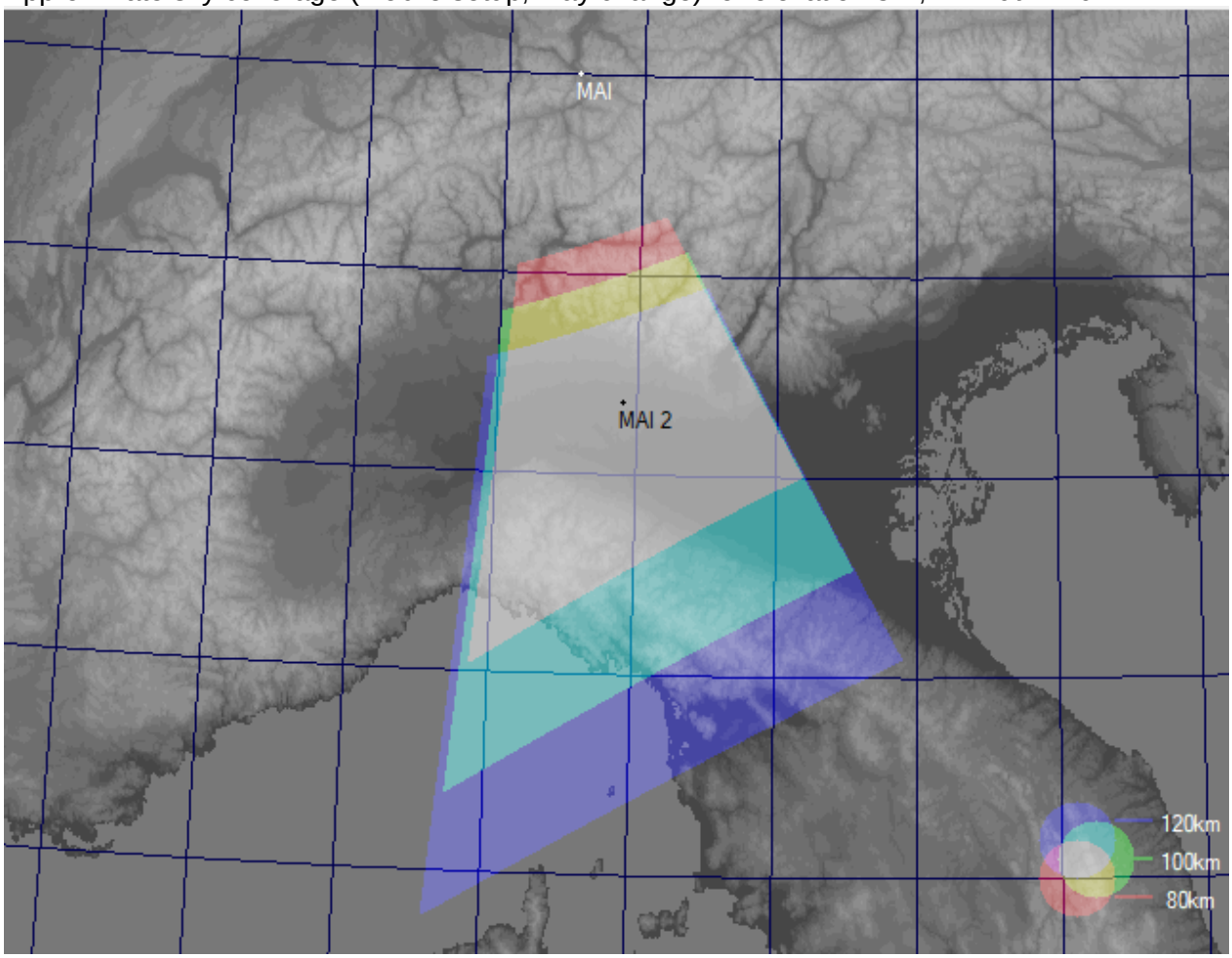
Meteor spectra 2022

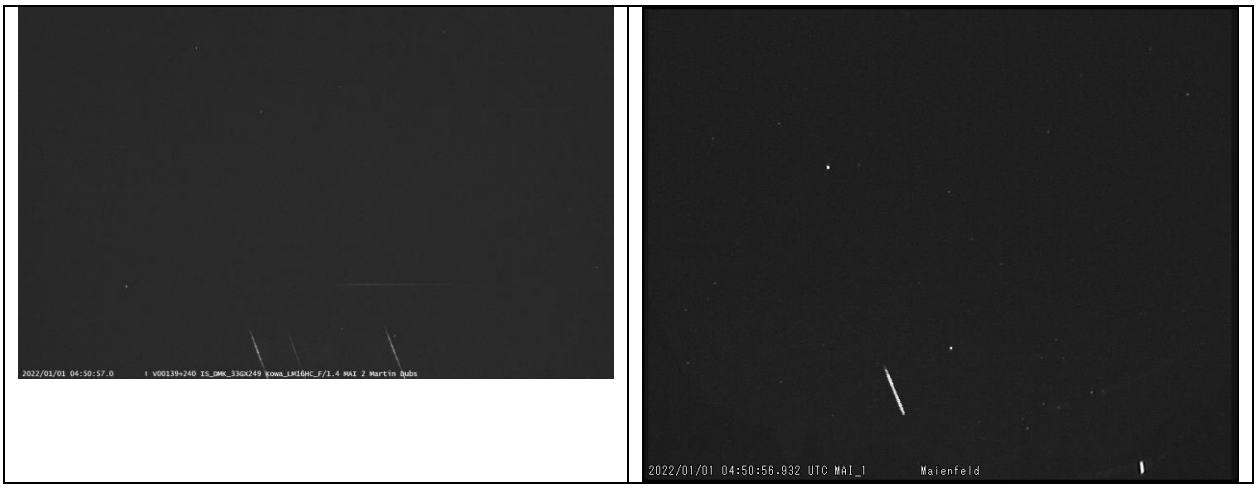
Overview

This is a collection of meteor spectra obtained at Maienfeld (MAI_2
Setup:
Camera: **DMK 33GX249**
Resolution 1920x1200
Frame Rate: 25 Hz
Sensor Type Sony IMX249LLJ-C
Sensor Format 1/1.2 inch
Pixel Size **5.86 µm**
Lens
Kowa LM16HC f: 16mm F/1.4
Field of view horizontal: 39°
Approximate sky coverage (mobile setup, may change) for elevation 37°, Azimuth 170°



Grating: Thorlabs 600l/mm, dispersion: 0.598 nm/pixel
Spectra analyzed with Python M_SPEC.py
In addition, meteors were recorded with a Watec 902H2 ultimate, equipped with a wide angle lens: Tamron VG412 ASIR at f ≅ 4mm, MAI_1

M20220101_045057_MAI_2, URS, -2.0m

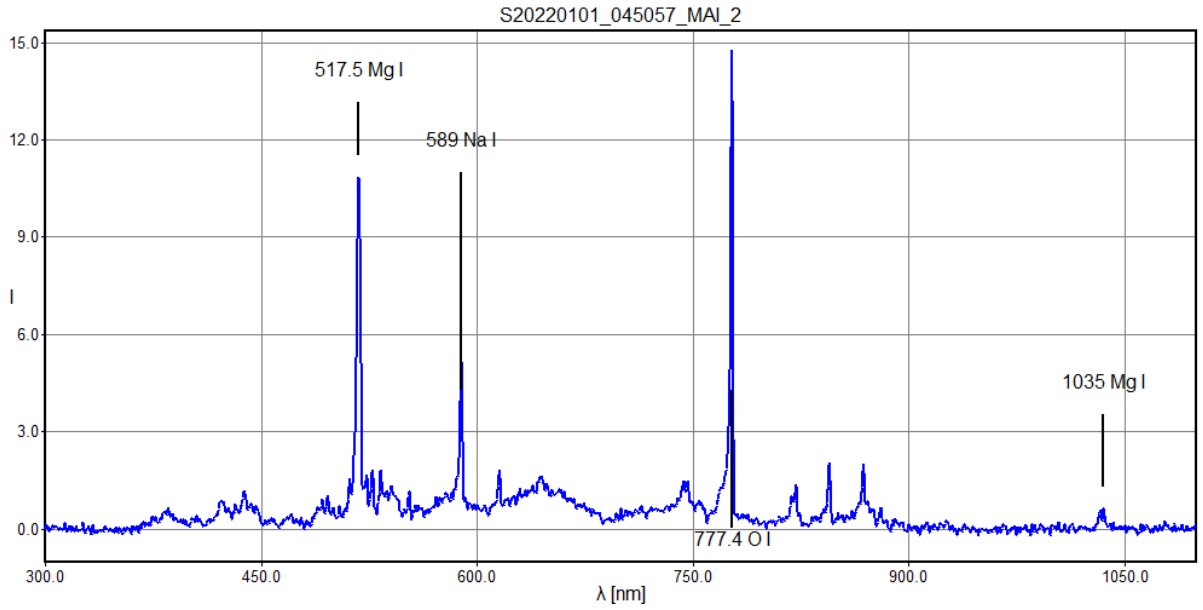


polynom for fit lambda c: [0.595 76.6688]

pixel	lambda	fit	error
741.41,	517.50,	517.78,	0.2790
861.04,	589.00,	588.95,	-0.0458
1176.97,	777.40,	776.92,	-0.4797
1611.16,	1035.00,	1035.25,	0.2465

rms_x = 0.3045

spectrum 220101\r_add6cal.dat saved



M20220101_233216_MAI_2, spo, -1.5m

polynom for fit lambda c: [0.5961 -281.4272]

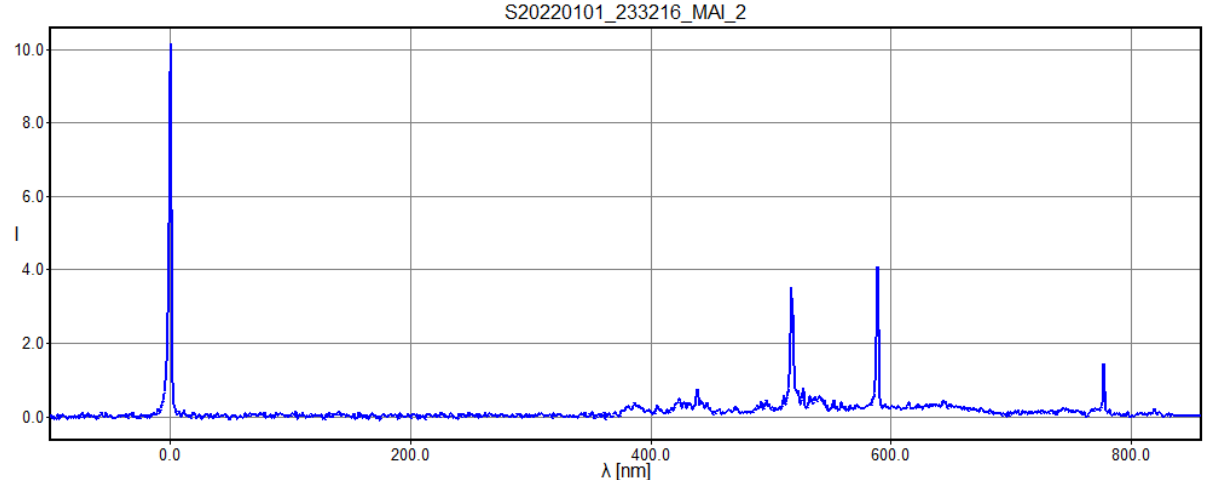
pixel	lambda	fit	error
472.94,	0.00,	0.49,	0.4913
1338.59,	517.50,	516.50,	-0.9965
1459.14,	589.00,	588.36,	-0.6369
1778.18,	777.40,	778.54,	1.1422

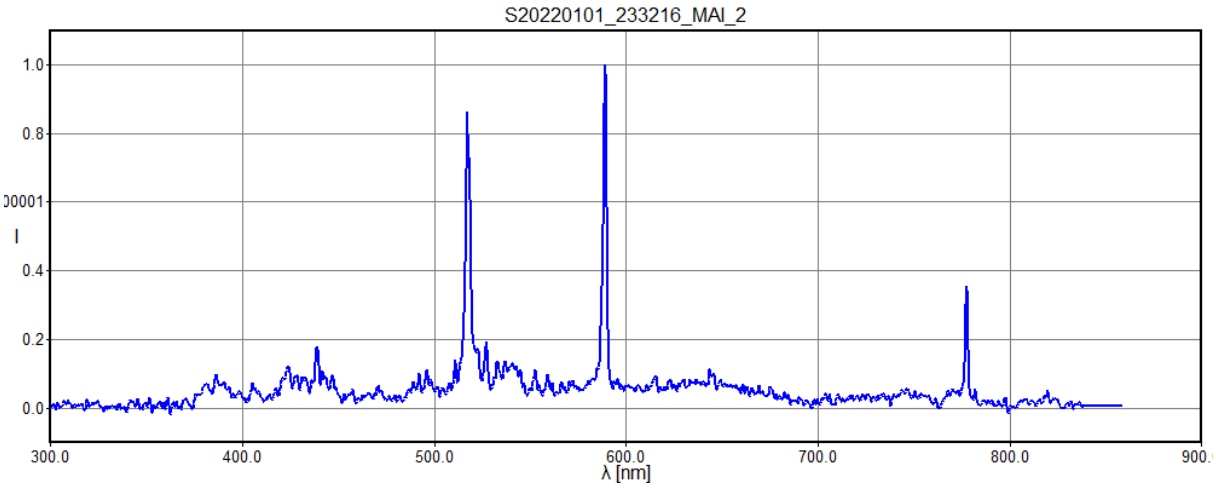
rms_x = 0.8580
spectrum 220101\r_add14cal.dat saved

polynom for fit lambda c: [-5.0793e-06 6.0704e-01 -2.8596e+02]

pixel	lambda	fit	error
472.94,	0.00,	-0.00,	-0.0006
1338.59,	517.50,	517.52,	0.0157
1459.14,	589.00,	588.98,	-0.0190
1778.18,	777.40,	777.40,	0.0039

rms_x = 0.0125
spectrum 220101\r_add14cal.dat saved



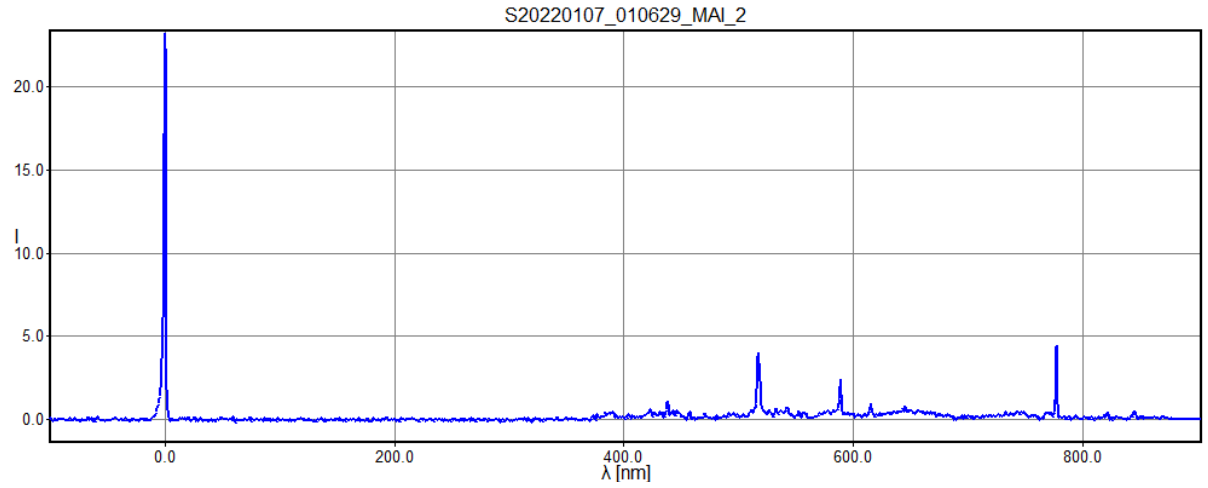


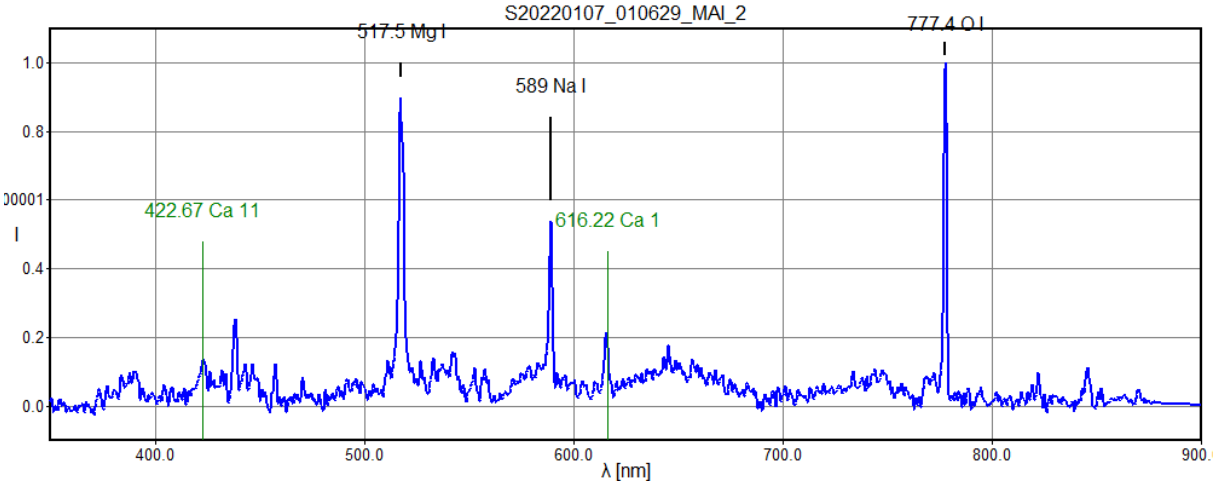
M20220107_010629_MAI_2P, URS, -1.7m

polynom for fit lambda c: [-4.5173e-06 6.0768e-01 -2.4446e+02]

pixel	lambda	fit	error
403.49,	0.00,	0.00,	0.0013
1265.73,	517.50,	517.47,	-0.0308
1385.87,	589.00,	589.04,	0.0373
1703.11,	777.40,	777.39,	-0.0077

rms_x = 0.0245



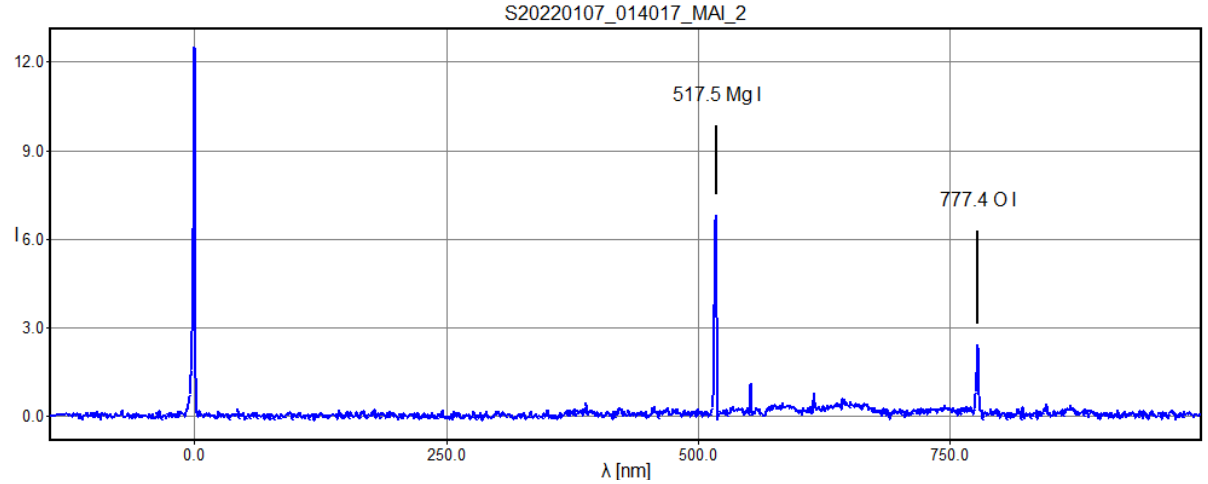


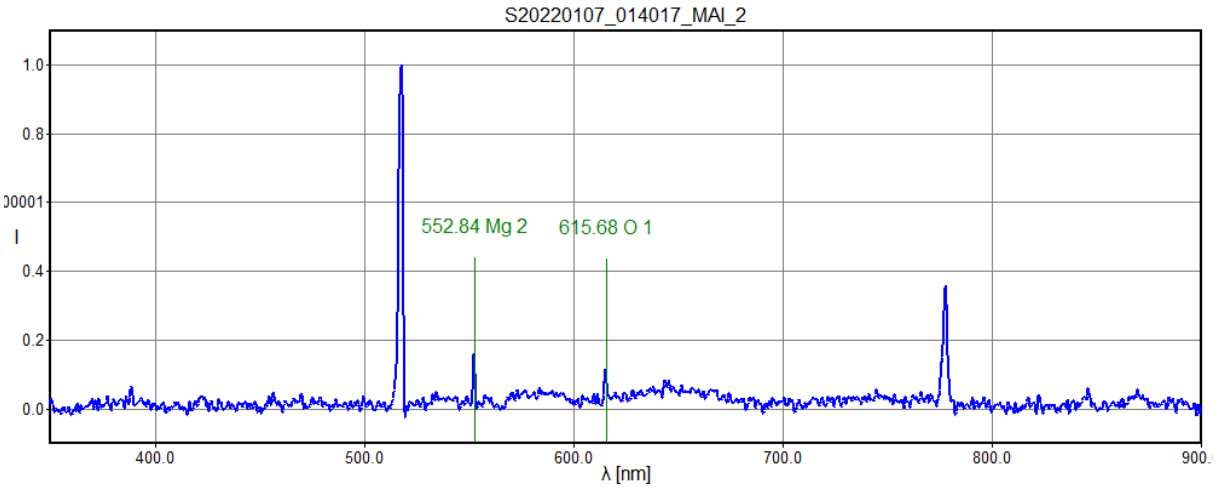
M20220107_014017_MAI_2, GEM, -0.7m

polynom for fit lambda c: [0.5973 -144.7853]

pixel	lambda	fit	error
242.44,	0.00,	0.03,	0.0287
1108.62,	517.50,	517.41,	-0.0857
1543.97,	777.40,	777.46,	0.0570

rms_x = 0.0617





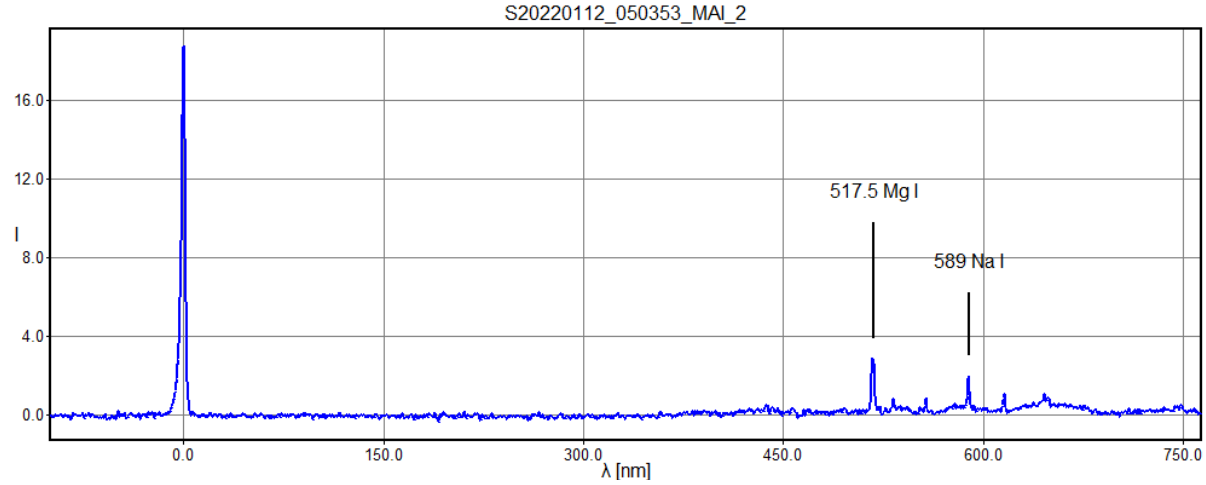
Notice missing Na-line!

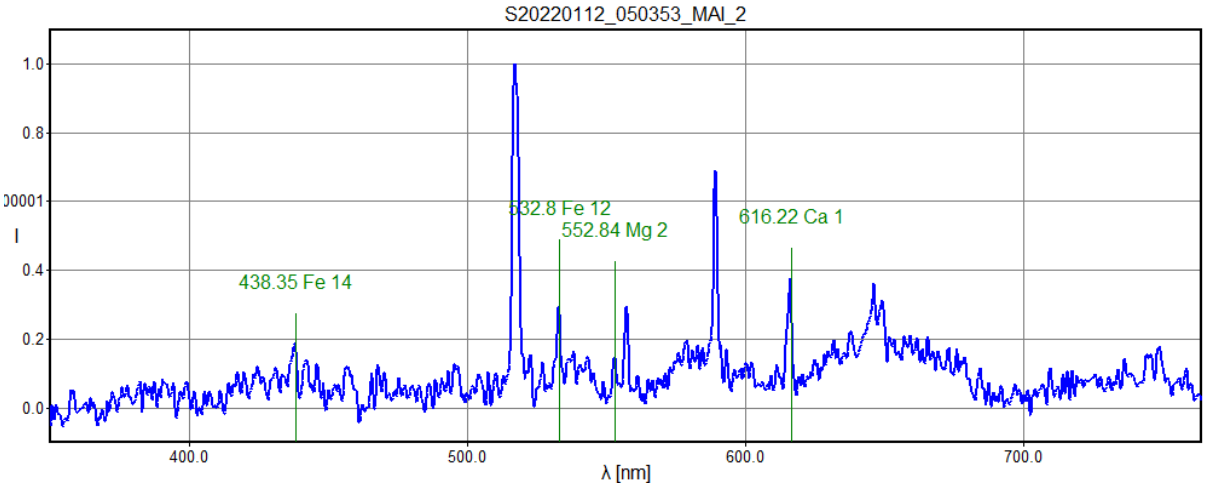
M20220112_050353_MAI_2, COM, -1.6m

polynom for fit lambda c: [0.5981 -382.545]

pixel	lambda	fit	error
639.65,	0.00,	0.02,	0.0242
1504.53,	517.50,	517.30,	-0.1984
1624.70,	589.00,	589.17,	0.1742

rms_x = 0.1531





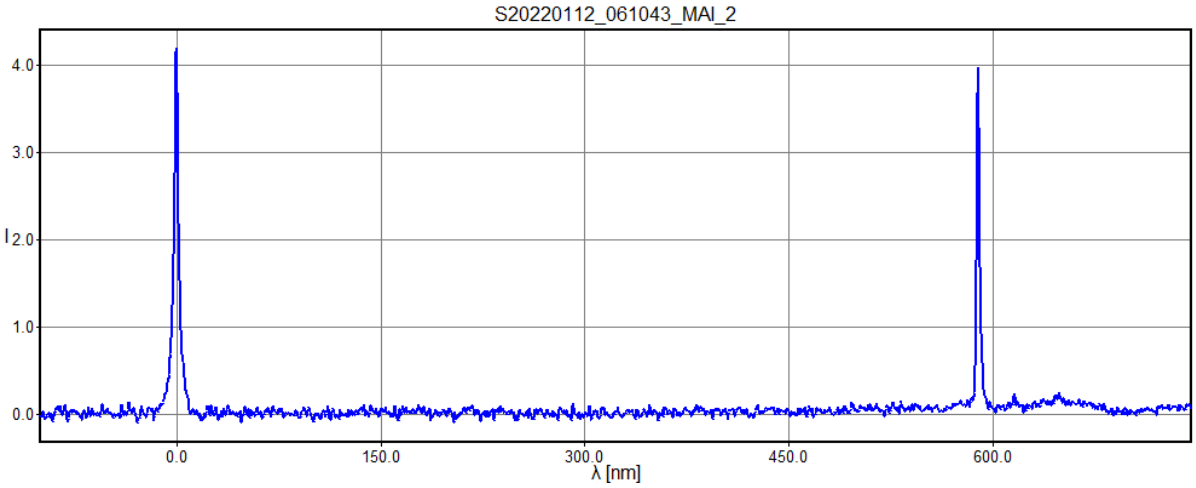
M20220112_061043_MAI_2, spo, -1.6m

polynom for fit lambda c: [0.5984 -400.2699]

pixel	lambda	fit	error
668.94,	0.00,	0.00,	0.0000
1653.29,	589.00,	589.00,	0.0000

rms_x = 0.0000

spectrum 220112\ra_add6cal.dat saved



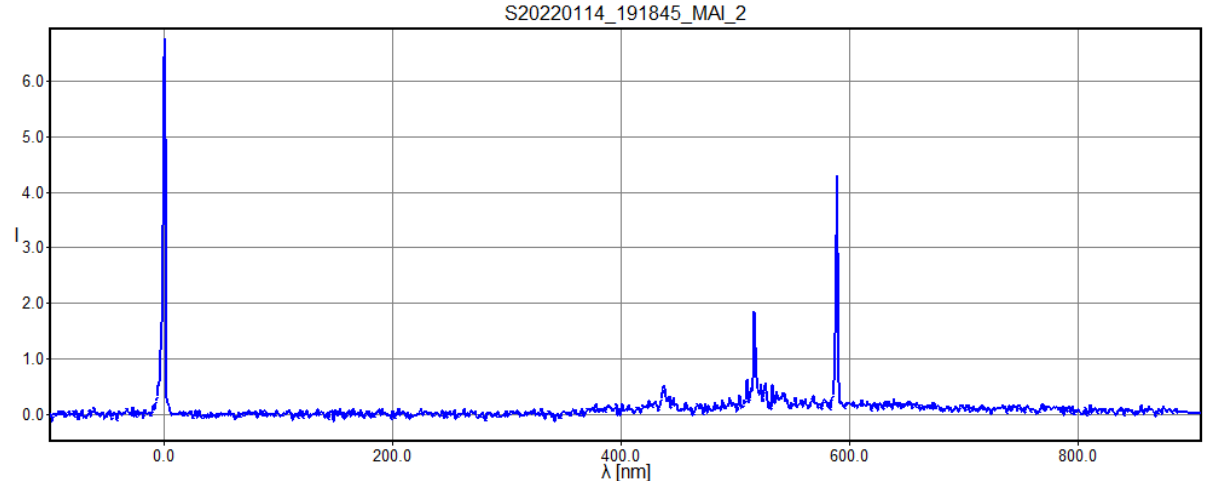
M20220114_191845_MAI_2, spo, -0.4m

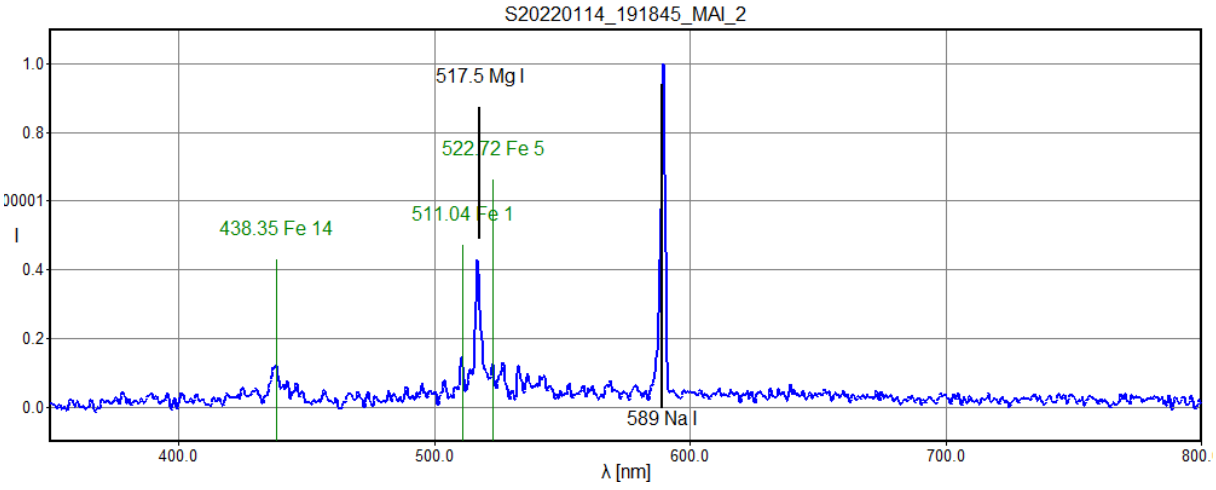
polynom for fit lambda c: [0.6002 -241.1926]

pixel	lambda	fit	error
401.94,	0.00,	0.06,	0.0584
1263.24,	517.50,	517.02,	-0.4752
1383.85,	589.00,	589.42,	0.4169

rms_x = 0.3665

spectrum 220114\r_add6cal.dat saved



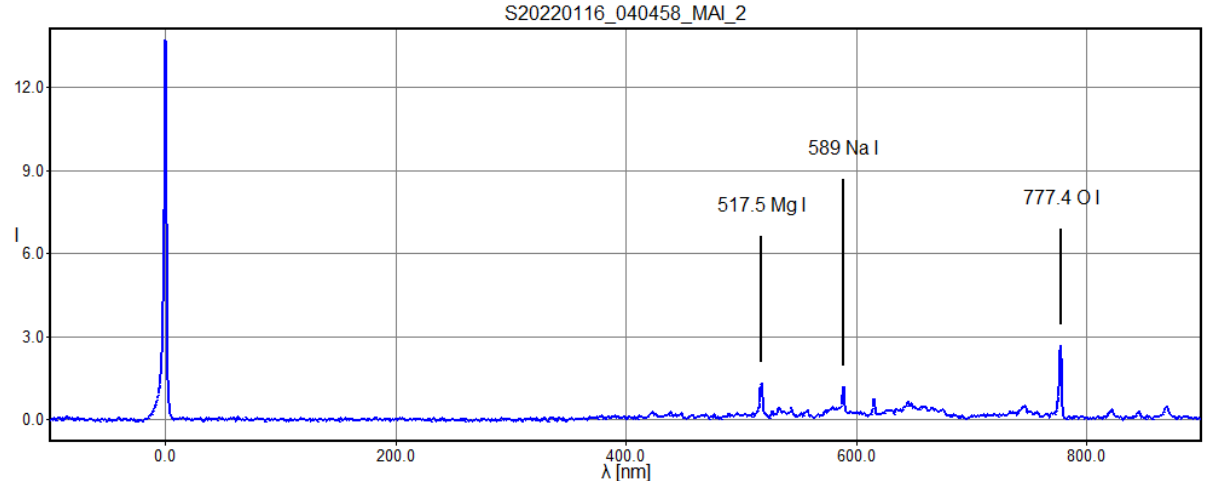


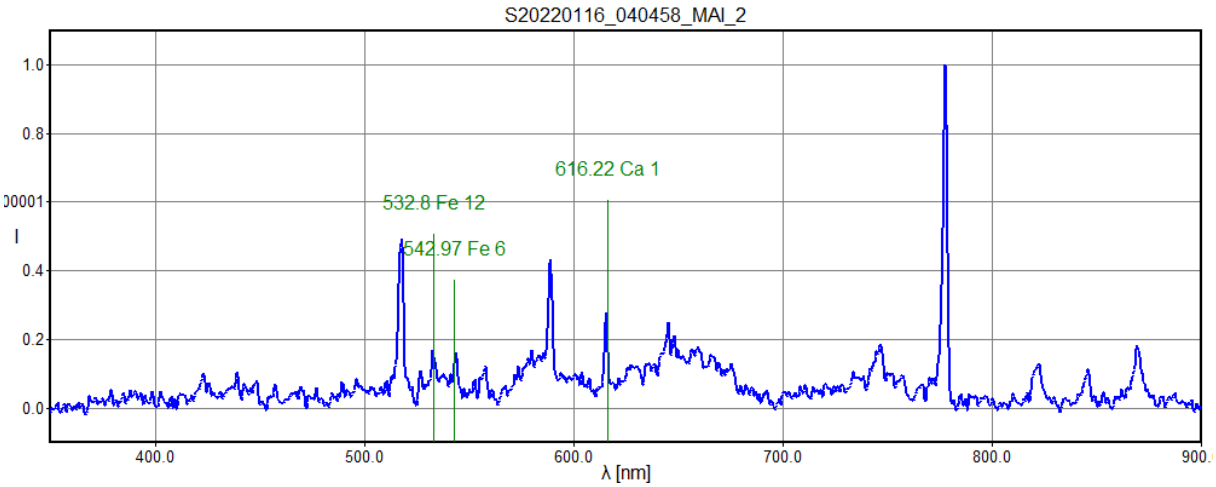
M20220116_040458_MAI_2, spo, -1.6m

polynom for fit lambda c: [-5.4388e-06 6.1107e-01 -2.3424e+02]

pixel	lambda	fit	error
384.64,	0.00,	-0.00,	-0.0041
1244.14,	517.50,	517.60,	0.0993
1363.56,	589.00,	588.88,	-0.1200
1680.70,	777.40,	777.42,	0.0248

rms_x = 0.0789





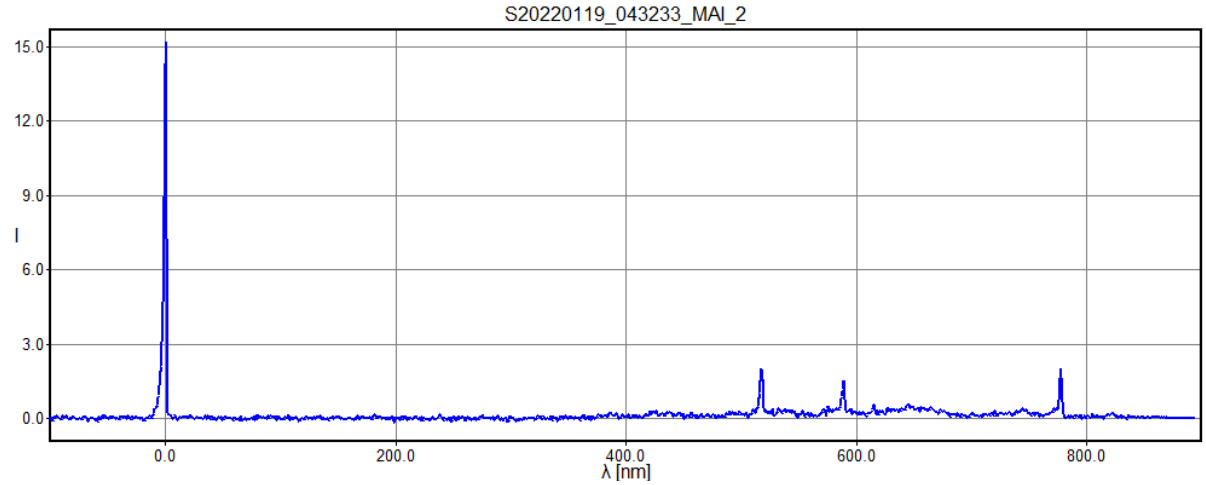
M20220119_043233_MAI_2, spo, -1.5m

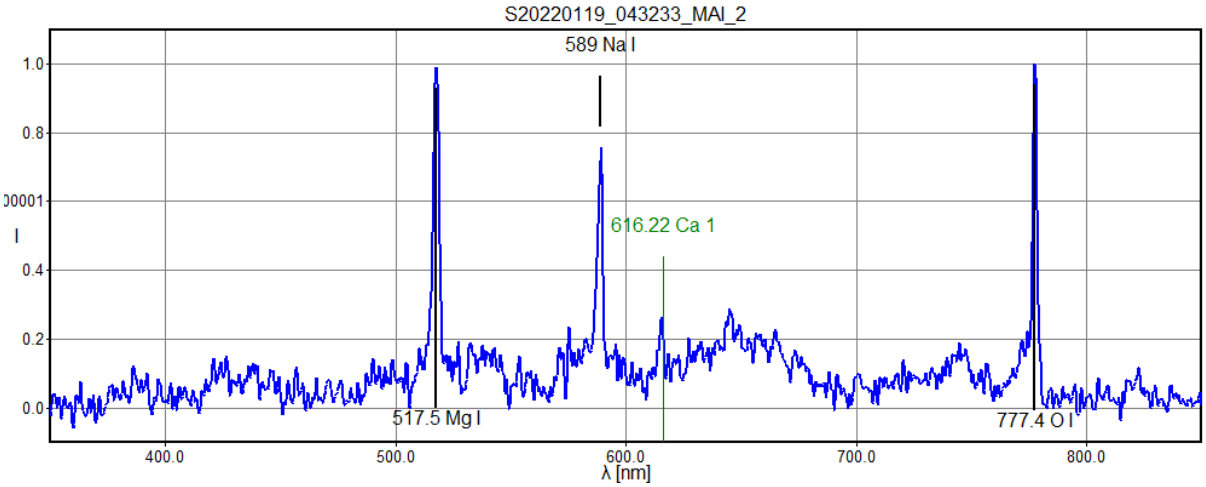
polynom for fit lambda c: [-3.8091e-06 6.0375e-01 -2.4864e+02]

pixel	lambda	fit	error
412.90,	0.00,	-0.00,	-0.0046
1279.49,	517.50,	517.61,	0.1135
1399.53,	589.00,	588.86,	-0.1372
1718.12,	777.40,	777.43,	0.0284

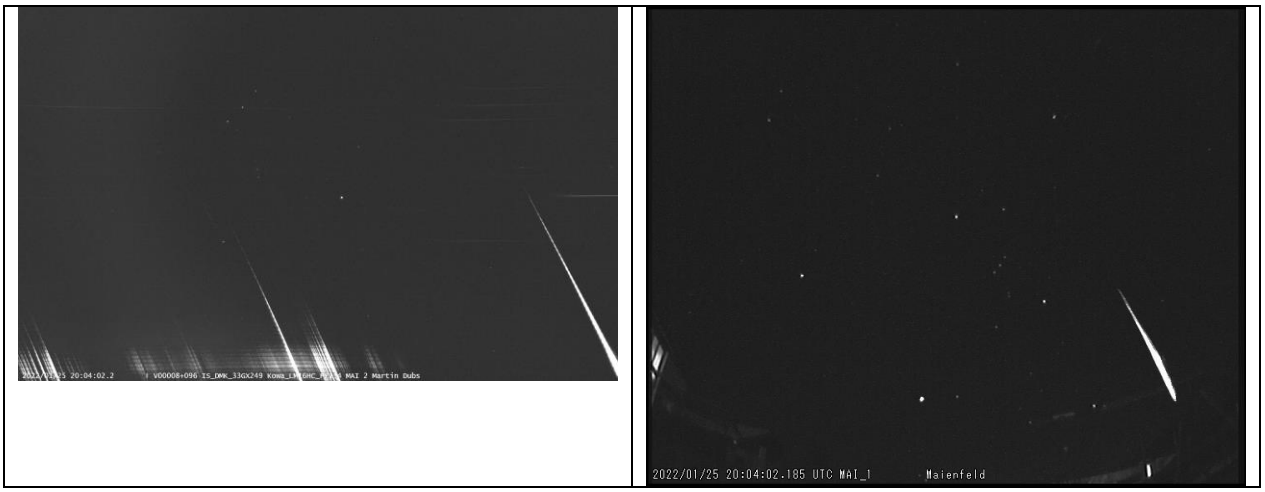
rms_x = 0.0902

spectrum 220119\r_add9cal.dat saved





M20220125_200402_MAI_2, spo, -2.0m

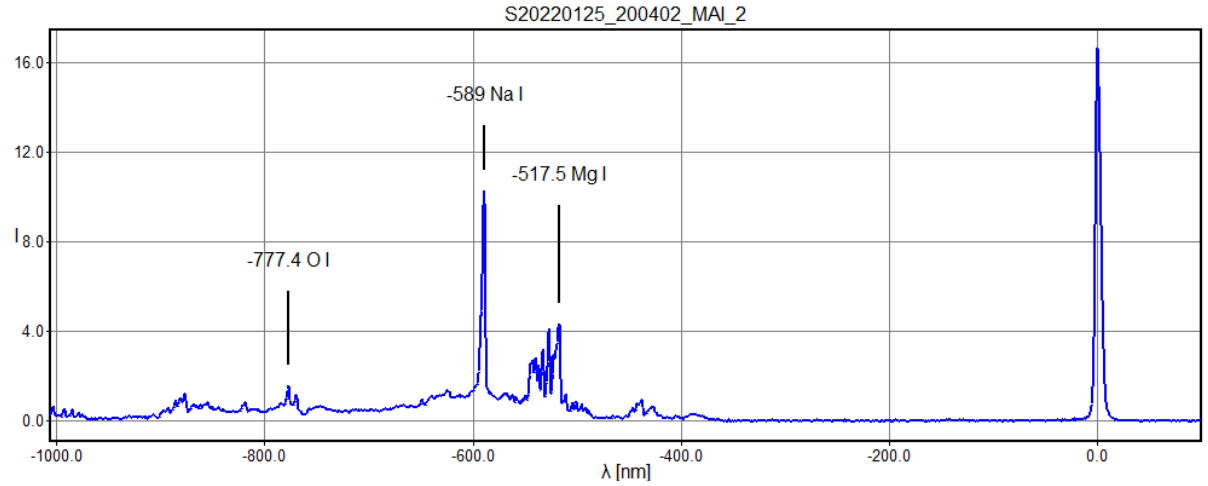


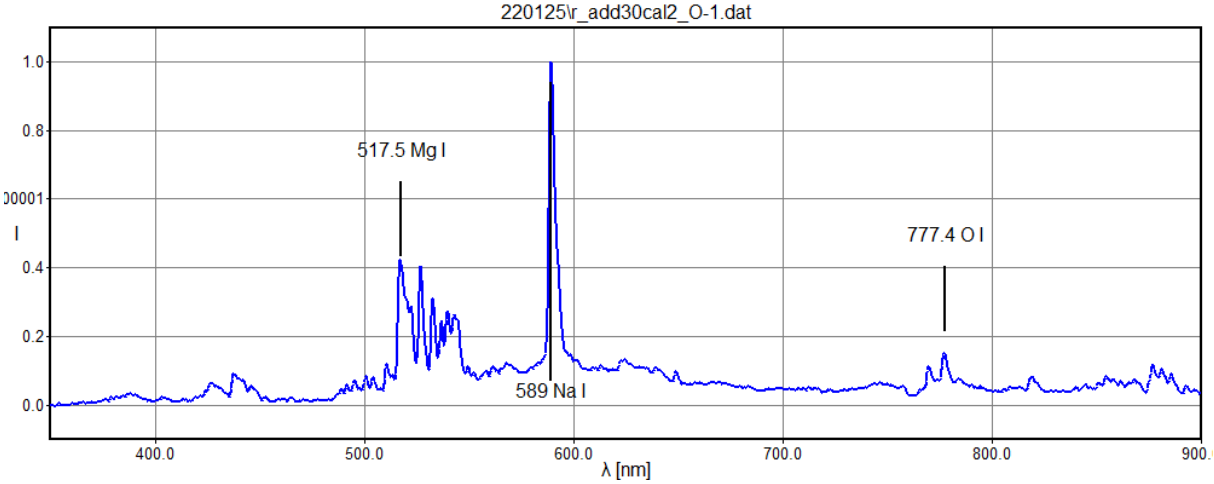
polynom for fit lambda c: [5.9733e-01 -1.0071e+03]

pixel	lambda	fit	error
1686.10,	0.00,	0.08,	0.0766
819.72,	-517.50,	-517.44,	0.0650
699.23,	-589.00,	-589.41,	-0.4069
384.95,	-777.40,	-777.13,	0.2654

rms_x = 0.2480

spectrum 220125\r_add30cal.dat saved





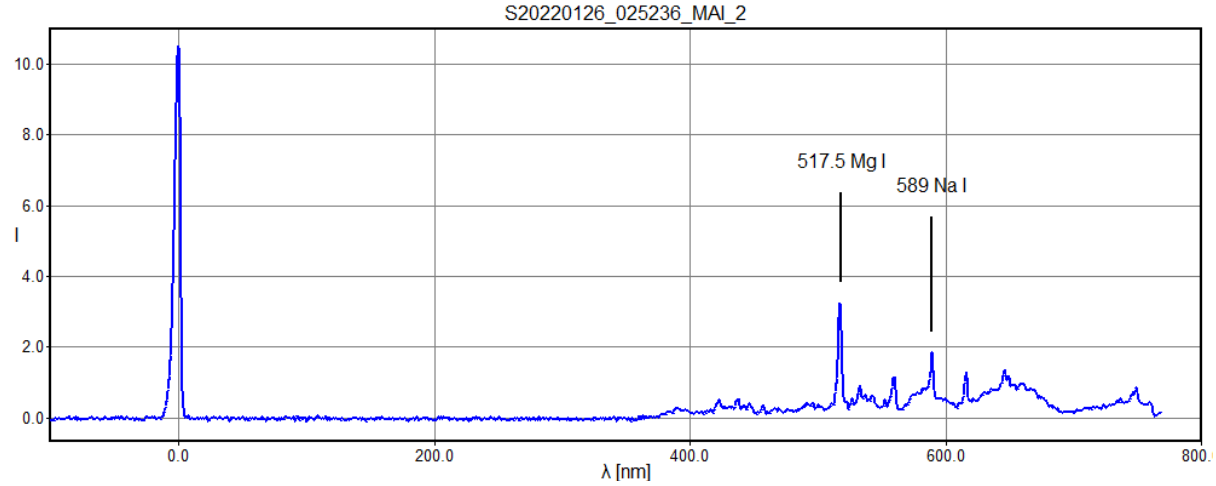
M20220126_025236_MAI_2, spo, -1.5m

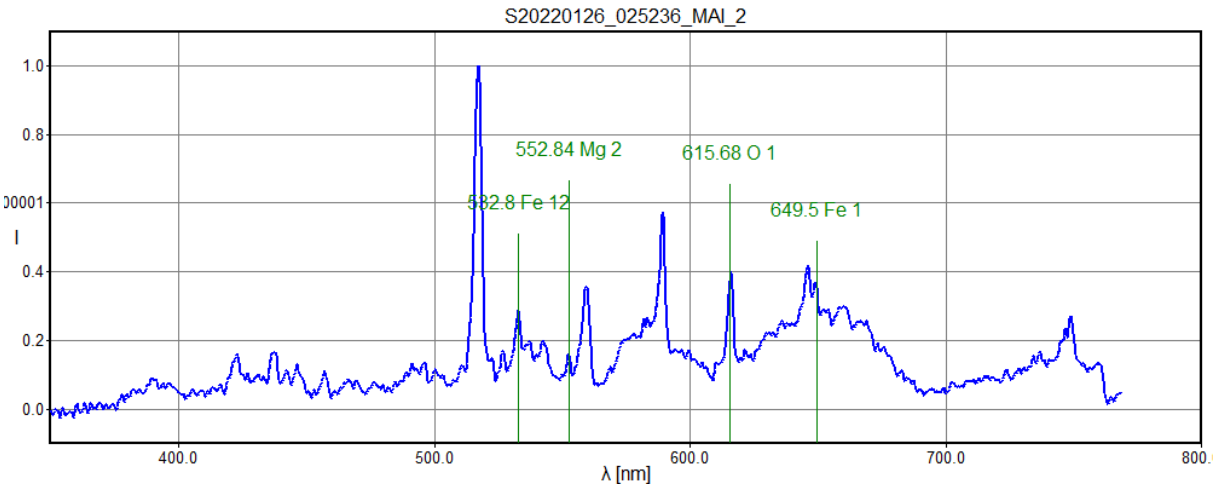
polynom for fit lambda c: [0.5977 -375.9895]

pixel	lambda	fit	error
629.16,	0.00,	0.03,	0.0297
1494.59,	517.50,	517.26,	-0.2436
1614.99,	589.00,	589.21,	0.2138

rms_x = 0.1879

spectrum 220126\ra_add18cal.dat saved





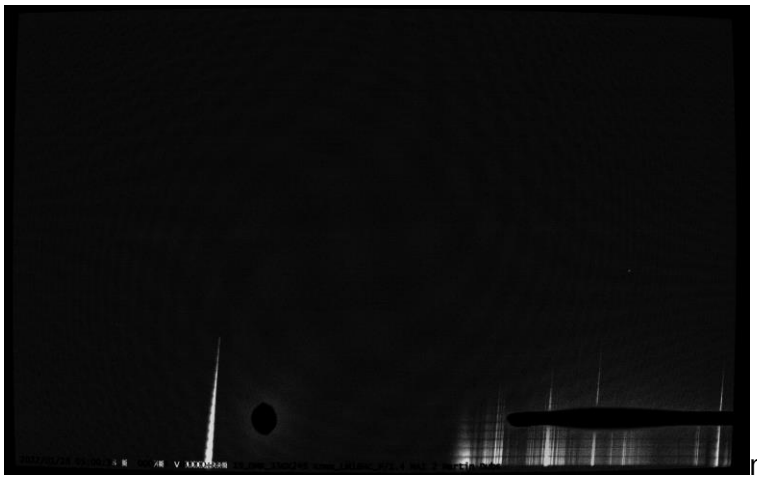
M20220126_050032_MAI_2, spo, -3.2m (-5.8m)

polynom for fit lambda c: [-6.0455e-06 6.1012e-01 -3.3595e+02]

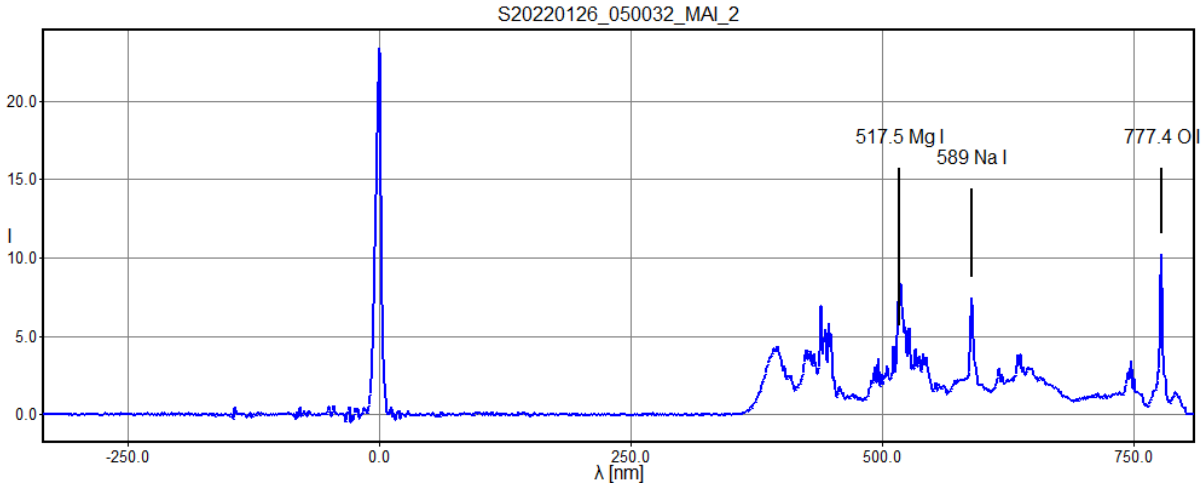
pixel	lambda	fit	error
553.67,	0.00,	-0.00,	-0.0024
1418.88,	517.50,	517.56,	0.0589
1539.39,	589.00,	588.93,	-0.0712
1859.09,	777.40,	777.41,	0.0147

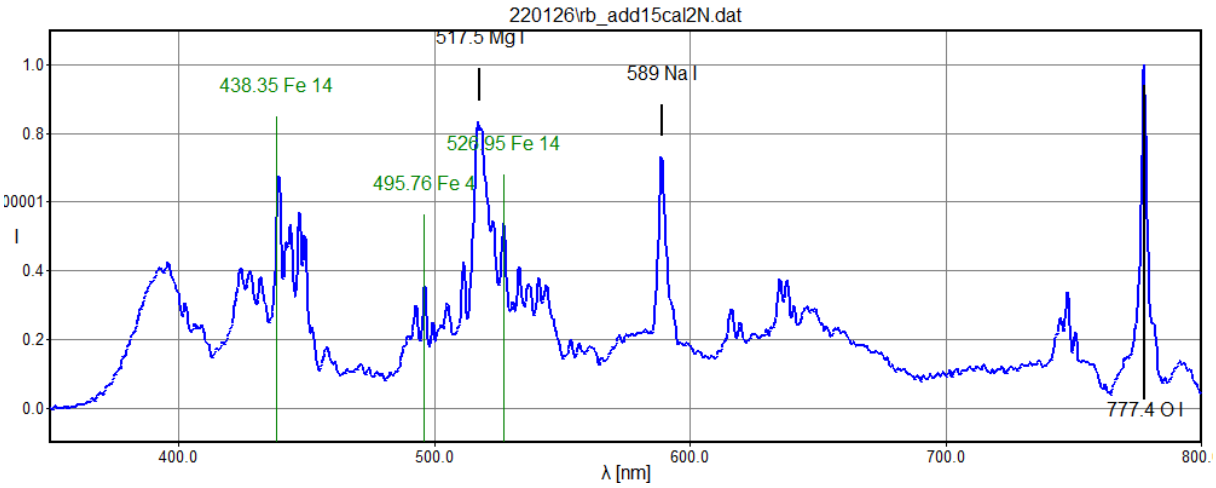
rms_x = 0.0468

spectrum 220126\rb_add15cal.dat saved



mdist_peak, background removed!




220126\rb_add15cal2N.dat
517.5 Mg I
589 Na I
438.35 Fe 14
526.95 Fe 14
495.76 Fe 4
777.4 O I
1.0
0.8
0.4
0.2
0.0
400.0
500.0
600.0
700.0
λ [nm]

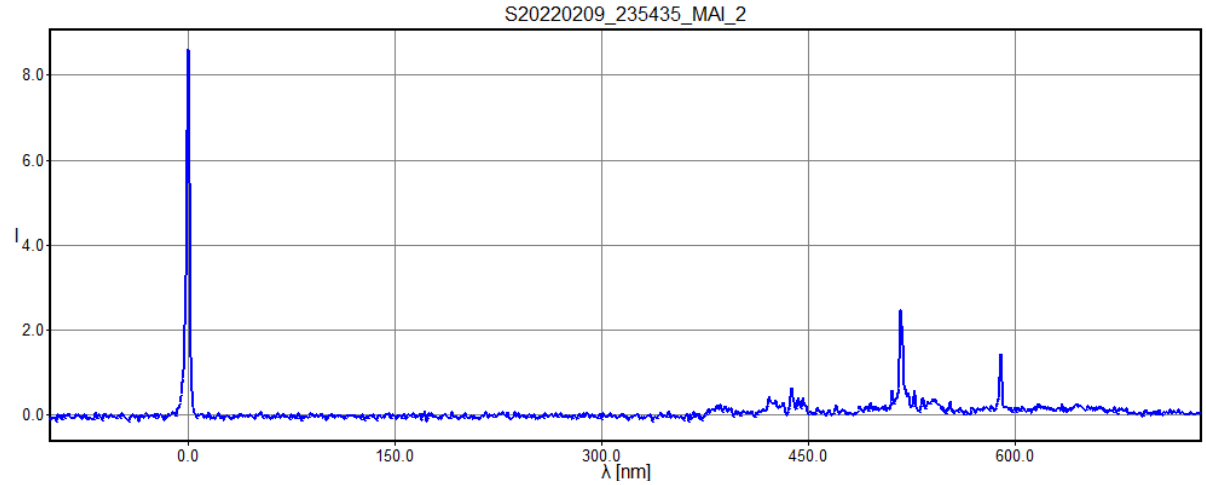
M20220209_235435_MAI_2, spo, -0.7m

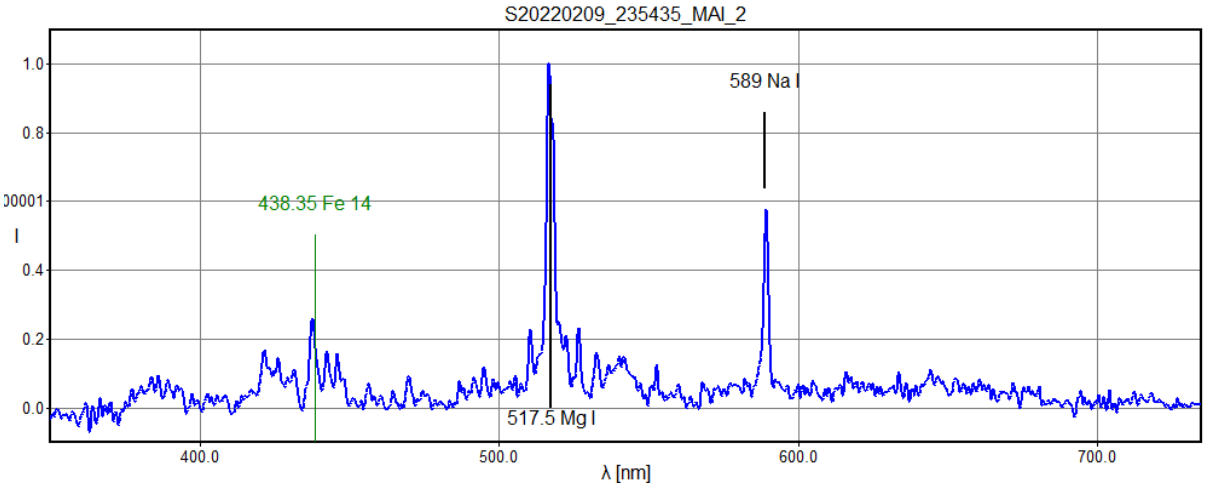
polynom for fit lambda c: [0.5982 -411.4455]

pixel	lambda	fit	error
687.90,	0.00,	0.05,	0.0461
1552.31,	517.50,	517.12,	-0.3765
1673.02,	589.00,	589.33,	0.3304

rms_x = 0.2904

spectrum 220209\r_add14cal.dat saved





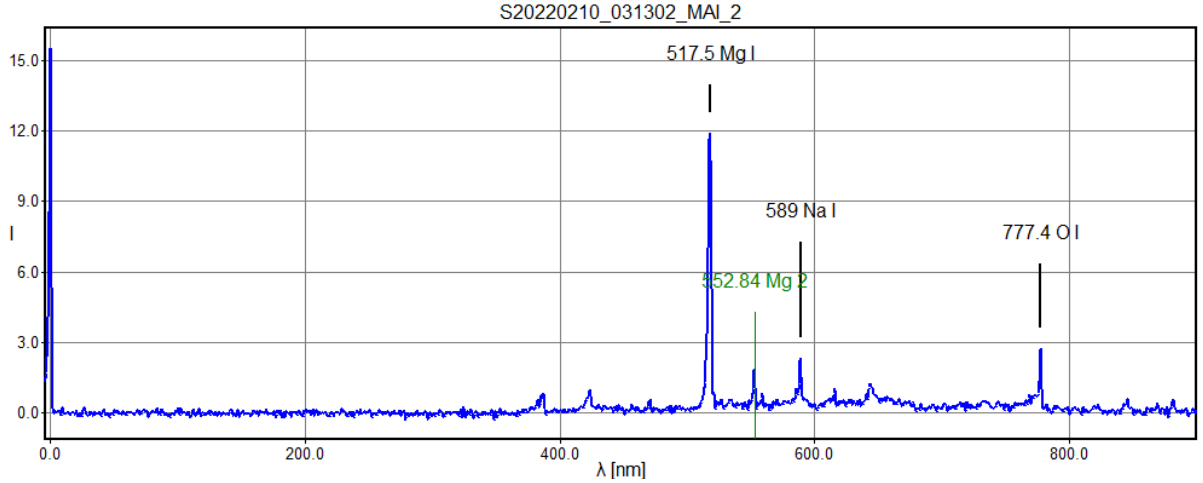
M20220210_031302_MAI_2, spo, -1.2m

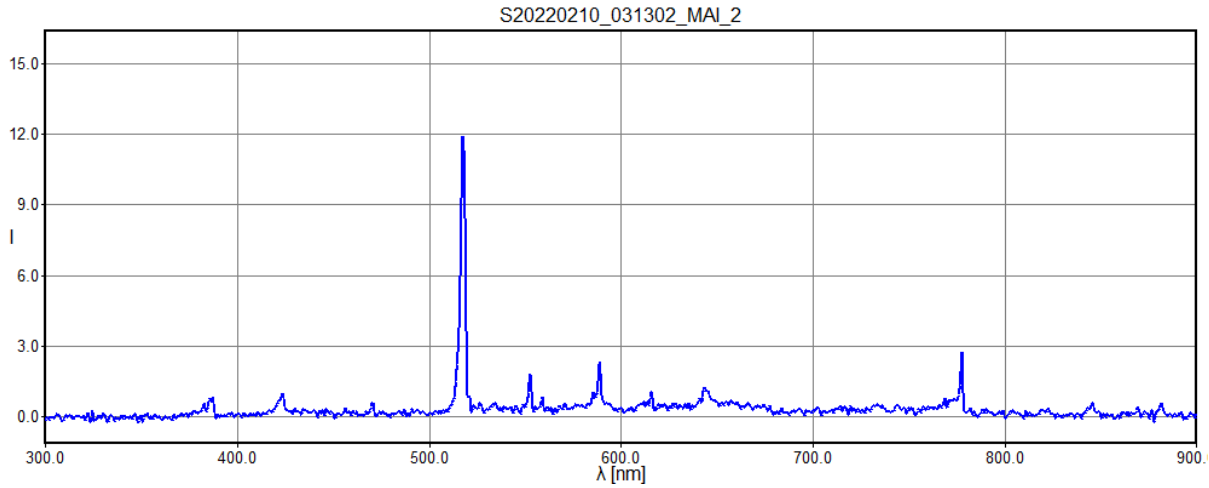
polynom for fit lambda c: [0.5966 -5.8859]

pixel	lambda	fit	error
9.81,	0.00,	-0.03,	-0.0334
877.69,	517.50,	517.73,	0.2309
996.85,	589.00,	588.82,	-0.1800
1312.92,	777.40,	777.38,	-0.0174

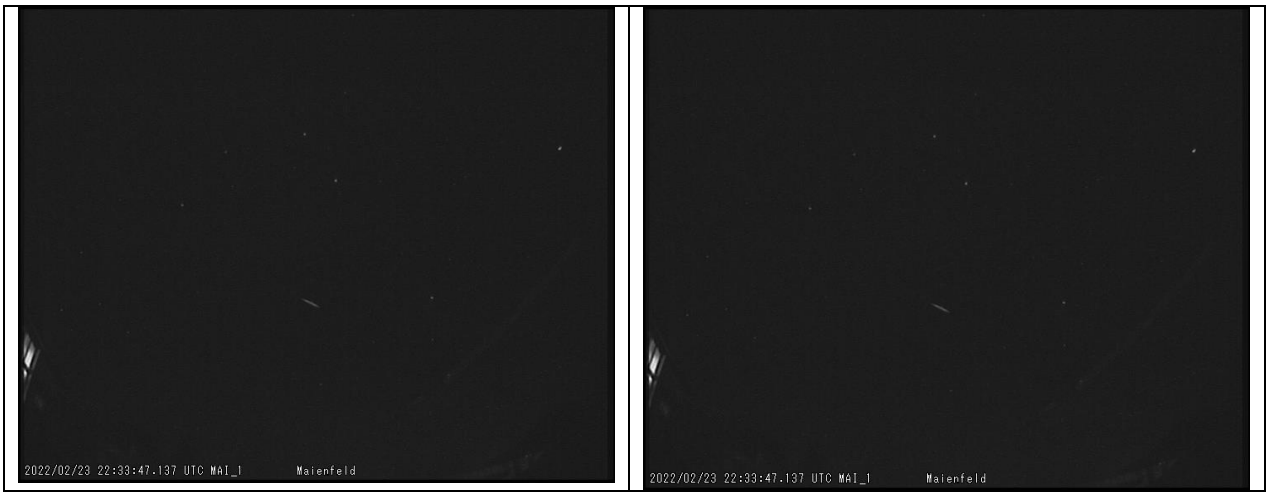
rms_x = 0.1476

spectrum 220210\r_add9cal.dat saved





M20220223_223347_MAI_2, spo, 0.6m

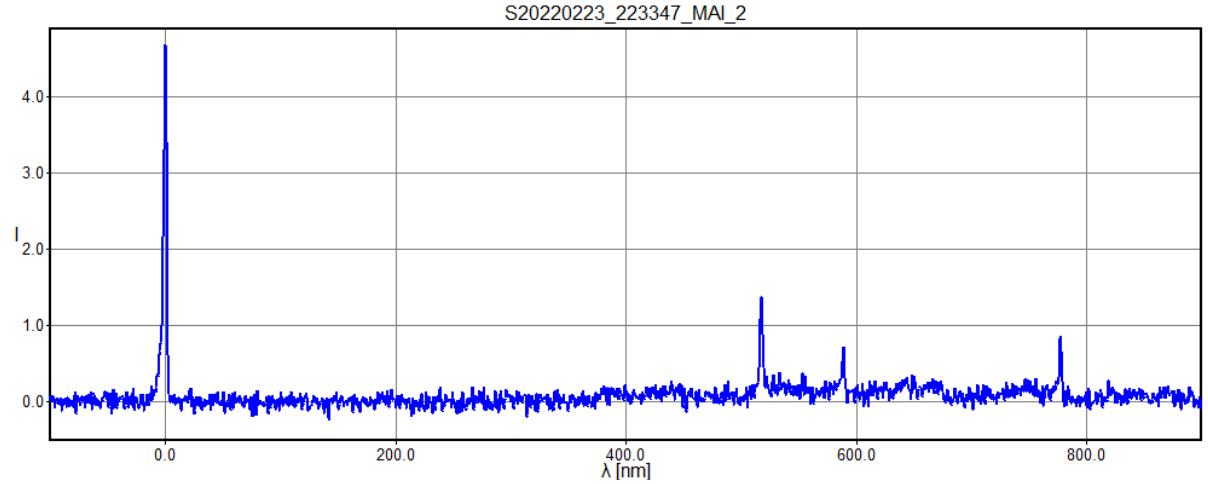


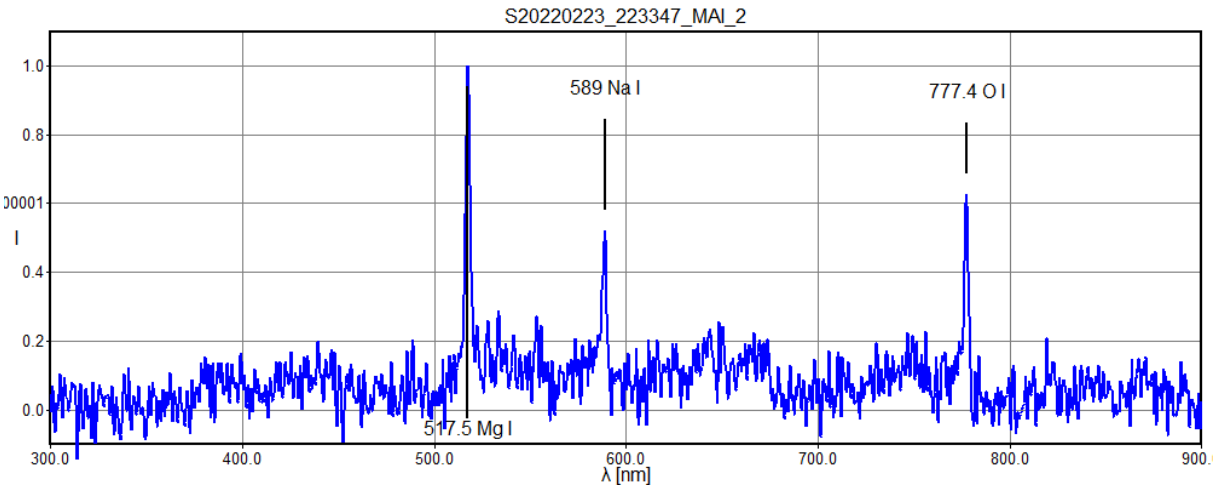
polynom for fit lambda c: [-4.4207e-06 6.0582e-01 -1.0873e+02]

pixel	lambda	fit	error
179.70,	0.00,	-0.00,	-0.0044
1041.79,	517.50,	517.61,	0.1082
1161.34,	589.00,	588.87,	-0.1308
1478.70,	777.40,	777.43,	0.0271

rms_x = 0.0860

spectrum 220223\r_add15cal.dat saved





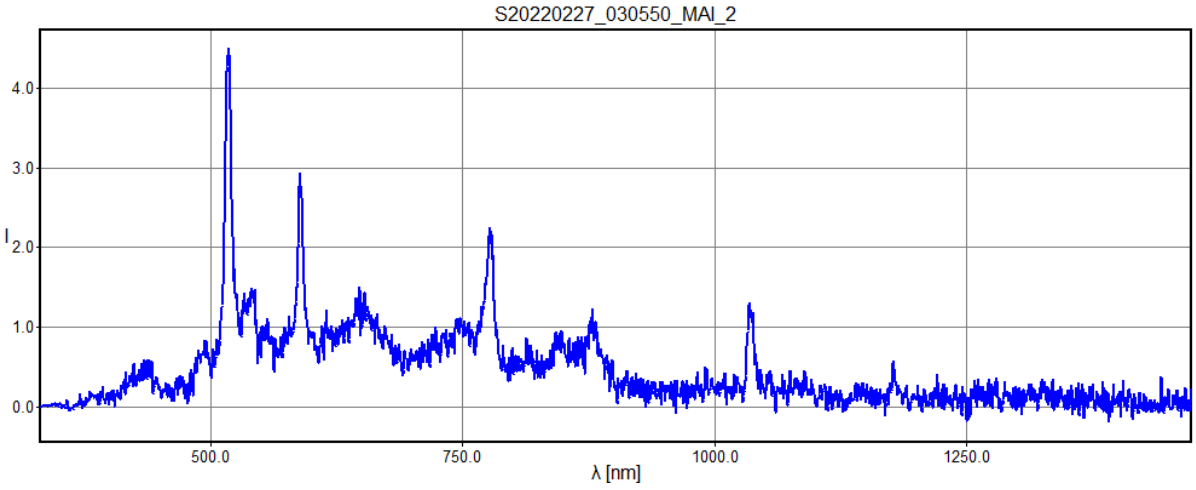
M20220227_030550_MAI_2, spo, -1.7m

polynom for fit lambda c: [0.5962 330.897]

pixel	lambda	fit	error
313.39,	517.50,	517.74,	0.2405
432.72,	589.00,	588.89,	-0.1149
748.43,	777.40,	777.11,	-0.2883
1181.27,	1035.00,	1035.17,	0.1714
1420.82,	1178.00,	1177.99,	-0.0087

rms_x = 0.1916

spectrum 220227\r_add16cal.dat saved



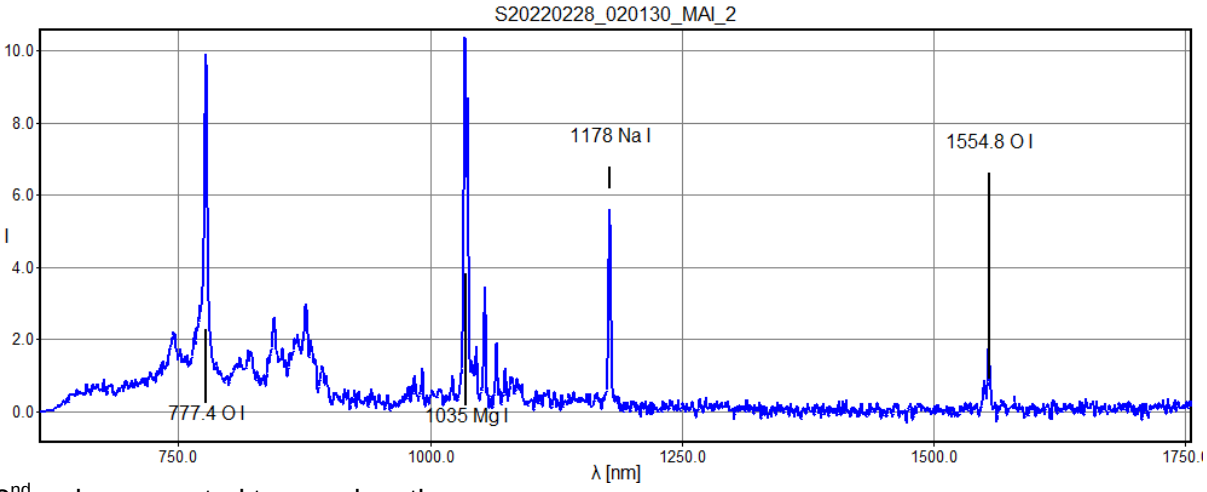
M20220228_020130_MAI_2, spo, -2.1m

polynom for fit lambda c: [5.9682e-01 6.1234e+02]

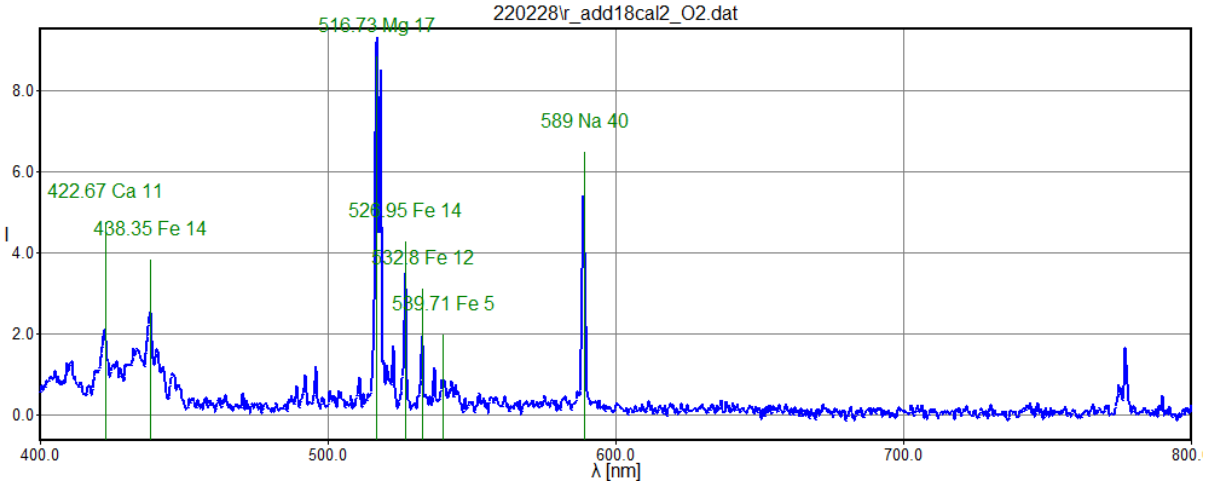
pixel	lambda	fit	error
276.68,	777.40,	777.47,	0.0705
707.72,	1035.00,	1034.72,	-0.2759
948.18,	1178.00,	1178.24,	0.2356
1579.08,	1554.80,	1554.77,	-0.0302

rms_x = 0.1854

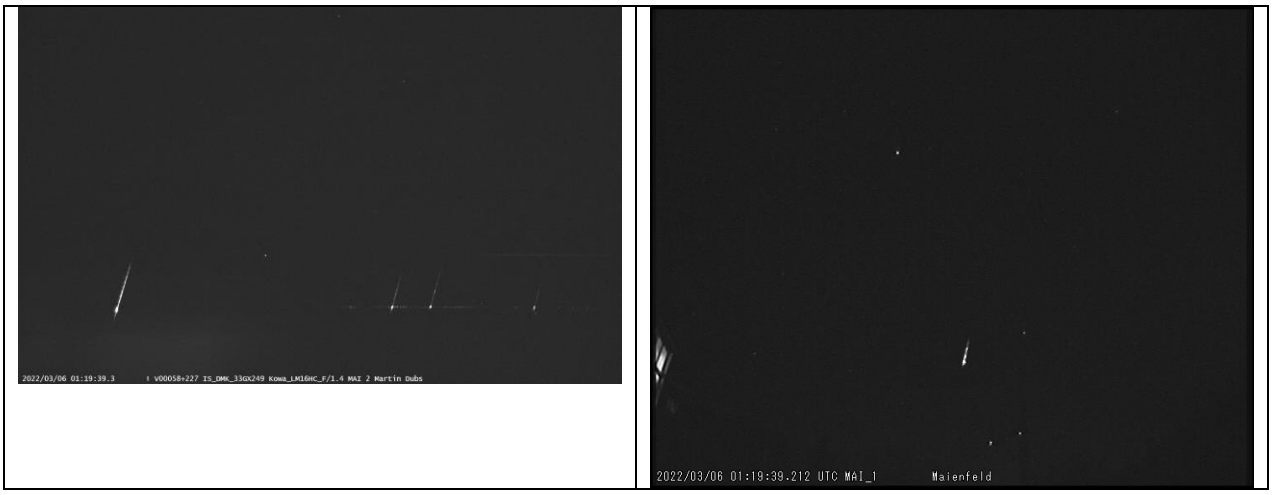
spectrum 220228\r_add18cal.dat saved



2nd order converted to wavelength:



M20220306_011939_MAI_2, spo, -2.7m

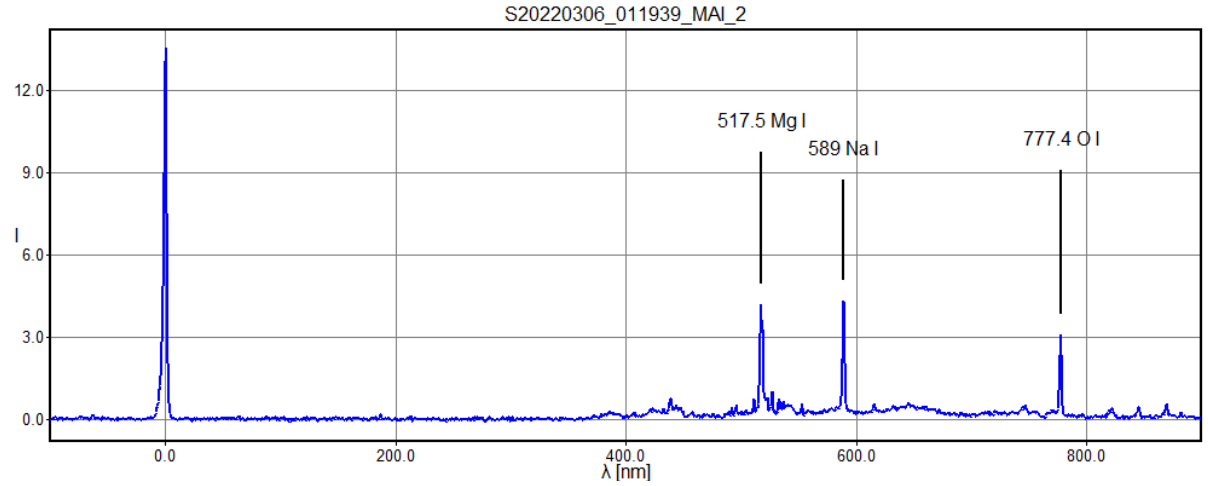


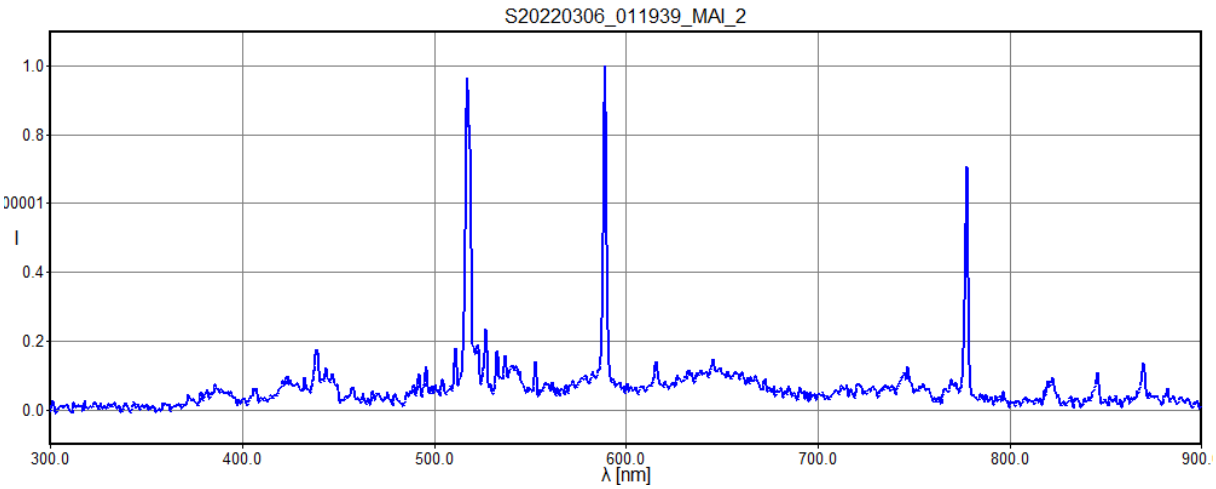
polynom for fit lambda c: [-3.5345e-06 6.0402e-01 -2.1566e+02]

pixel	lambda	fit	error
357.79,	0.00,	-0.00,	-0.0006
1222.58,	517.50,	517.52,	0.0157
1342.70,	589.00,	588.98,	-0.0190
1660.23,	777.40,	777.40,	0.0039

rms_x = 0.0125

spectrum D:\DatenD\meteor-spectrum-latest\220306\r_add12cal.dat saved





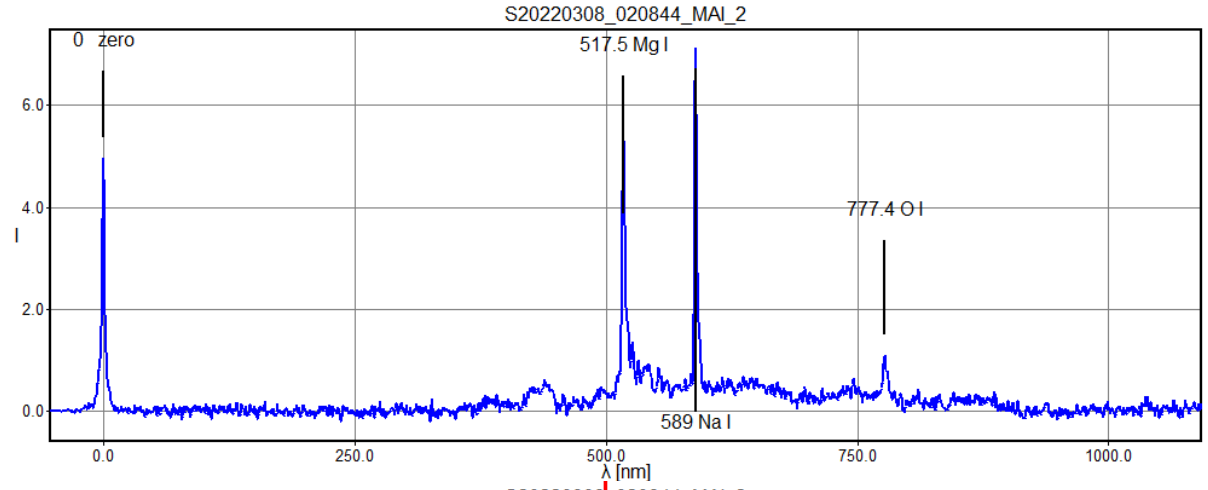
M20220308_020844_MAI_2, EVI, -.9m

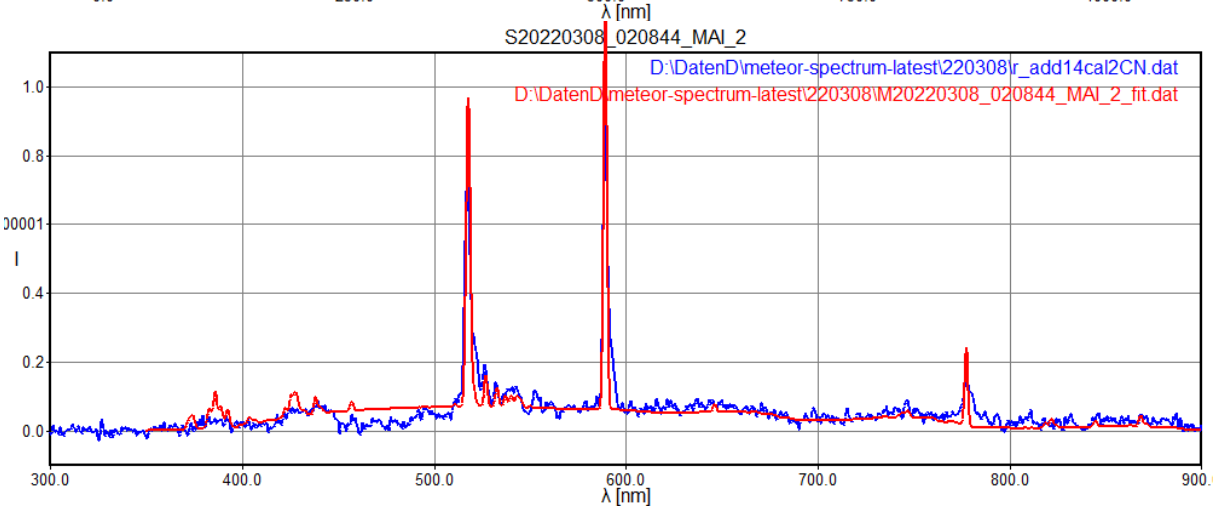
polynom for fit lambda c: [1.3647e-06 5.9624e-01 -5.4772e+01]

pixel	lambda	fit	error
91.85,	0.00,	0.00,	0.0036
957.56,	517.50,	517.41,	-0.0885
1077.25,	589.00,	589.11,	0.1074
1391.24,	777.40,	777.38,	-0.0225

rms_x = 0.0705

spectrum D:\DatenD\meteor-spectrum-latest\220308\r_add14cal.dat saved





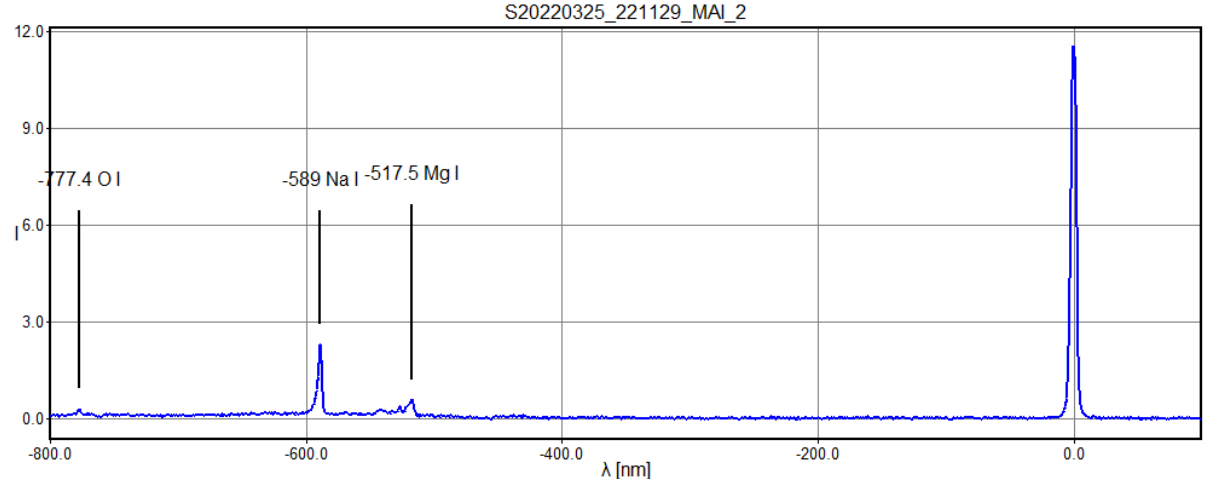
M20220325_221129_MAI_2, spo, -2.5m

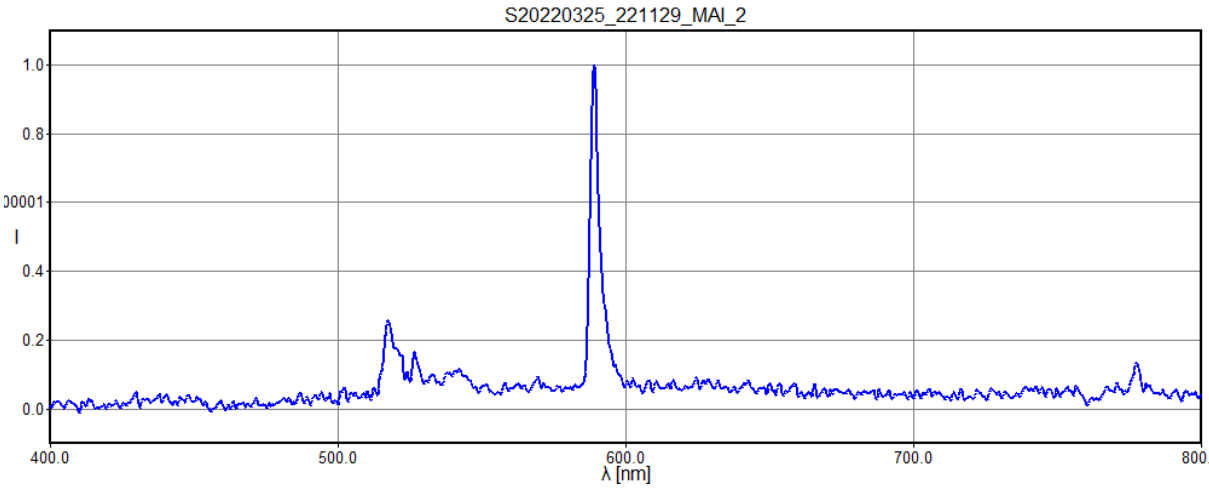
polynom for fit lambda c: [5.9817e-01 -8.4157e+02]

pixel	lambda	fit	error
1406.88,	0.00,	-0.01,	-0.0145
541.78,	-517.50,	-517.50,	0.0050
422.33,	-589.00,	-588.95,	0.0531
107.21,	-777.40,	-777.44,	-0.0435

rms_x = 0.0352

spectrum 220325\r_add36cal.dat saved





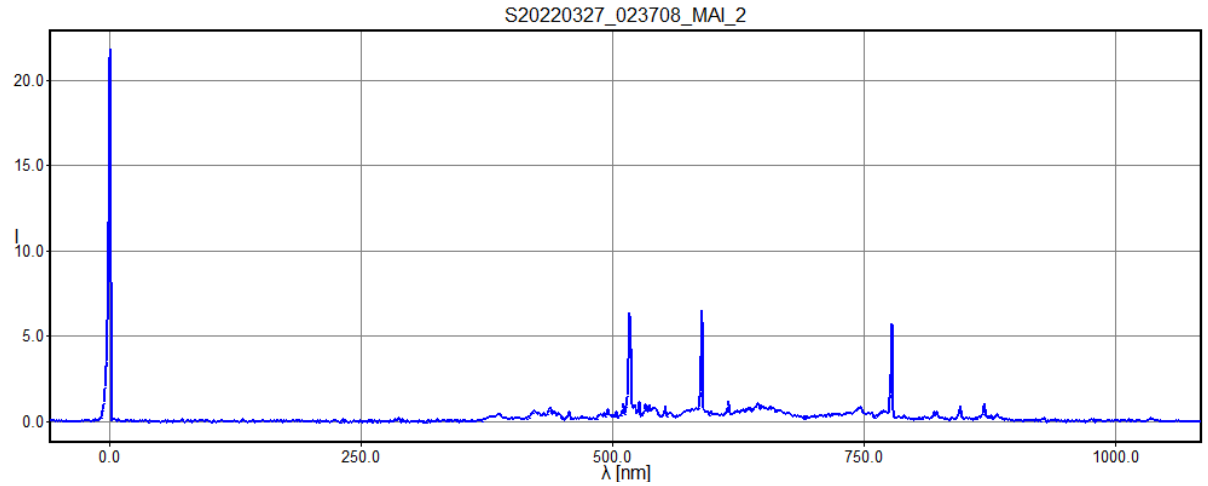
M20220327_023708_MAI_2,spo, -2.2m

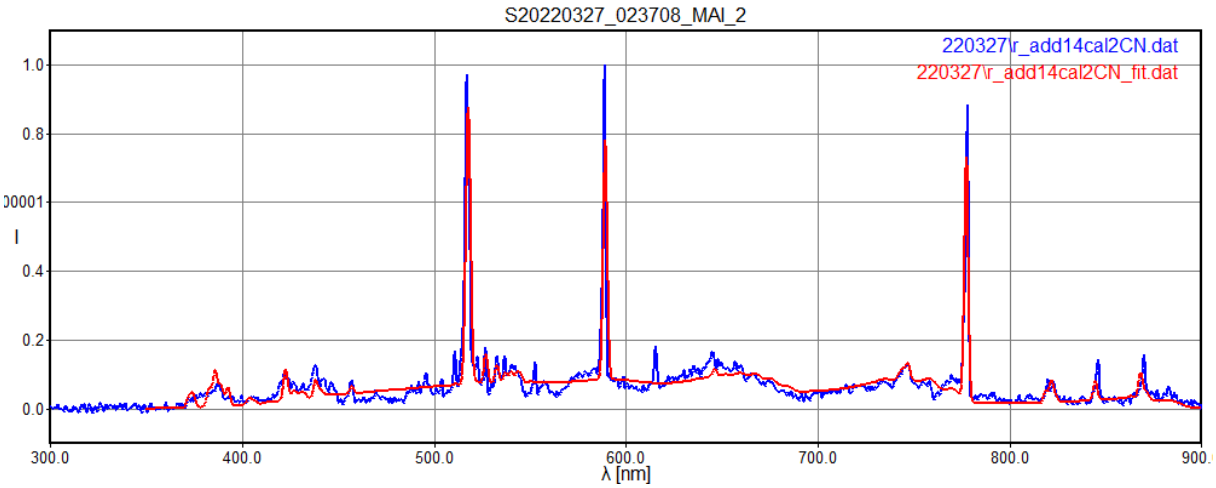
polynom for fit lambda c: [0.5979 -60.1227]

pixel	lambda	fit	error
100.86,	0.00,	0.18,	0.1814
965.56,	517.50,	517.19,	-0.3148
1085.15,	589.00,	588.69,	-0.3120
1401.52,	777.40,	777.85,	0.4454

rms_x = 0.3270

spectrum 220327\r_add14cal.dat saved





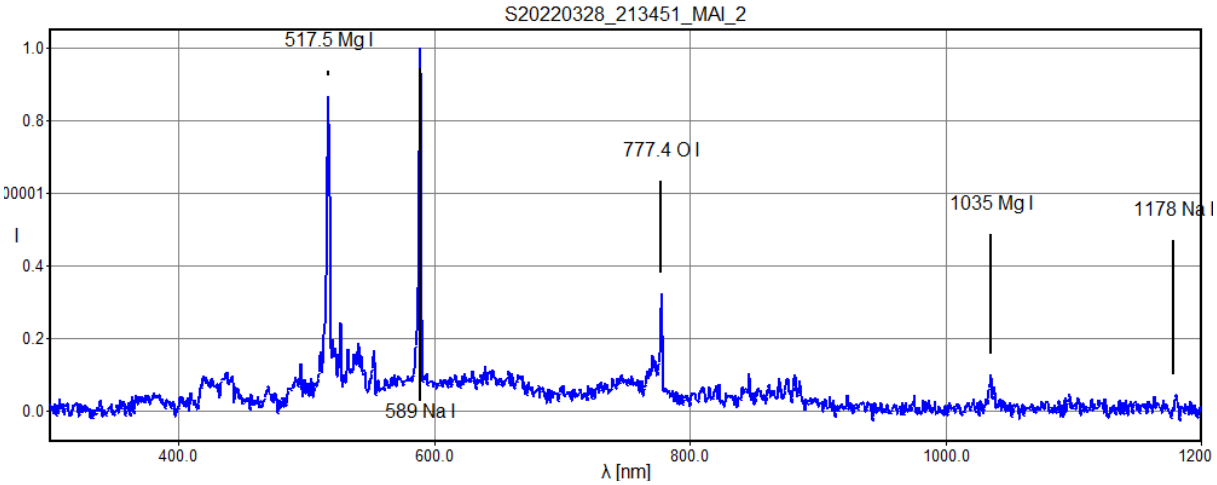
M20220328_213451_MAI_2, spo, -2m

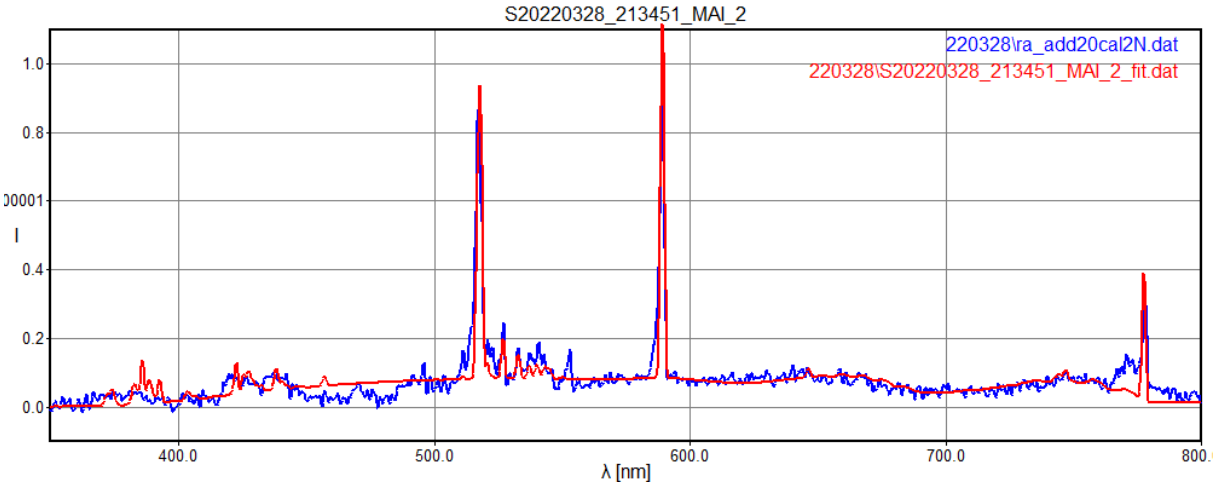
polynom for fit lambda c: [0.6 149.24]

pixel	lambda	fit	error
733.01,	589.00,	589.06,	0.0608
613.35,	517.50,	517.26,	-0.2376
1047.52,	777.40,	777.77,	0.3731
1475.89,	1035.00,	1034.80,	-0.1962

rms_x = 0.2439

spectrum 220328\ra_add20cal.dat saved





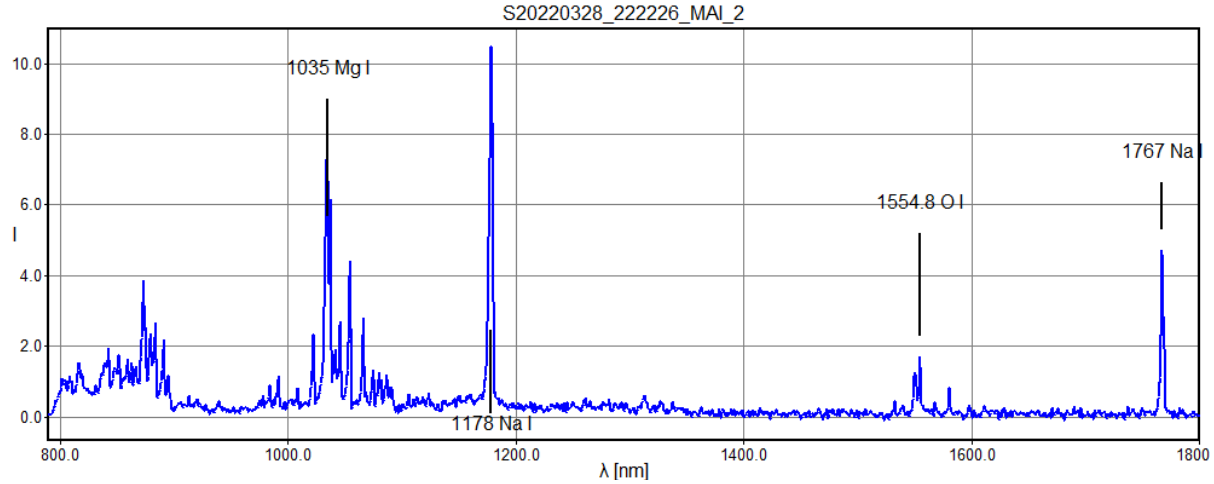
M20220328_222226_MAI_2, spo, -4m

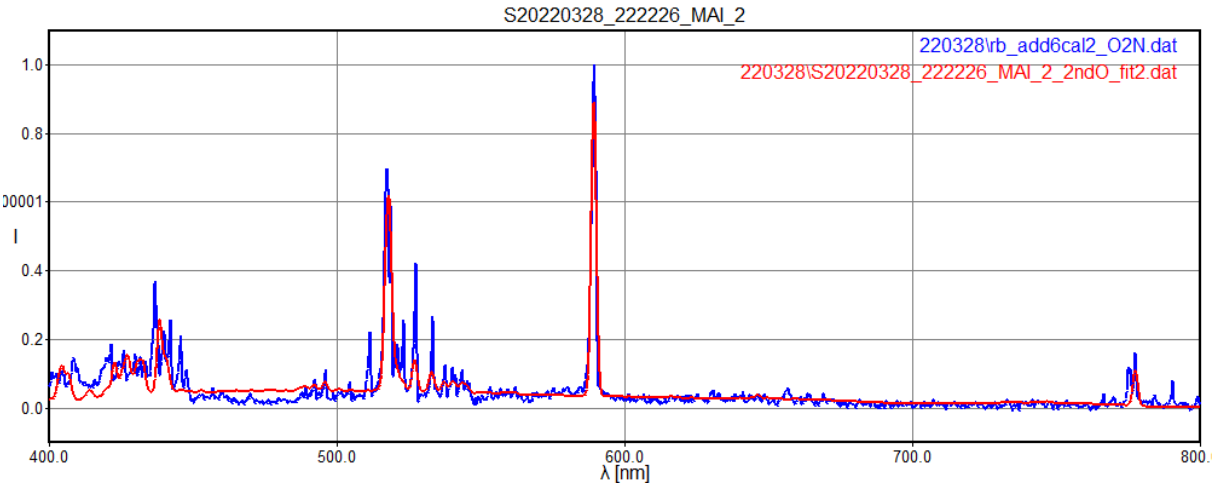
polynom for fit lambda c: [5.9893e-01 7.7351e+02]

pixel	lambda	fit	error
435.90,	1035.00,	1034.58,	-0.4161
676.38,	1178.00,	1178.61,	0.6145
1304.03,	1554.80,	1554.53,	-0.2673
1658.89,	1767.00,	1767.07,	0.0689

rms_x = 0.3959

spectrum 220328\rb_add6cal.dat saved





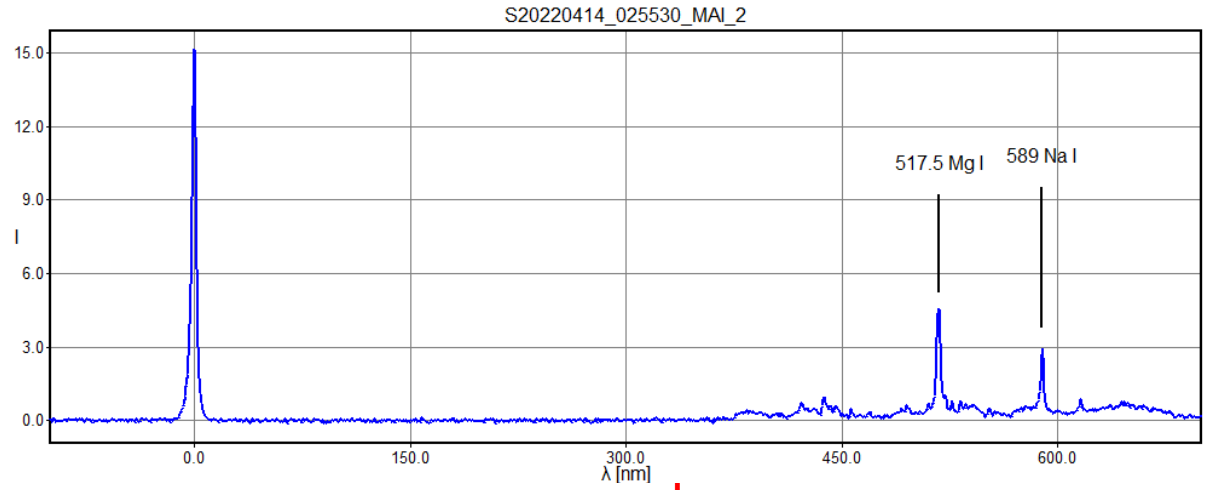
M20220414_025530_MAI_2, spo, -3.0m

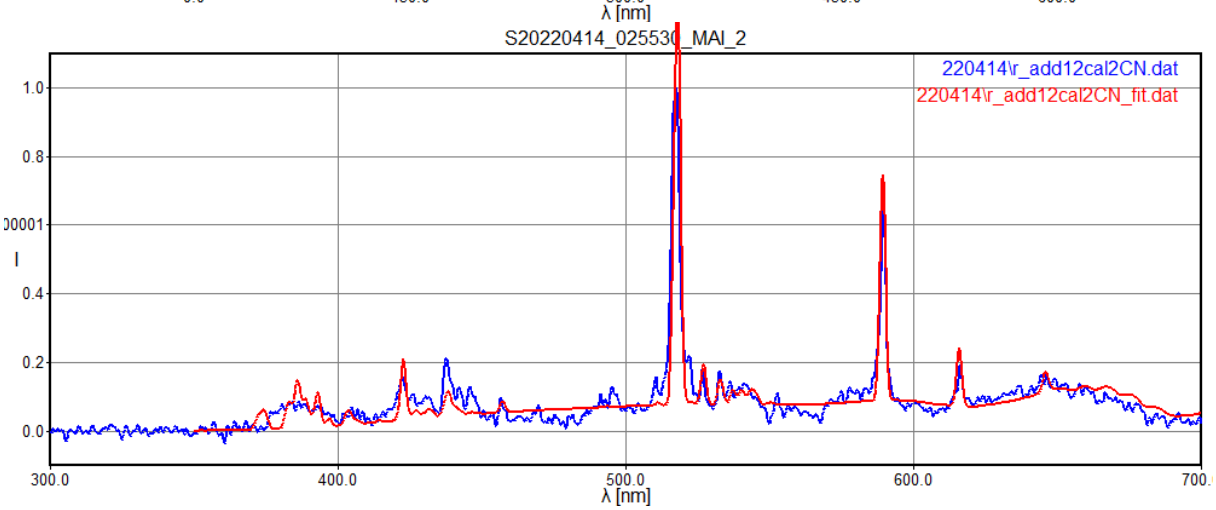
polynom for fit lambda c: [0.5982 -433.0423]

pixel	lambda	fit	error
723.95,	0.00,	0.05,	0.0453
1588.31,	517.50,	517.13,	-0.3698
1708.99,	589.00,	589.32,	0.3245

rms_x = 0.2852

spectrum 220414\r_add12cal.dat saved





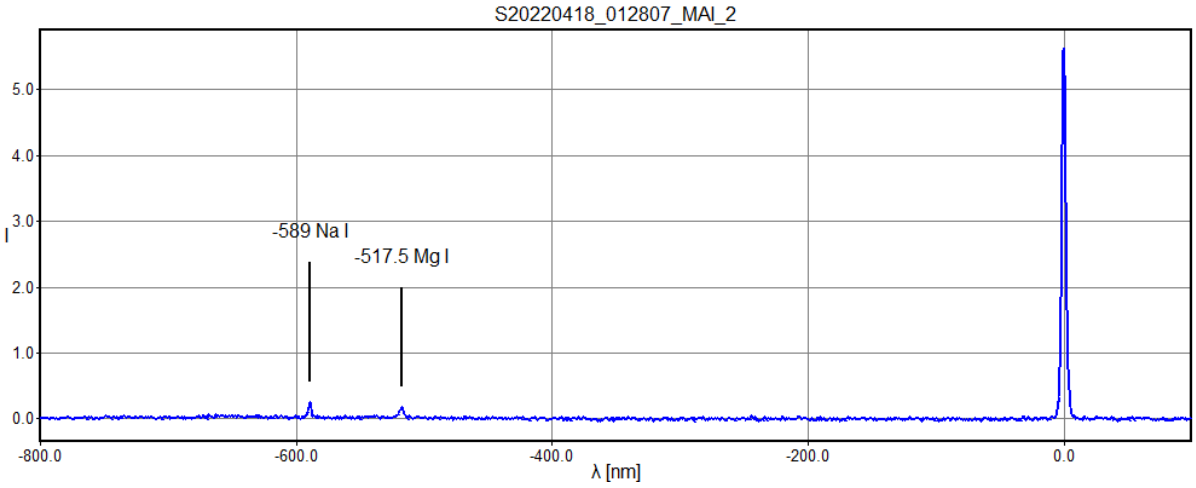
M20220418_012807_MAI_2, spo, -1.2m

polynom for fit lambda c: [5.9778e-01 -8.1542e+02]

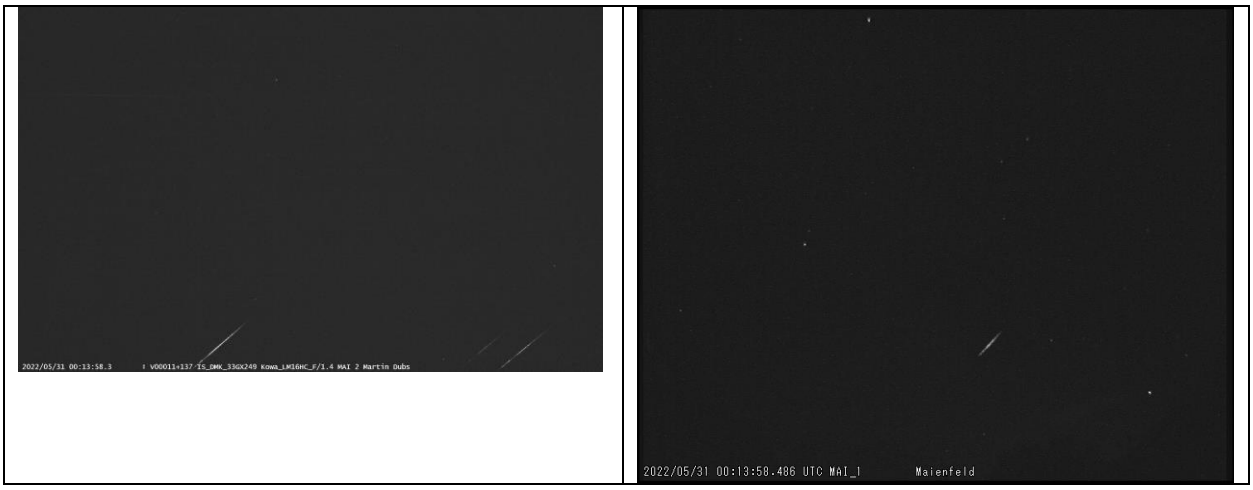
pixel	lambda	fit	error
378.66,	-589.00,	-589.06,	-0.0618
498.49,	-517.50,	-517.43,	0.0703
1364.06,	0.00,	-0.01,	-0.0086

rms_x = 0.0543

spectrum 220418\r_add14cal.dat saved



M20220531_001358_MAI_2, spo, -1.0m

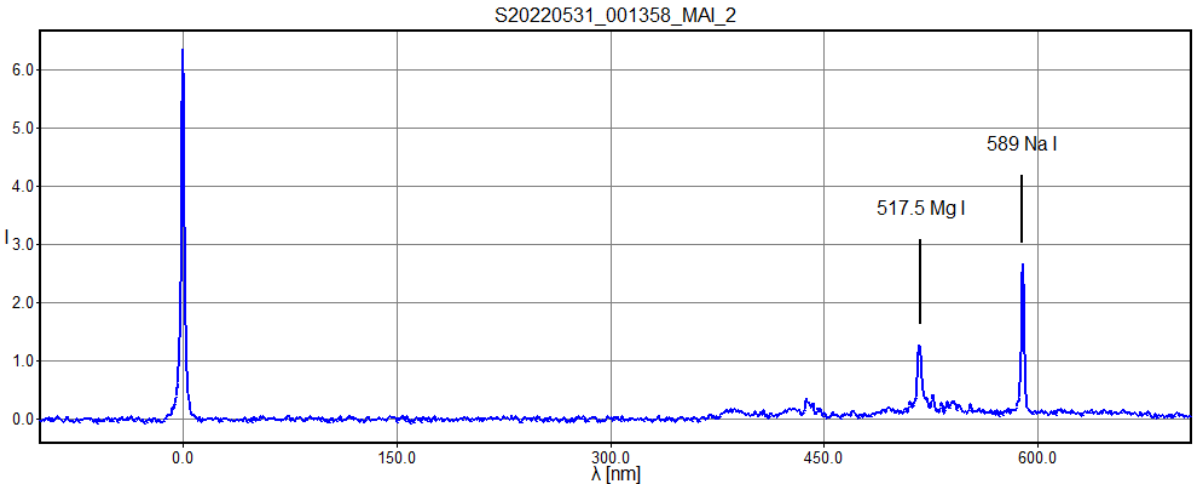


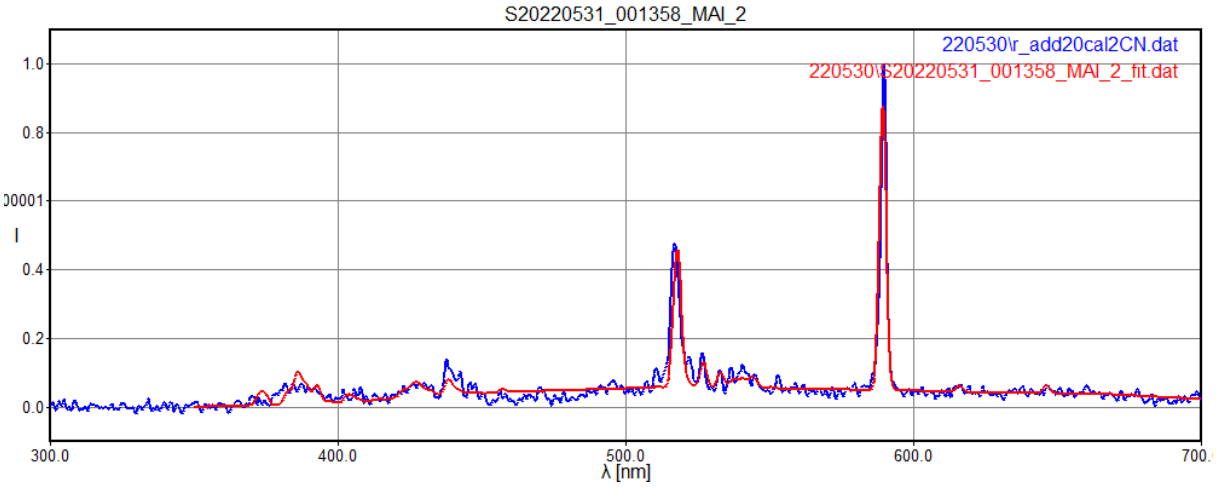
polynom for fit lambda c: [0.5978 -437.5764]

pixel	lambda	fit	error
732.10,	0.00,	0.07,	0.0683
1596.74,	517.50,	516.94,	-0.5553
1718.09,	589.00,	589.49,	0.4870

rms_x = 0.4282

spectrum 220530\r_add20cal.dat saved





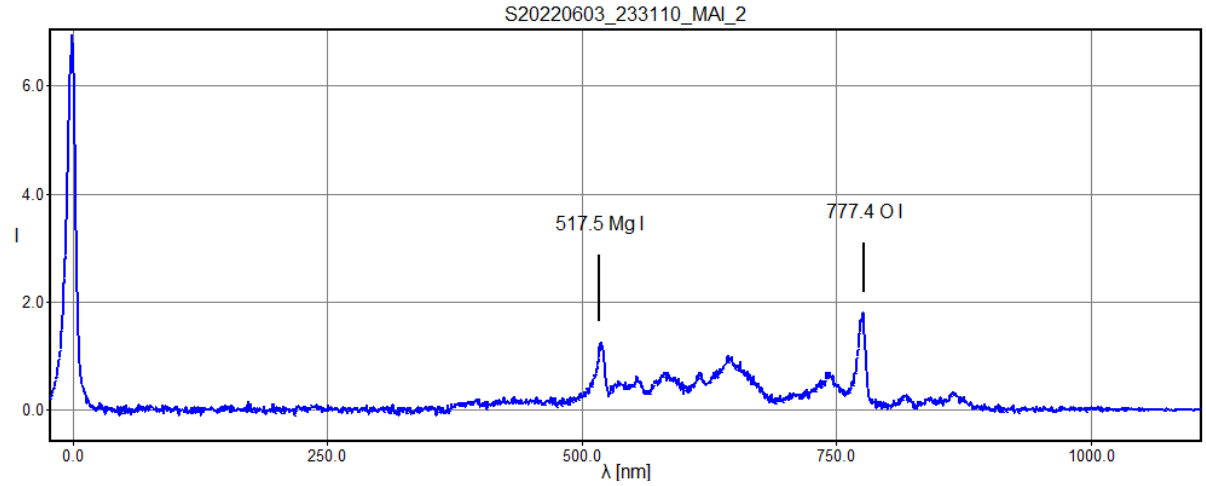
M20220603_233110_MAI_2, spo, -2.0m

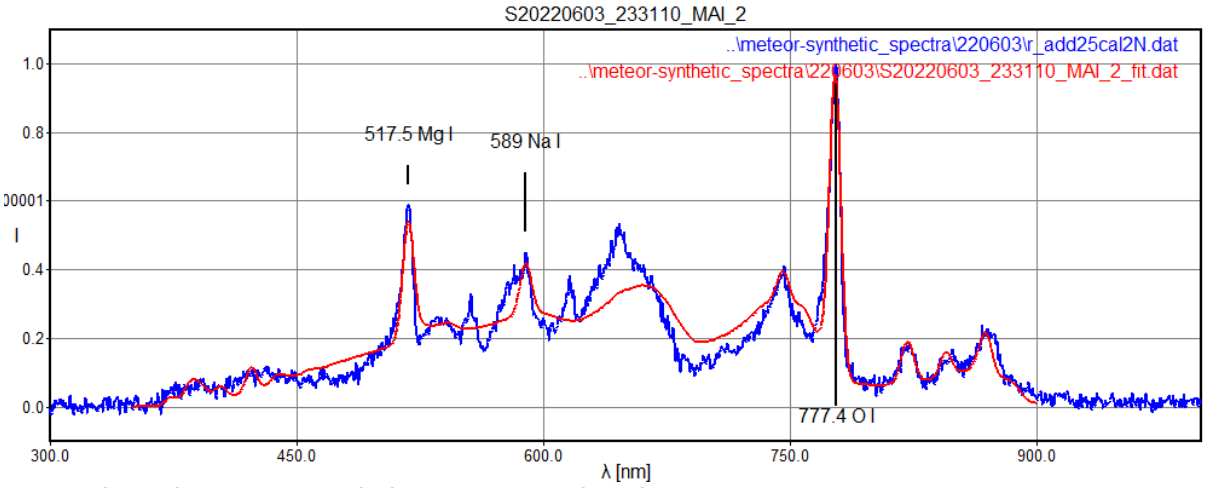
polynom for fit lambda c: [0.5913 -23.0949]

pixel	lambda	fit	error
38.04,	0.00,	-0.60,	-0.6017
917.32,	517.50,	519.32,	1.8197
1351.72,	777.40,	776.18,	-1.2180

rms_x = 1.3111

spectrum ..\meteor-synthetic_spectra\220603\ra_add13cal.dat saved





Large slant gives poor resolution, strong N2 band

Meteor spectral lines

Table 3-7: List of spectral lines frequently found in meteor spectra and their relative intensities. Th
tification of the lines (numbers) in our example is also given. Lines marked with an asterisk appear b
spectra of fast meteors, such as the Perseids, but much fainter in spectra of slow meteors.

Laboratory data			ident.	Laboratory data			ident.
λ_{lab}, [Å]	atom/ion	intensity	number	λ_{lab}, [Å]	atom/ion	intensity	number
3719.9	Fe	10	2	4923.9	Fe^+	2*	
3734.9	Fe	8		4957.6	Fe	4	
3737.1	Fe	9	3	5012.1	Fe	1	
3745.6	Fe	8		5018.4	Fe^+	3*	
3749.5	Fe	8		5110.4	Fe	1	
3820.4	Fe	9		5167.3	Mg	17	
3825.9	Fe	8		5172.7	Mg	25	
3829.4	Mg	10		5183.6	Mg	28	
3832.3	Mg	11		5208.4	Cr	10	
3838.3	Mg	12		5227.2	Fe	5	
3859.9	Fe	11		5269.5	Fe	14	
3886.3	Fe	9		5328.0	Fe	12	
3933.7	Ca^+	40*	8	5371.5	Fe	9	
3968.5	Ca^+	35*	9	5397.1	Fe	5	
4030.8	Mn	10		5405.8	Fe	6	
4045.8	Fe	10		5429.7	Fe	6	
4063.6	Fe	9		5434.5	Fe	4	
4131.0	Si^+	1*		5446.9	Fe	4	
4226.7	Ca	11	12	5455.6	Fe	4	
4254.4	Cr	9		5528.4	Mg	2	
4271.8	Fe	10		5615.7	Fe	1	
4274.8	Cr	8		5890.0	Na	40	
4289.7	Cr	7		5895.9	Na	35	
4307.9	Fe	10		6156.8	O	1*	
4325.8	Fe	10		6162.2	Ca	1	
4383.5	Fe	14	15	6347.1	Si^+	6*	
4404.8	Fe	11		6371.4	Si^+	3*	
4481.2	Mg^+	15*		6495.0	Fe	1	
4920.5	Fe	3		6562.9	H	2*	

From: Spectral lines, (IMO PhotographicHandbook 03 Spectra, p 47)
http://www.imo.net/docs/03spectra.pdf

Another list from Borovicka, 2005
https://ui.adsabs.harvard.edu/abs/2005Icar..174...15B/abstract
Free access from:
https://sci-hub.st/https://doi.org/10.1016/j.icarus.2004.09.011

Table 1
List of the most important atomic lines used to fit the spectra in the 4200–8500 Å range, ordered according to line groups

λ (Å)	Atom & multiplet		Typical intensity	λ (Å)	Atom & multiplet		Typical intensity
Low temperature lines				*Wake lines*[a]			
4226	Ca I	2	80	4216	Fe I	3	16
4273	Fe I	42	30	4376	Fe I	2	26
4308	Fe I	42	25	4427	Fe I	2	21
4326	Fe I	42	25	4462	Fe I	2	12
4384	Fe I	41	45	4482	Fe I	2	7
4405	Fe I	41	25	4571	Mg I	1	17
4920	Fe I	318	11	5110	Fe I	1	9
4957	Fe I	318	16	5169	Fe I	1	8
5047	Fe I	114	13	5205	Fe I	1	5
5182	Mg I	2	200	*Atmospheric lines*			
5269	Fe I	15	23	5330	O I	12	47
5328	Fe I	15	19	5436	O I	11	34
5371	Fe I	15	17	6157	O I	10	150
5404	Fe I	15	15	6455	O I	9	17
5431	Fe I	15	13	6484	N I	21	27
5449	Fe I	15	11	7424	N I	3	60
5528	Mg I	9	22	7442	N I	3	120
5589	Ca I	21	5	7468	N I	3	150
5892	Na I	1	150	7774	O I	1	1400
6163	Ca I	3	4	8186	N I	2	400
6439	Ca I	18	3	8218	N I	2	700
6463	Ca I	18	2	8243	N I	2	280
8194	Na I	4	3	8446	O I	4	800
High temperature line				*Train line*			
4481	Mg II	4	36	5577	[O I]	3*F*	31

[a] Wake lines are low excitation intercombination lines with a small transition probability. They are so named because they are prominent in meteor wakes, i.e., in the radiation forming a "tail" just behind the meteor head. They may be, nevertheless, present also in meteor heads, in particular when the collisional deexcitation rate is low.

Content