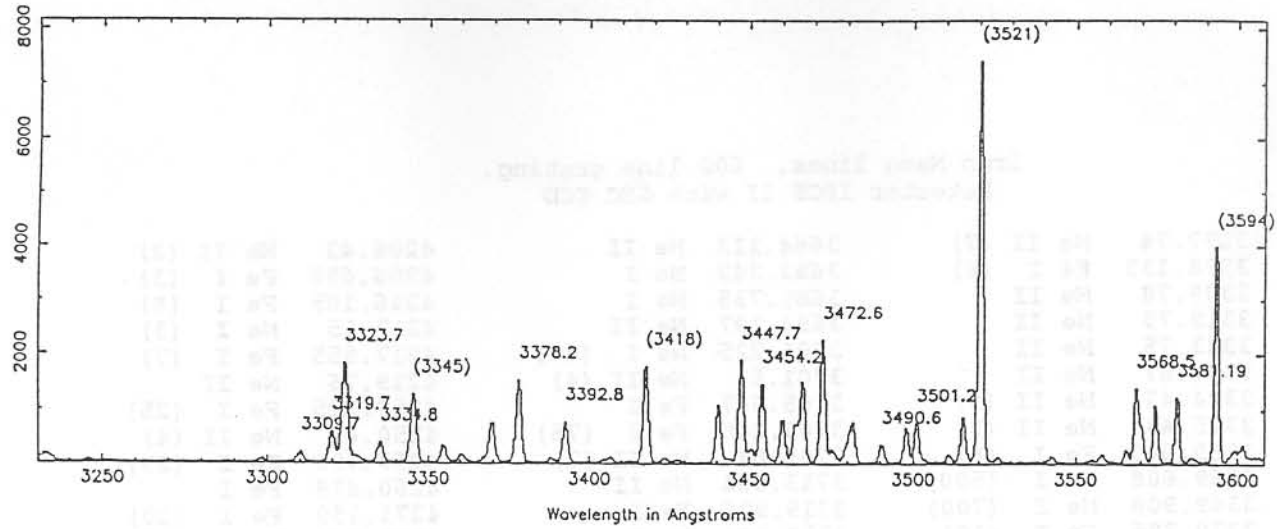
3647.844	Fe I		4202.032	Fe I				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(3418)
3447.7
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3319.7
3309.7
3334.8
3568.5
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6000
4000
2000
3250
3300
3350
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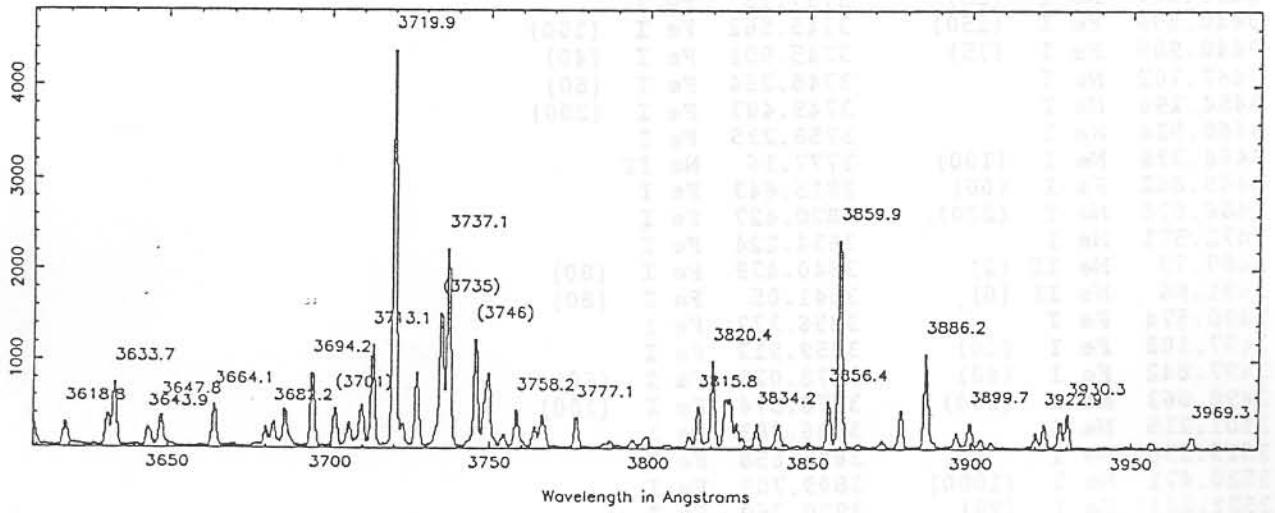
3450
3500
3550
3600
Wavelength in Angstroms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3856.4
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1000
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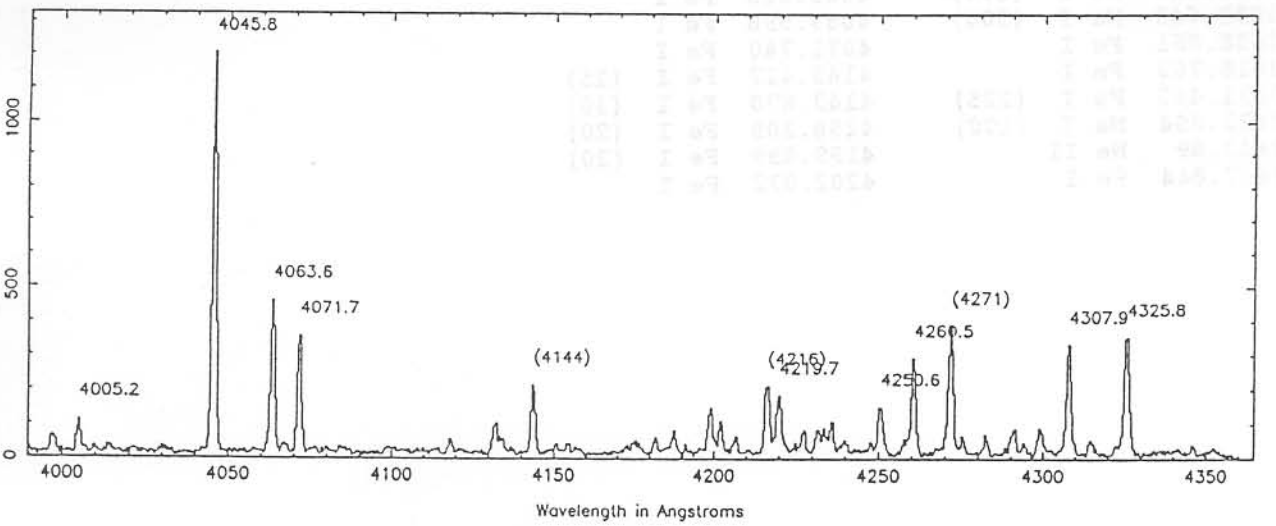
3700
3750
3800
3850
3900
3950
Wavelength in Angstroms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500
0
4000
4050
4100
4150
4200
4250
4300
4350
Wavelength in Angstroms

Iron Argon lines. 600 line grating.
Detector IPCS II with GEC CCD

3293.641	Ar II	(10)	3748.264	Fe I	(60)	4076.939	Ar II	(9)
3293.921	Ar	(9)	3749.487	Fe I	(200)	4079.582	Ar II	(12)
3307.229	Ar II		3758.235	Fe I		4080.645	Ar II	(6)
3350.933	Ar II		3763.791	Fe I	(100)	4080.686	Ar II	(4)
3376.443	Ar II		3765.269	Ar II	(20)	4103.913	Ar II	
3440.606	Fe I	(150)	3766.118	Ar II	(11)	4131.730	Ar II	
3440.989	Fe I	(75)	3780.843	Ar II		4158.591	Ar I	
3464.132	Ar II	(10)	3803.172	Ar II		4164.179	Ar I	
3465.787	Ar II	(4)	3809.456	Ar II		4181.884	Ar I	
3465.862	Fe I	(60)	3815.840	Fe I		4190.714	Ar I	(600)
3466.343	Ar I	(8)	3820.427	Fe I		4191.029	Ar I	(1200)
3475.451	Fe I	(70)	3833.310	Fe I	(5)	4198.309	Fe I	(20)
3476.704	Fe I	(40)	3834.224	Fe I	(100)	4198.318	Ar I	(1200)
3476.747	Ar II	(20)	3834.679	Ar I	(800)	4199.099	Fe I	(20)
3490.575	Fe I	(100)	3840.439	Fe I	(80)	4200.675	Ar I	(1200)
3491.243	Ar II	(20)	3841.050	Fe I	(80)	4227.432	Fe I	(30)
3491.538	Ar II	(25)	3850.578	Ar II		4228.158	Ar II	(20)
3509.783	Ar II		3856.373	Fe I		4237.223	Ar II	
3513.819	Fe I	(30)	3859.913	Fe I		4259.362	Ar I	(1200)
3514.388	Ar II	(20)	3868.524	Ar II		4260.479	Fe I	(35)
3545.597	Ar II	(18)	3878.021	Fe I	(60)	4266.287	Ar I	(1200)
3545.842	Ar II	(18)	3878.574	Fe I	(100)	4266.528	Ar II	(25)
3559.508	Ar II	(25)	3886.284	Fe I	(40)	4271.159	Fe I	(20)
3561.031	Ar II	(20)	3895.658	Fe I		4271.763	Fe I	(35)
3570.099	Fe I	(100)	3899.709	Fe I		4272.169	Ar I	(1200)
3570.26	Fe I	(20)	3920.260	Fe I		4277.524	Ar II	
3576.611	Ar II		3922.913	Fe I		4300.101	Ar I	(1200)
3581.195	Fe I	(250)	3927.922	Fe I		4300.650	Ar II	(12)
3581.608	Ar II	(18)	3930.298	Fe I		4325.765	Fe I	
3582.362	Ar II	(20)	3946.096	Ar II		4345.167	Ar I	(1000)
3582.697	Ar I	(30)	3948.979	Ar I		4348.063	Ar II	(50)
3588.448	Ar II		3979.356	Ar II	(12)	4352.204	Ar II	(15)
3606.522	Ar I		3979.715	Ar I	(10)	4352.737	Fe I	(9)
3608.861	Fe I		3994.789	Ar II				
3618.769	Fe I		4005.244	Fe I				
3631.465	Fe I		4013.858	Ar II				
3647.844	Fe I		4030.755	Mn I				
3679.915	Fe I		4033.073	Mn I				
3705.567	Fe I		4034.490	Mn I				
3717.174	Ar II	(10)	4035.728	Mn I				
3718.208	Ar II	(12)	4041.361	Mn I				
3719.936	Fe I	(250)	4042.896	Ar II	(15)			
3729.310	Ar II		4045.815	Fe I	(60)			
3733.319	Fe I	(40)	4052.923	Ar II				
3734.866	Fe I	(300)	4063.596	Fe I				
3737.133	Fe I	(150)	4071.740	Fe I	(40)			
3737.893	Ar II	(15)	4072.006	Ar II	(25)			
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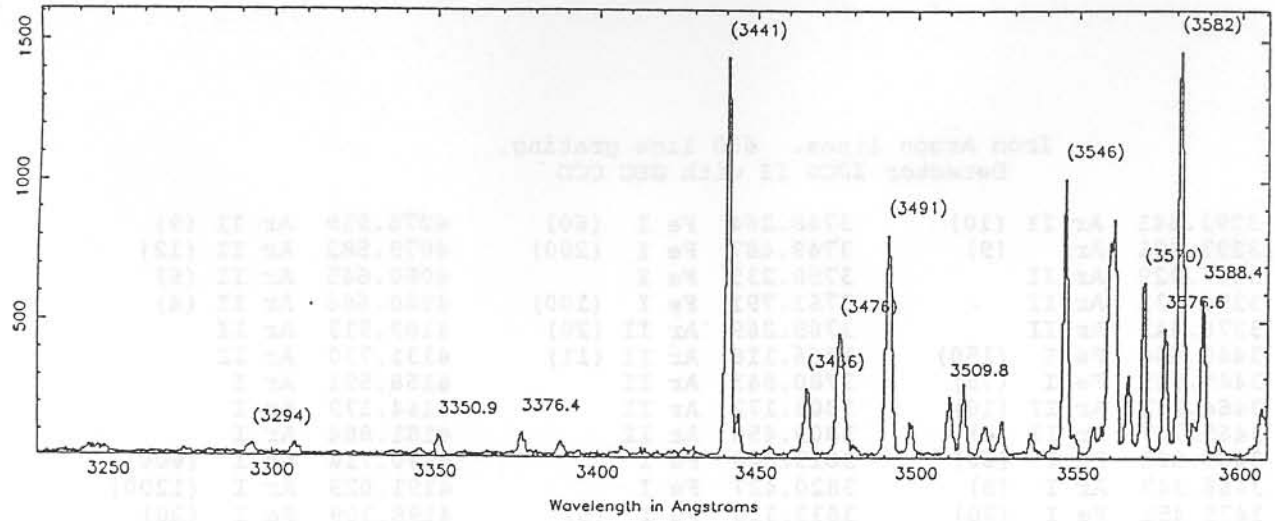
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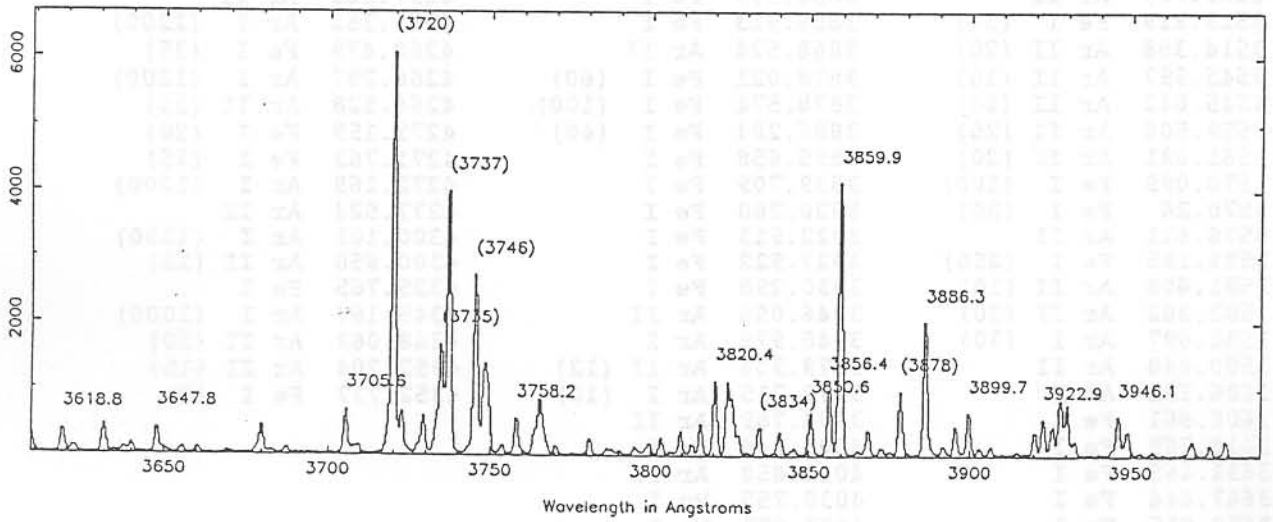
3400
3450
3500
3550
3600
Wavelength in Angstroms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(3834)
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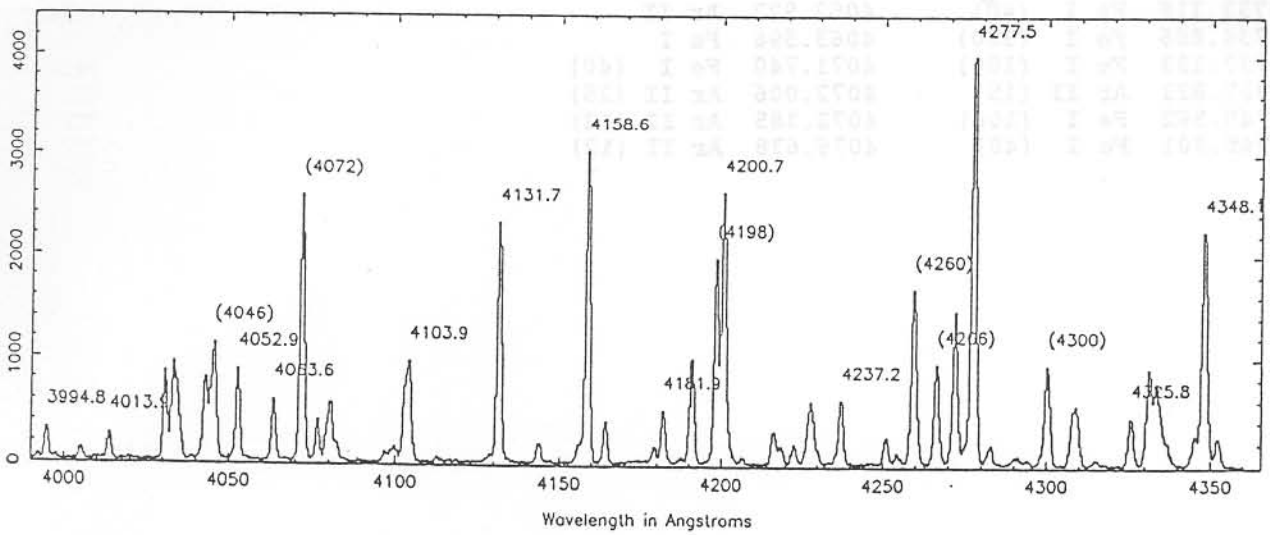
3950
Wavelength in Angstroms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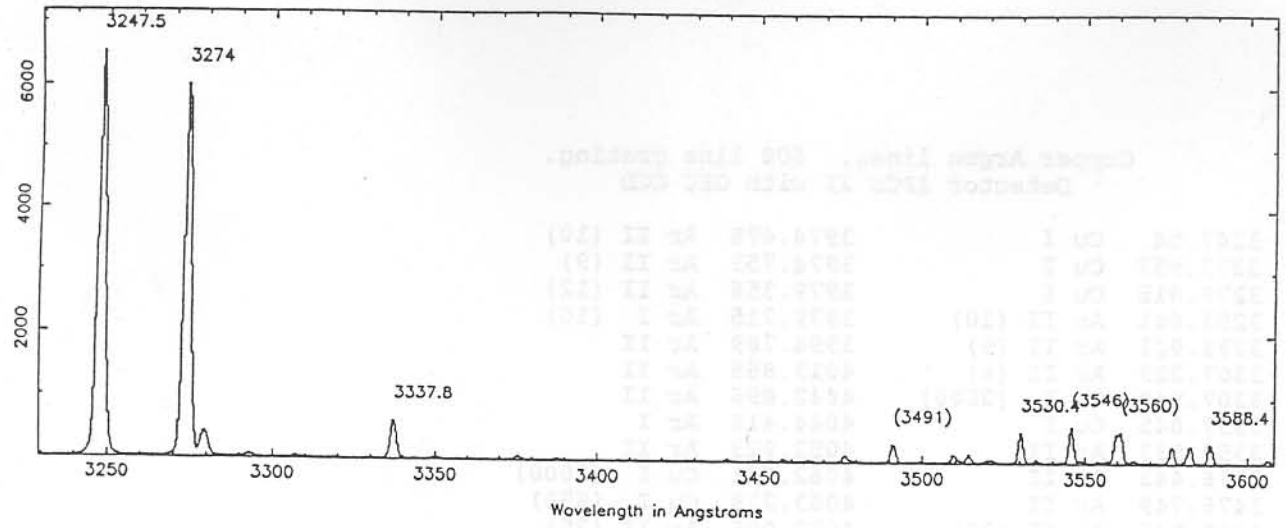
4000
3000
2000
1000
0
4000
4050
4100
4150
4200
4250
4300
4350
Wavelength in Angstroms

Copper Argon lines. 600 line grating.
Detector IPCS II with GEC CCD

3247.54	Cu I		3974.478	Ar II	(10)
3273.957	Cu I		3974.753	Ar II	(9)
3279.815	Cu I		3979.356	Ar II	(12)
3293.641	Ar II	(10)	3979.715	Ar I	(10)
3293.921	Ar II	(9)	3994.789	Ar II	
3307.229	Ar II	(9)	4013.858	Ar II	
3307.948	Cu I	(2500)	4042.896	Ar II	
3337.845	Cu I		4044.418	Ar I	
3350.933	Ar II		4052.923	Ar II	
3376.443	Ar II		4062.641	Cu I	(2000)
3476.749	Ar II		4063.238	Cu I	(650)
3491.243	Ar II	(20)	4072.006	Ar II	(25)
3491.538	Ar II	(25)	4072.385	Ar II	(12)
3509.783	Ar II		4079.582	Ar II	(12)
3514.388	Ar II		4080.645	Ar II	(6)
3530.383	Cu I		4080.686	Ar II	(4)
3545.597	Ar II	(18)	4103.913	Ar II	
3545.842	Ar II	(18)	4131.730	Ar II	
3559.508	Ar II	(25)	4158.591	Ar I	
3561.031	Ar II	(20)	4164.179	Ar I	
3576.611	Ar II		4181.884	Ar I	
3581.608	Ar II	(18)	4190.714	Ar I	(600)
3582.362	Ar II	(20)	4191.029	Ar I	(1200)
3582.697	Ar I	(30)	4198.318	Ar I	
3588.448	Ar II		4200.675	Ar I	
3606.522	Ar I		4228.162	Ar II	(20)
3622.140	Ar II		4229.872	Ar II	(8)
3717.174	Ar II	(10)	4237.223	Ar II	
3718.208	Ar II	(12)	4259.362	Ar I	
3729.310	Ar II		4266.287	Ar I	(1200)
3737.893	Ar II		4266.524	Ar II	(25)
3753.521	Ar II	(9)	4272.169	Ar I	
3754.052	Ar II	(6)	4277.528	Ar II	
3765.269	Ar II	(20)	4300.101	Ar I	(1200)
3766.118	Ar II	(11)	4300.650	Ar II	(12)
3770.370	Ar I		4309.09	Ar II	(8)
3780.840	Ar II		4309.236	Ar II	(9)
3803.172	Ar II		4345.167	Ar I	(1000)
3809.456	Ar II		4348.063	Ar II	(50)
3834.679	Ar I		4352.204	Ar II	
3845.406	Ar II				
3850.578	Ar II				
3868.524	Ar II				
3925.722	Ar II				
3928.629	Ar II				
3931.235	Ar II	(12)			
3932.548	Ar II	(15)			
3946.096	Ar II				
3948.979	Ar I				
3968.36	Ar II				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3300
3350
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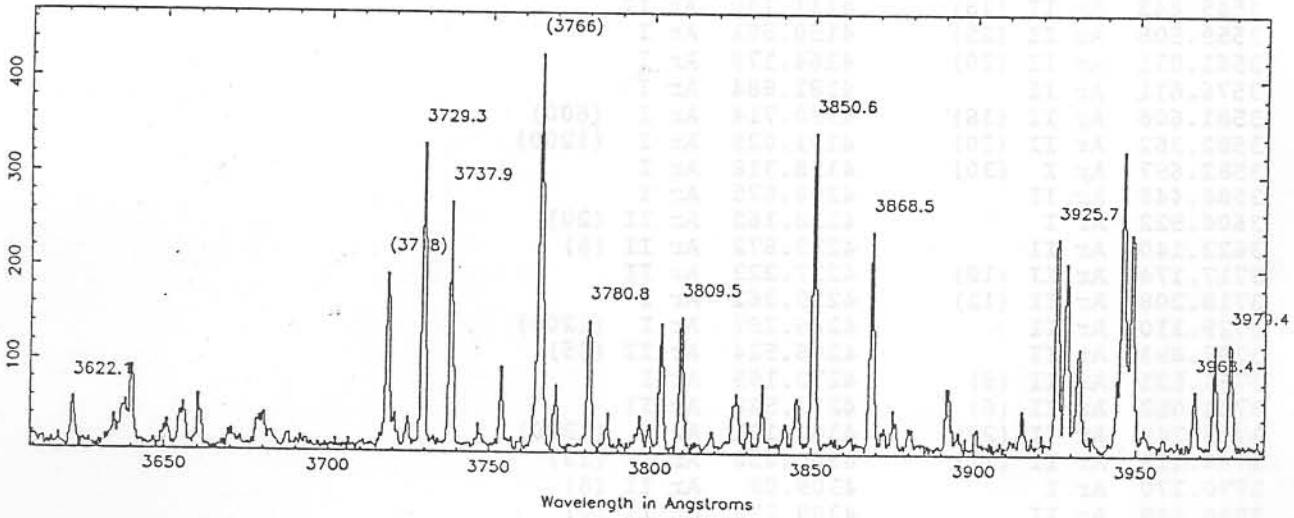
Wavelength in Angstroms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3868.5
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400
300
200
100
3650
3700
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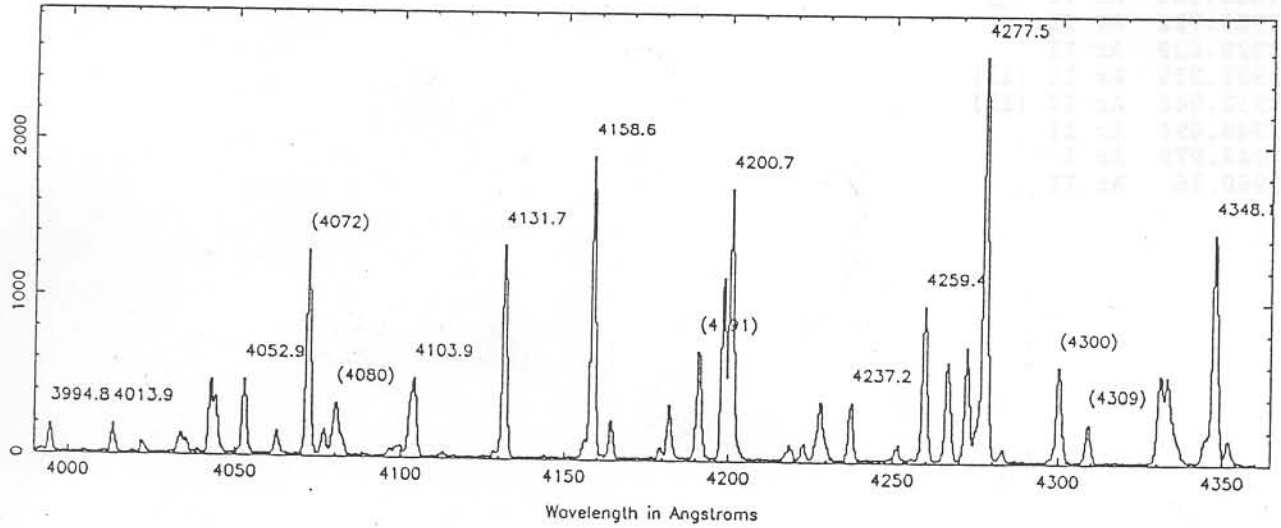
3800
3850
3900
3950
Wavelength in Angstroms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2000
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0
4000
4050
4100
4150
4200
4250
4300
4350
Wavelength in Angstroms