

Meteor spectra 2022

Overview

This is a collection of meteor spectra obtained at Maienfeld (station MAI_2, <http://www.meteorastronomie.ch/stationen.html>)

Setup:

Camera: **DMK 33GX249**

Resolution 1920x1200

Frame Rate: 25 Hz

Sensor Type Sony IMX249LLJ-C

Sensor Format 1/1.2 inch

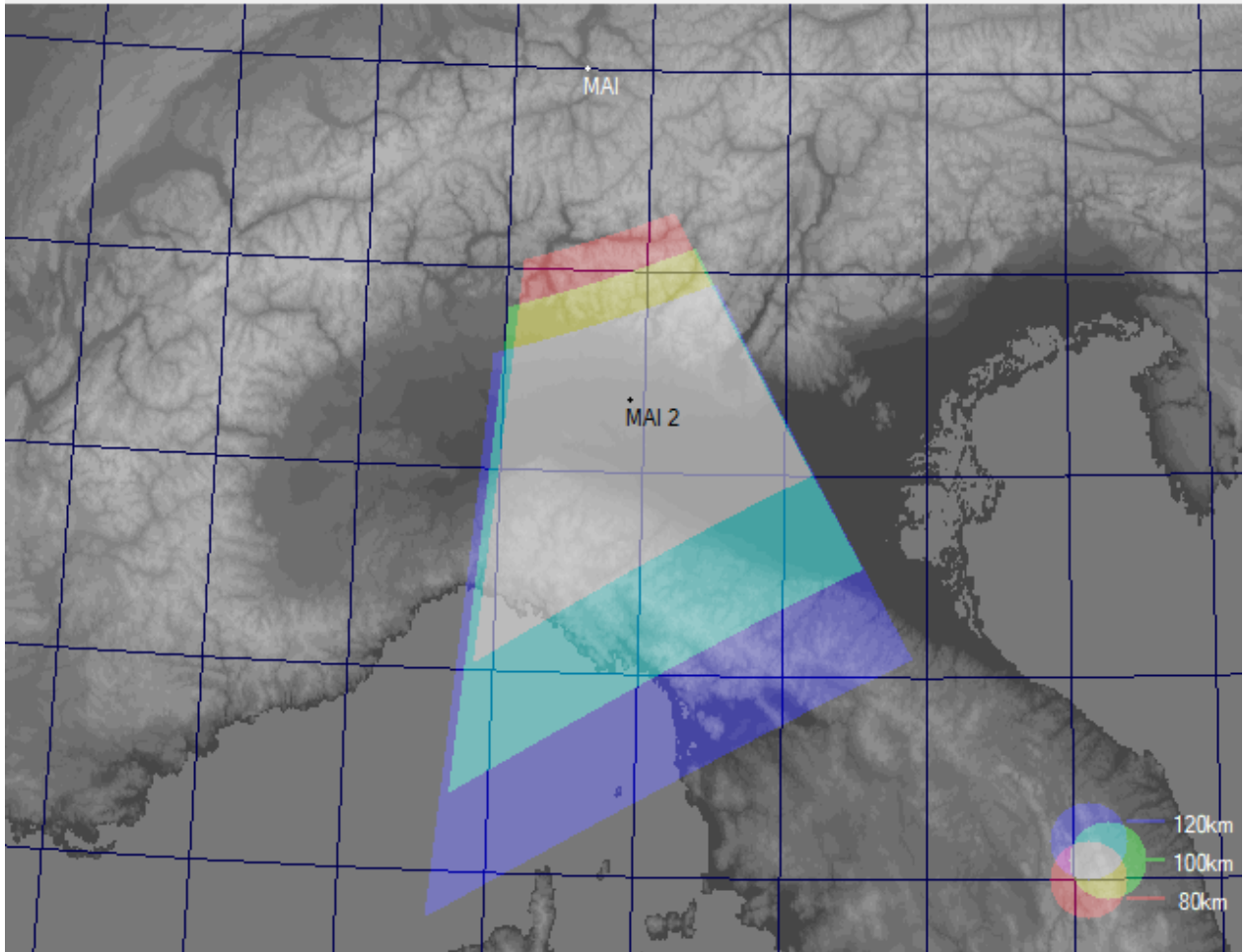
Pixel Size **5.86 μm**

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.

Starting end of march, 1st order spectra were further analysed by fitting synthetic meteor spectra to the observed spectra

(<https://meteorspectroscopy.org/2022/03/08/synthetic-meteor-spectra/>).

In addition, meteors were recorded with a Watec 902H2 ultimate, equipped with a wide angle lens: Tamron VG412 ASIR at $f \cong 4\text{mm}$, MAI_1.

M20220101_045057_MAI_2, URS, -2.0m

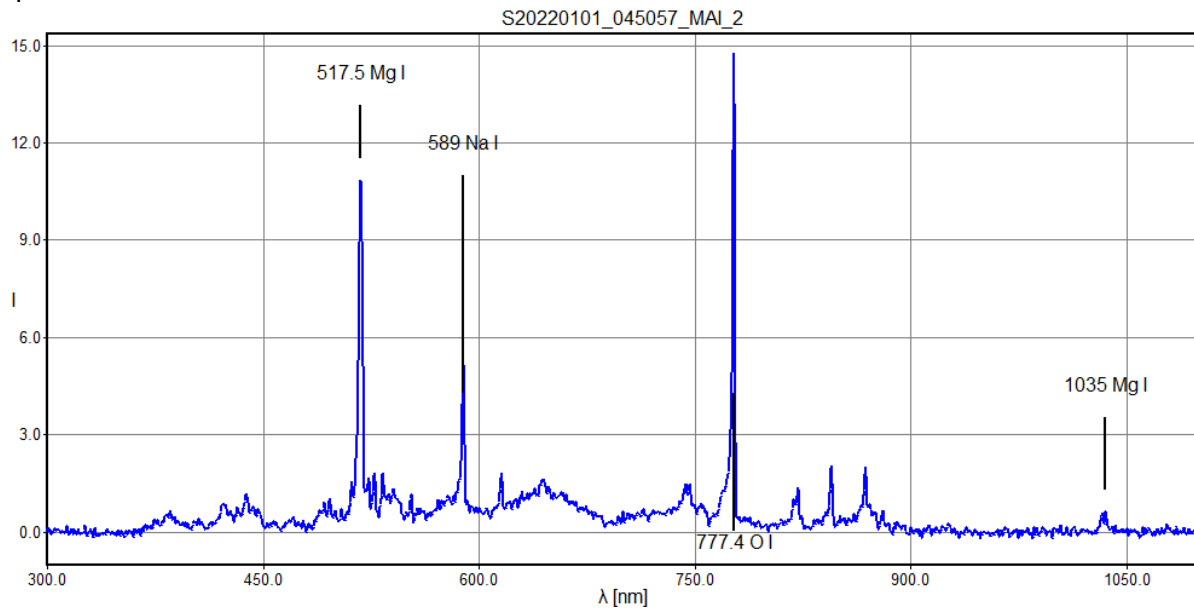


polynom for fit lambda c: [0.595 76.6688]

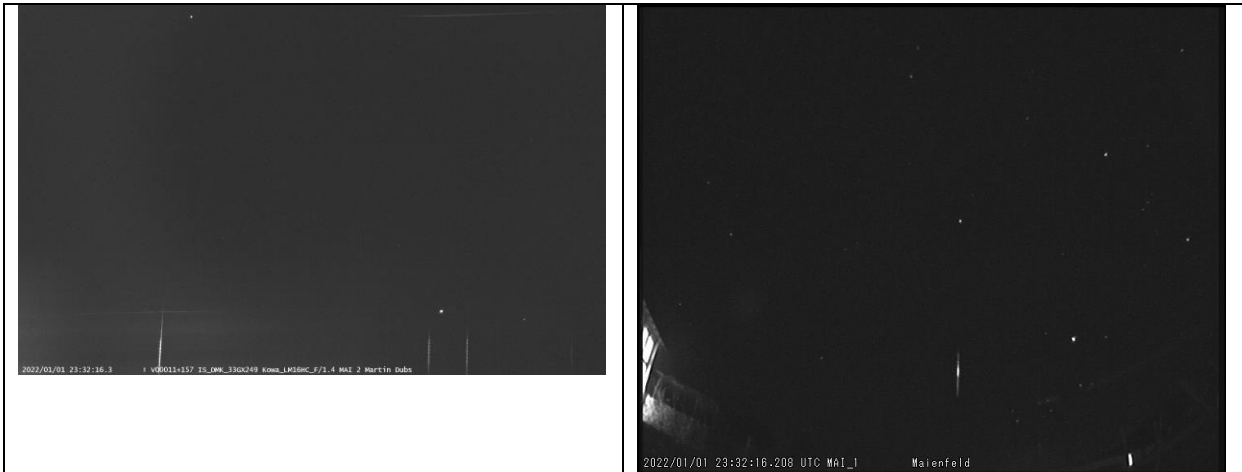
pixel	lambda	fit	error
741.41,	517.50,	517.78,	0.2790
861.04,	589.00,	588.95,	-0.0458
1176.97,	777.40,	776.92,	-0.4797
1611.16,	1035.00,	1035.25,	0.2465

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

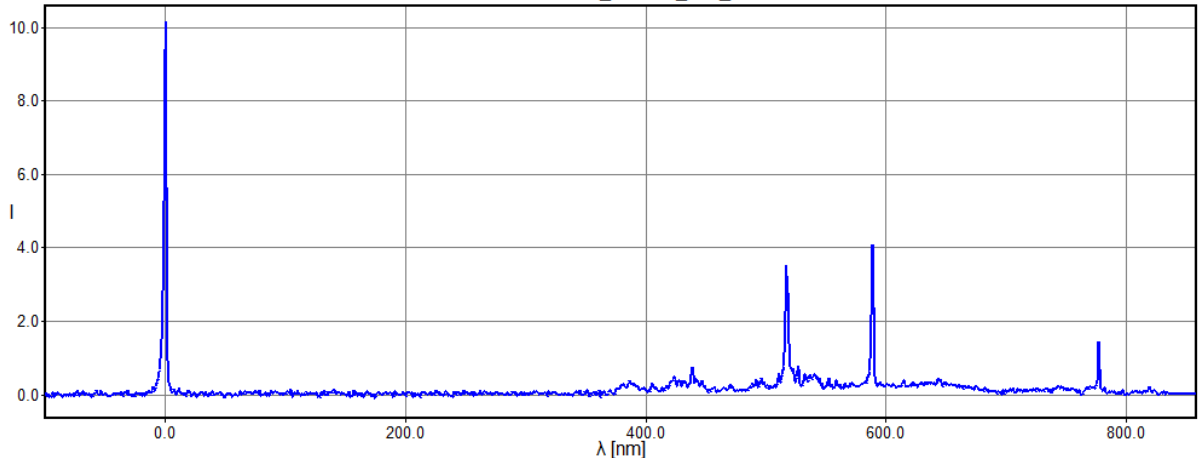
rms_x = 0.8580
spectrum 220101\r_add14cal.dat saved

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

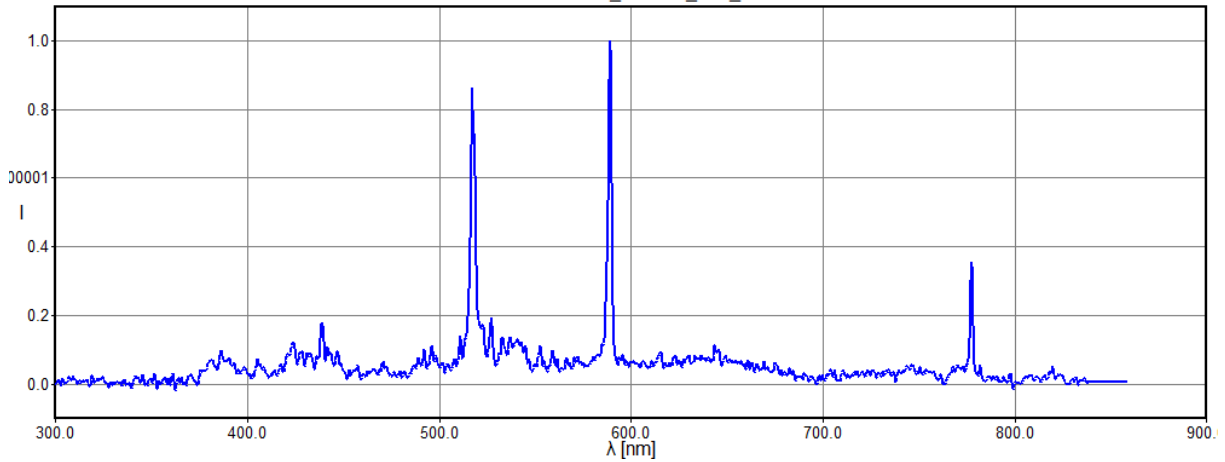
pixel	lambda	fit	error
472.94,	0.00,	-0.00,	-0.0006
1338.59,	517.50,	517.52,	0.0157
1459.14,	589.00,	588.98,	-0.0190
1778.18,	777.40,	777.40,	0.0039

rms_x = 0.0125
spectrum 220101\r_add14cal.dat saved

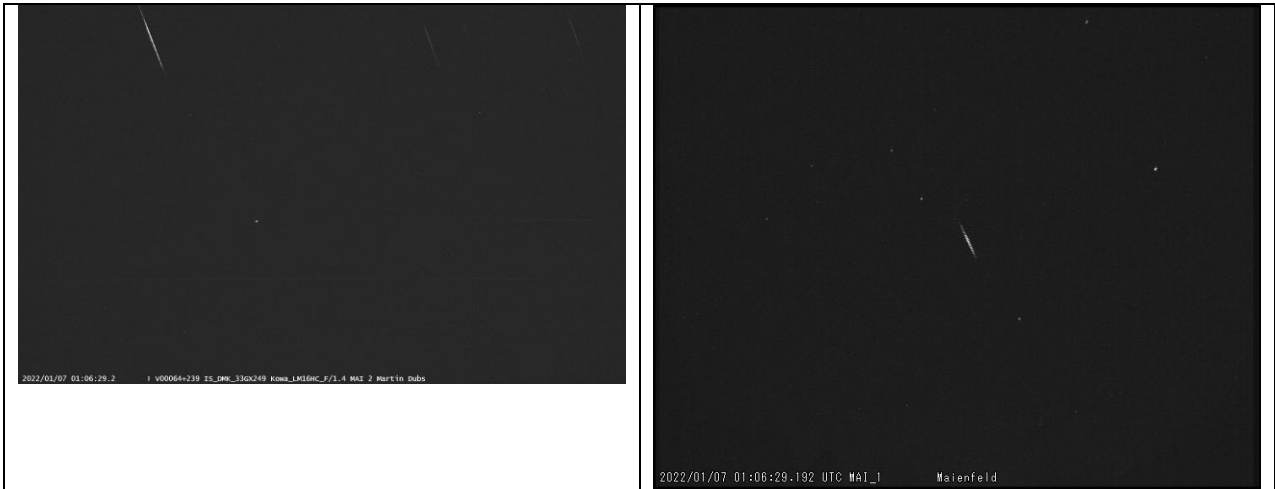
S20220101_233216_MAI_2



S20220101_233216_MAI_2



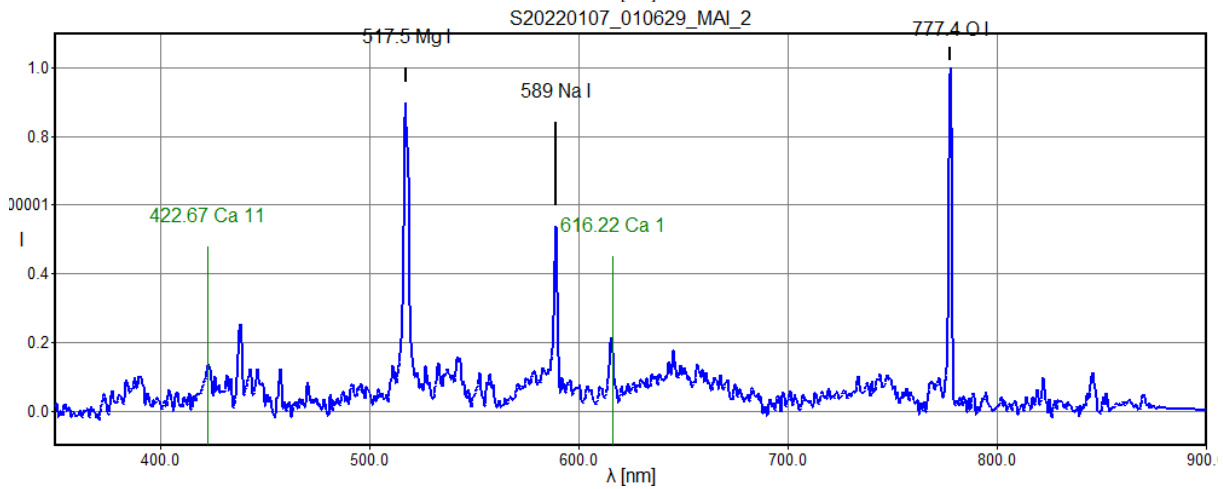
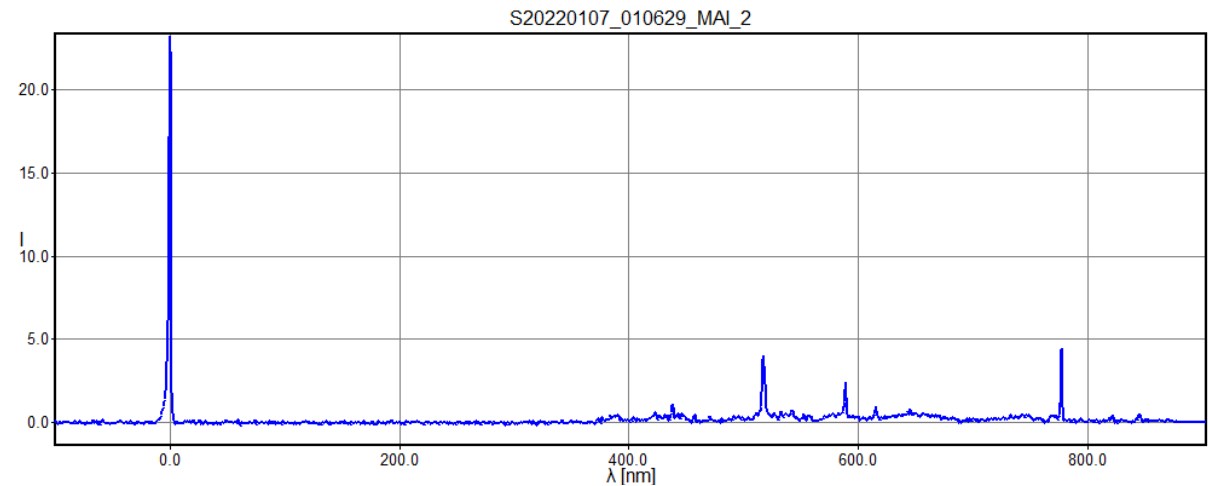
M20220107_010629_MAI_2P, URS, -1.7m



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



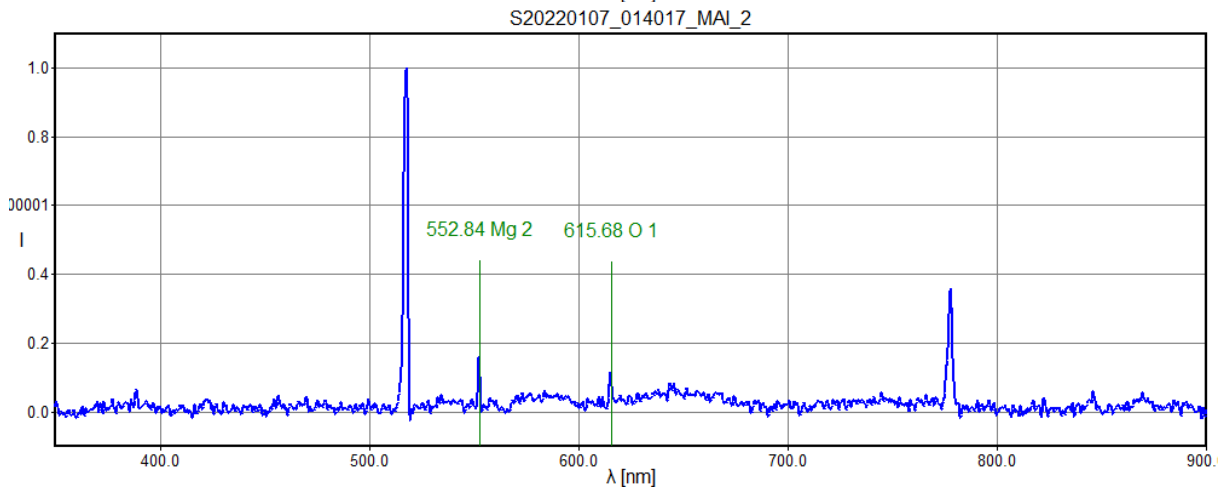
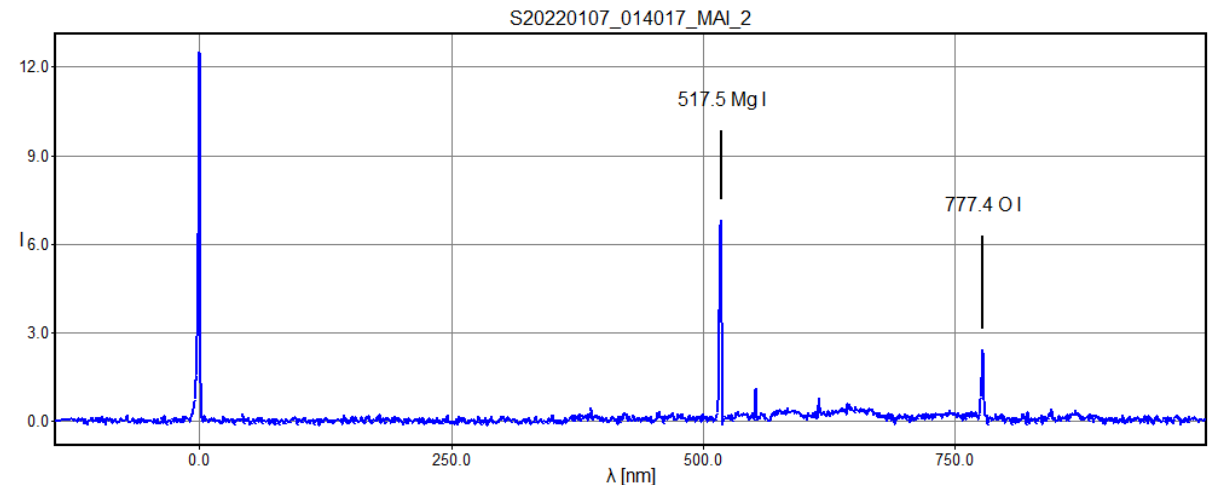
M20220107_014017_MAI_2, GEM, -0.7m



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

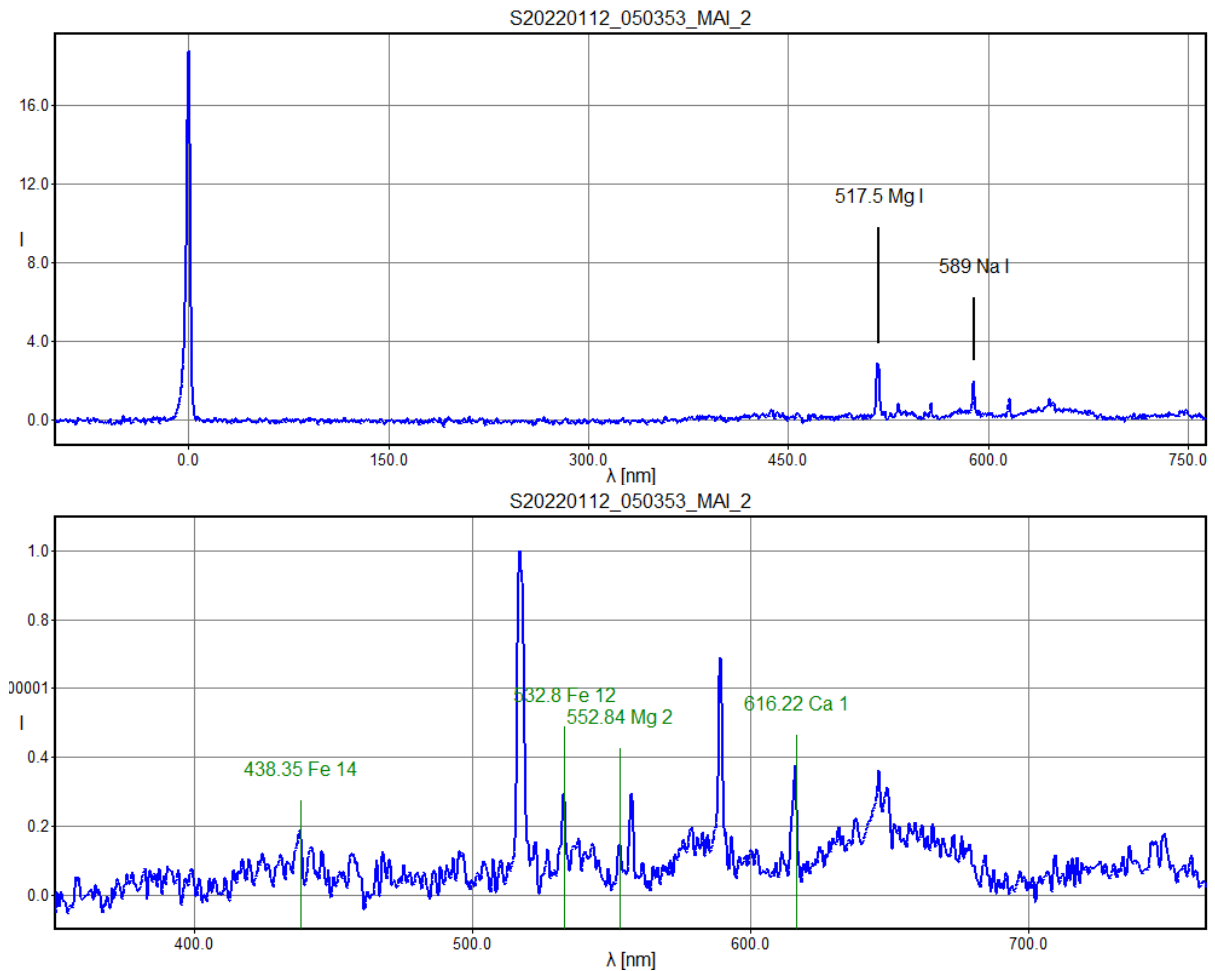


Notice missing Na-line!

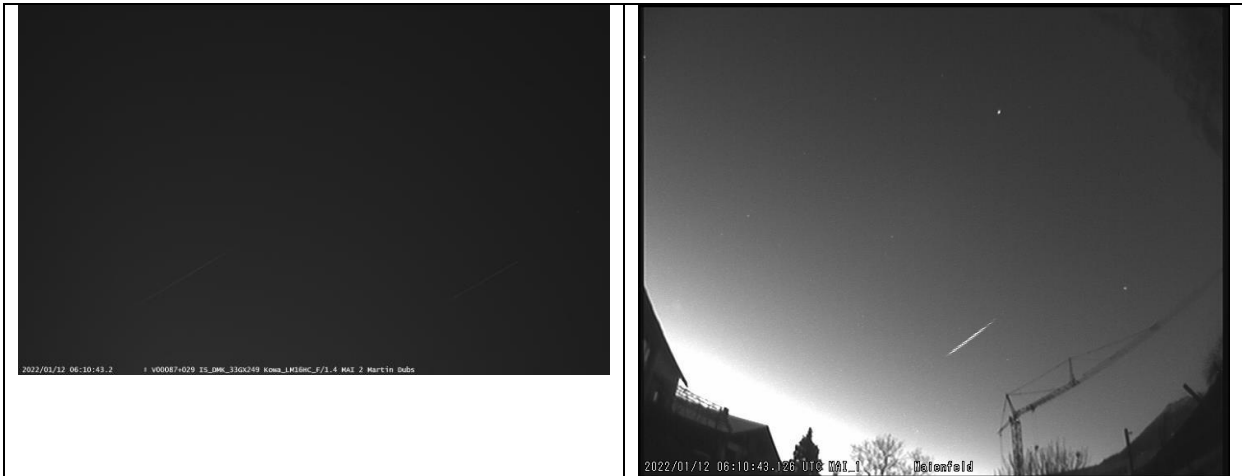
M20220112_050353_MAI_2, COM, -1.6m



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



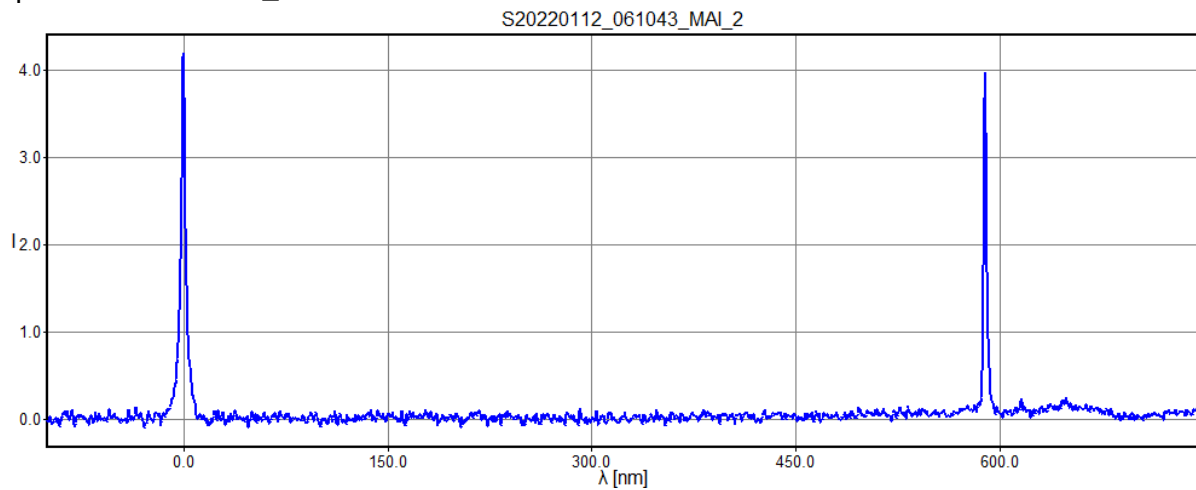
M20220112_061043_MAI_2, spo, -1.6m



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

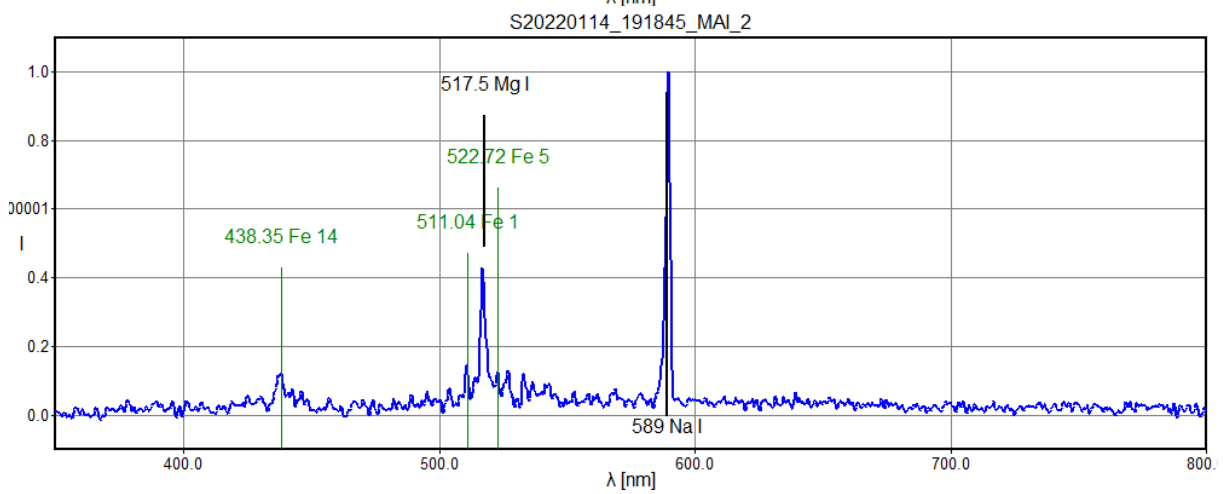
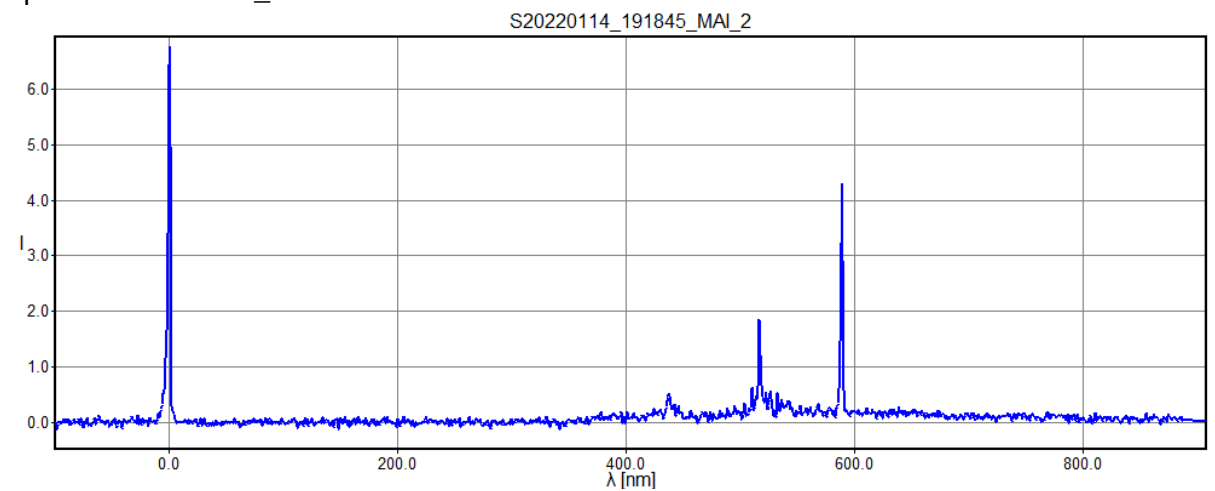


polynom for fit lambda c: [0.6002 -241.1926]

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



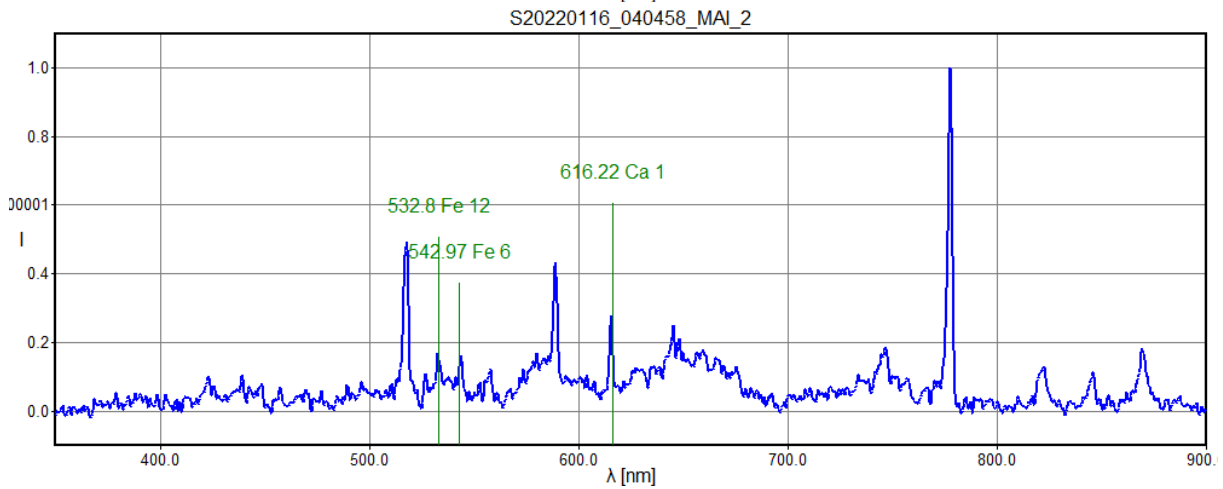
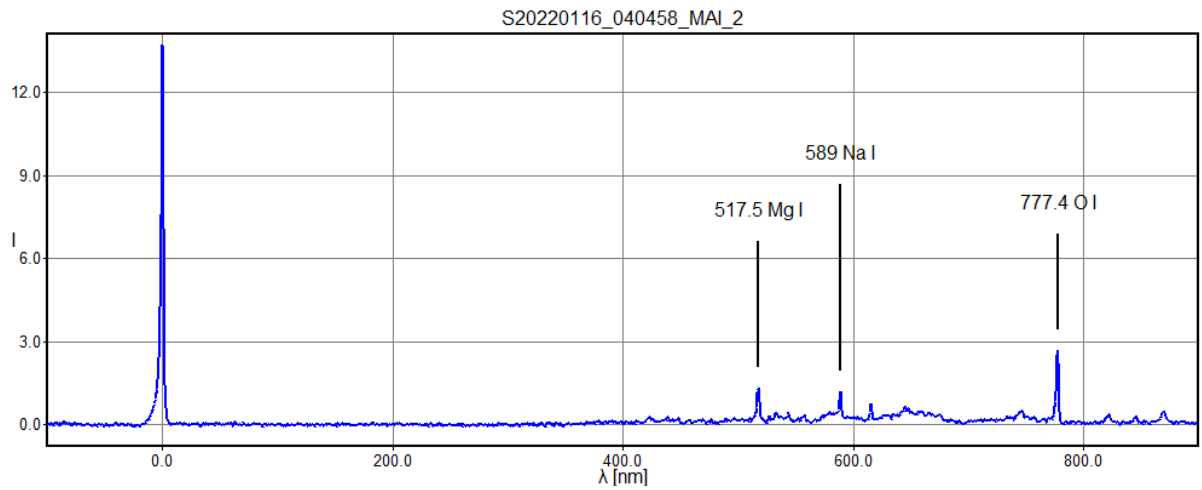
M20220116_040458_MAI_2, spo, -1.6m



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

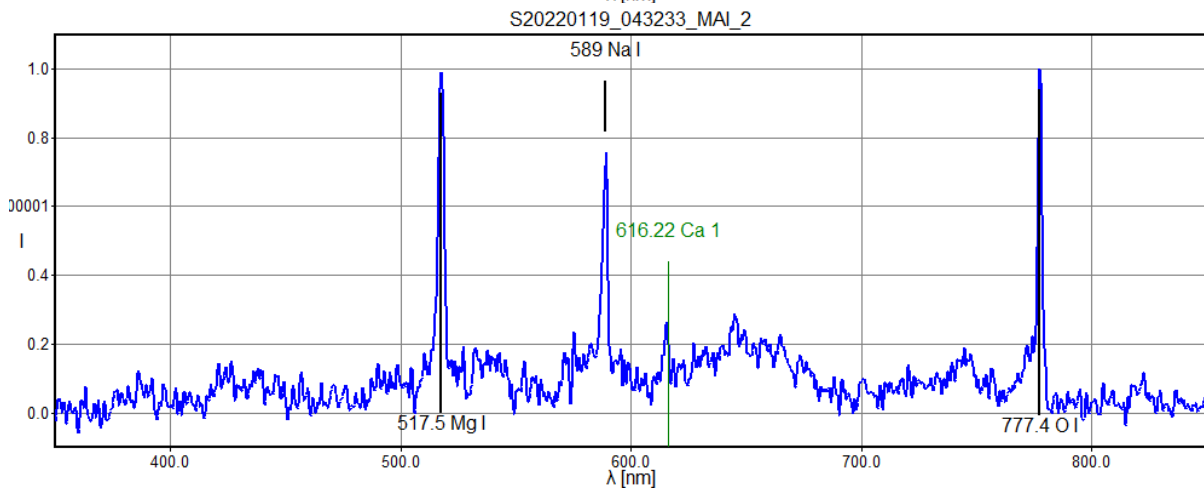
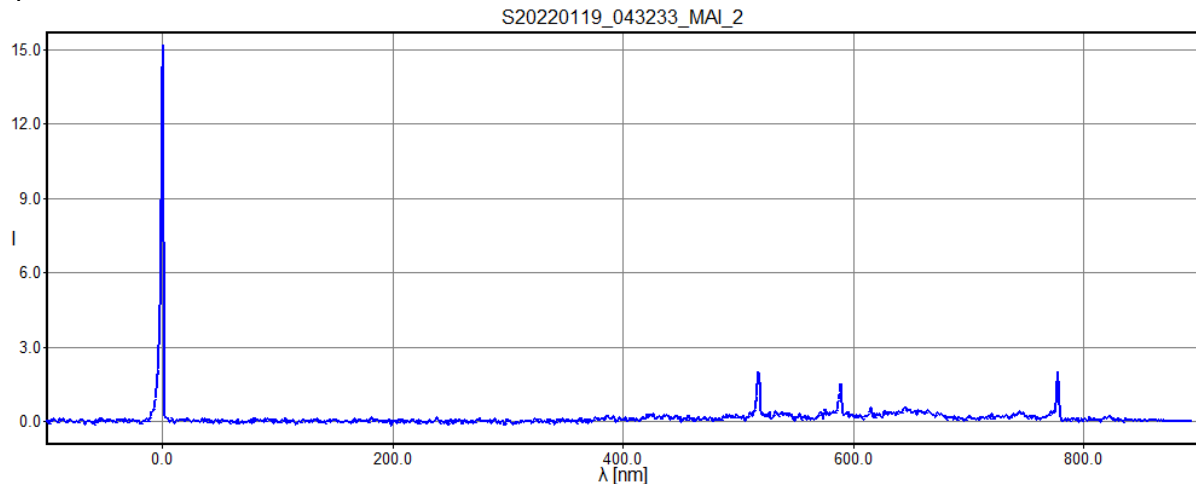


polynom for fit lambda c: [-3.8091e-06 6.0375e-01 -2.4864e+02]

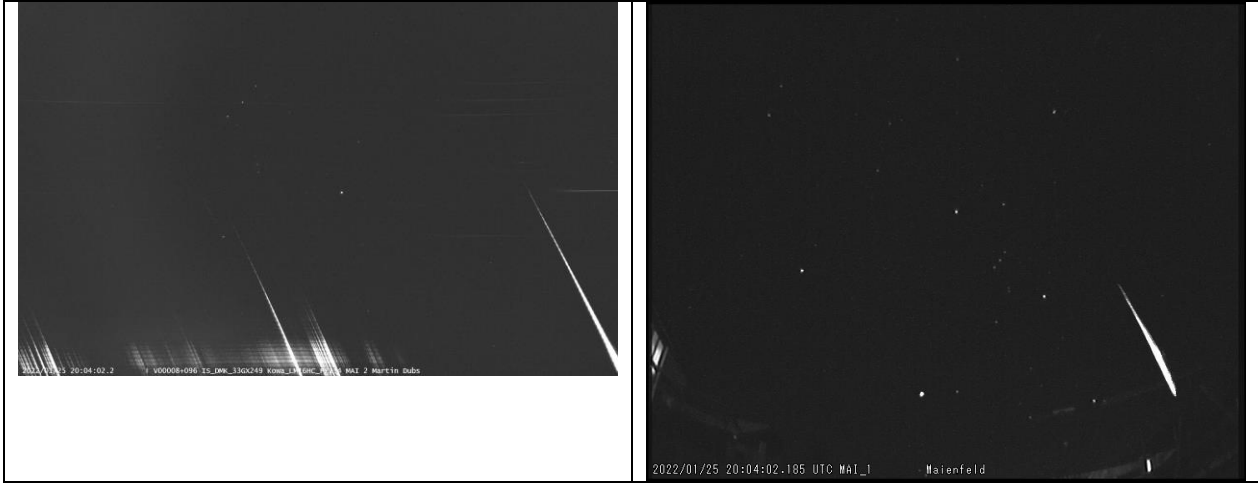
pixel	lambda	fit	error
412.90,	0.00,	-0.00,	-0.0046
1279.49,	517.50,	517.61,	0.1135
1399.53,	589.00,	588.86,	-0.1372
1718.12,	777.40,	777.43,	0.0284

rms_x = 0.0902

spectrum 220119\r_add9cal.dat saved



M20220125_200402_MAI_2, spo, -2.0m

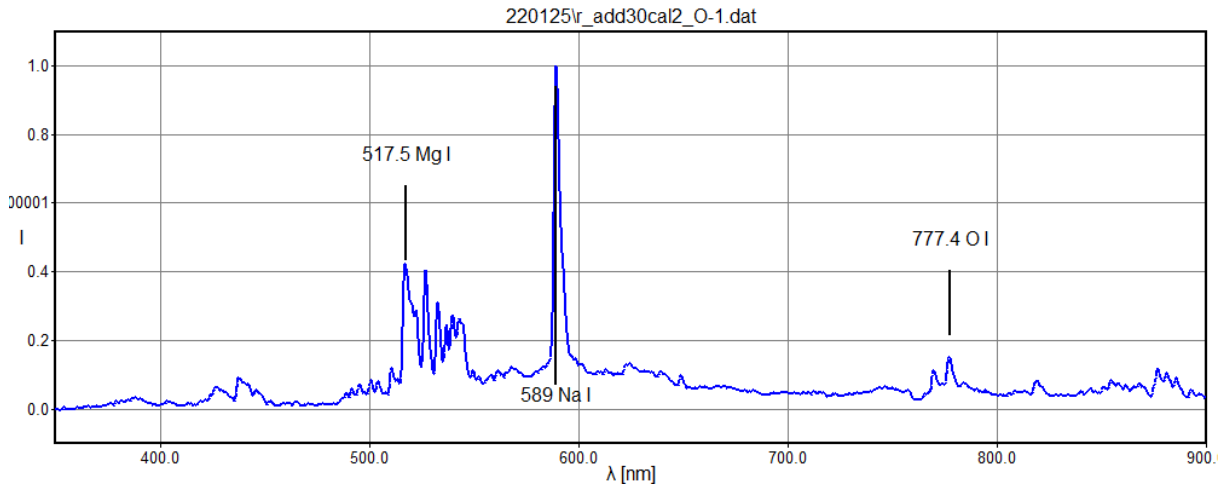
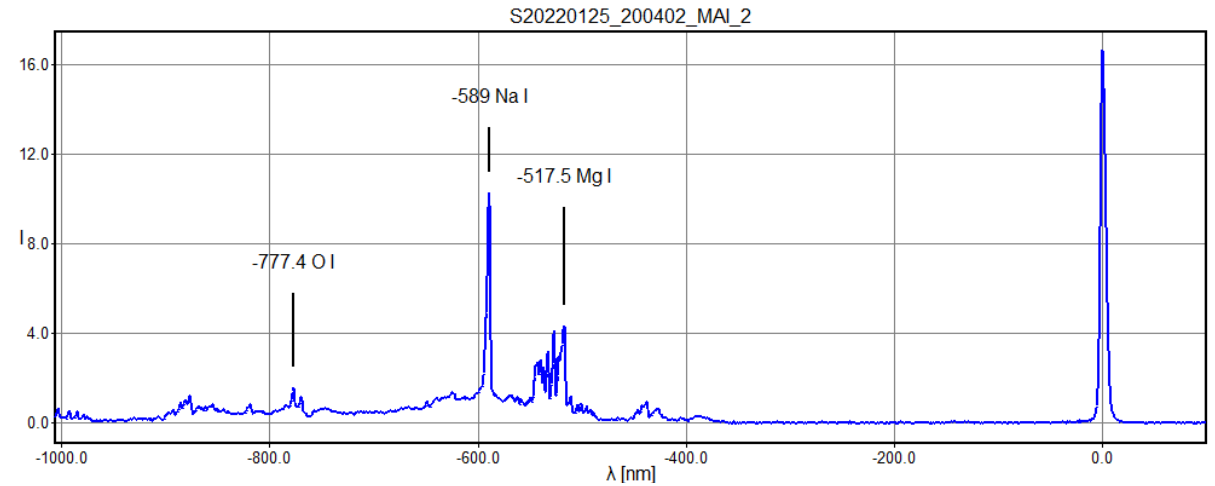


polynom for fit lambda c: [5.9733e-01 -1.0071e+03]

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



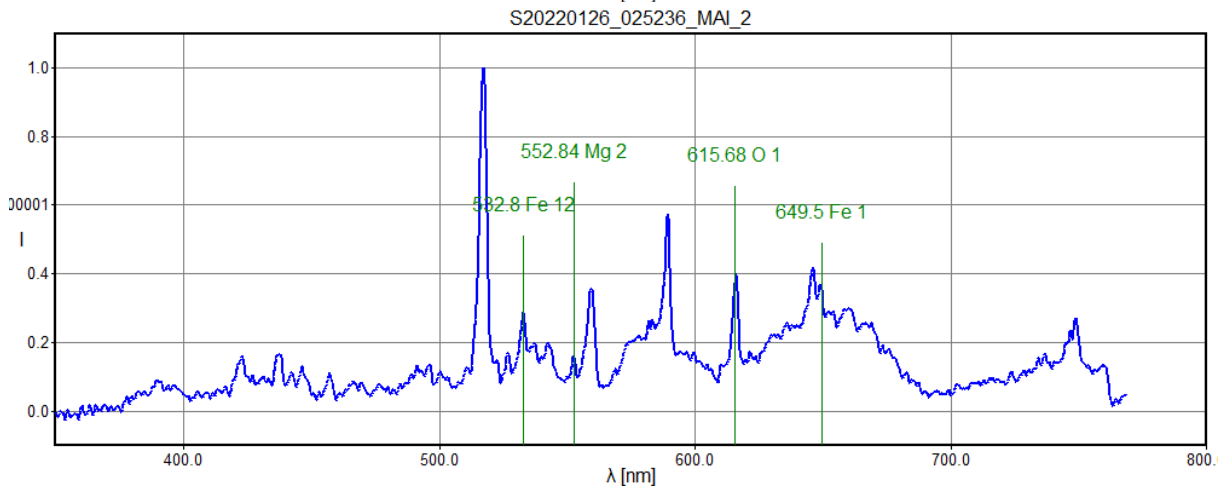
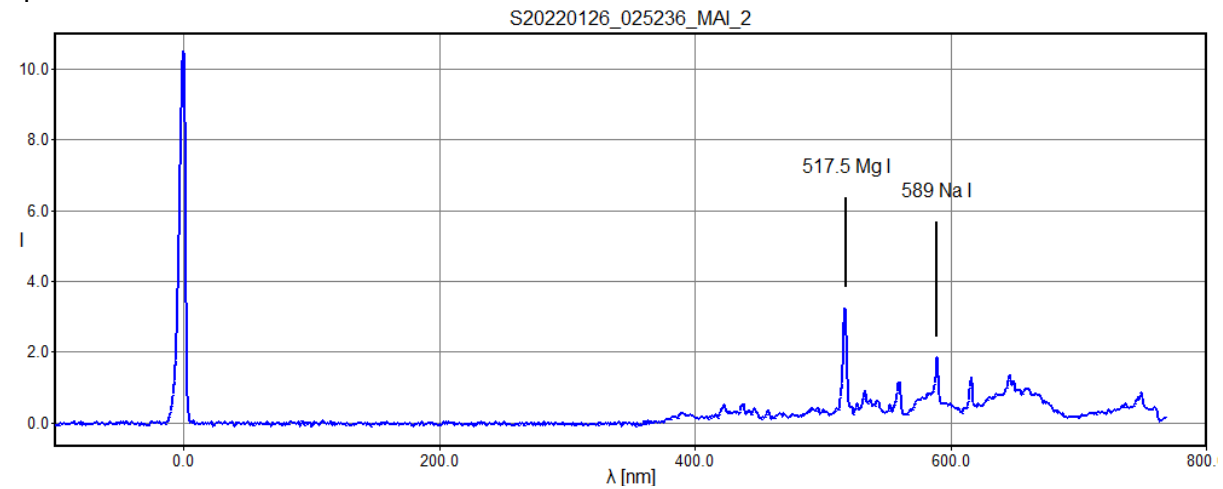
M20220126_025236_MAI_2, spo, -1.5m



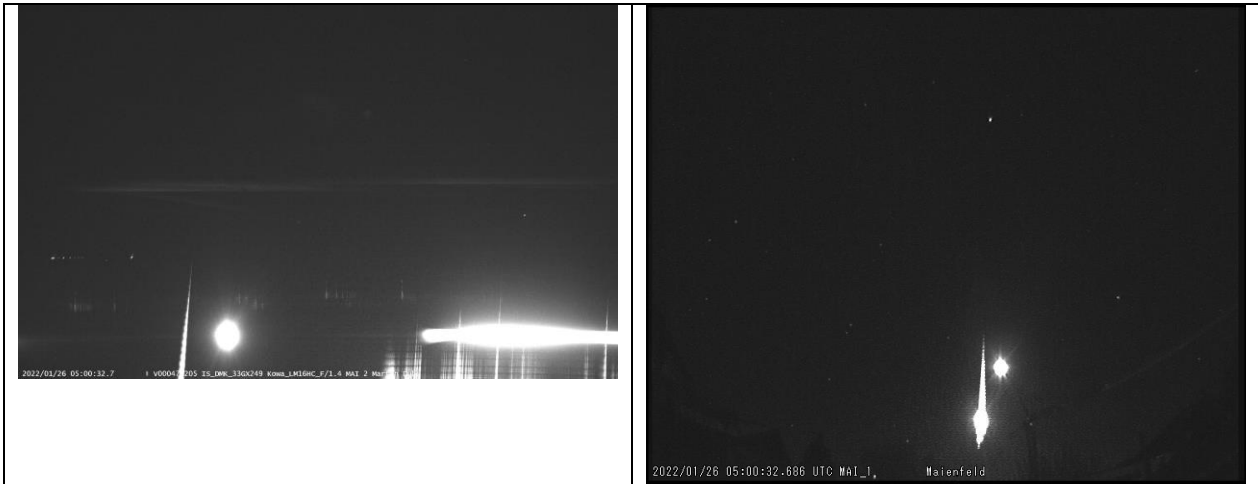
2022/01/26 02:52:36.3 I V00023+214 IS_DMK_330x249 Kowa_LM16HC_F/1.4 MAI_2 Martin Dubs
 polynomial for fit lambda c: [0.5977 -375.9895]

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)

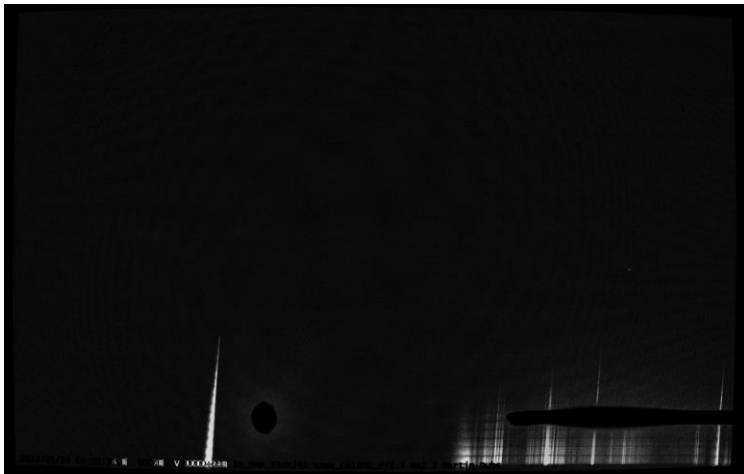


polynom for fit lambda c: [-6.0455e-06 6.1012e-01 -3.3595e+02]

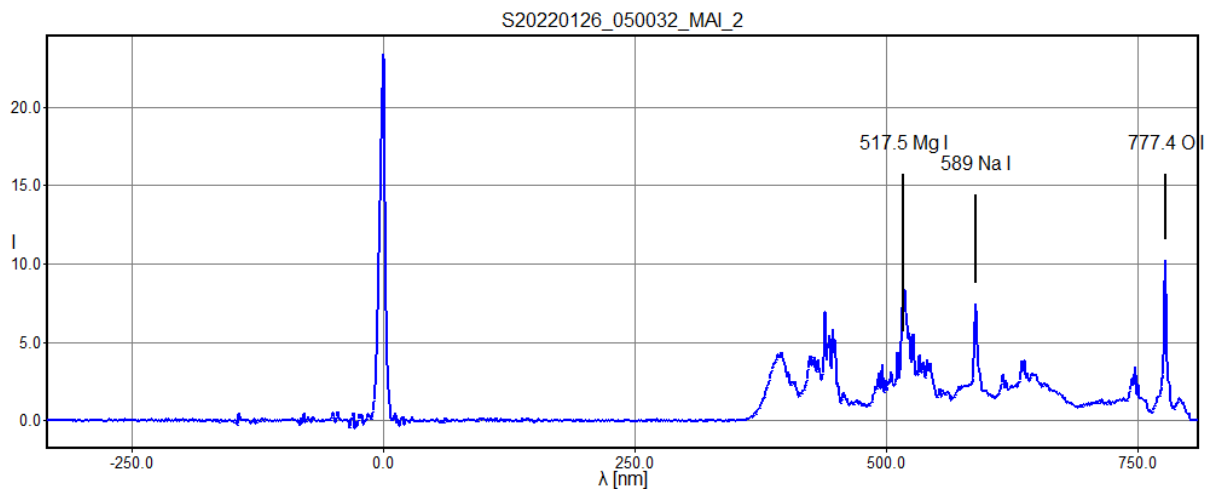
pixel	lambda	fit	error
553.67,	0.00,	-0.00,	-0.0024
1418.88,	517.50,	517.56,	0.0589
1539.39,	589.00,	588.93,	-0.0712
1859.09,	777.40,	777.41,	0.0147

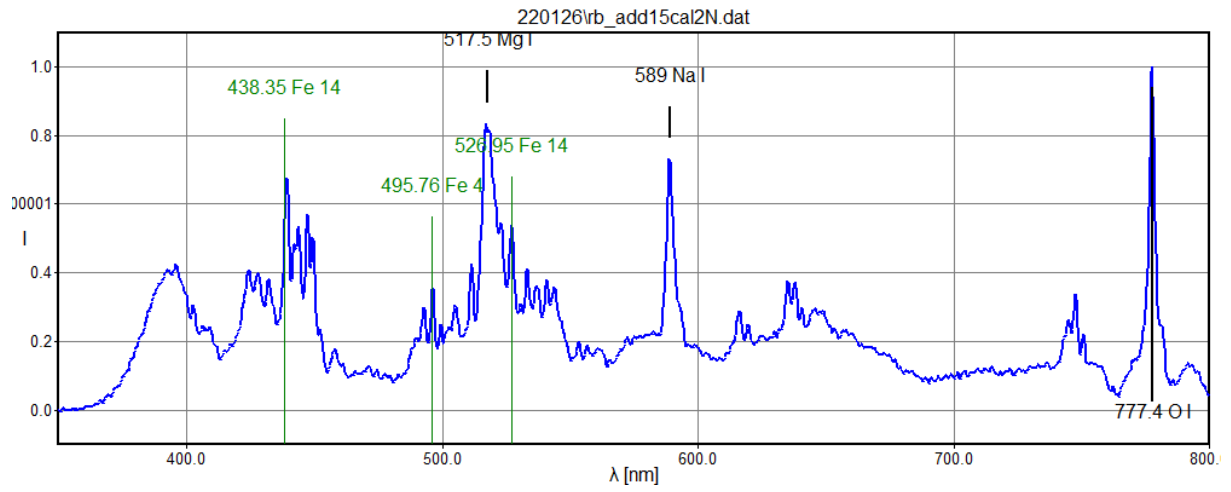
rms_x = 0.0468

spectrum 220126\rb_add15cal.dat saved



mdist_peak, background removed!





M20220209_235435_MAI_2, spo, -0.7m

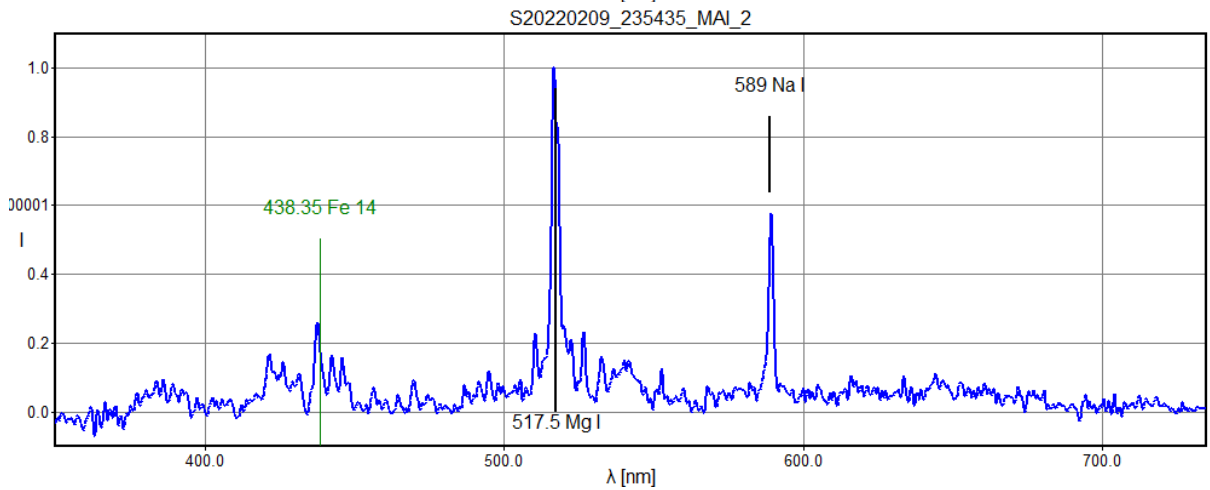
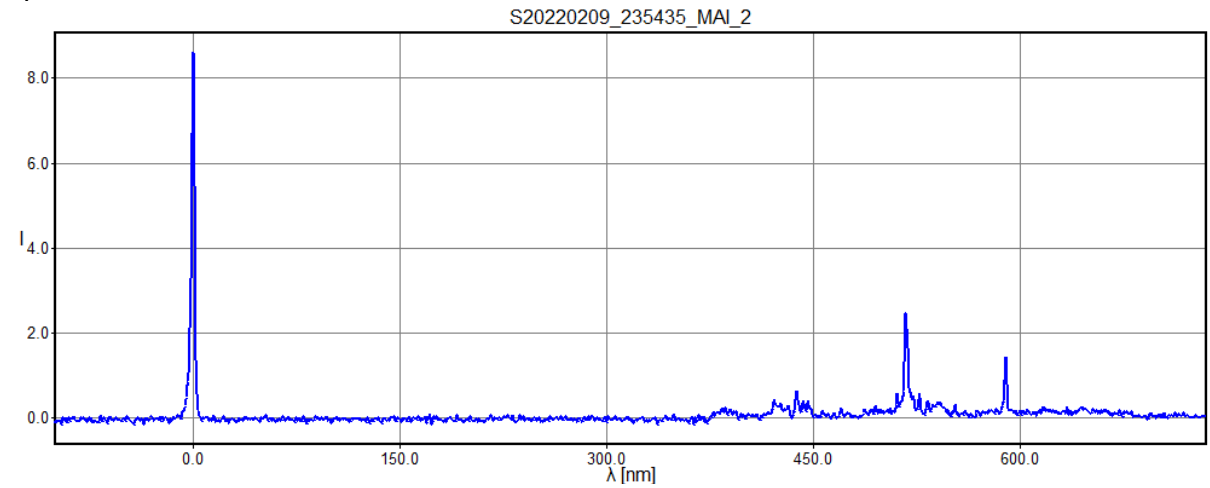


polynom for fit lambda c: [0.5982 -411.4455]

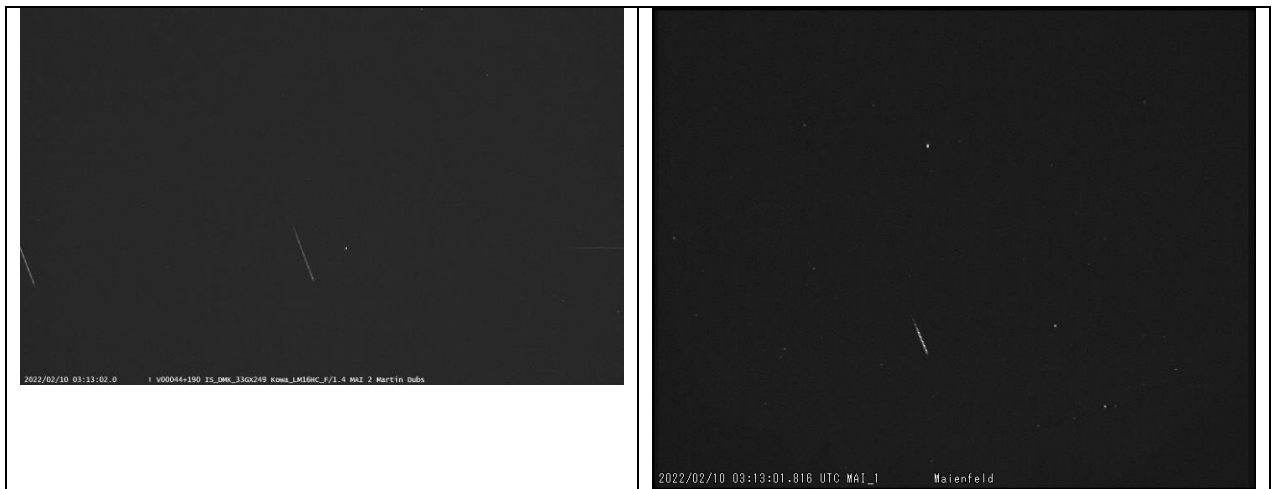
pixel	lambda	fit	error
687.90,	0.00,	0.05,	0.0461
1552.31,	517.50,	517.12,	-0.3765
1673.02,	589.00,	589.33,	0.3304

rms_x = 0.2904

spectrum 220209\r_add14cal.dat saved



M20220210_031302_MAI_2, spo, -1.2m

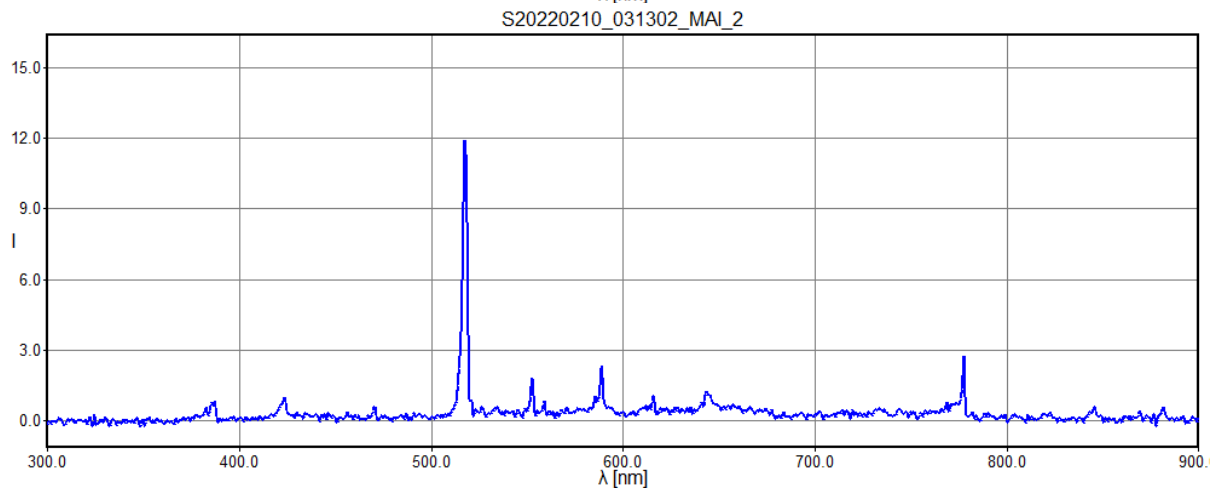
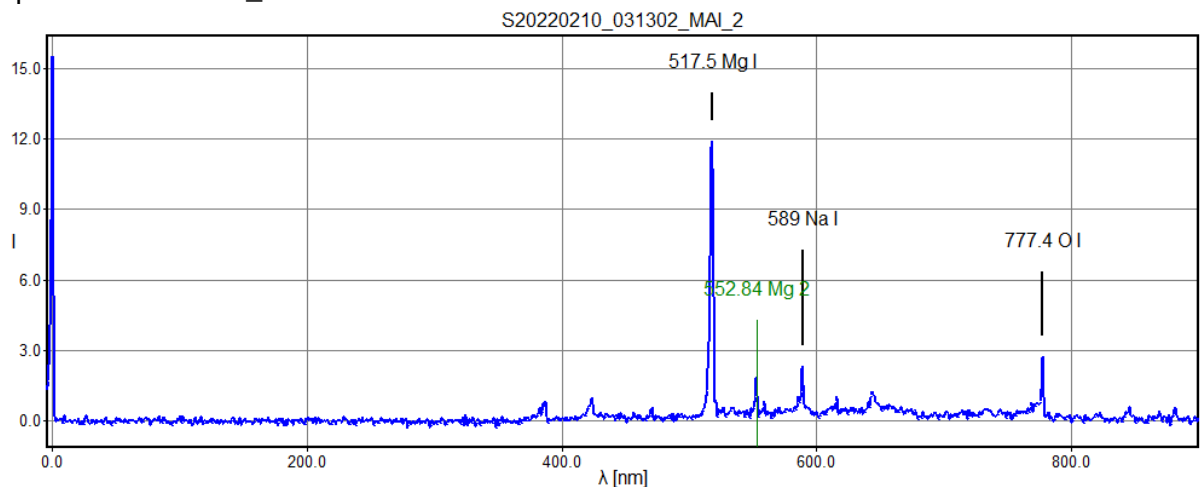


polynom for fit lambda c: [0.5966 -5.8859]

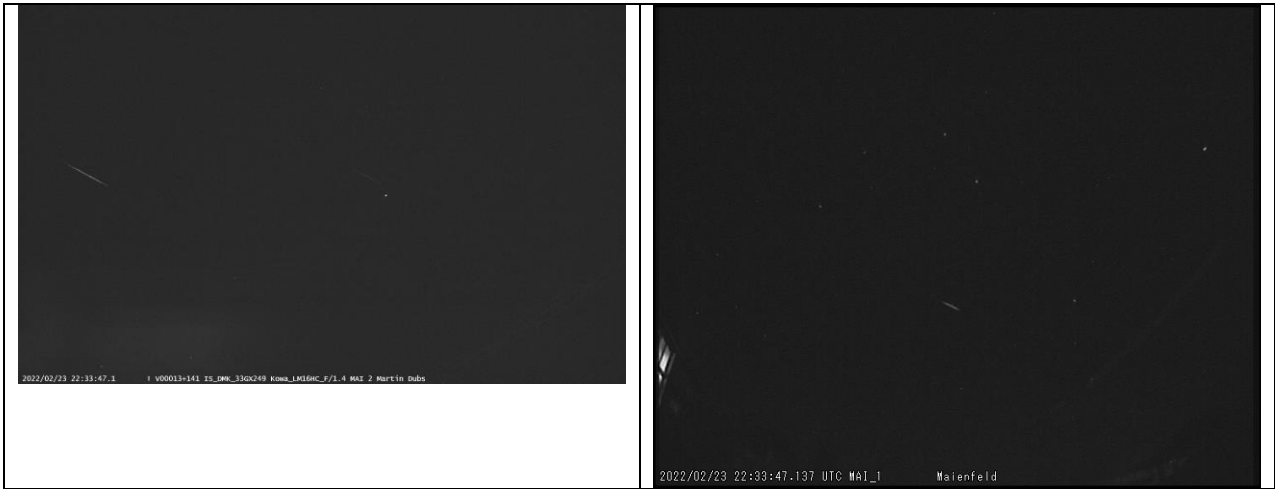
pixel	lambda	fit	error
9.81	0.00	-0.03	-0.0334
877.69	517.50	517.73	0.2309
996.85	589.00	588.82	-0.1800
1312.92	777.40	777.38	-0.0174

rms_x = 0.1476

spectrum 220210\r_add9cal.dat saved



M20220223_223347_MAI_2, spo, 0.6m

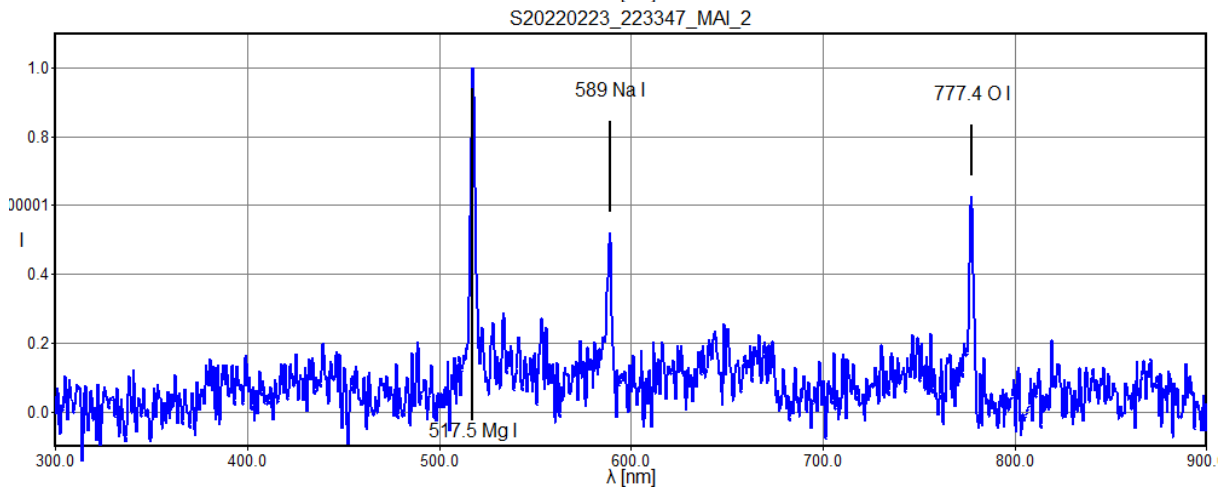
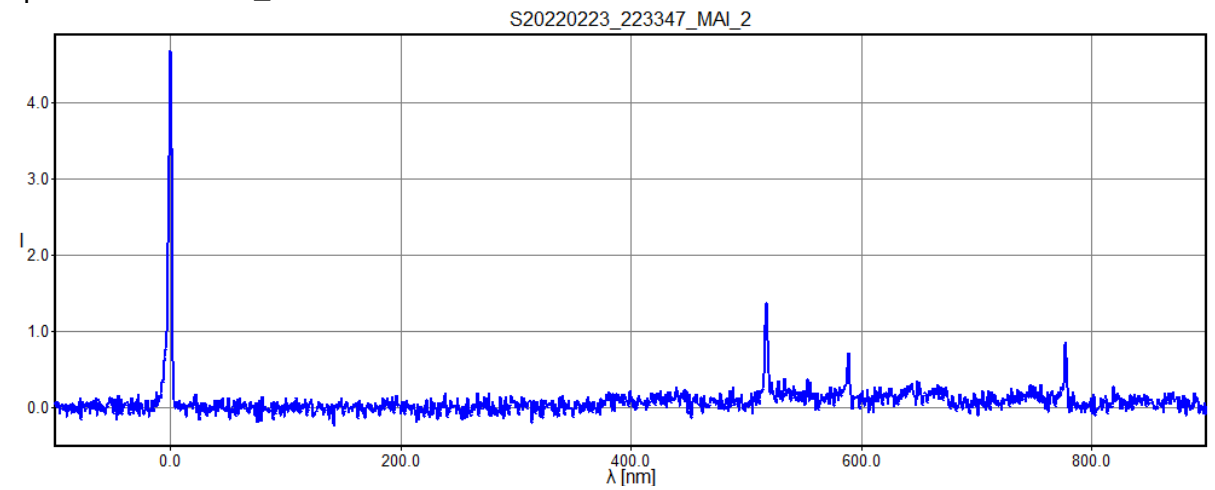


polynom for fit lambda c: [-4.4207e-06 6.0582e-01 -1.0873e+02]

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

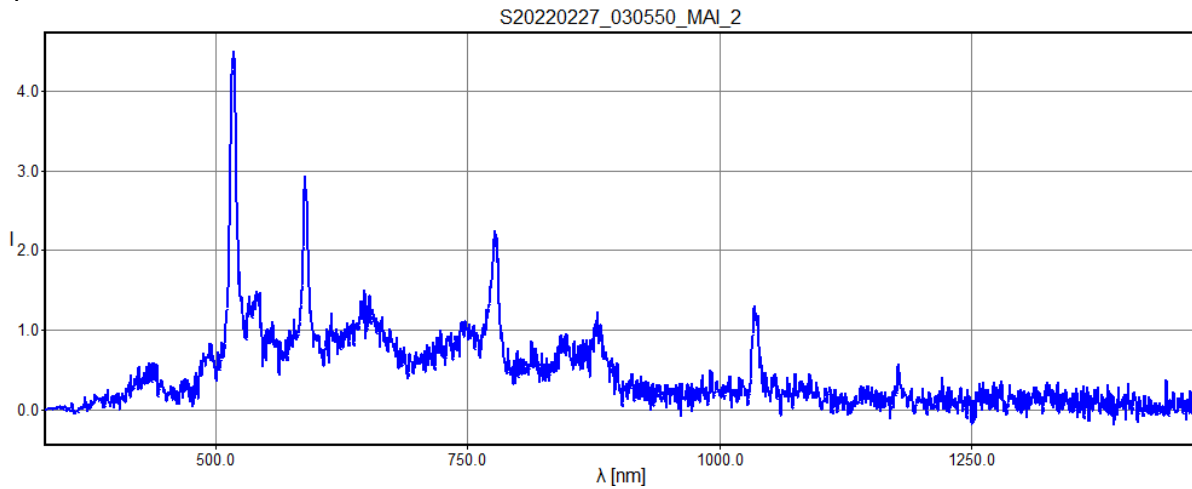


polynom for fit lambda c: [0.5962 330.897]

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

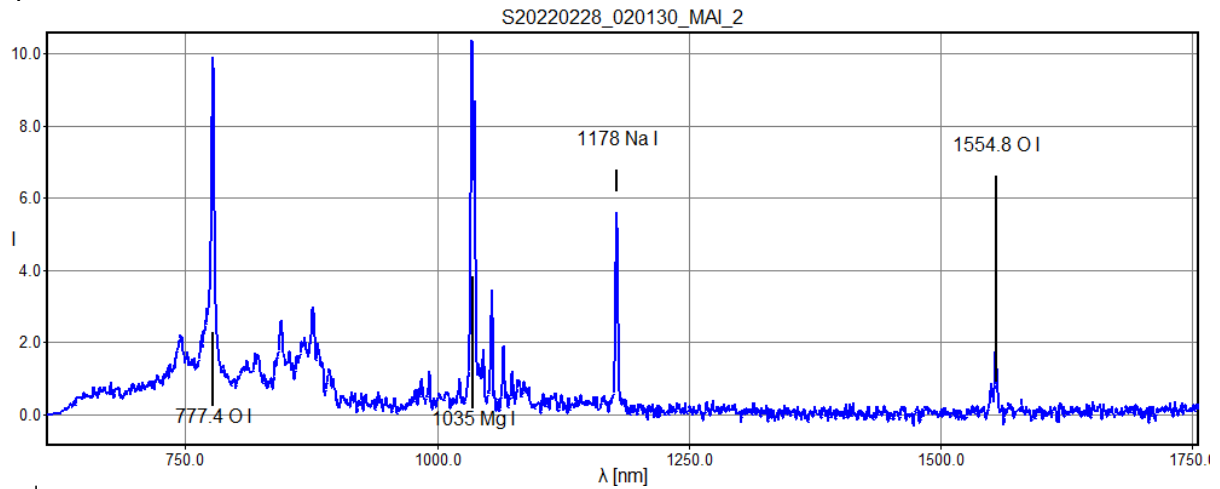


polynom for fit lambda c: [5.9682e-01 6.1234e+02]

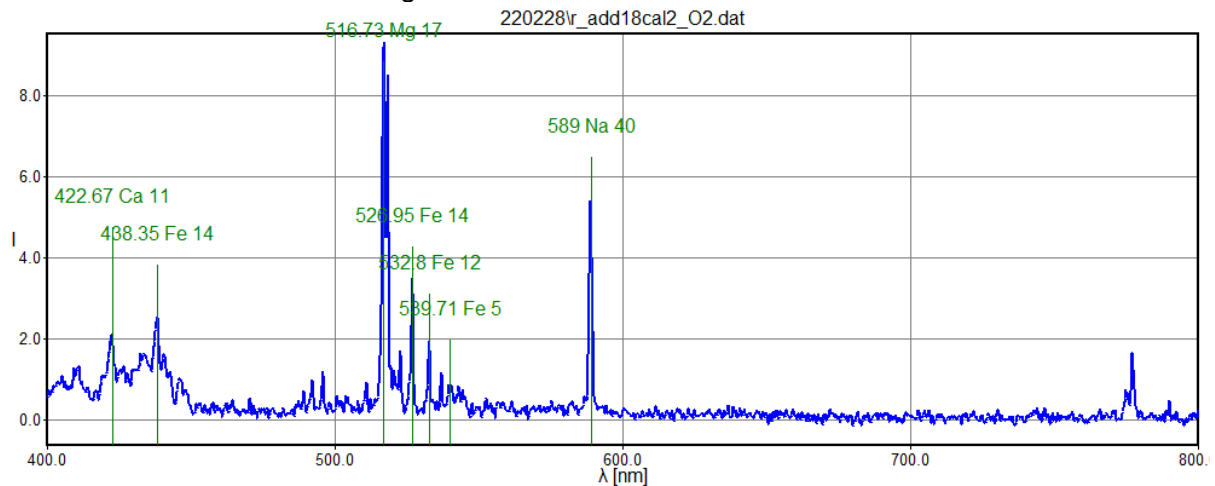
pixel	lambda	fit	error
276.68,	777.40,	777.47,	0.0705
707.72,	1035.00,	1034.72,	-0.2759
948.18,	1178.00,	1178.24,	0.2356
1579.08,	1554.80,	1554.77,	-0.0302

rms_x = 0.1854

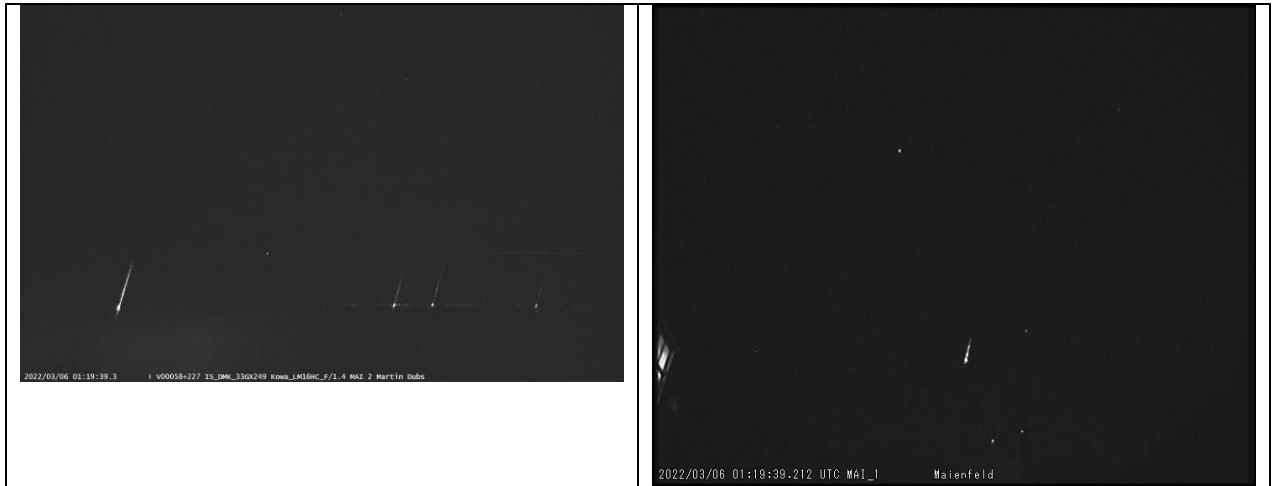
spectrum 220228\r_add18cal.dat saved



2nd order converted to wavelength:



M20220306_011939_MAI_2, spo, -2.7m

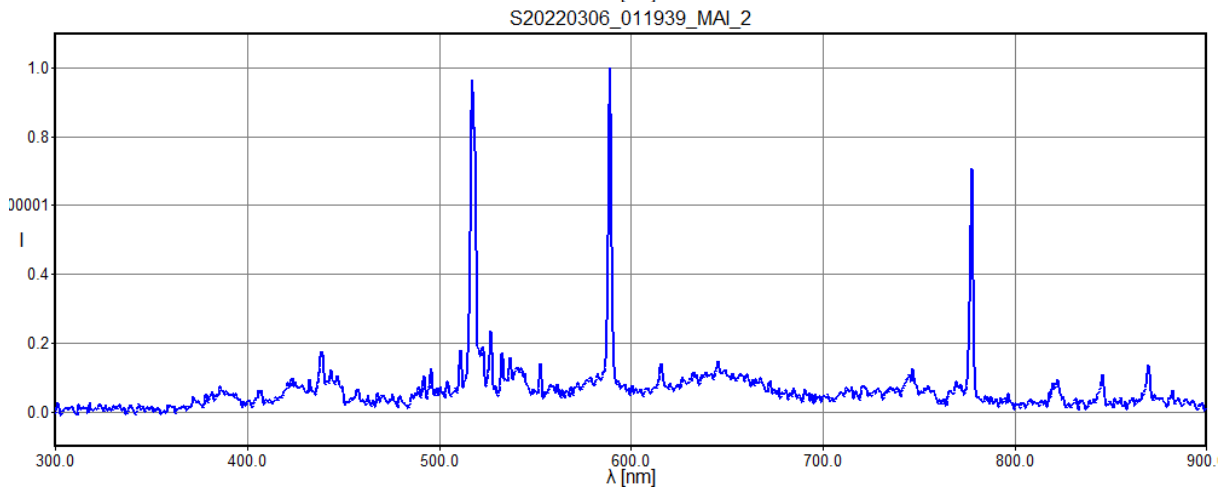
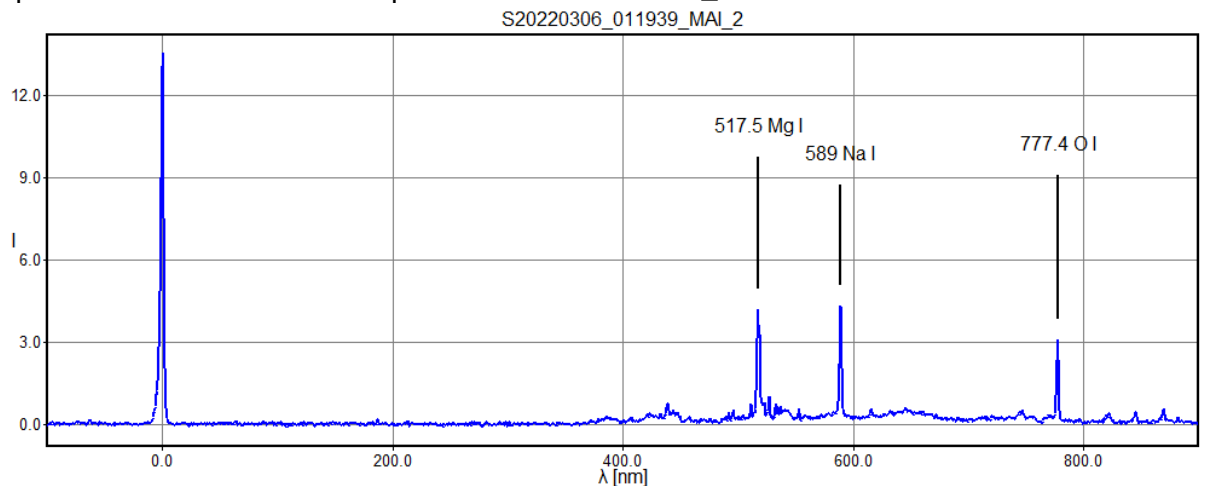


polynom for fit lambda c: [-3.5345e-06 6.0402e-01 -2.1566e+02]

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

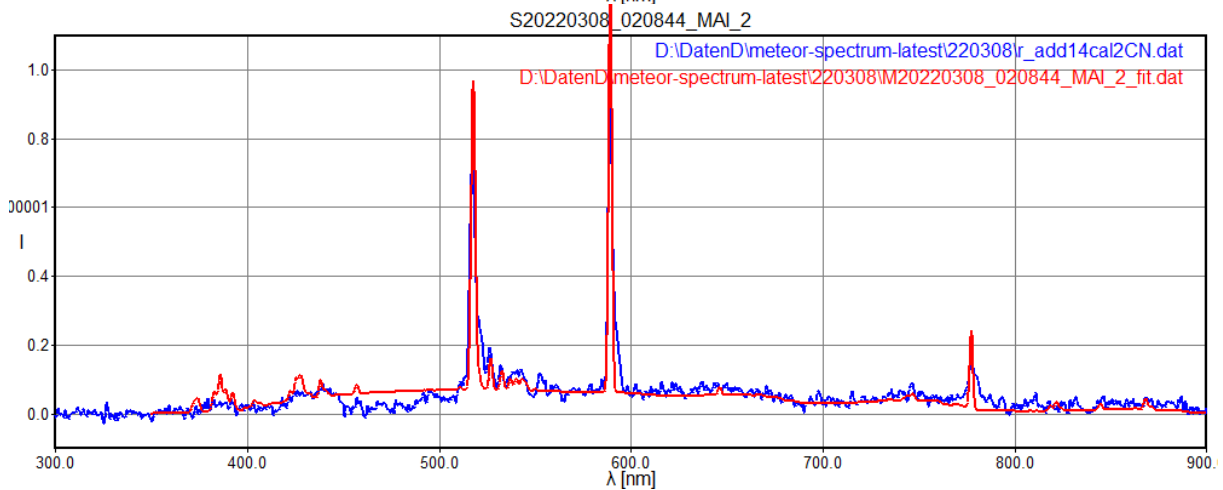
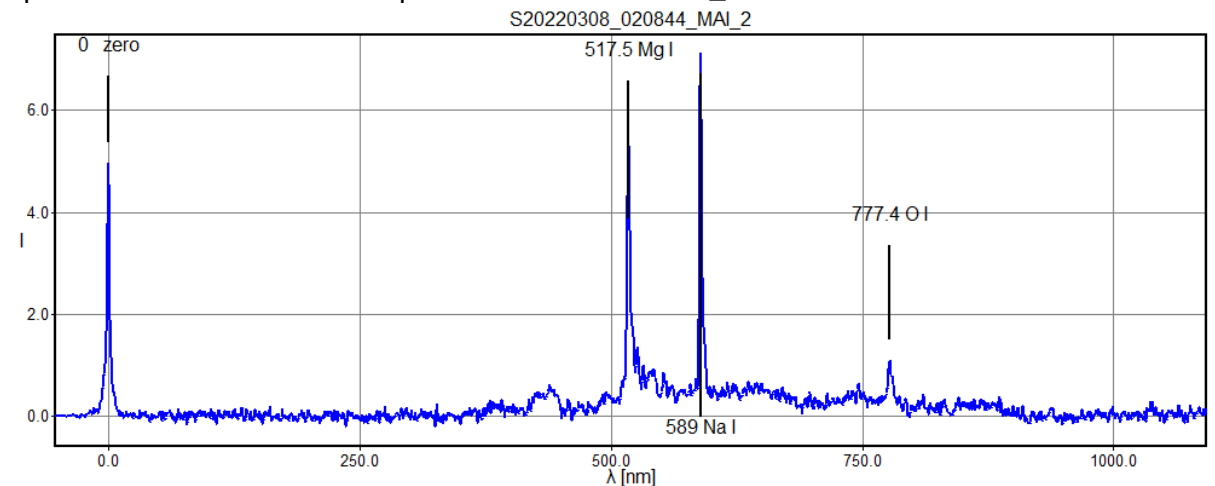


polynom for fit lambda c: [1.3647e-06 5.9624e-01 -5.4772e+01]

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

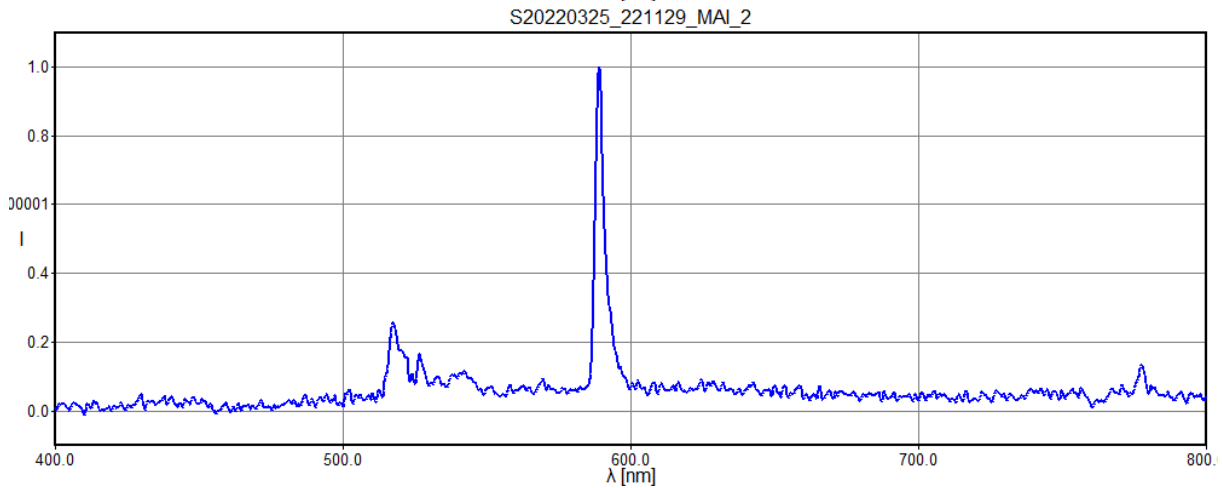
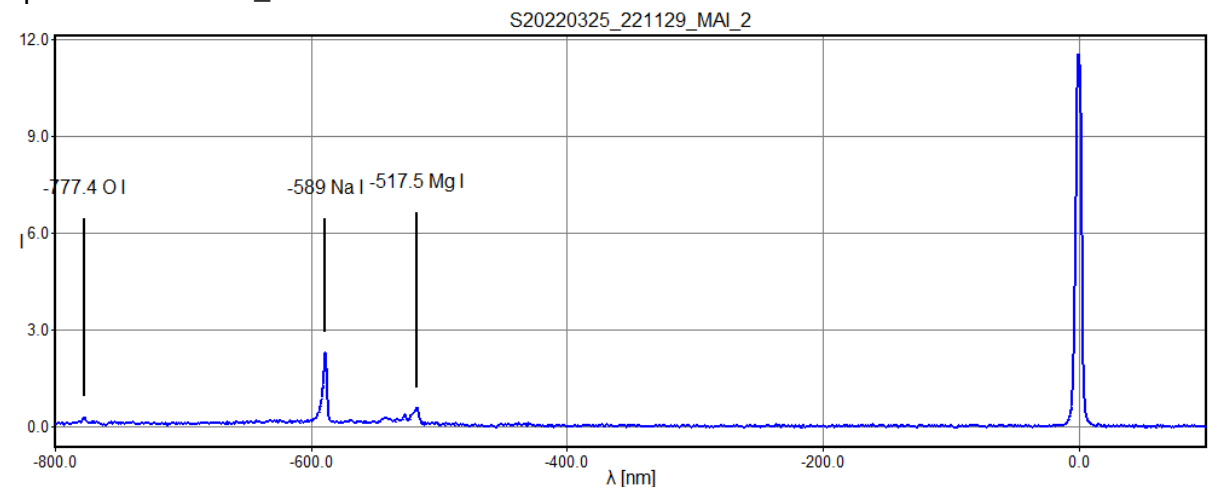


polynom for fit lambda c: [5.9817e-01 -8.4157e+02]

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

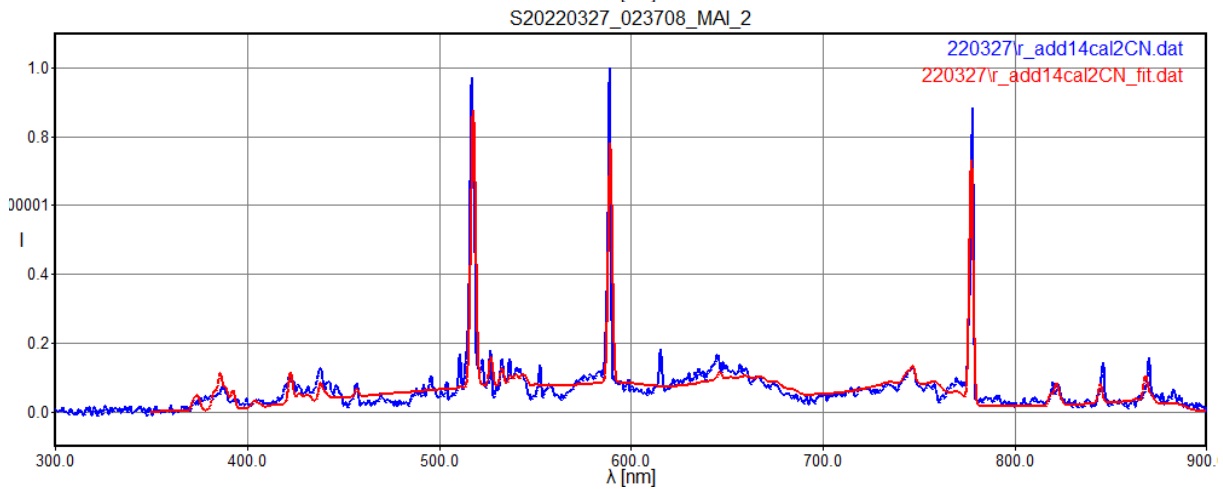
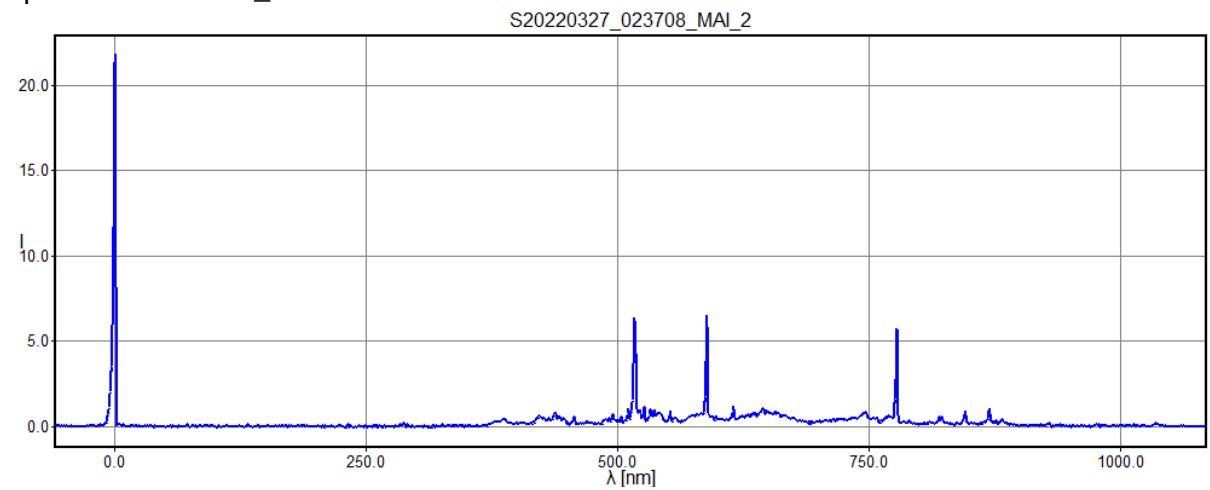


polynom for fit lambda c: [0.5979 -60.1227]

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

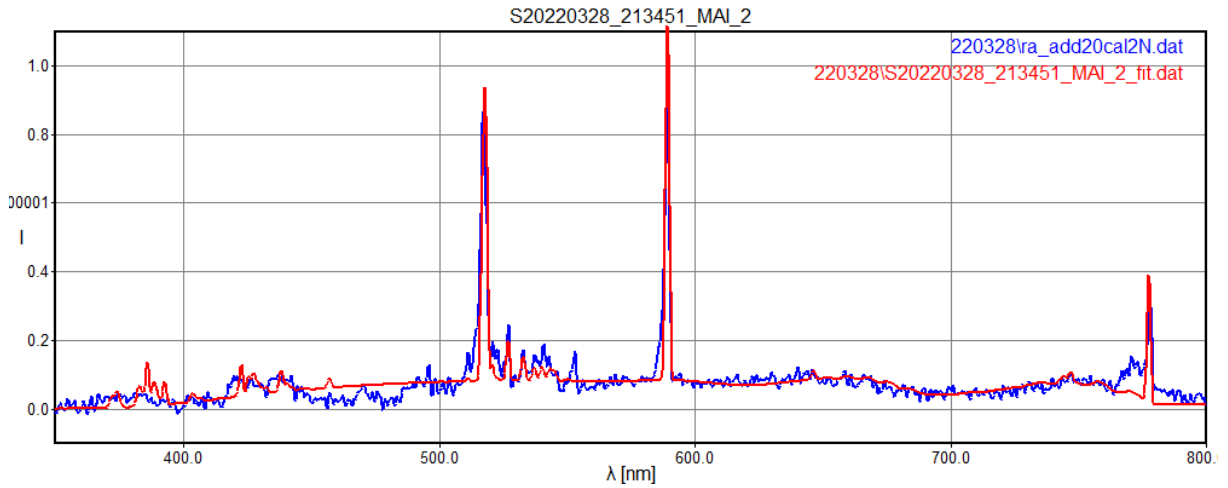
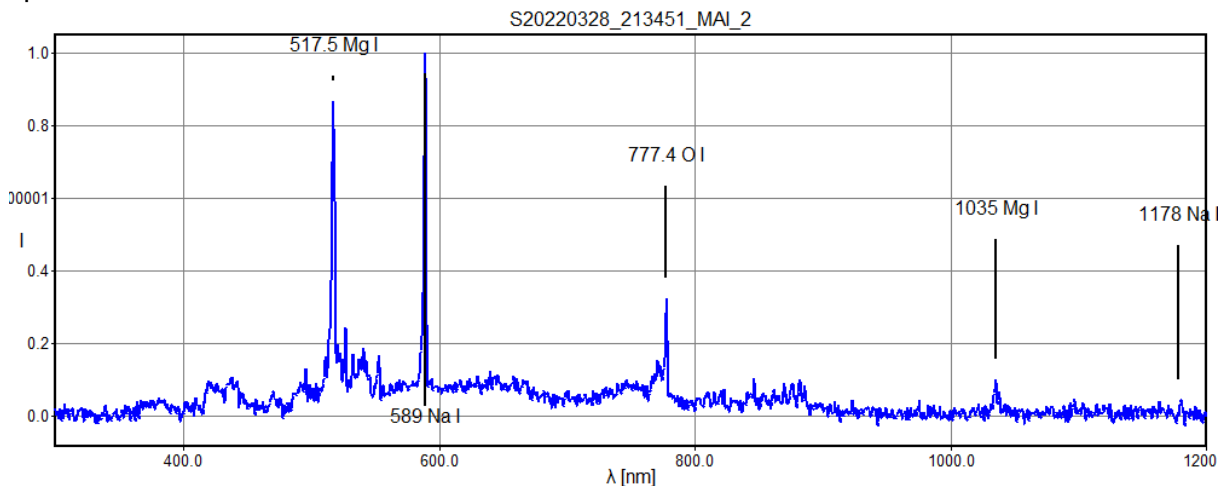
spectrum 220327\r_add14cal.dat saved



M20220328_213451_MAI_2, spo, -2m



polynom for fit lambda c: [0.600 149.24]
 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

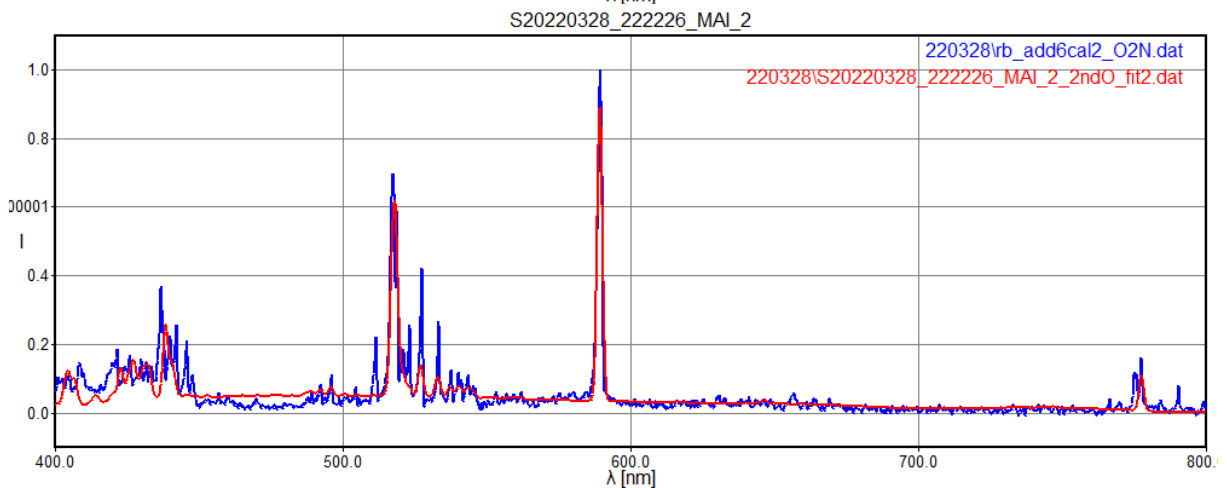
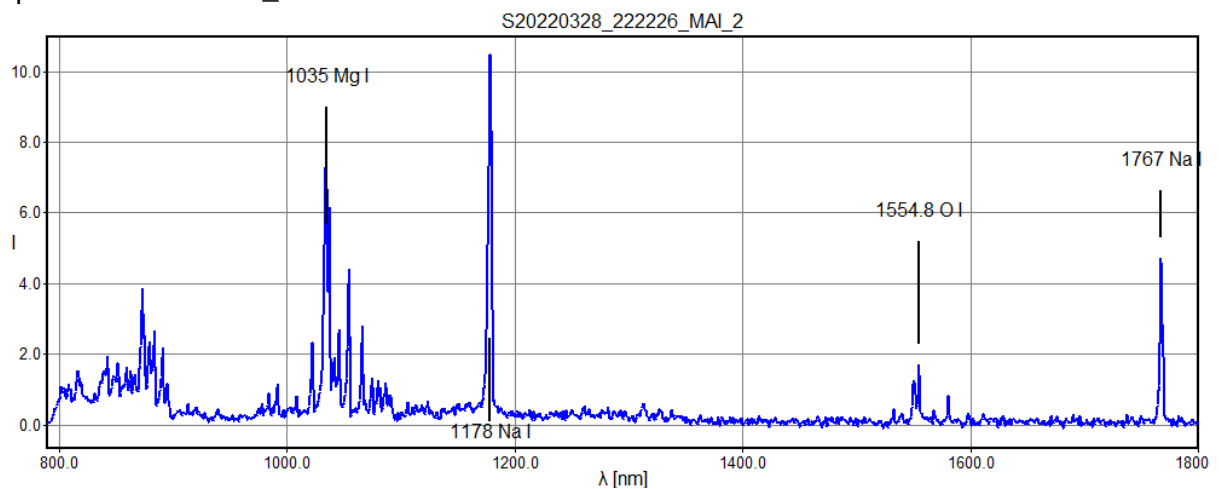


polynom for fit lambda c: [5.9893e-01 7.7351e+02]

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

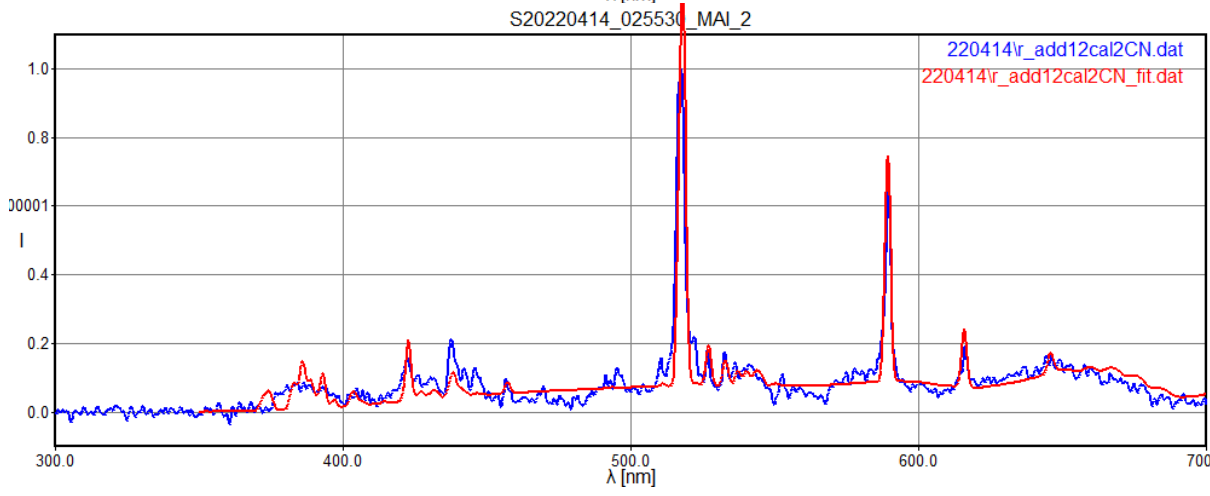
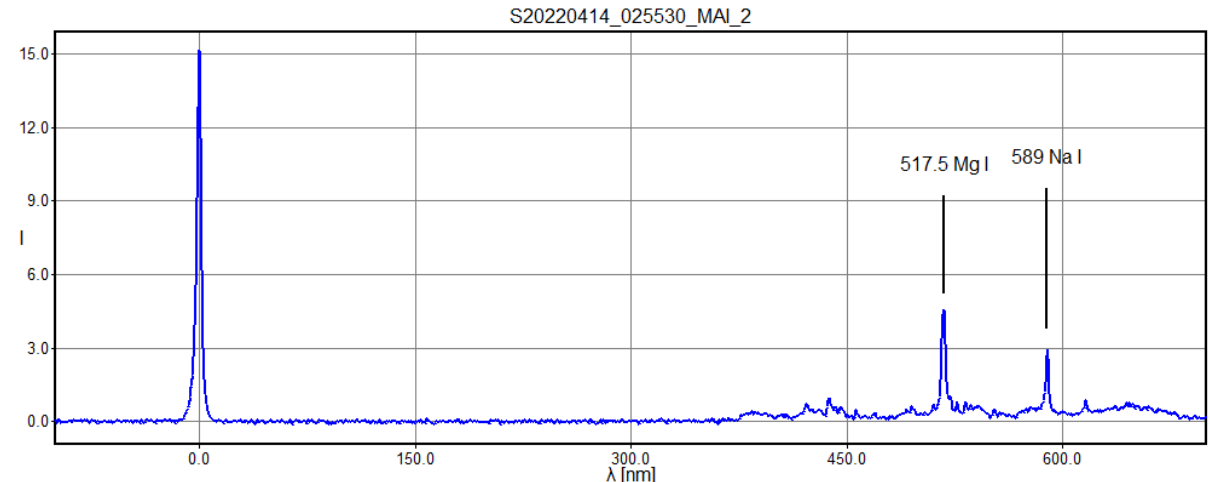
spectrum 220328\rb_add6cal.dat saved



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

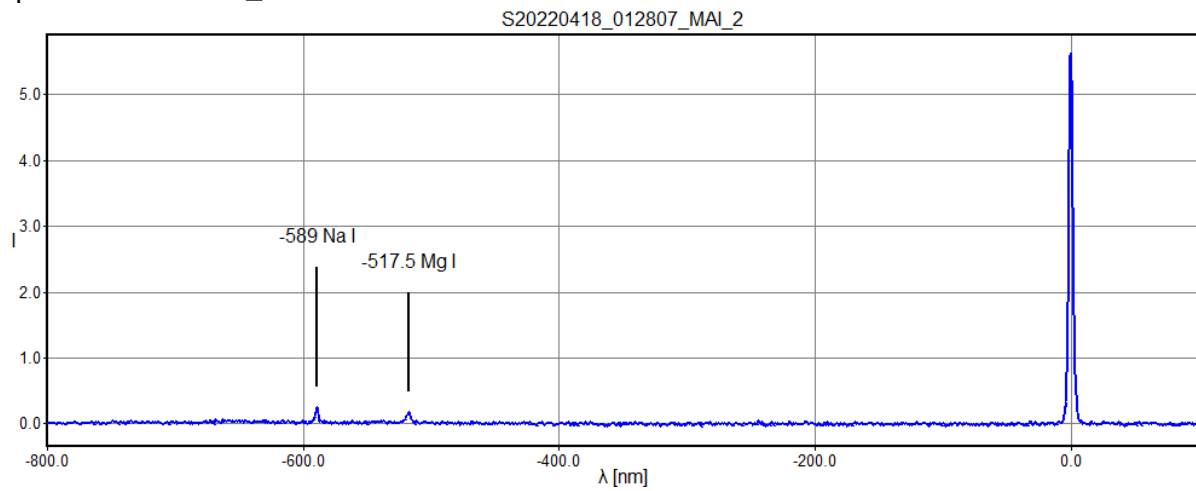


polynom for fit lambda c: [5.9778e-01 -8.1542e+02]

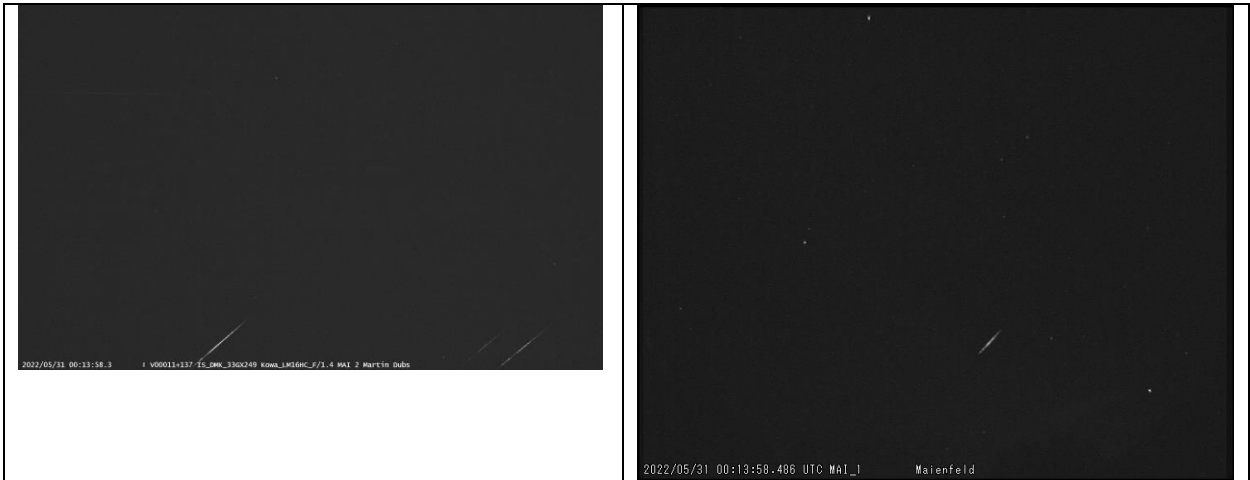
pixel	lambda	fit	error
378.66	-589.00	-589.06	-0.0618
498.49	-517.50	-517.43	0.0703
1364.06	0.00	-0.01	-0.0086

rms_x = 0.0543

spectrum 220418\r_add14cal.dat saved



M20220531_001358_MAI_2, spo, -1.0m

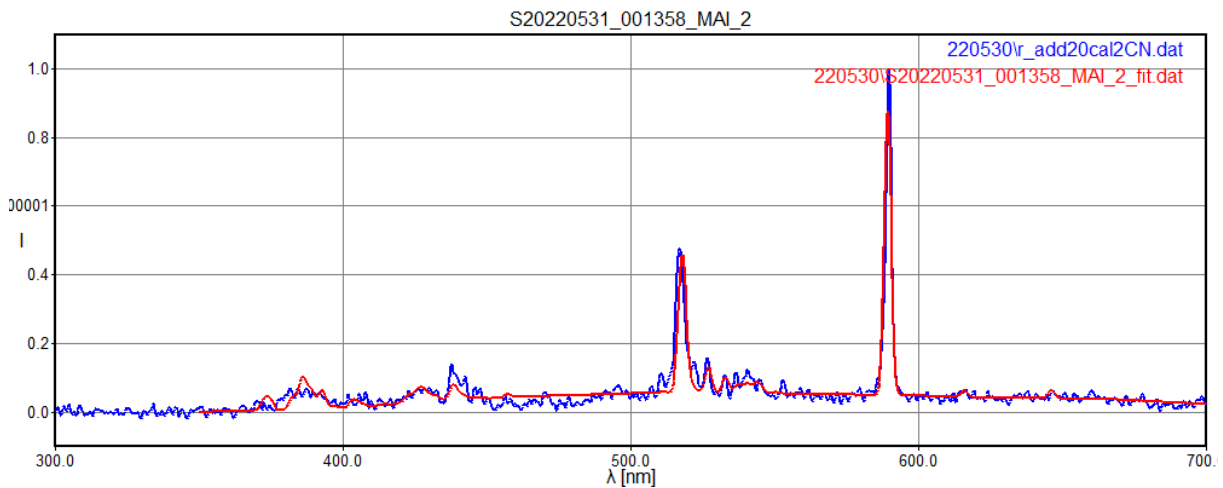
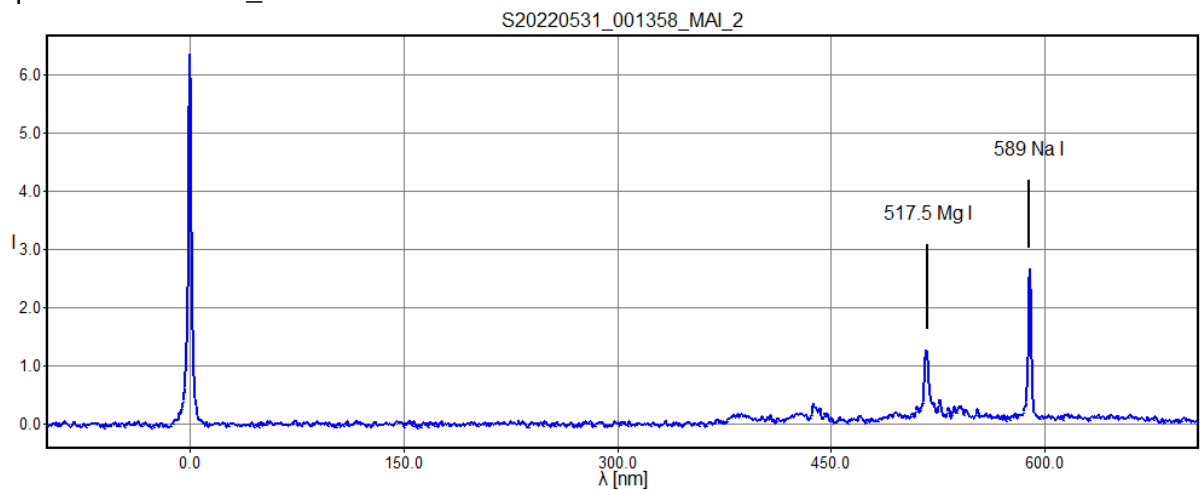


polynom for fit lambda c: [0.5978 -437.5764]

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

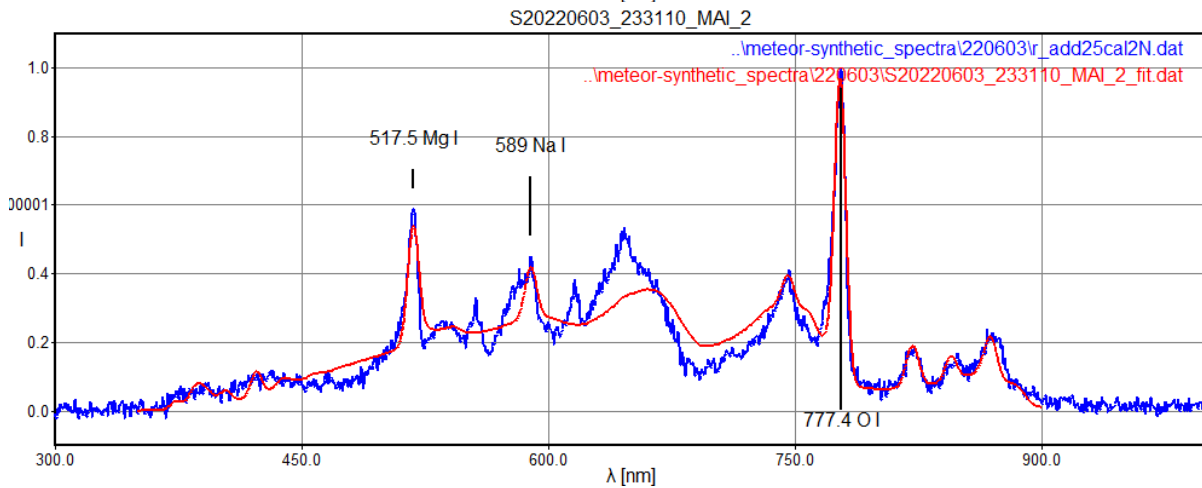
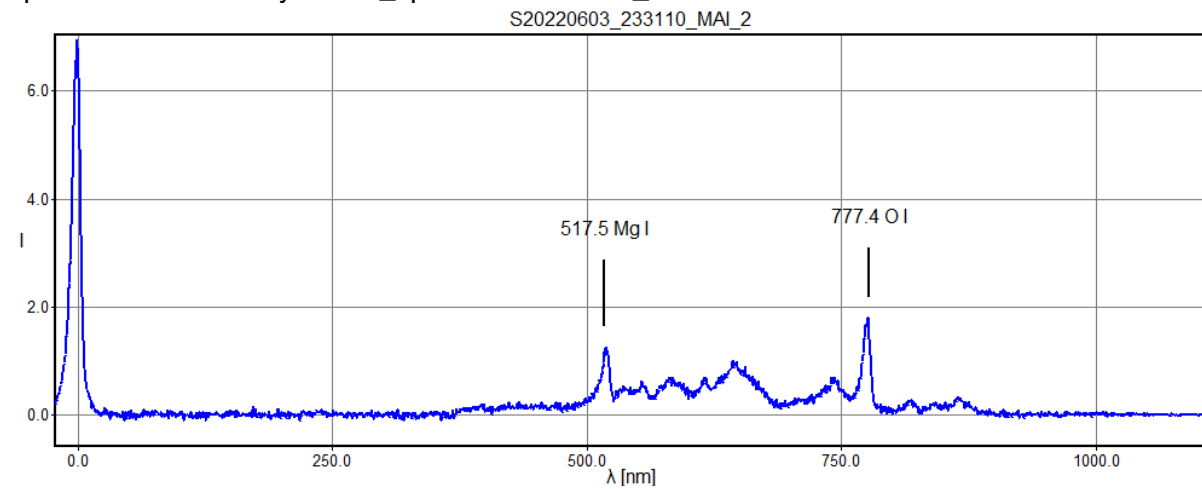


polynom for fit lambda c: [0.5913 -23.0949]

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

M20220708_233717_MAI_2, spo, -1.3m

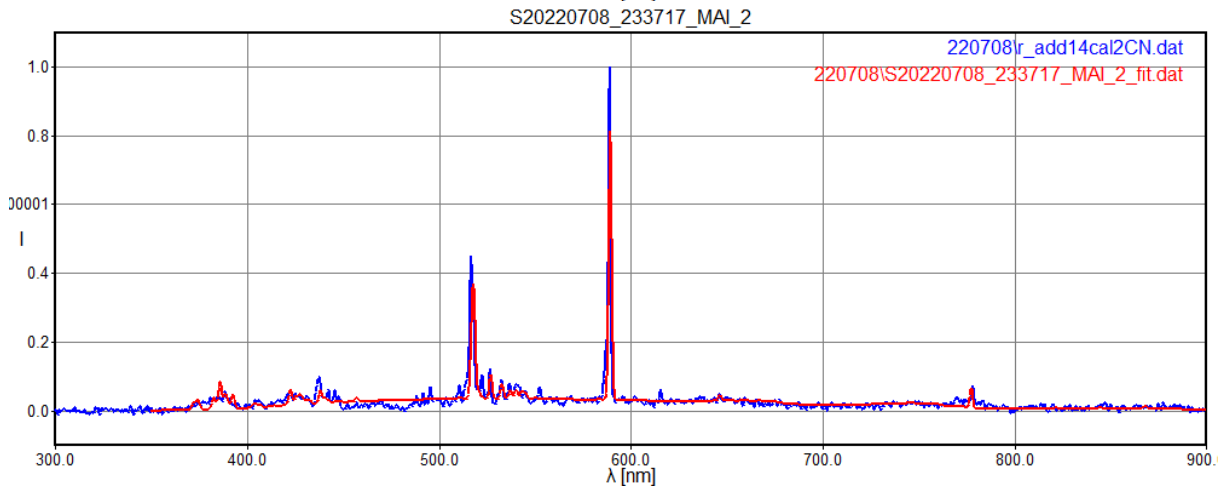
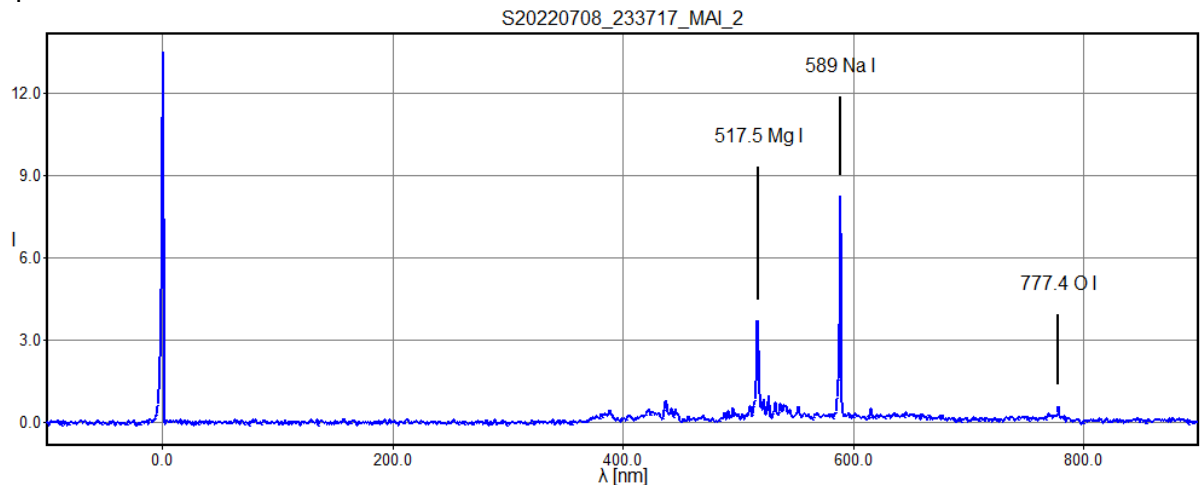


polynom for fit lambda c: [0.5974 -232.0425]

pixel	lambda	fit	error
388.95,	0.00,	0.30,	0.2970
1253.59,	517.50,	516.79,	-0.7097
1374.07,	589.00,	588.76,	-0.2409
1690.96,	777.40,	778.05,	0.6536

rms_x = 0.5189

spectrum 220708\r_add14cal.dat saved



M20220713_001311_MAI_2, spo, -1.6m

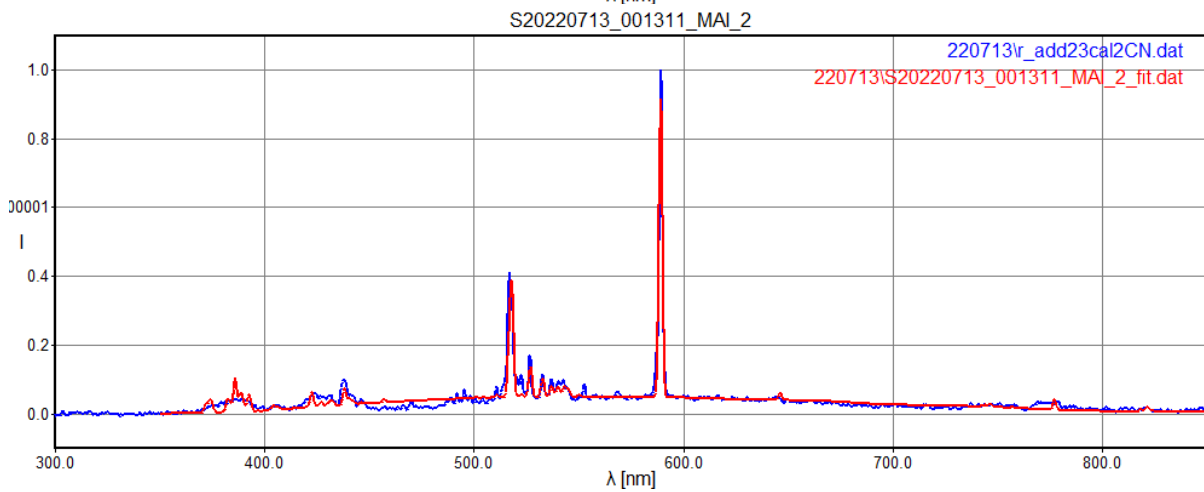
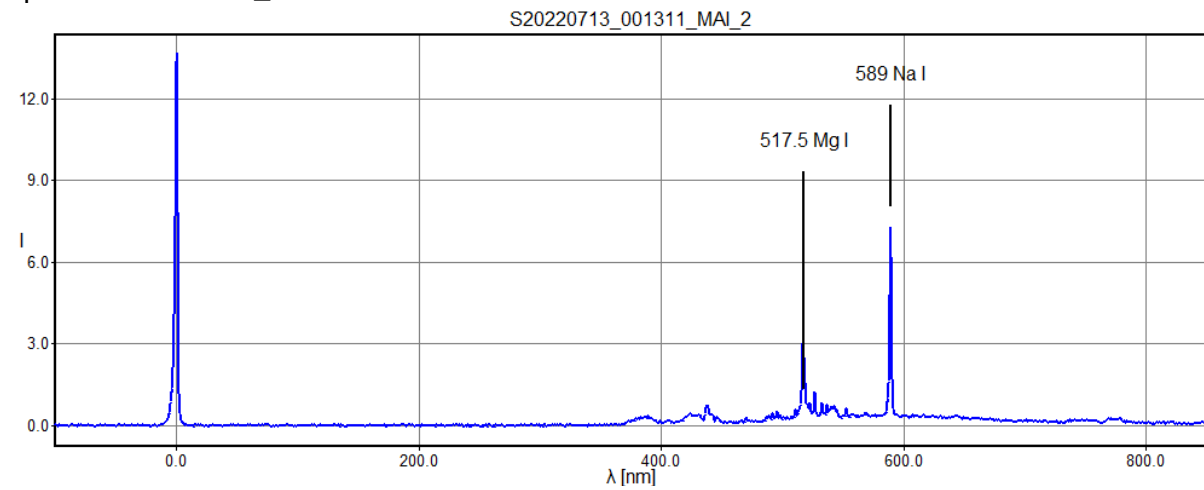


polynom for fit lambda c: [0.5981 -292.924]

pixel	lambda	fit	error
1354.57,	517.50,	517.22,	-0.2806
1475.00,	589.00,	589.25,	0.2463
489.83,	0.00,	0.03,	0.0343

rms_x = 0.2165

spectrum 220713\r_add23cal.dat saved



M20220717_235647_MAI_2, PER, (-1.7m)

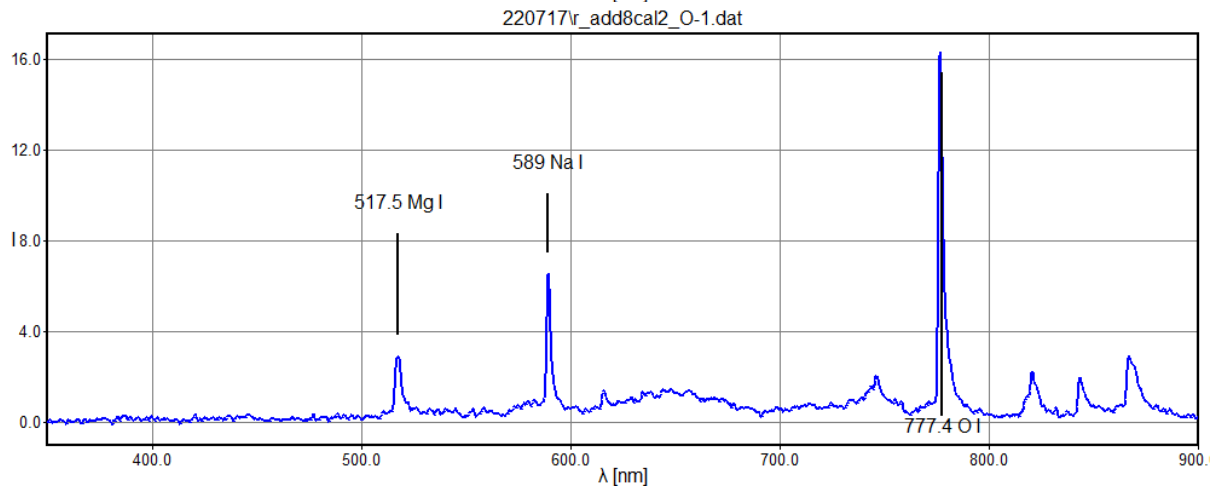
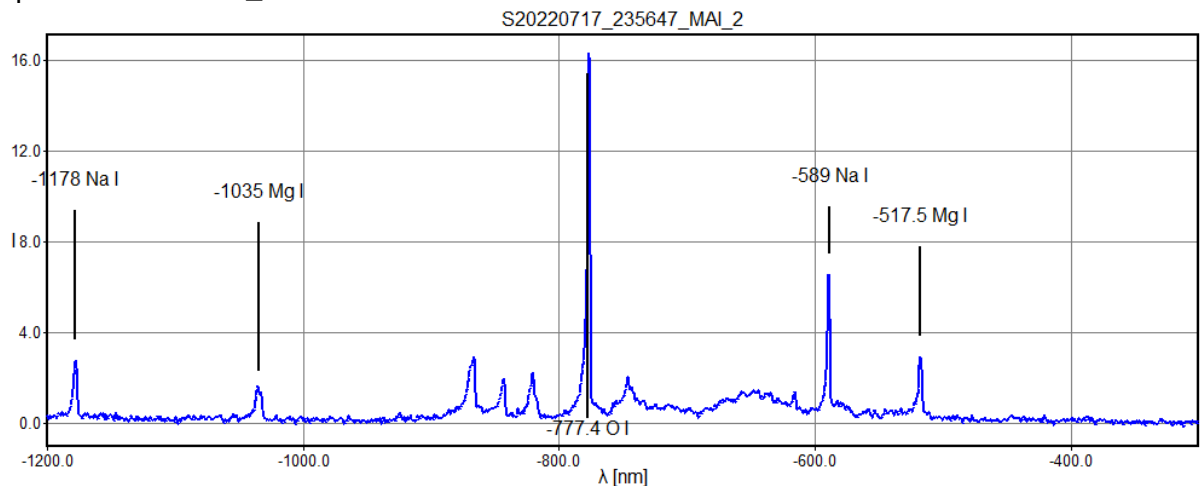


2022/07/17 23:56:47.1 I:\V00099\238 TS_PMK_33cv249_kovm-1M16HC_C\1_4_MAI_2_Martin_nibs_Maienfeld_5
 polynom for fit lambda c: [6.0014e-01 -1.2244e+03]

pixel	lambda	fit	error
1177.90	-517.50	-517.50	-0.0008
1058.14	-589.00	-589.37	-0.3734
746.03	-777.40	-776.68	0.7174
314.81	-1035.00	-1035.47	-0.4742
77.54	-1178.00	-1177.87	0.1310

rms_x = 0.4234

spectrum 220717\r_add8cal.dat saved



M20220808_202517_MAI_2, PER, -3.3m

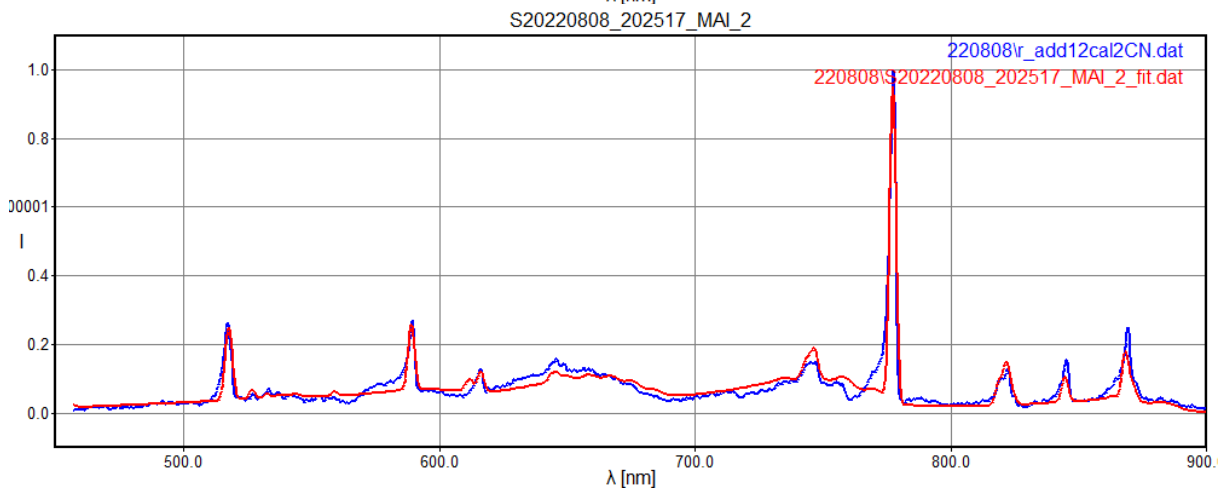
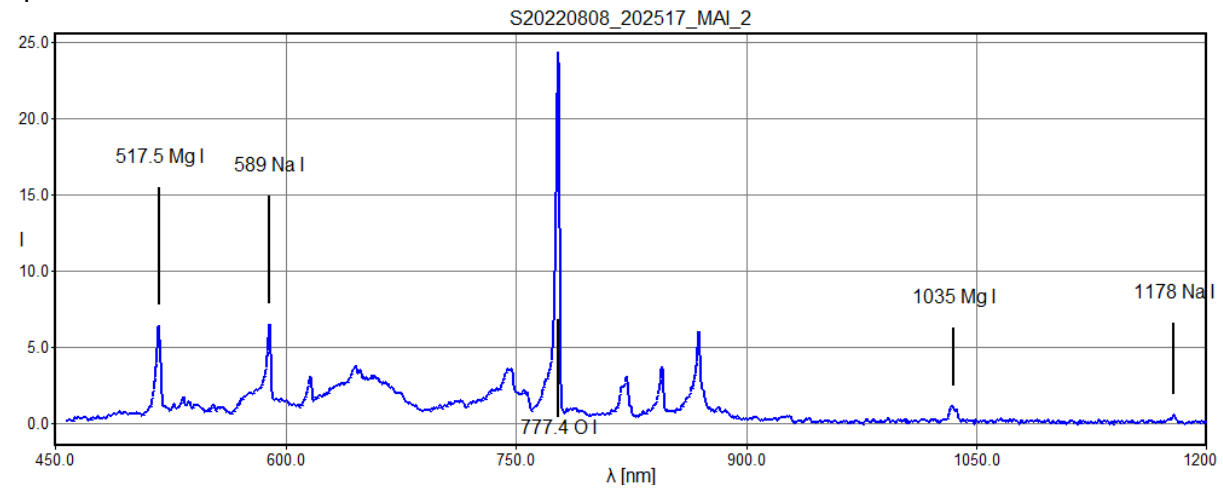


polynom for fit lambda c: [0.5999 456.7871]

pixel	lambda	fit	error
100.98,	517.50,	517.37,	-0.1300
220.90,	589.00,	589.32,	0.3160
534.49,	777.40,	777.45,	0.0543
962.36,	1035.00,	1034.15,	-0.8451
1203.13,	1178.00,	1178.60,	0.6048

rms_x = 0.4898

spectrum 220808\r_add12cal.dat saved



M20220808_210927_MAI_2, PER, -2.5m

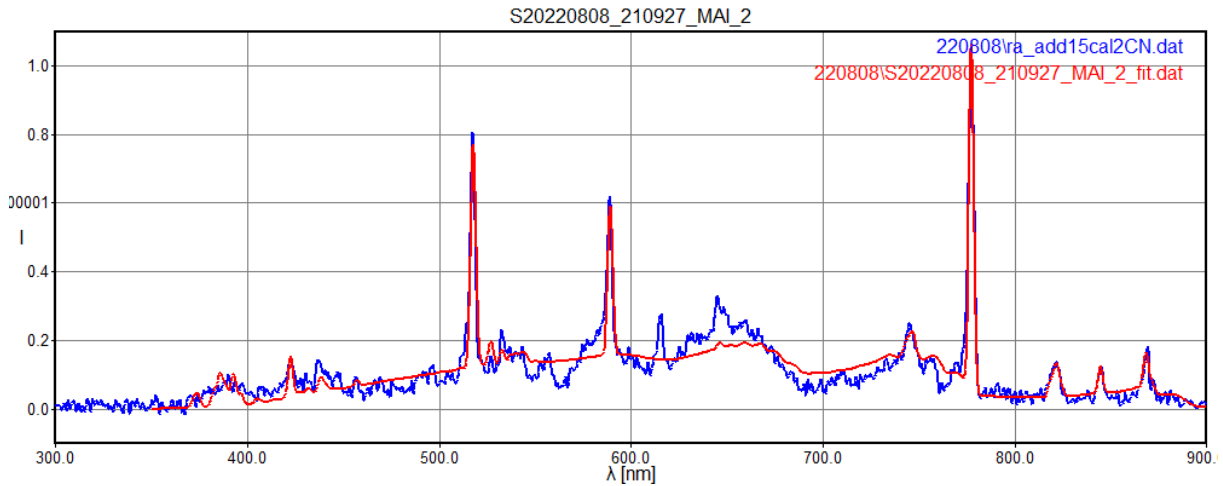
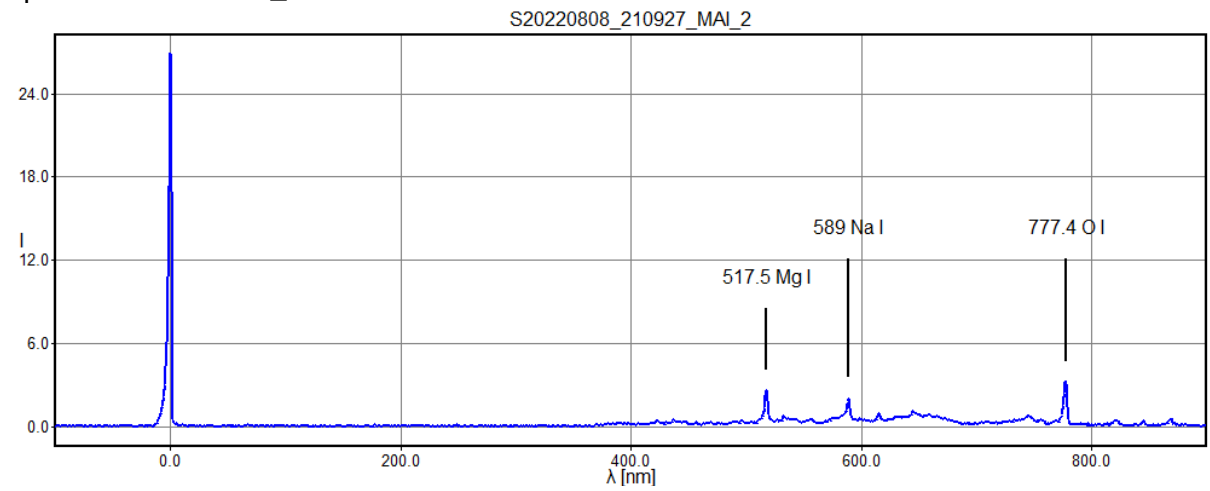


polynom for fit lambda c: [-4.5111e-06 6.0577e-01 -1.0201e+02]

pixel	lambda	fit	error
168.61,	0.00,	-0.00,	-0.0019
1030.68,	517.50,	517.55,	0.0462
1150.49,	589.00,	588.94,	-0.0559
1467.80,	777.40,	777.41,	0.0116

rms_x = 0.0367

spectrum 220808\ra_add15cal.dat saved



M20220809_010732_MAI_2, CAP, -2.5m

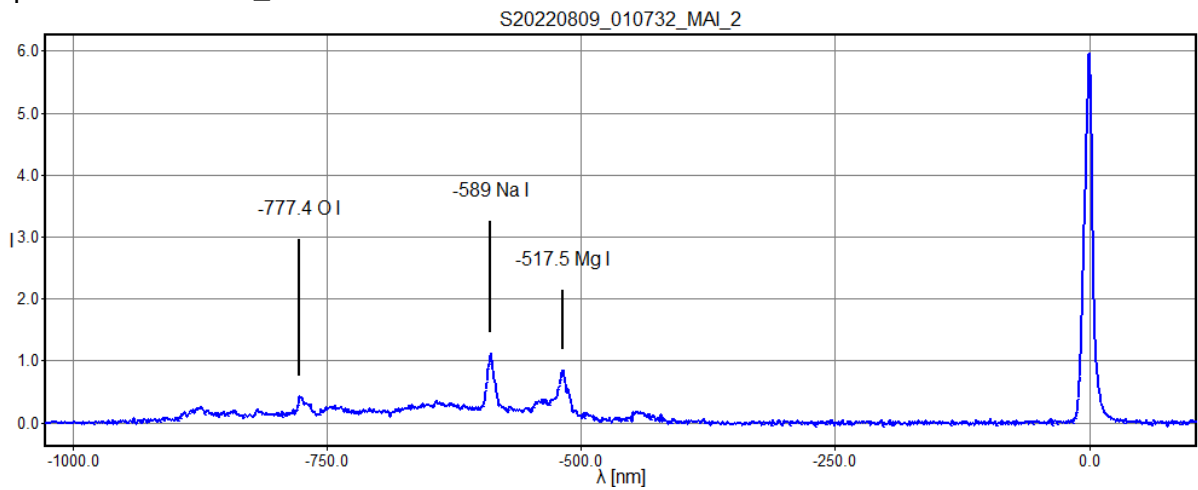


polynom for fit lambda c: [5.9194e-01 -1.0285e+03]

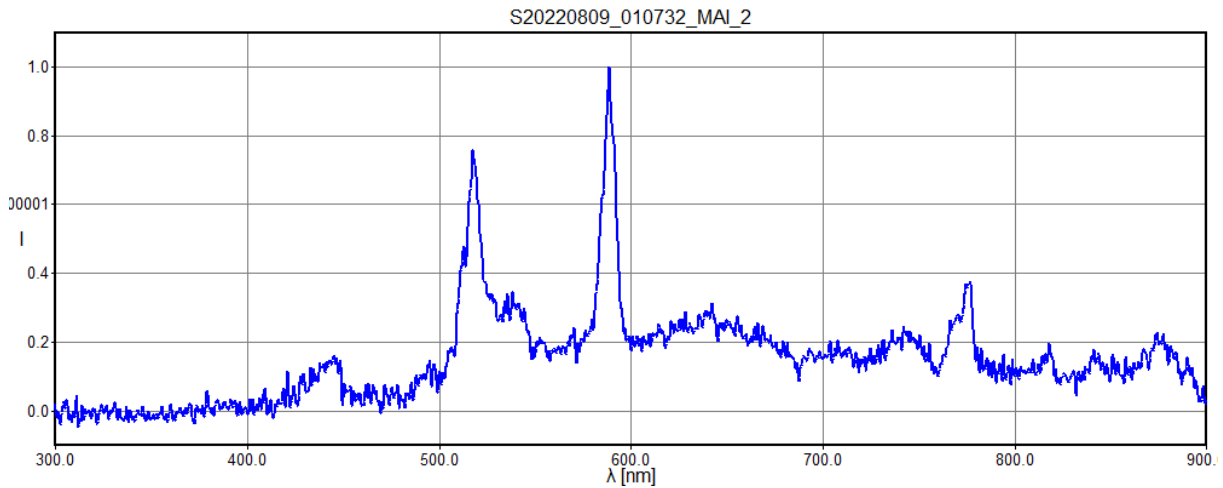
pixel	lambda	fit	error
1737.54,	0.00,	0.05,	0.0540
862.45,	-517.50,	-517.95,	-0.4498
743.09,	-589.00,	-588.60,	0.3958

rms_x = 0.3473

spectrum 220809\rr_add30cal.dat saved



-1stO reversed:



M20220810_210141_MAI_2, PER, -4.6m

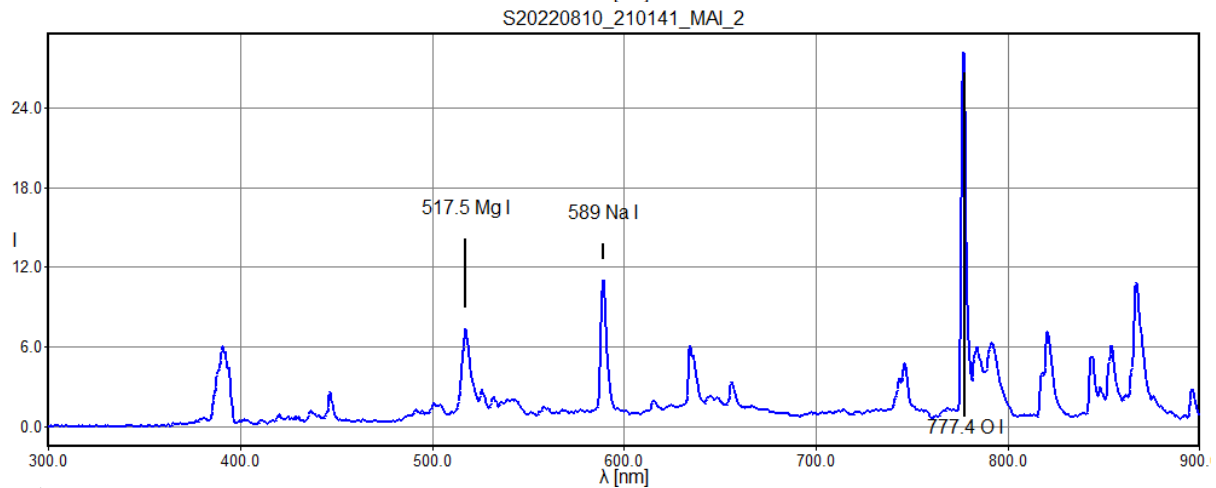
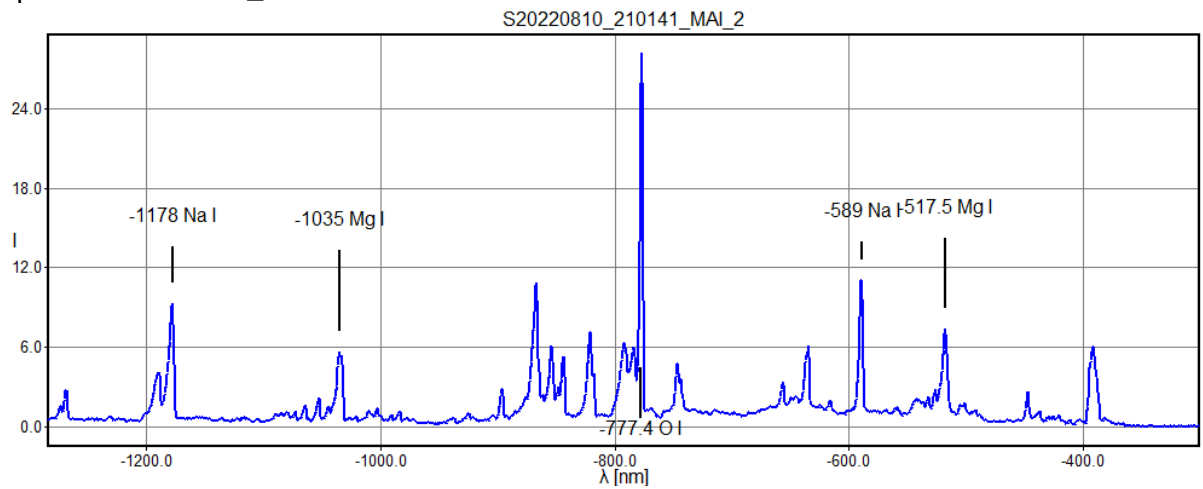


polynom for fit lambda c: [5.9949e-01 -1.2855e+03]

pixel	lambda	fit	error
1280.98,	-517.50,	-517.59,	-0.0876
1161.45,	-589.00,	-589.25,	-0.2451
848.33,	-777.40,	-776.96,	0.4414
418.19,	-1035.00,	-1034.82,	0.1751
178.89,	-1178.00,	-1178.28,	-0.2838

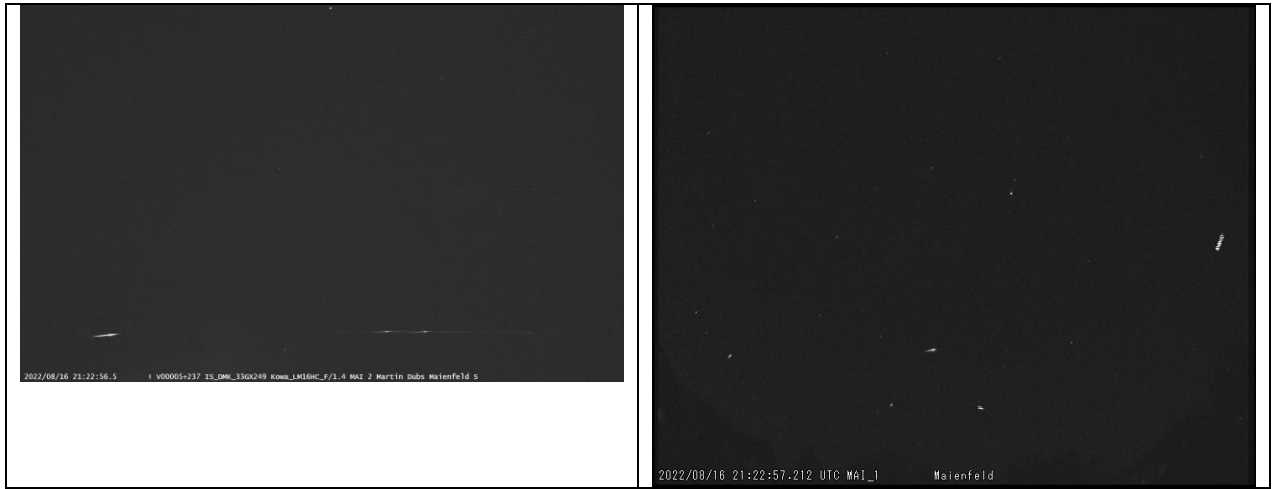
rms_x = 0.2734

spectrum 220810\r_add9cal.dat saved



-1st order reversed

M20220816_212256_MAI_2, spo, -0.8m



Slow object

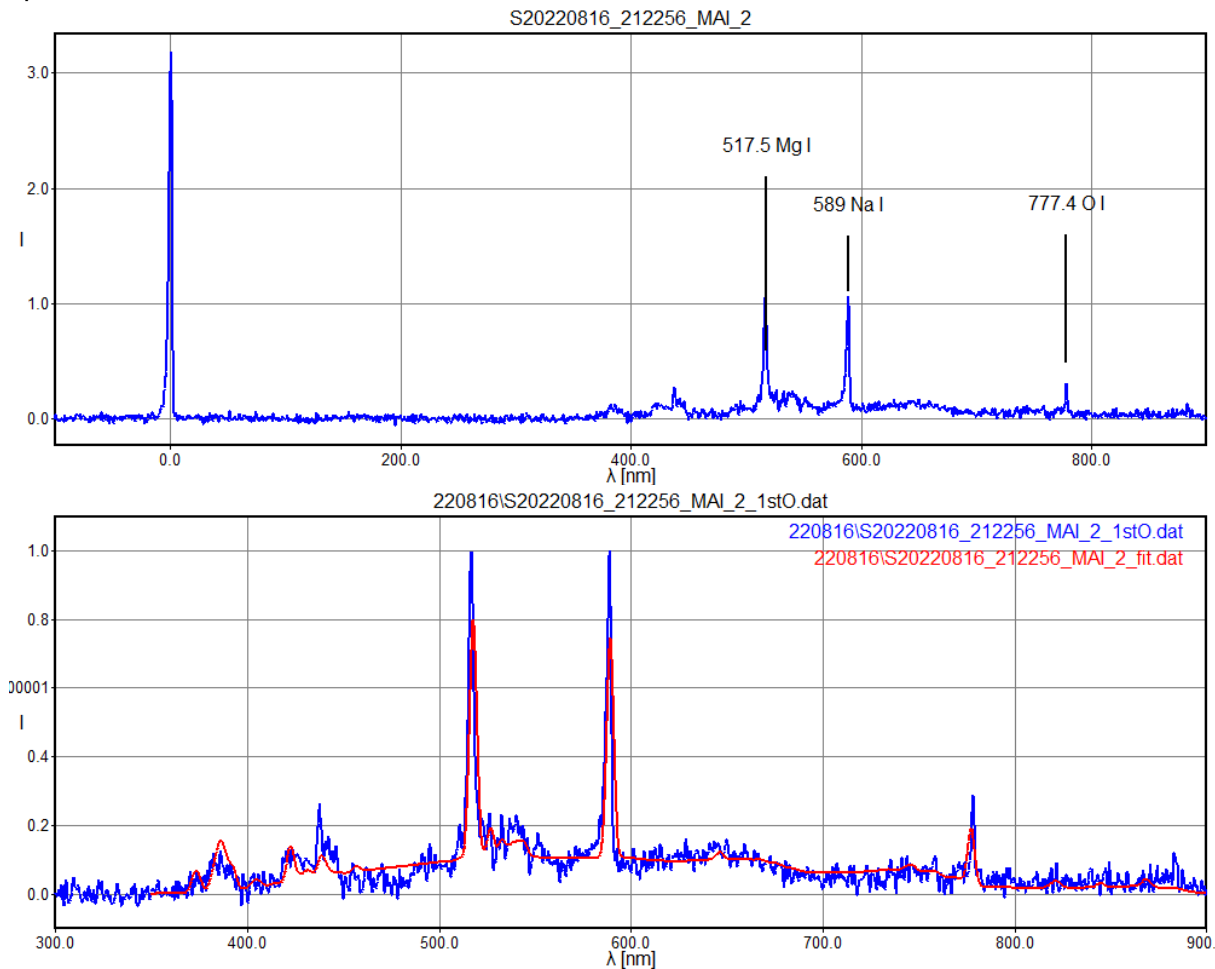
MAI_2: 1.34°/sec, 1.14sec, (MAI_1: 2.39 °/sec, 0.24sec)

polynom for fit lambda c: [0.5964 -144.9305]

pixel	lambda	fit	error
243.61,	0.00,	0.35,	0.3487
1109.51,	517.50,	516.74,	-0.7633
1230.05,	589.00,	588.62,	-0.3781
1547.93,	777.40,	778.19,	0.7927

rms_x = 0.6074

spectrum 220816\r_add30cal.dat saved



M20220821_191252_MAI_2, KCG, -1.6m



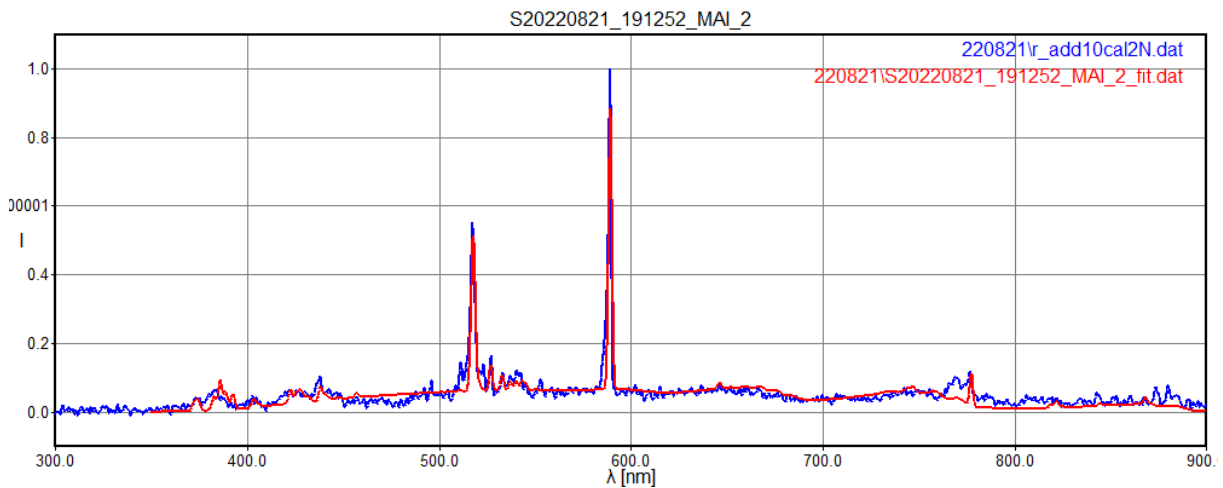
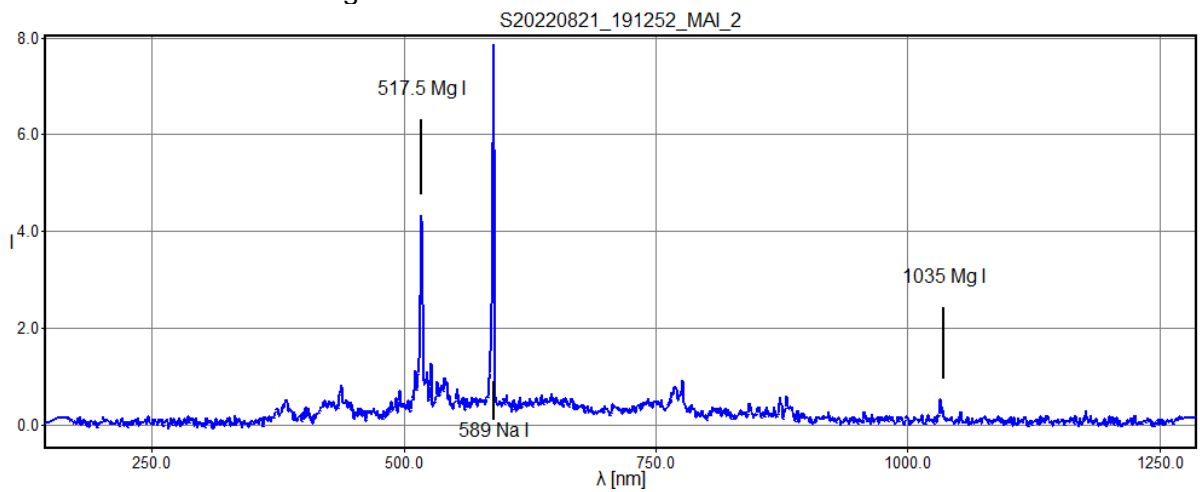
polynom for fit lambda c: [0.5965 143.6744]

pixel	lambda	fit	error
626.72,	517.50,	517.50,	0.0000
746.59,	589.00,	589.00,	0.0000

rms_x = 0.0000

spectrum test\r_add10cal.dat saved

calibration checked with Mg I at 1035 nm



M20220905_001410_MAI_2, spo, -1.2m

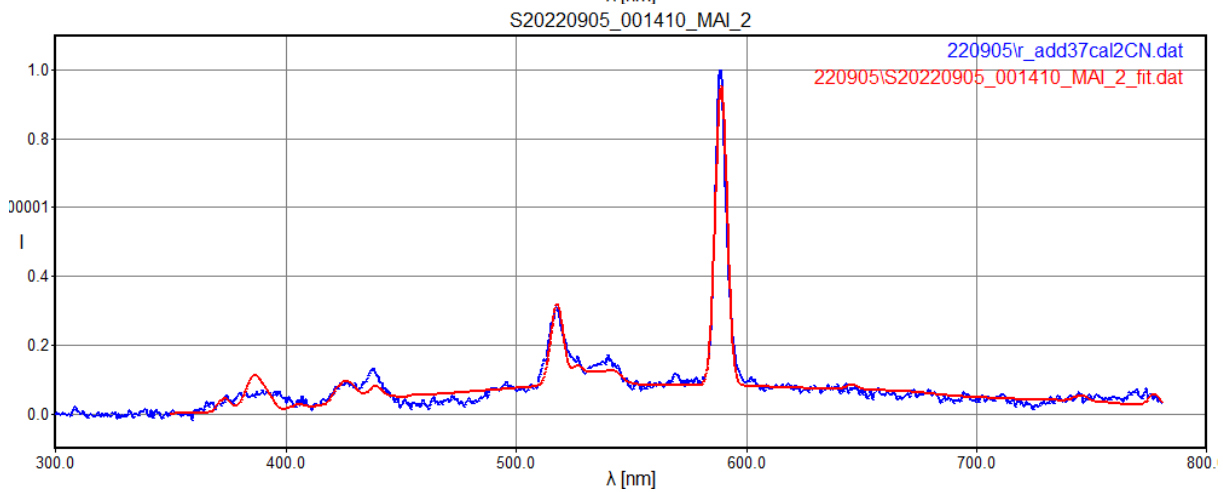
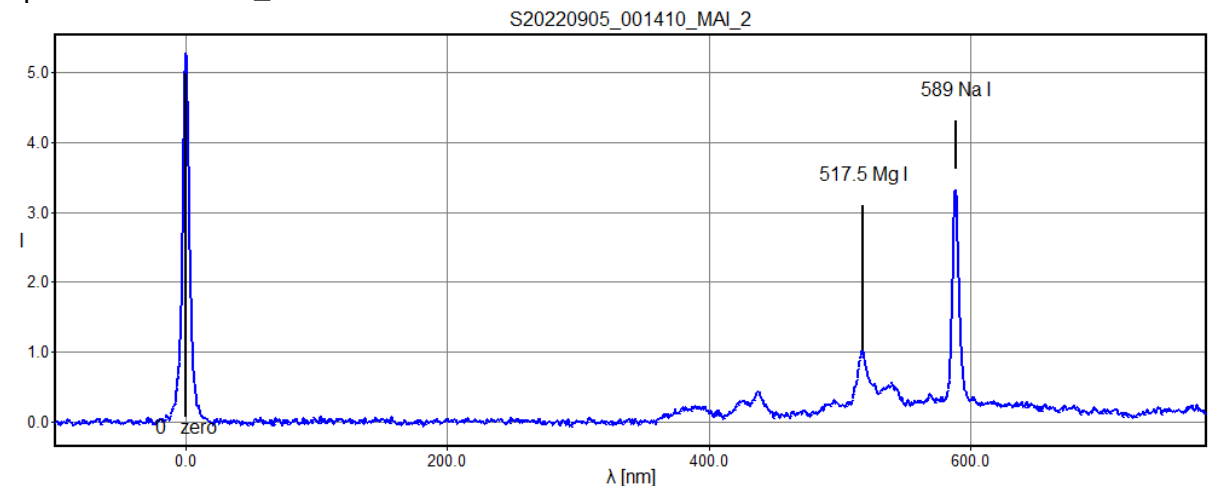


polynom for fit lambda c: [0.5935 -356.8244]

pixel	lambda	fit	error
601.17	0.00	-0.02	-0.0236
1473.47	517.50	517.70	0.1957
1593.32	589.00	588.83	-0.1721

rms_x = 0.1511

spectrum 220905\r_add37cal.dat saved



M20221004_194554_MAI_2, spo, -1.8m

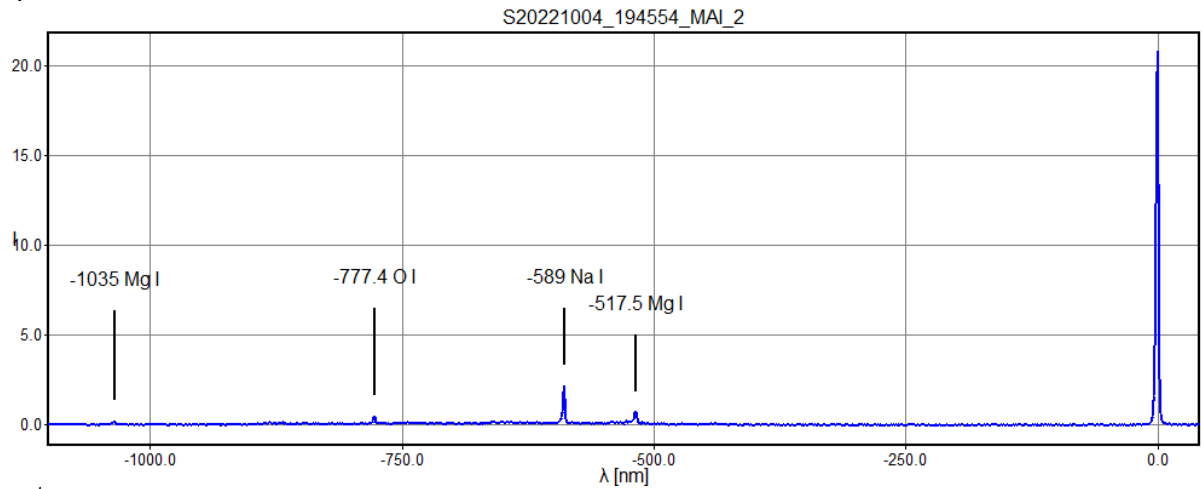


polynom for fit lambda c: [-1.4310e-06 5.9998e-01 -1.1029e+03]

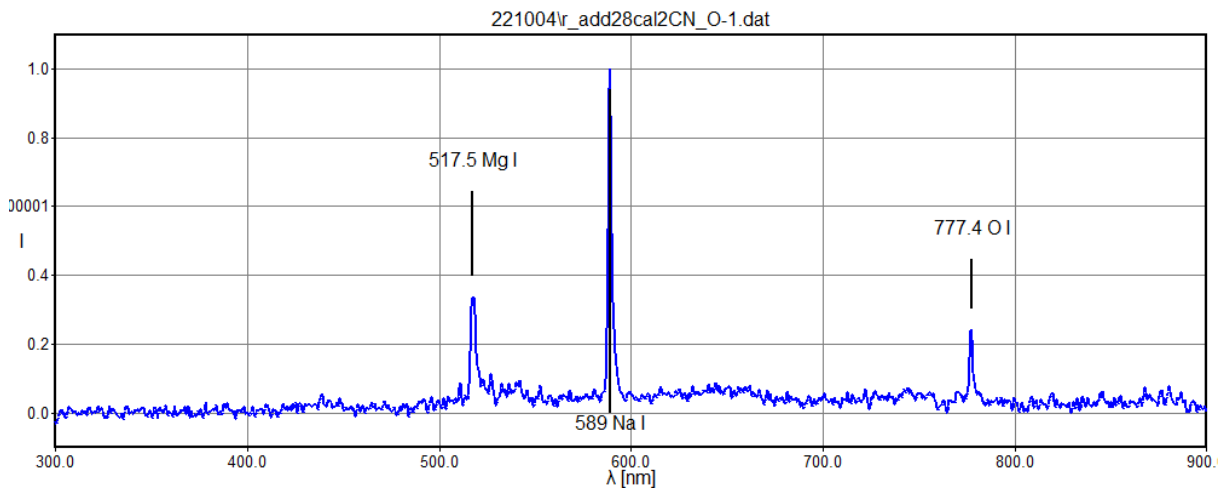
pixel	lambda	fit	error
1846.41,	0.00,	0.03,	0.0303
977.71,	-517.50,	-517.66,	-0.1639
858.24,	-589.00,	-589.03,	-0.0299
543.66,	-777.40,	-777.14,	0.2586
113.05,	-1035.00,	-1035.10,	-0.0952

rms_x = 0.1447

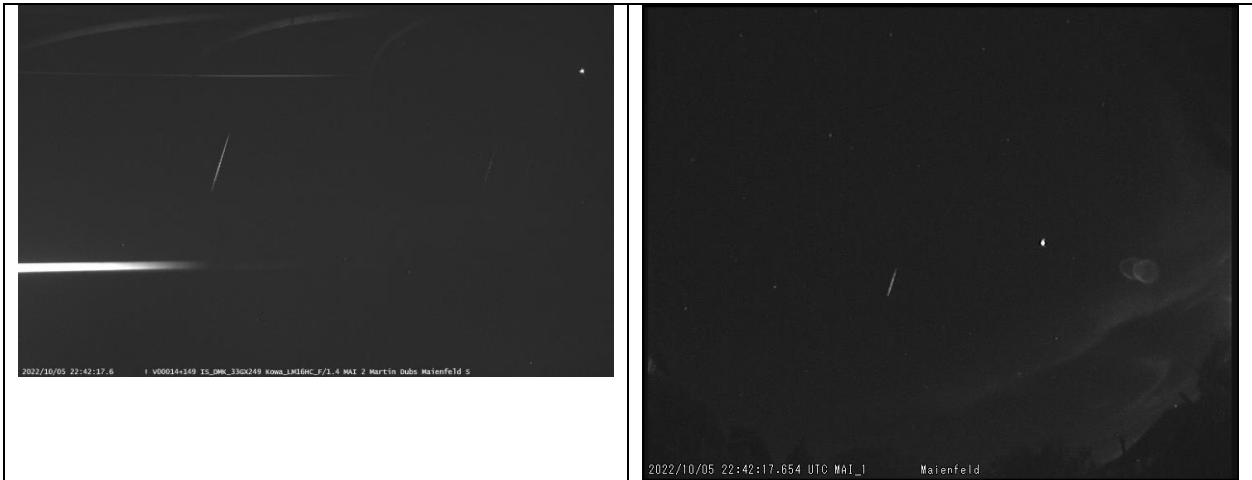
spectrum 221004\r_add28cal.dat saved



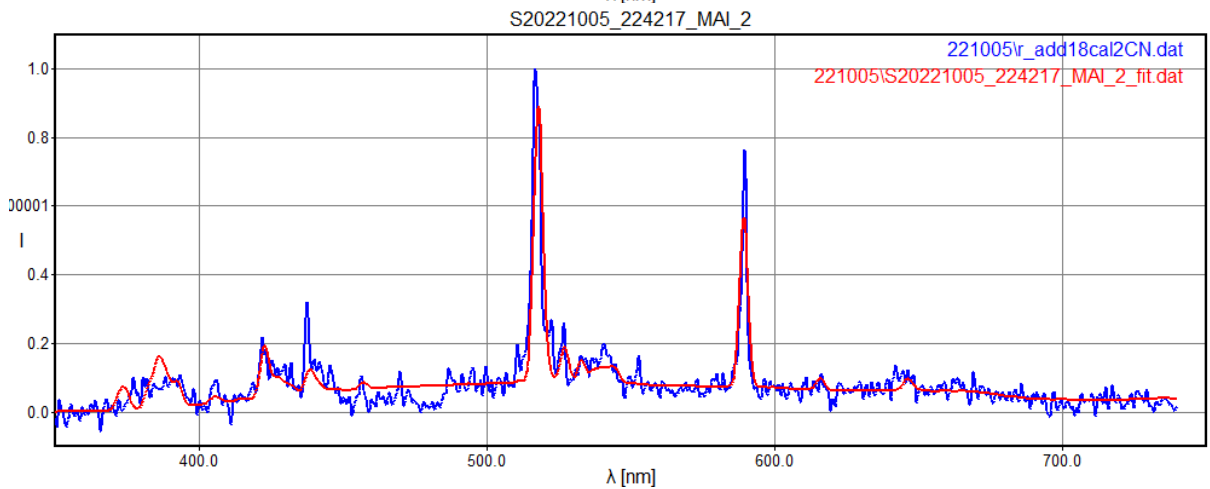
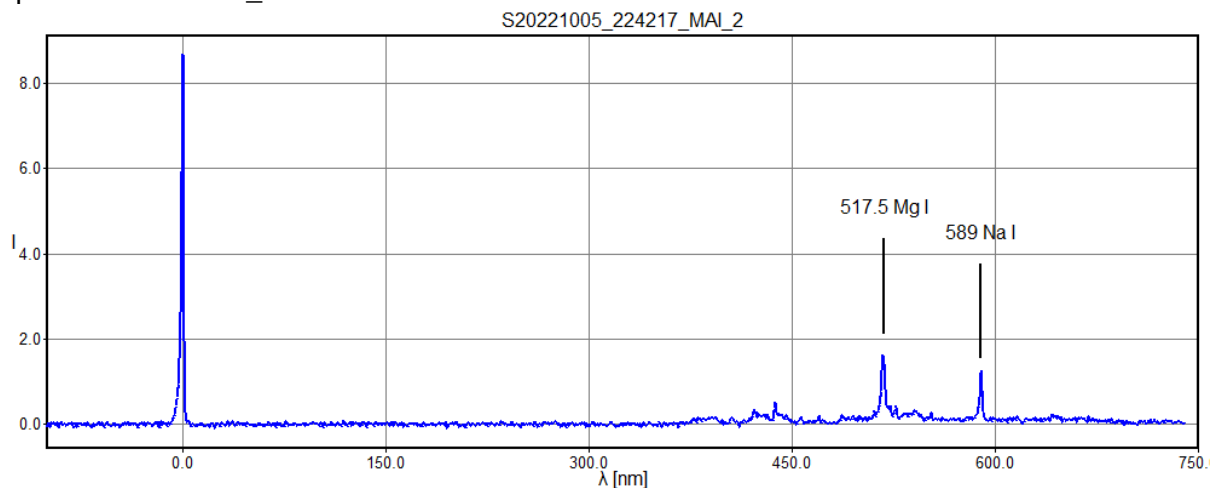
-1st order reversed:



M20221005_224217_MAI_2, spo, -0.2m



polynom for fit lambda c: [0.598 -405.6901]
 pixel lambda fit error
 678.52, 0.00, 0.05, 0.0512
 1543.15, 517.50, 517.08, -0.4175
 1664.03, 589.00, 589.37, 0.3663
 rms_x = 0.3220
 spectrum 221005\r_add18cal.dat saved



M20221018_211317_MAI_2, spo, -1.5m

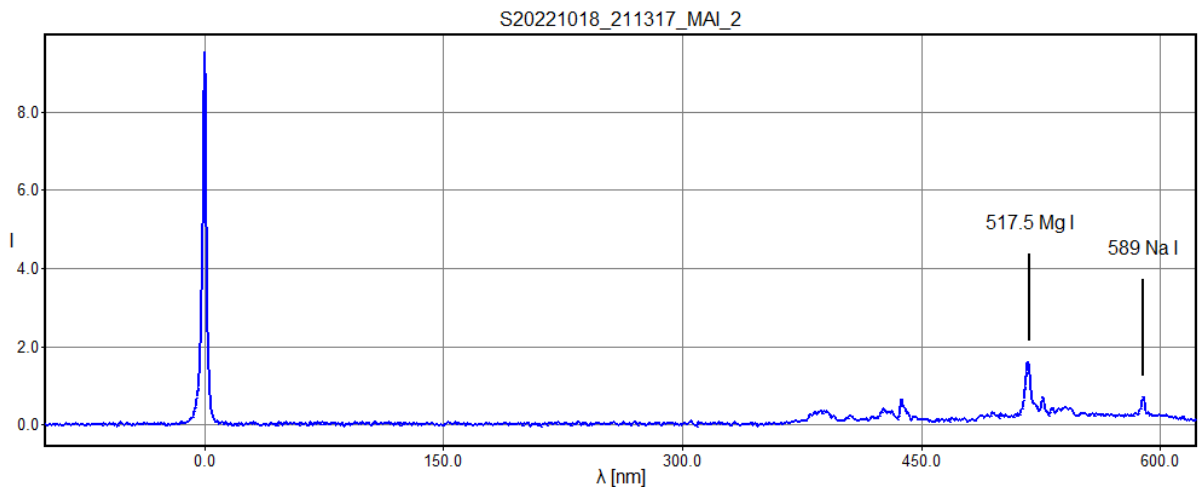


polynom for fit lambda c: [0.5964 -520.4532]

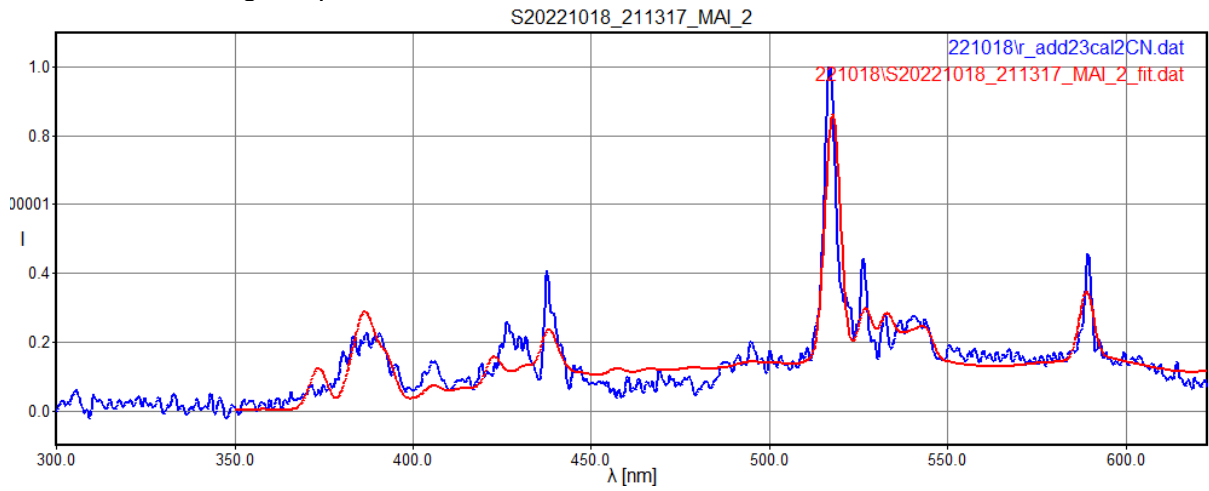
pixel	lambda	fit	error
872.76	0.00	0.06	0.0635
1739.49	517.50	516.98	-0.5162
1861.00	589.00	589.45	0.4527

rms_x = 0.3981

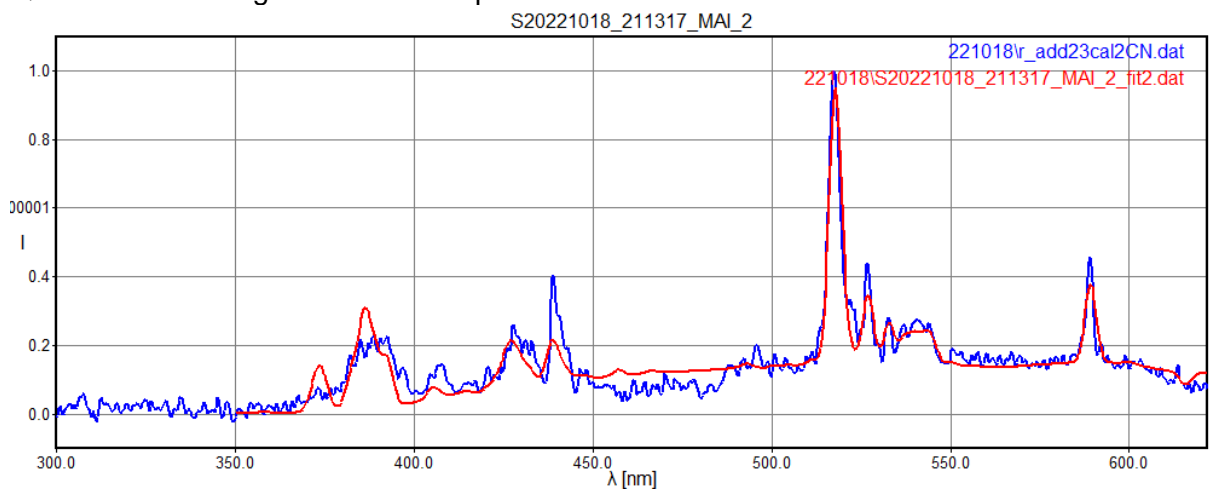
spectrum 221018\r_add23cal.dat saved



Linear calibration gives poor fit:



Quadratic wavelength calibration improves fit:



M20221019_032903_MAI_2, spo, -1.3m

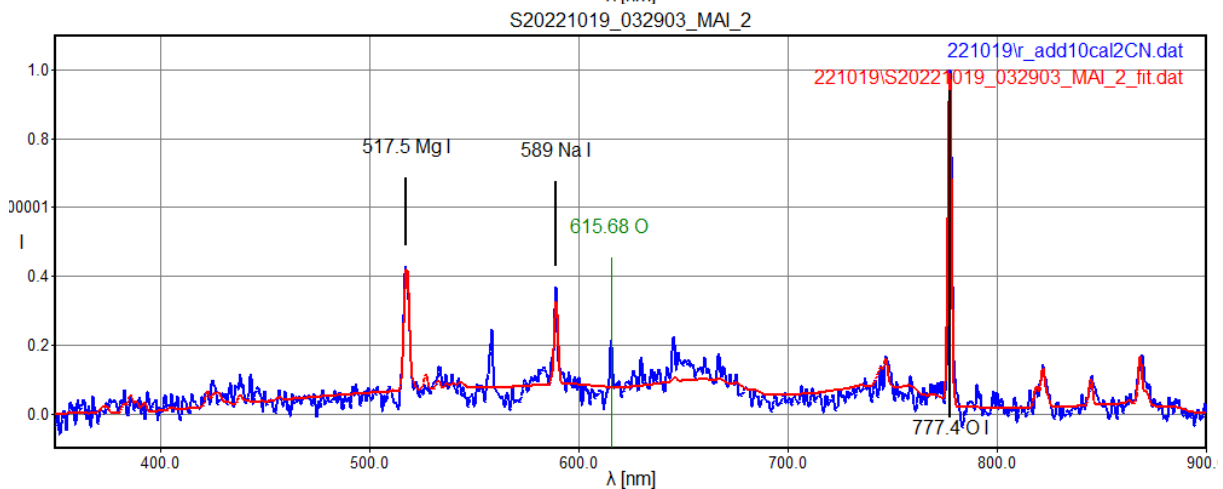
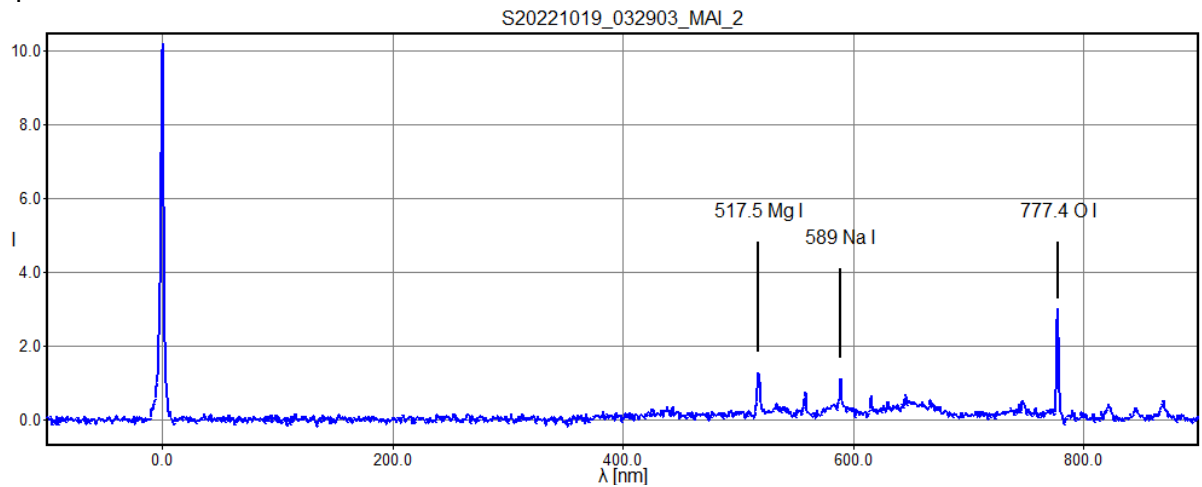


polynom for fit lambda c: [-5.1368e-06 6.0733e-01 -2.1884e+02]

pixel	lambda	fit	error
361.43,	0.00,	-0.01,	-0.0051
1225.33,	517.50,	517.63,	0.1251
1345.21,	589.00,	588.85,	-0.1512
1663.83,	777.40,	777.43,	0.0312

rms_x = 0.0994

spectrum 221019\r_add10cal.dat saved



M20221020_042100_MAI_1, ORI, -2.8m

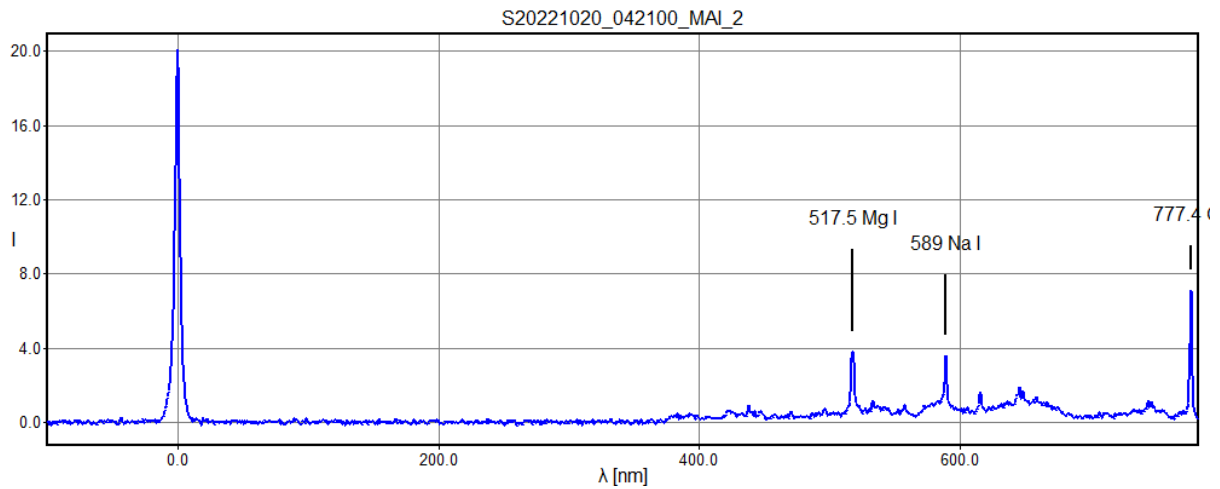


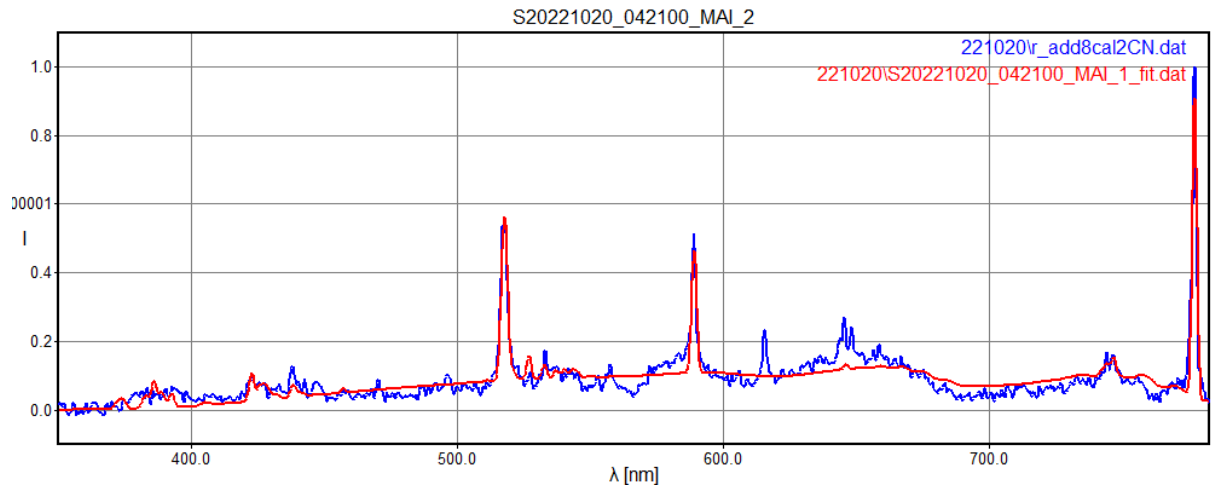
polynom for fit lambda c: [-6.0042e-06 6.1102e-01 -3.6608e+02]

pixel	lambda	fit	error
602.69,	0.00,	0.00,	0.0010
1467.17,	517.50,	517.48,	-0.0246
1587.90,	589.00,	589.03,	0.0297
1907.14,	777.40,	777.39,	-0.0062

rms_x = 0.0196

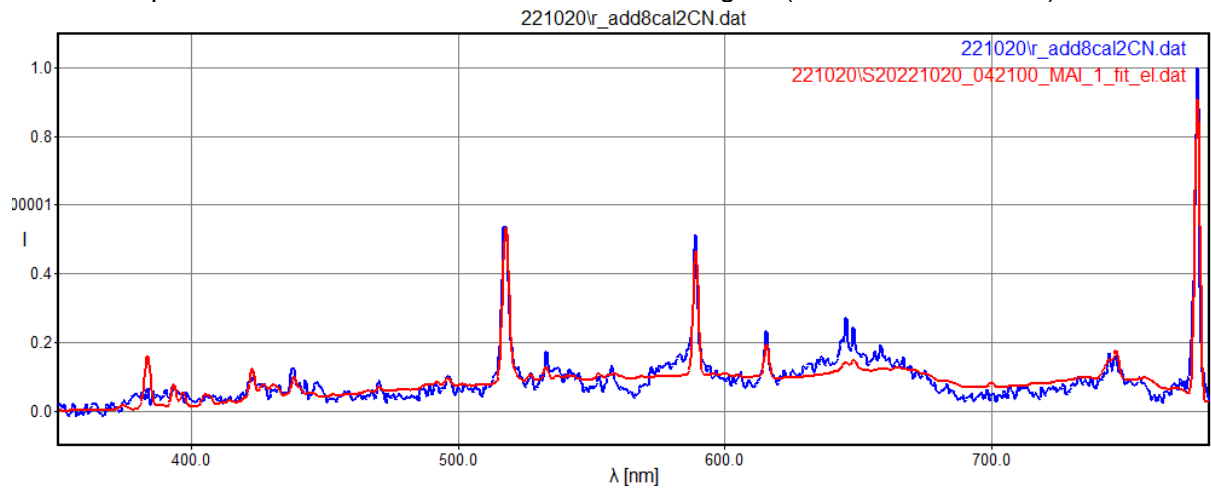
spectrum 221020\r_add8cal.dat saved



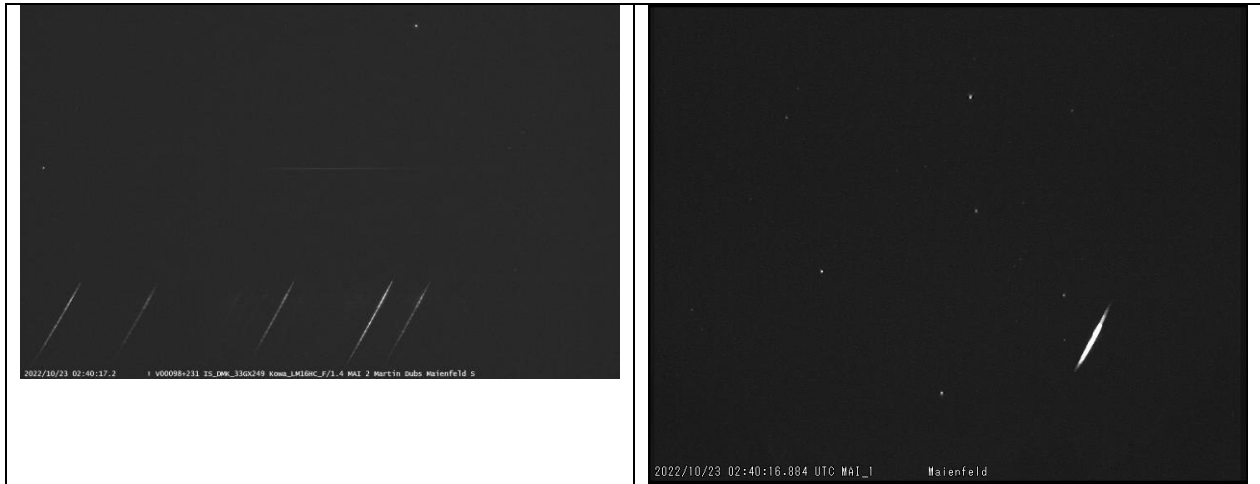


Without fit of plasma temperature (fixed at 3000K)

By fitting the plasma temperature as well, a slightly better fit is obtained ($t_{el} = 4820K$, see O-peak at 615 nm). The Mg-line at 383 nm is actually smeared out in the measured spectrum due to the poor resolution of the lens for short wavelengths (chromatic distortion):



M20221023_024017_MAI_2, NTA, -3.2m

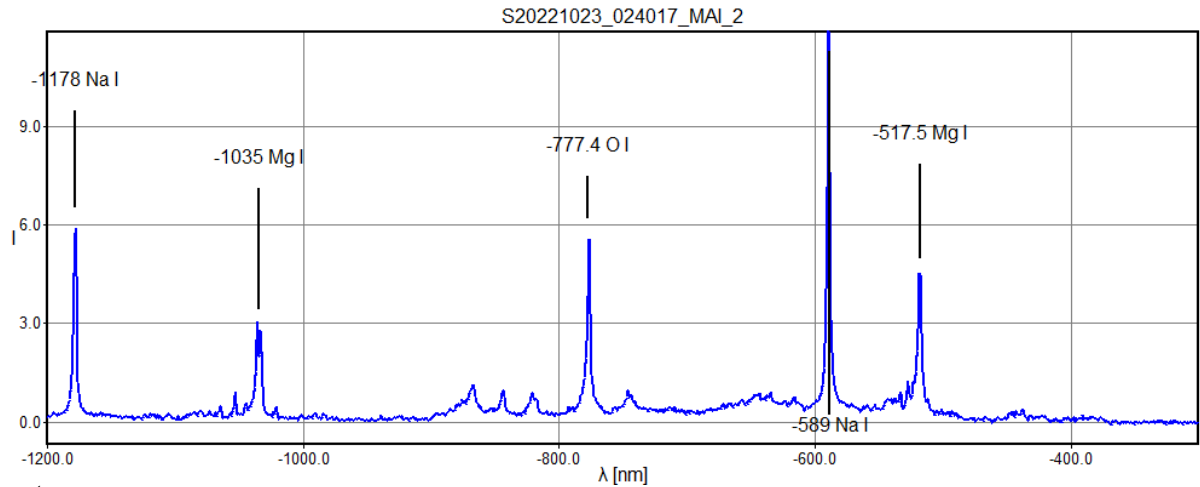


polynom for fit lambda c: [5.9687e-01 -1.2974e+03]

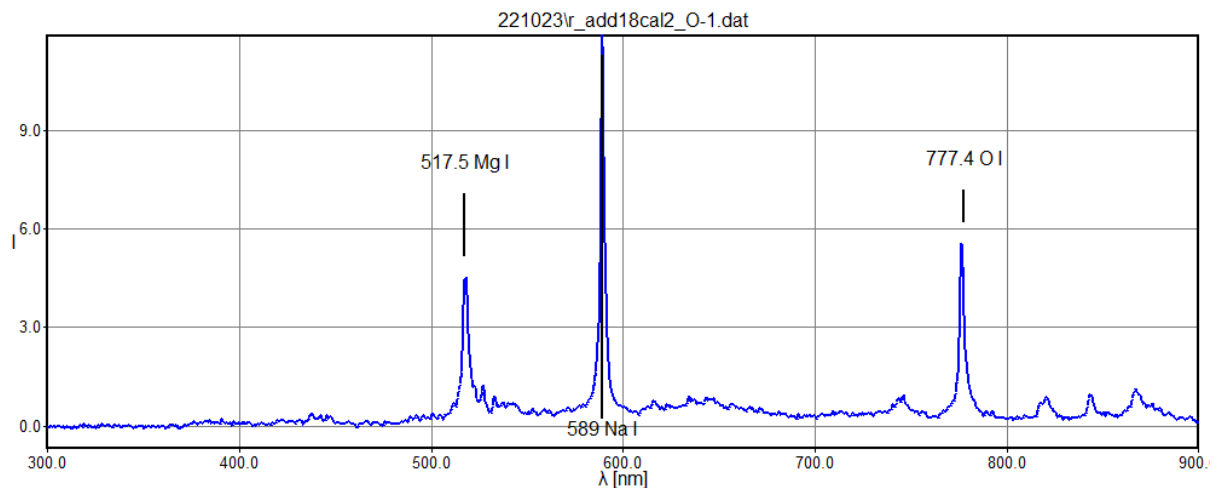
pixel	lambda	fit	error
1306.07	-517.50	-517.82	-0.3203
1186.51	-589.00	-589.18	-0.1825
872.75	-777.40	-776.46	0.9424
438.89	-1035.00	-1035.42	-0.4173
199.97	-1178.00	-1178.02	-0.0223

rms_x = 0.4896

spectrum 221023\r_add18cal.dat saved



-1st order converted:



M20221023_034839_MAI_2, spo, -3.0m

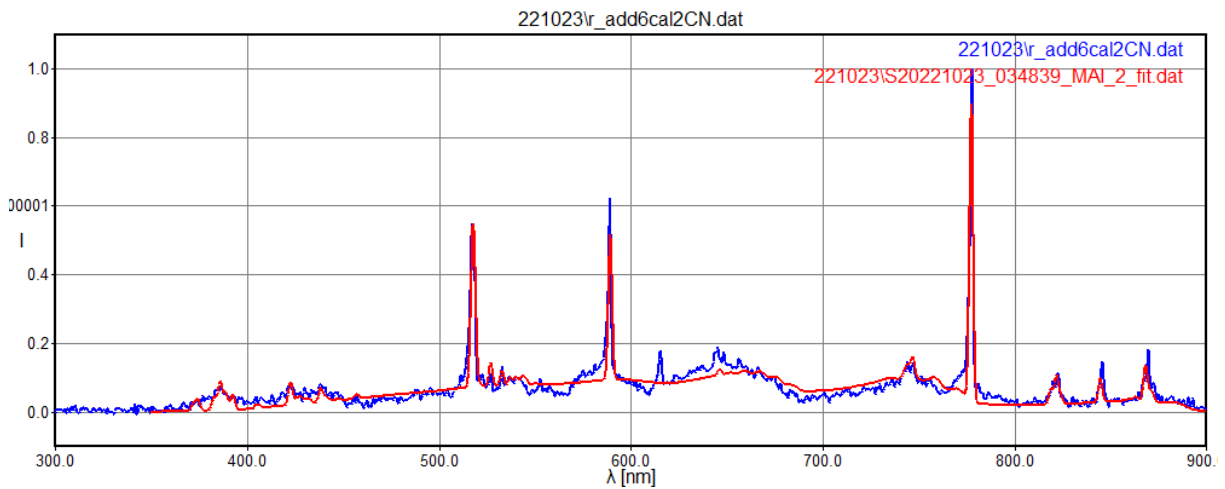
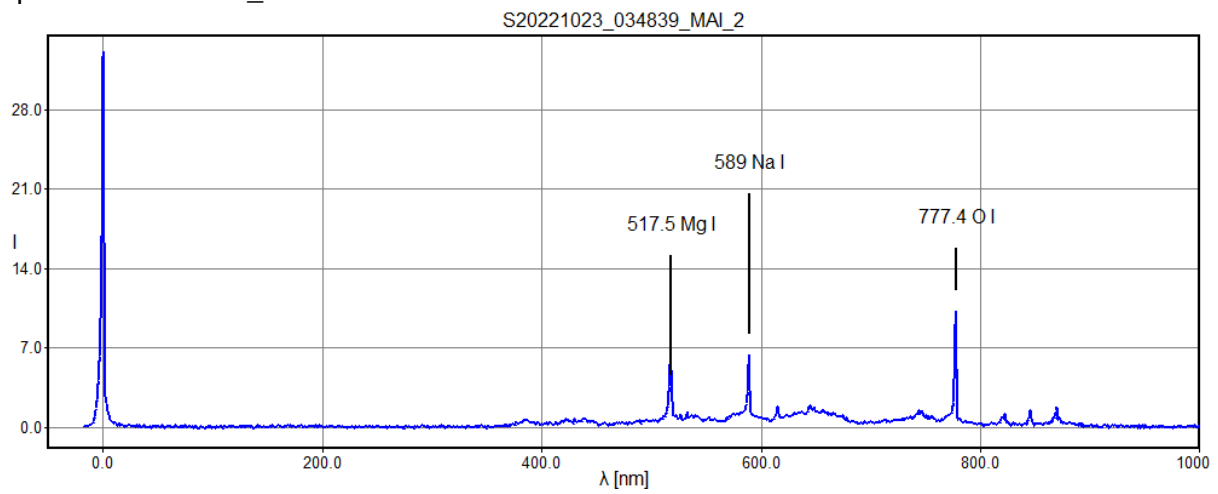


polynom for fit lambda c: [0.5978 -18.8809]

pixel	lambda	fit	error
31.59,	0.00,	0.00,	0.0048
897.26,	517.50,	517.54,	0.0362
1016.68,	589.00,	588.93,	-0.0699
1331.98,	777.40,	777.43,	0.0288

rms_x = 0.0420

spectrum 221023\r_add6cal.dat saved



M20221026_200153_MAI_2, spo, -2.5m

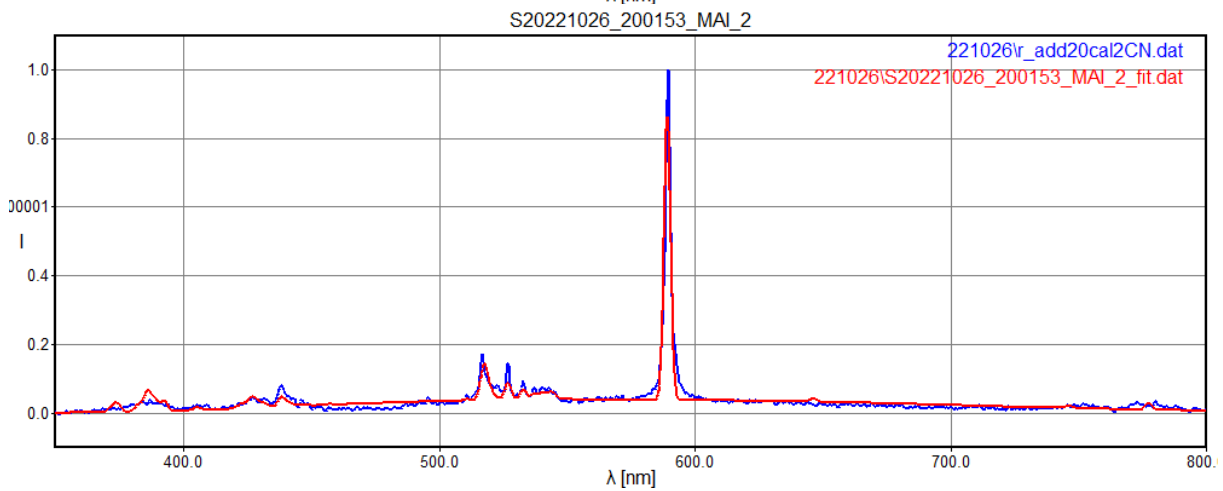
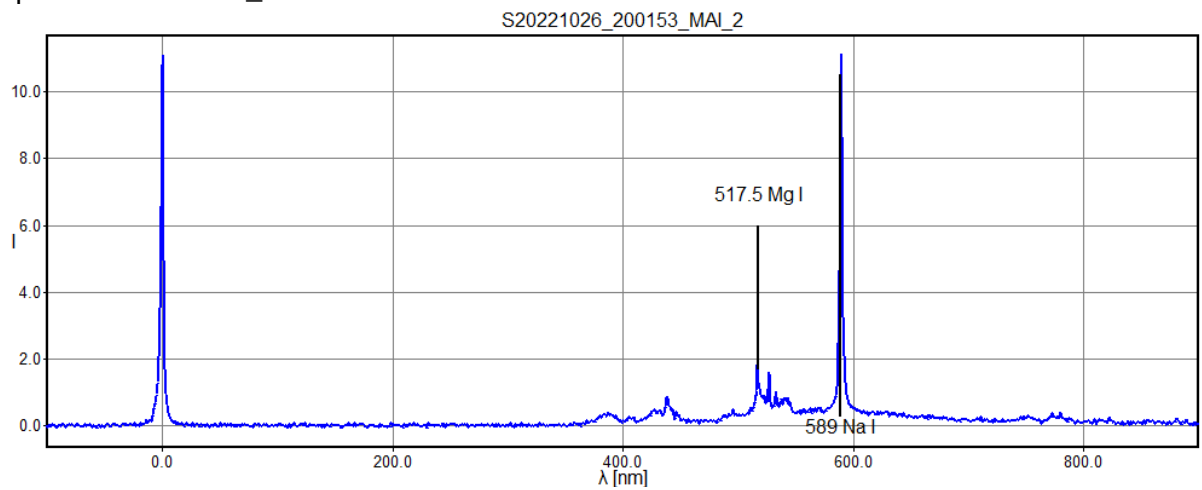


polynom for fit lambda c: [0.5983 -234.205]

pixel	lambda	fit	error
391.59,	0.00,	0.08,	0.0755
1255.42,	517.50,	516.89,	-0.6123
1376.85,	589.00,	589.54,	0.5368

rms_x = 0.4722

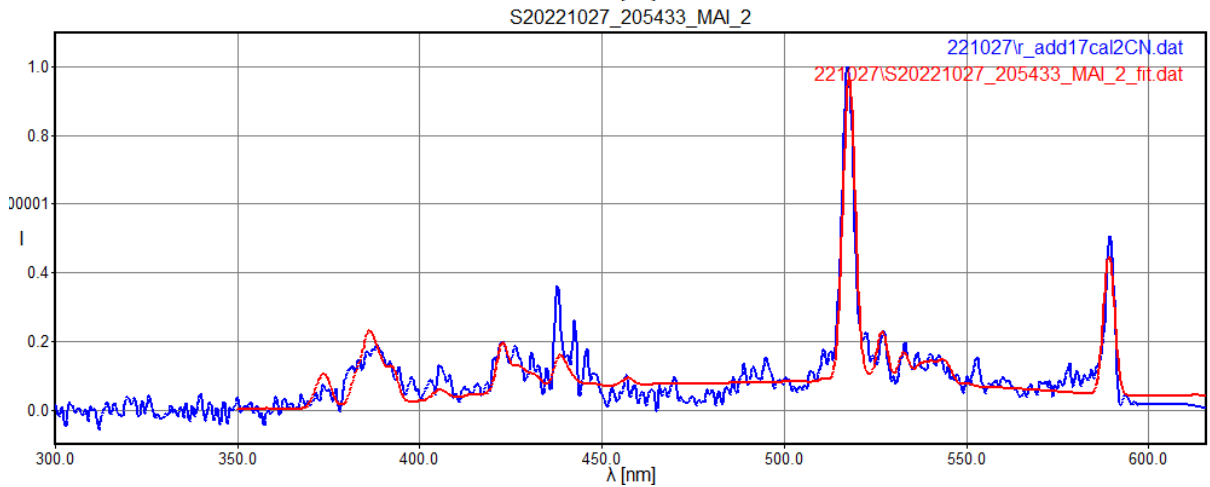
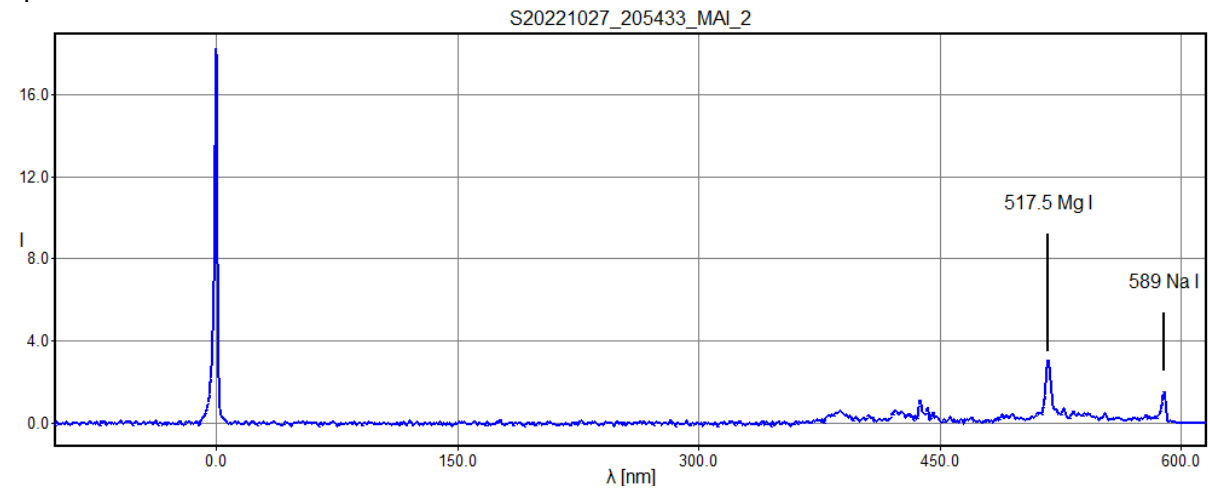
spectrum 221026\r_add20cal.dat saved



M20221027_205433_MAI_2, spo, -1.9m



polynom for fit lambda c: [0.5961 -526.1734]
 pixel lambda fit error
 882.68, 0.00, 0.00, 0.0000
 1750.81, 517.50, 517.50, 0.0000
 rms_x = 0.0000
 spectrum 221027\r_add17cal.dat saved



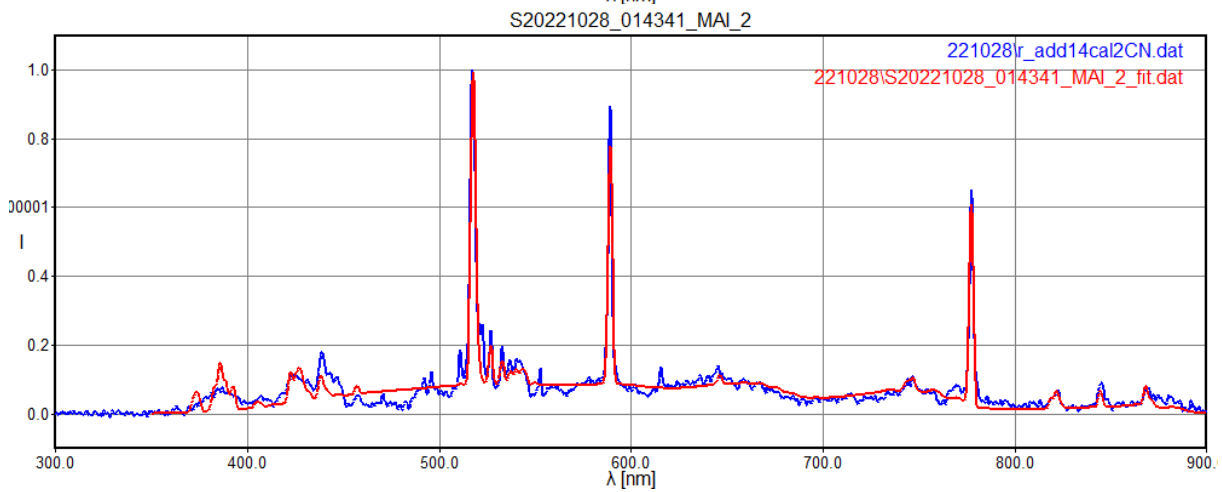
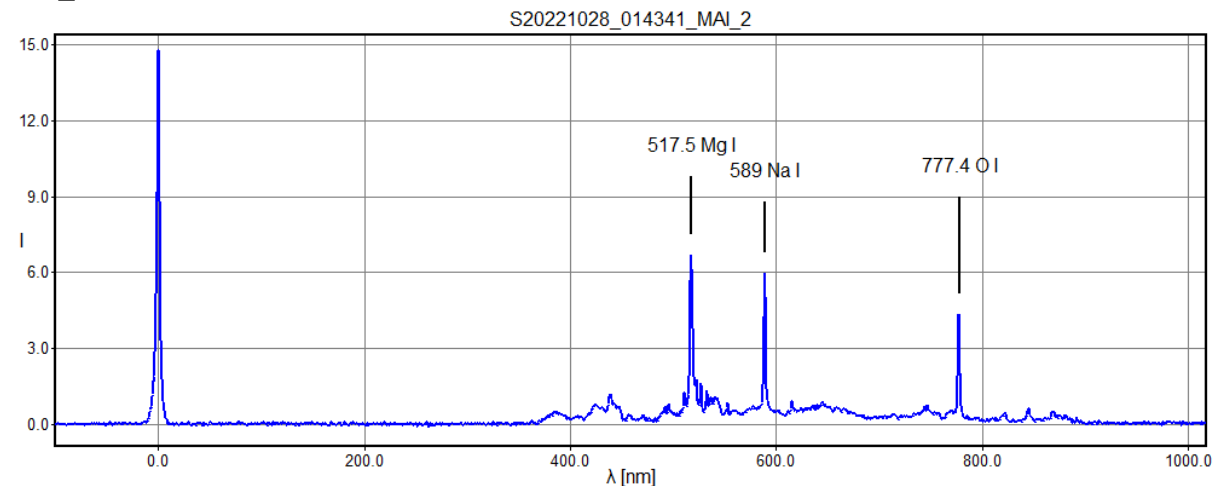
M20221028_014341_MAI_2, NTA, -2.0m



polynom for fit lambda c: [-2.7324e-06 6.0145e-01 -1.2443e+02]

pixel	lambda	fit	error
207.09,	0.00,	0.00,	0.0018
1072.47,	517.50,	517.46,	-0.0441
1192.75,	589.00,	589.05,	0.0534
1509.78,	777.40,	777.39,	-0.0111

rms_x = 0.0351



M20221028_190504_MAI_2, NTA, -1.2m

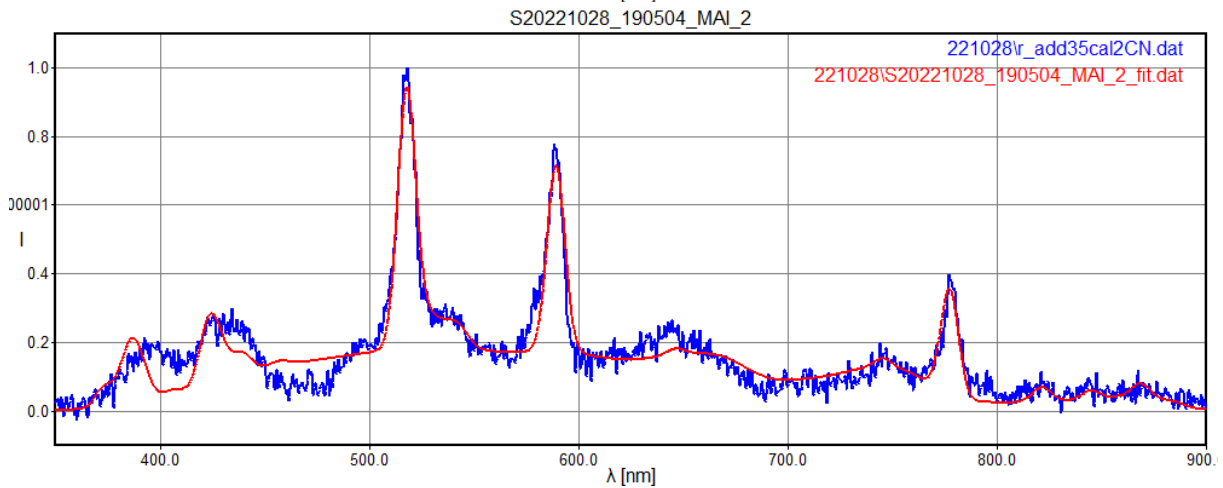
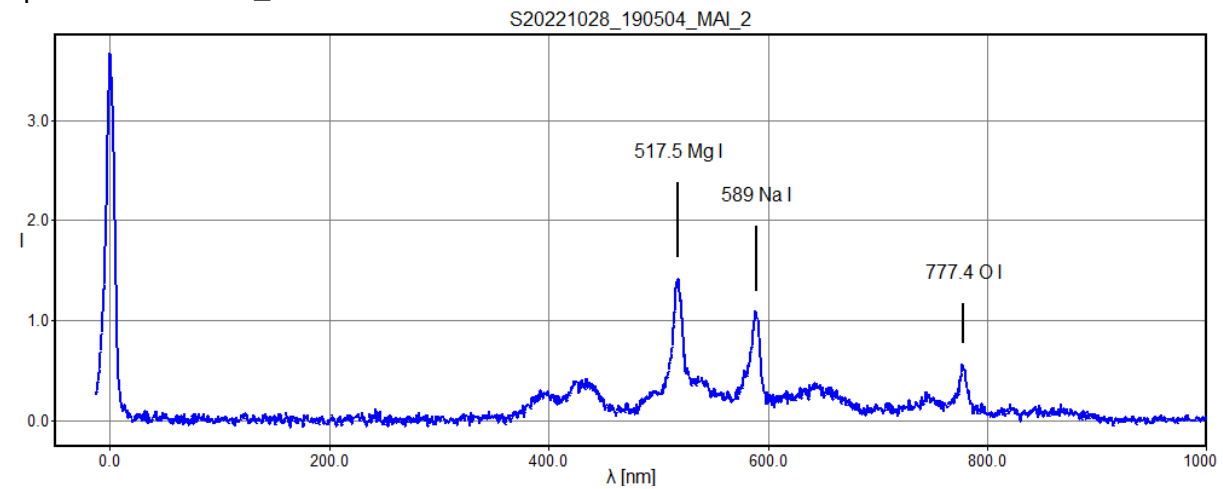


polynom for fit lambda c: [-1.7128e-06 5.9914e-01 -1.4548e+01]

pixel	lambda	fit	error
24.27,	0.00,	-0.01,	-0.0080
890.62,	517.50,	517.70,	0.1969
1009.88,	589.00,	588.76,	-0.2382
1326.93,	777.40,	777.45,	0.0493

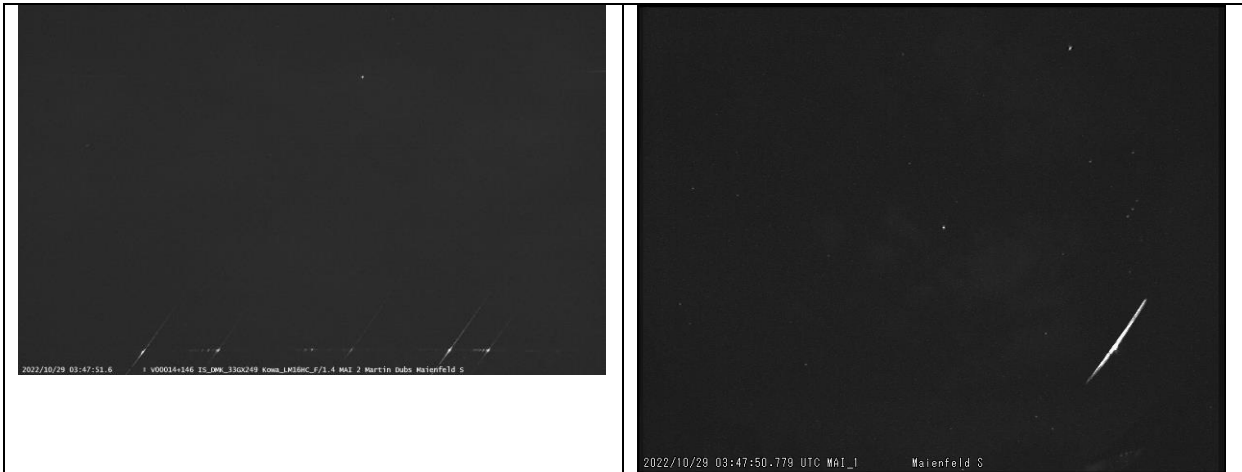
rms_x = 0.1565

spectrum 221028\r_add35cal.dat saved



Low resolution because of bad direction of meteor velocity

M20221029_034751_MAI_2, NTA, -3.7m

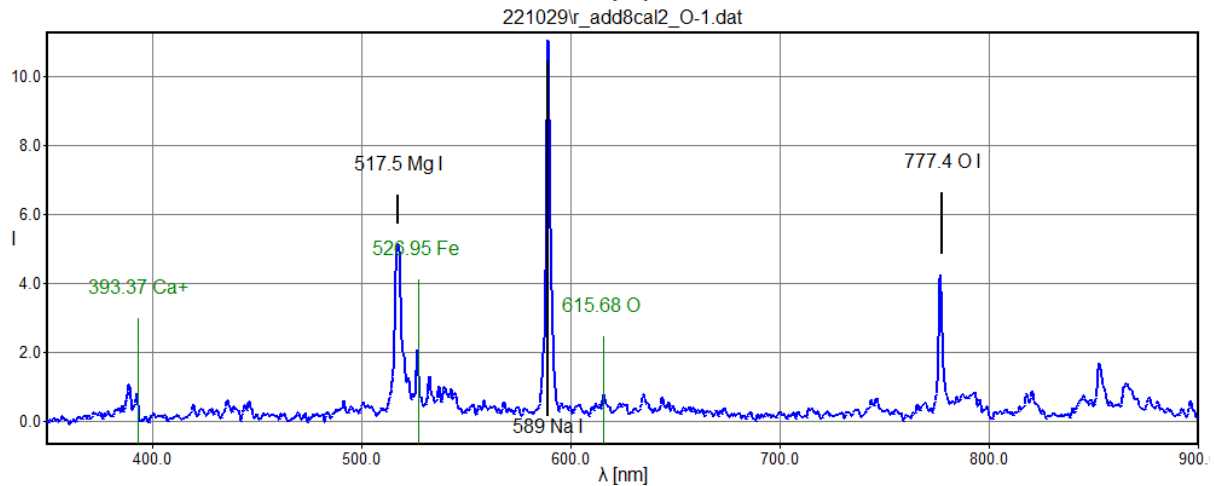
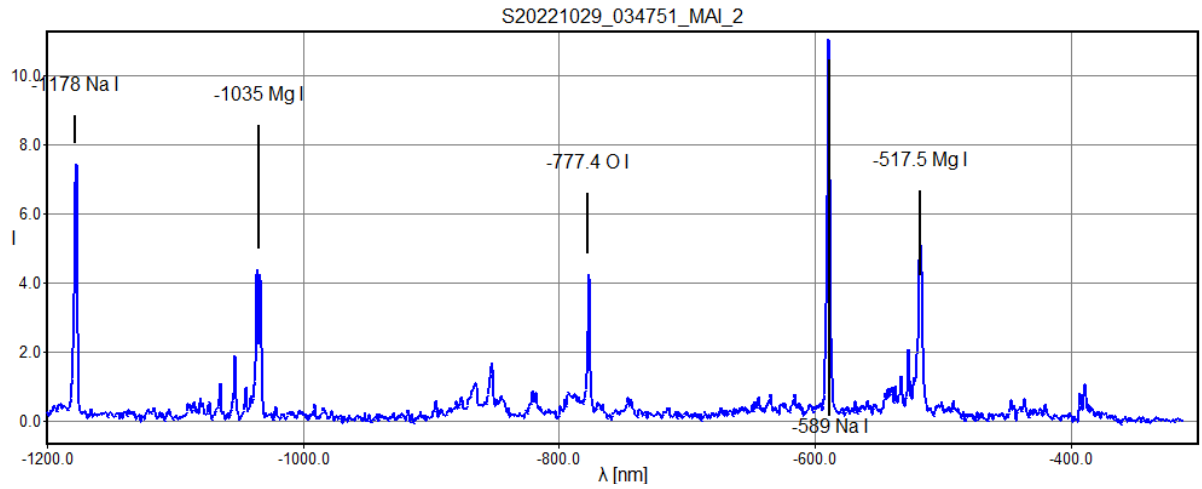


polynom for fit lambda c: [5.9703e-01 -1.4569e+03]

pixel	lambda	fit	error
1573.57,	-517.50,	-517.43,	0.0710
1453.17,	-589.00,	-589.31,	-0.3118
1139.27,	-777.40,	-776.72,	0.6793
705.06,	-1035.00,	-1035.96,	-0.9588
468.02,	-1178.00,	-1177.48,	0.5203

rms_x = 0.5922

spectrum 221029\r_add8cal.dat saved



M20221030_034734_MAI_2, NTA, -2.5m

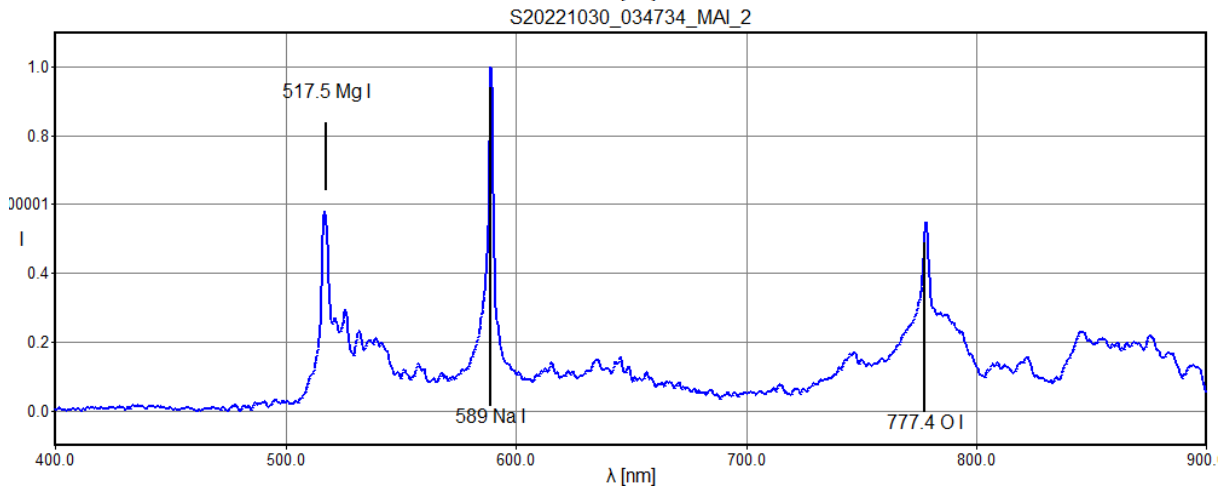
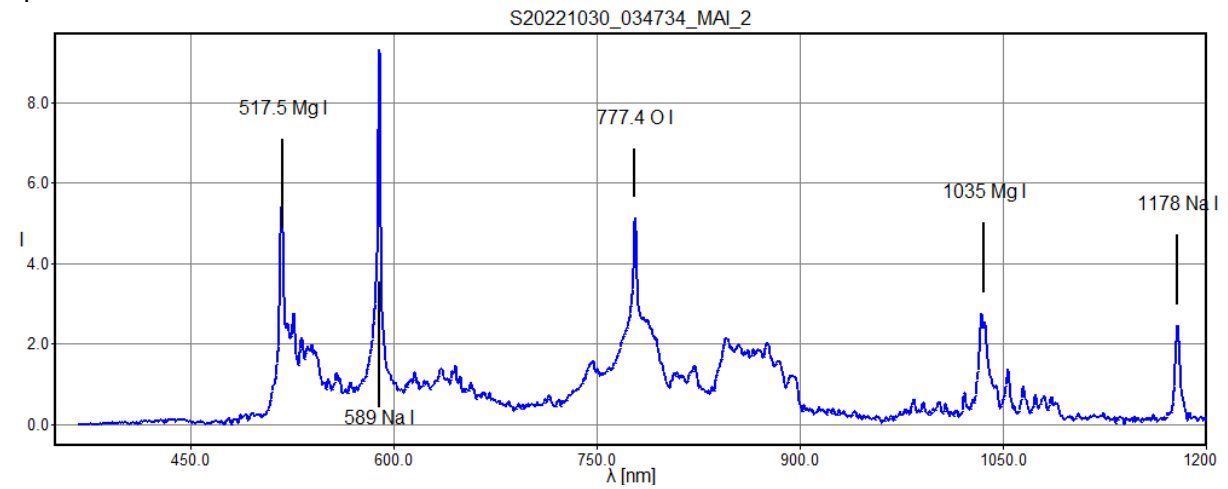


polynom for fit lambda c: [0.5994 366.1442]

pixel	lambda	fit	error
251.90,	517.50,	517.14,	-0.3623
372.11,	589.00,	589.19,	0.1937
687.21,	777.40,	778.07,	0.6705
1114.19,	1035.00,	1034.01,	-0.9899
1355.22,	1178.00,	1178.49,	0.4880

rms_x = 0.6060

spectrum 221030\r_add20cal.dat saved



M20221030_194051_MAI_2, NTA, -1.3m

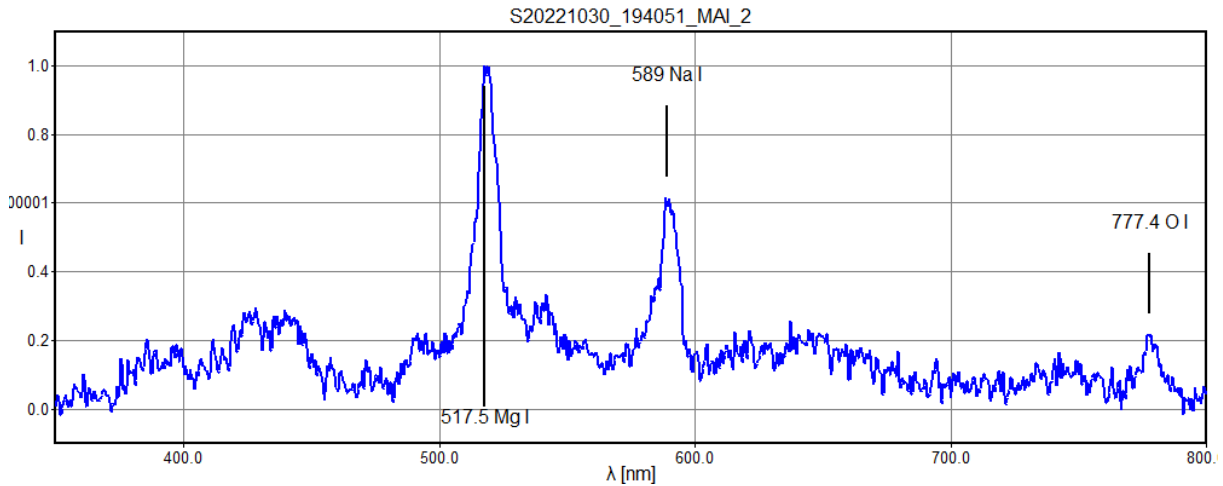
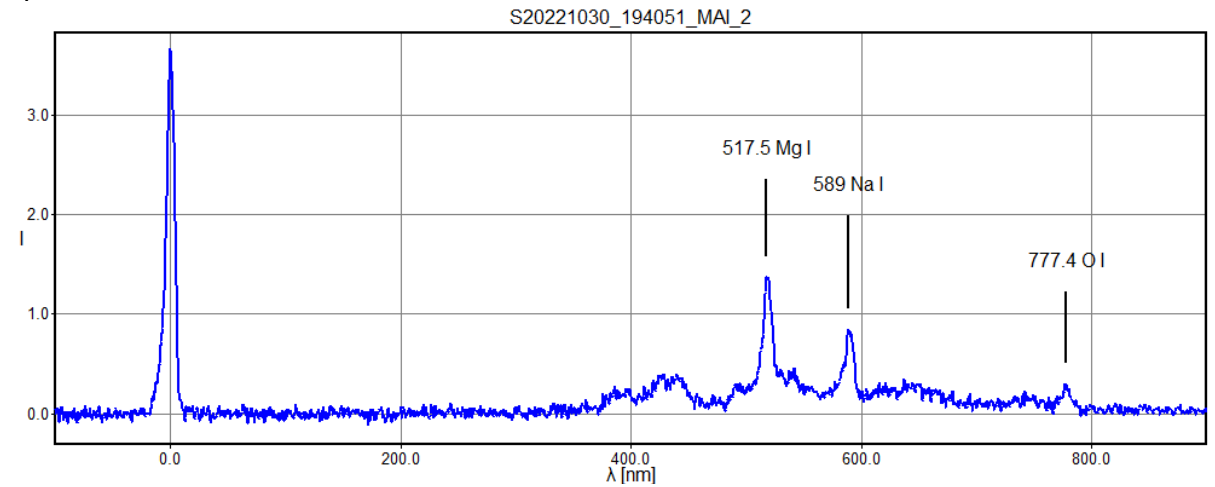


polynom for fit lambda c: [-7.0725e-06 6.1049e-01 -1.7446e+02]

pixel	lambda	fit	error
286.66,	0.00,	-0.04,	-0.0392
1150.38,	517.50,	518.48,	0.9769
1267.25,	589.00,	587.83,	-1.1732
1588.80,	777.40,	777.64,	0.2355

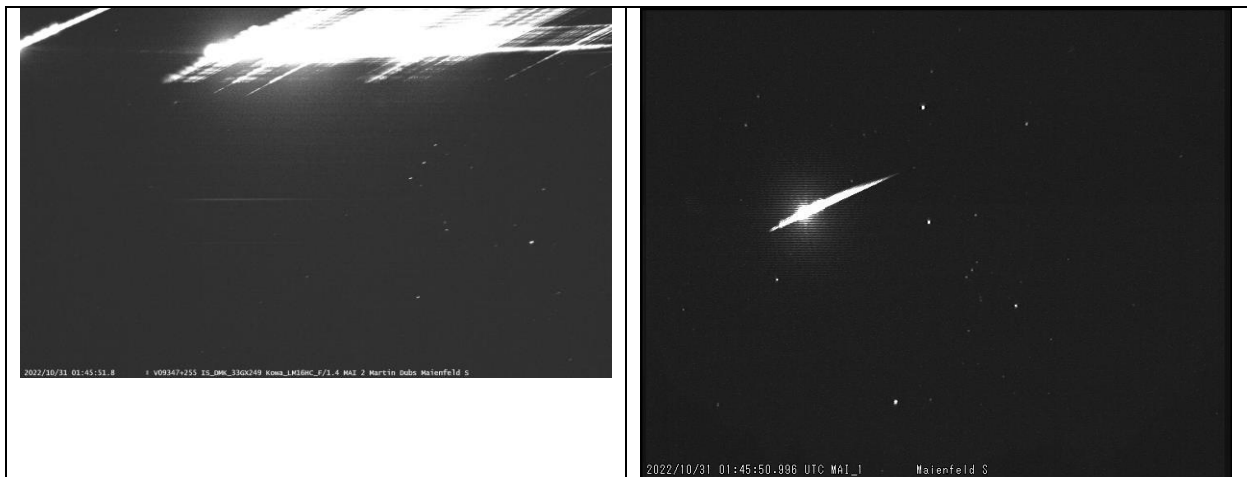
rms_x = 0.7726

spectrum 221030\ra_add25cal.dat saved



Low resolution, meteor movement almost parallel to dispersion.

M20221031_014551_MAI_2, STA, -7m

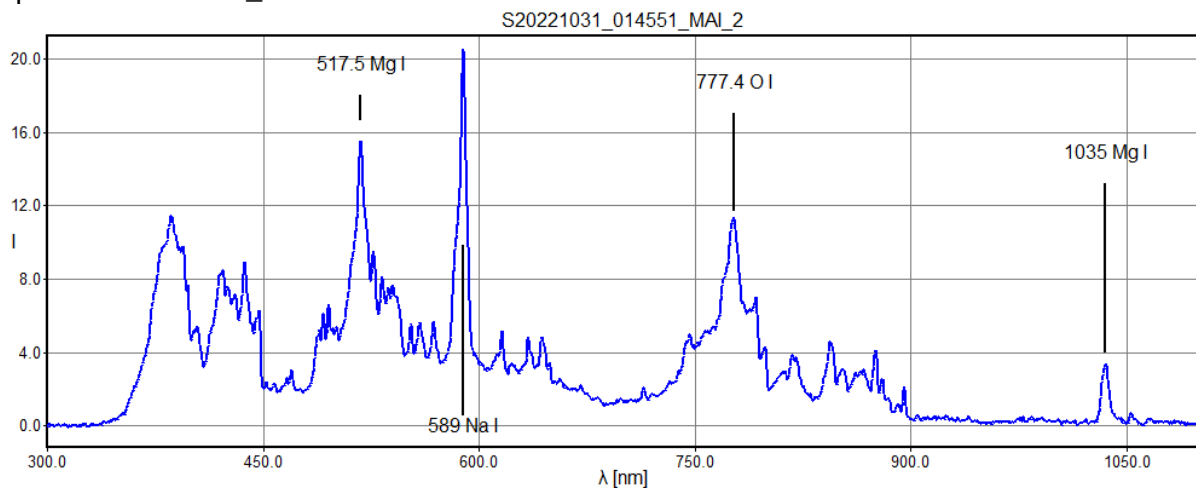


polynom for fit lambda c: [0.5973 36.8853]

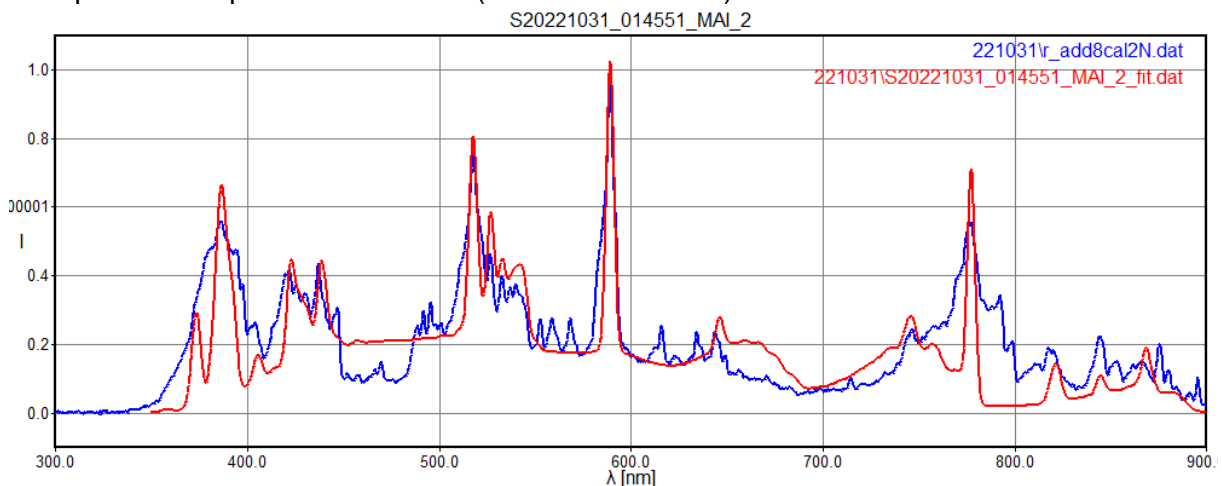
pixel	lambda	fit	error
805.18,	517.50,	517.81,	0.3080
924.40,	589.00,	589.02,	0.0164
1238.72,	777.40,	776.76,	-0.6447
1671.62,	1035.00,	1035.32,	0.3203

rms_x = 0.3916

spectrum 221031\r_add8cal.dat saved



A simulation of the spectrum gives a poor fit because of strong saturation (although only the later part of the spectrum was used (mdist18 – mdist25))



M20221031_195813_MAI_2, NTA, -2.8m

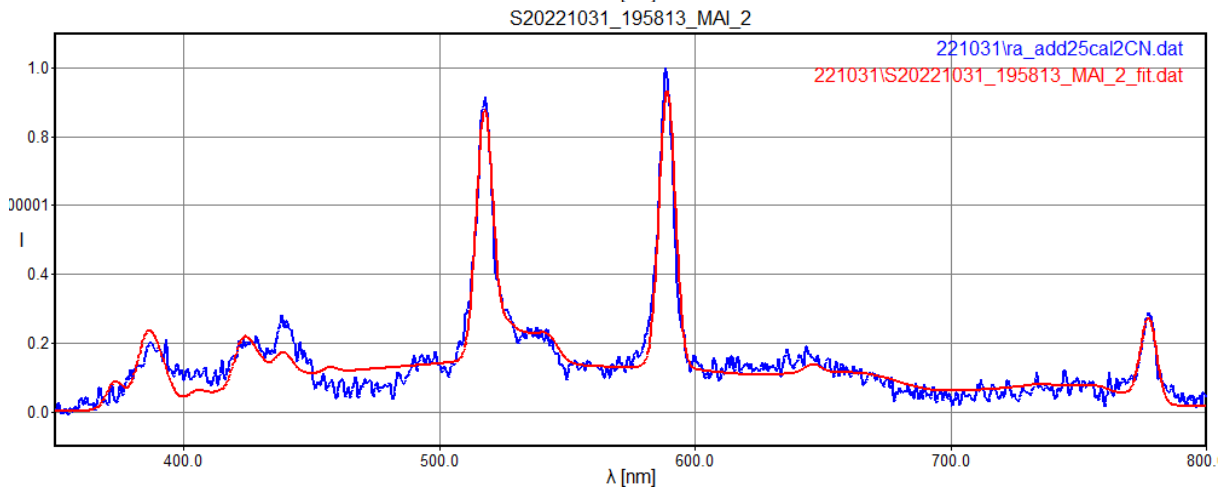
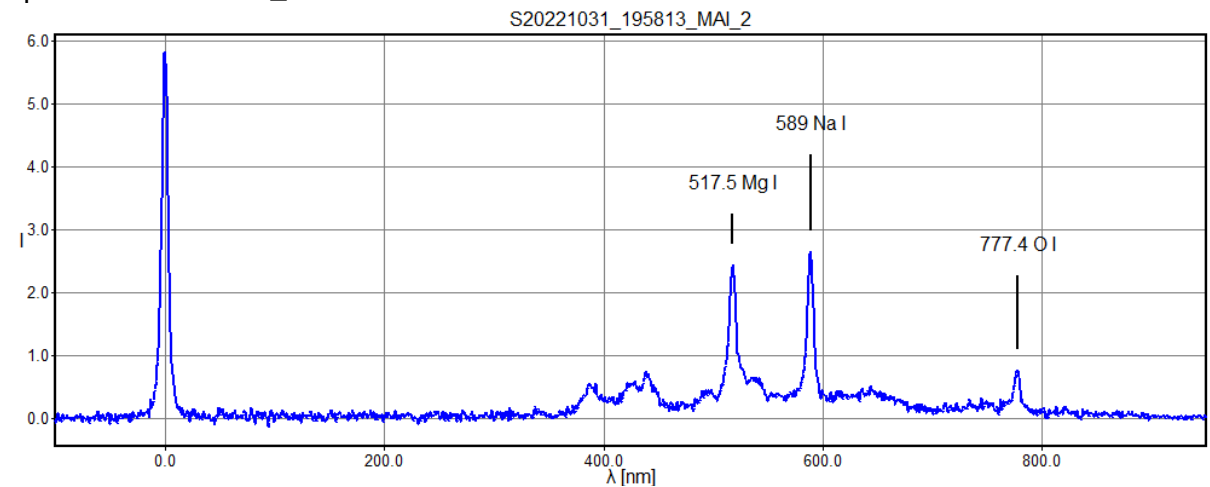


polynom for fit lambda c: [-3.5543e-06 6.0143e-01 -1.5293e+02]

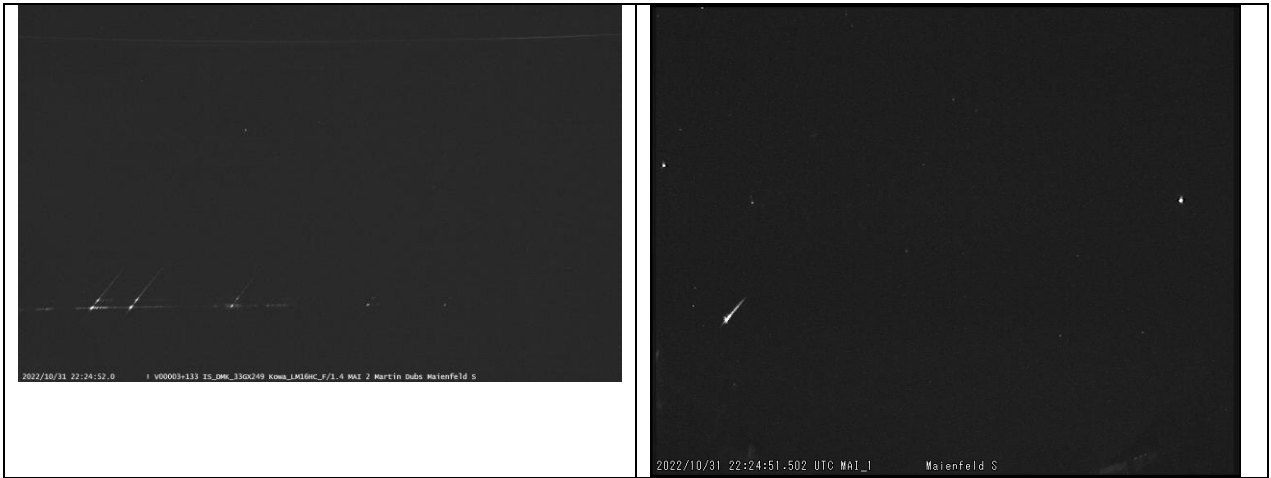
pixel	lambda	fit	error
254.65,	0.00,	-0.01,	-0.0106
1122.61,	517.50,	517.76,	0.2599
1242.21,	589.00,	588.69,	-0.3140
1561.38,	777.40,	777.46,	0.0647

rms_x = 0.2064

spectrum 221031\ra_add25cal.dat saved



M20221031_222452_MAI_2, AND, -3.0m

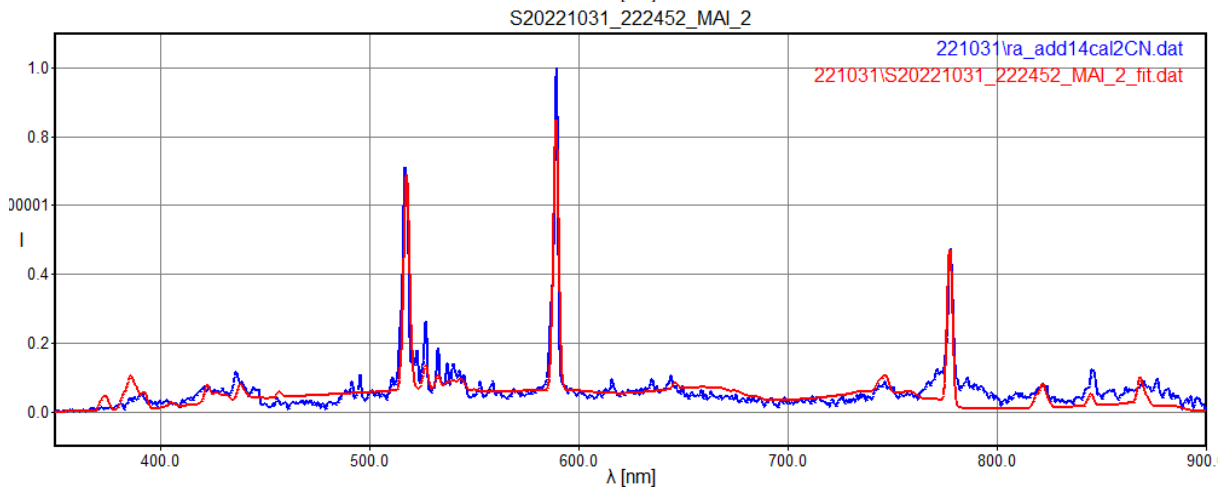
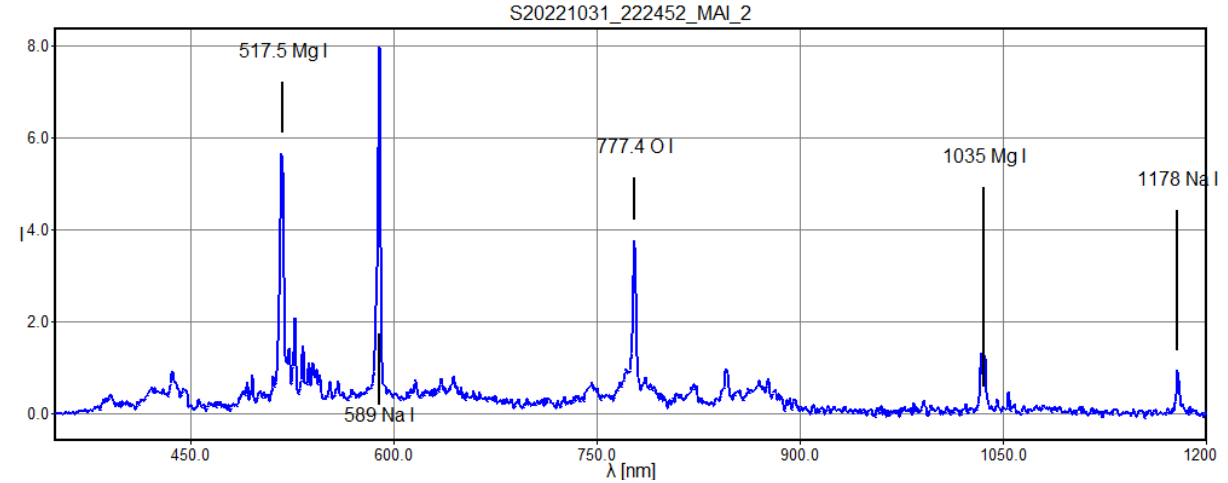


polynom for fit lambda c: [0.5989 340.3358]

pixel	lambda	fit	error
295.64,	517.50,	517.38,	-0.1201
415.73,	589.00,	589.30,	0.2958
730.14,	777.40,	777.58,	0.1803
1158.07,	1035.00,	1033.85,	-1.1538
1400.12,	1178.00,	1178.80,	0.7979

rms_x = 0.6484

spectrum 221031\ra_add14cal.dat saved



M20221031_231557_MAI_2, STA, -1.6m

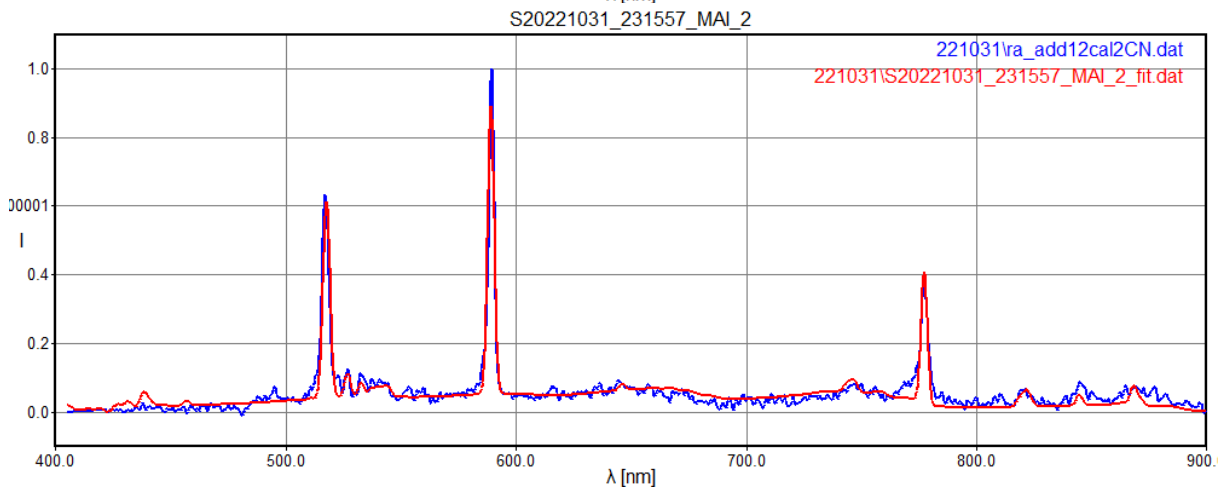
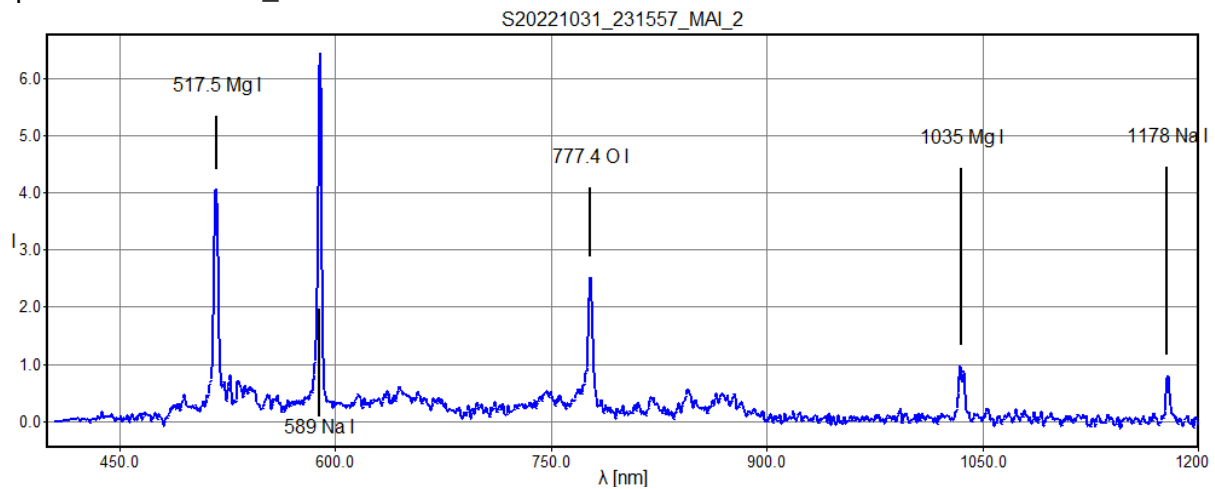


polynom for fit lambda c: [0.5978 404.072]

pixel	lambda	fit	error
189.33	517.50	517.26	-0.2381
310.10	589.00	589.46	0.4635
624.37	777.40	777.35	-0.0520
1054.24	1035.00	1034.34	-0.6568
1295.34	1178.00	1178.48	0.4835

rms_x = 0.4334

spectrum 221031\ra_add12cal.dat saved



M20221101_011254_MAI_2, -2.8m

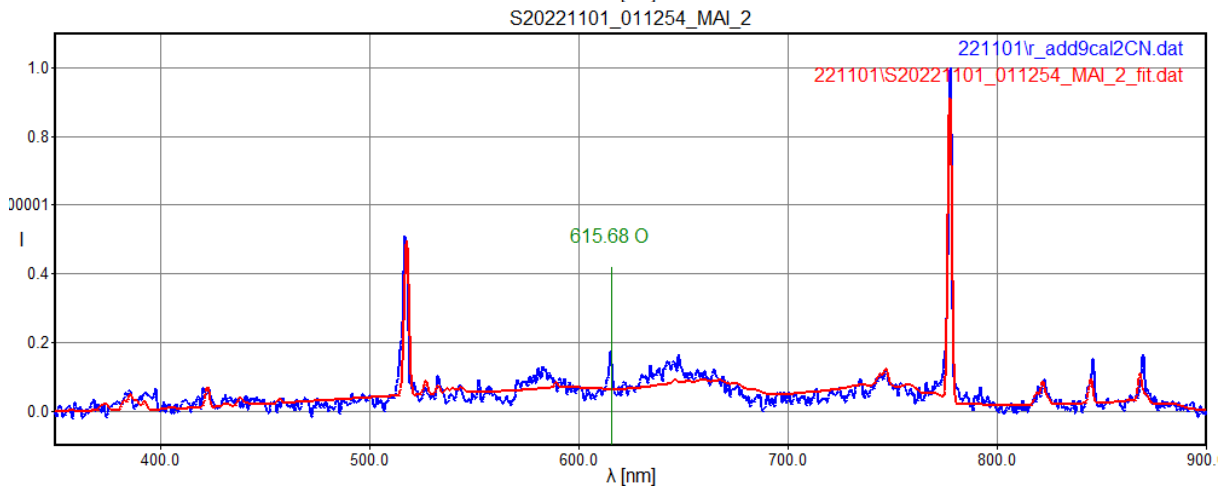
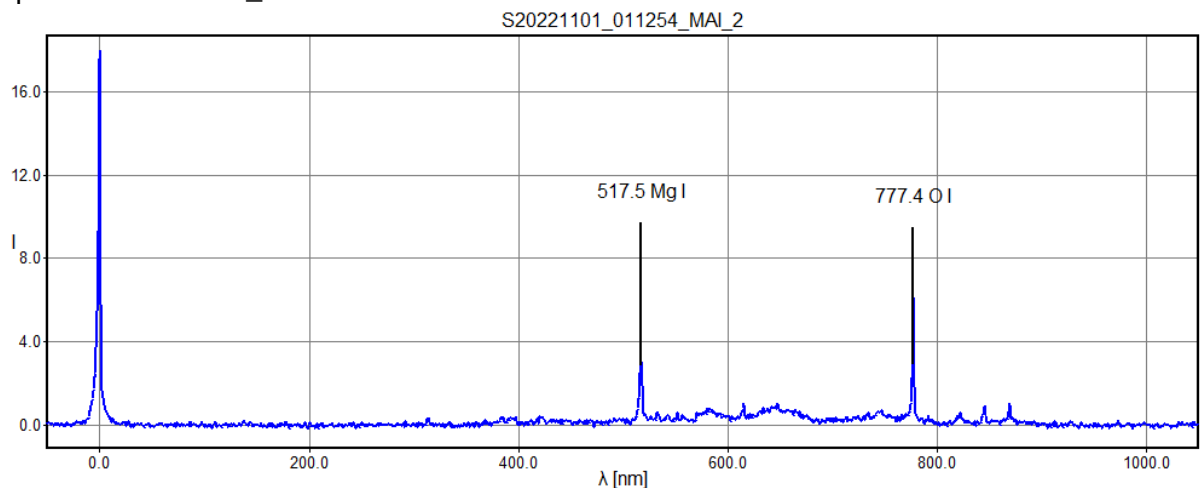


polynom for fit lambda c: [0.5979 -58.9274]

pixel	lambda	fit	error
98.59,	0.00,	0.02,	0.0181
964.02,	517.50,	517.45,	-0.0542
1398.87,	777.40,	777.44,	0.0361

rms_x = 0.0390

spectrum 221101\r_add9cal.dat saved



M20221102_000159_MAI_2, NTA, -2.0m

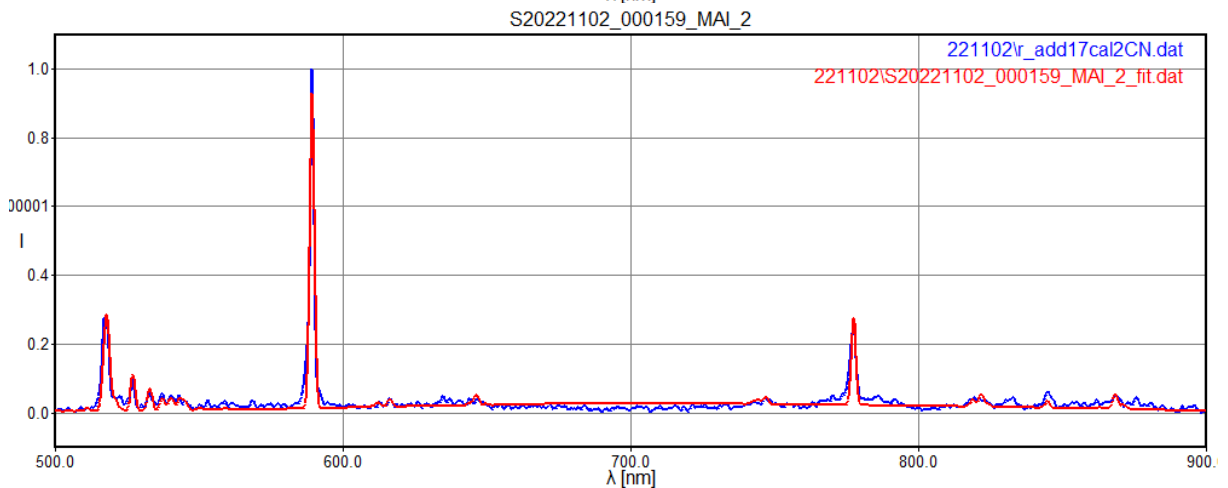
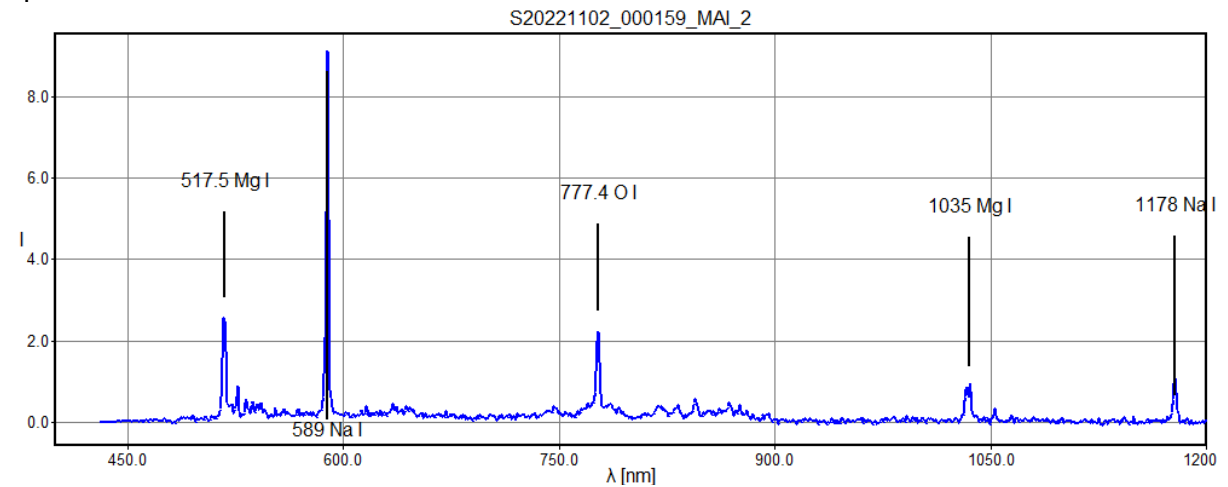


polynom for fit lambda c: [2.6376e-06 5.9380e-01 4.3056e+02]

pixel	lambda	fit	error
146.19,	517.50,	517.43,	-0.0733
266.85,	589.00,	589.21,	0.2060
582.12,	777.40,	777.12,	-0.2811
1013.82,	1035.00,	1035.28,	0.2791
1251.56,	1178.00,	1177.87,	-0.1307

rms_x = 0.2106

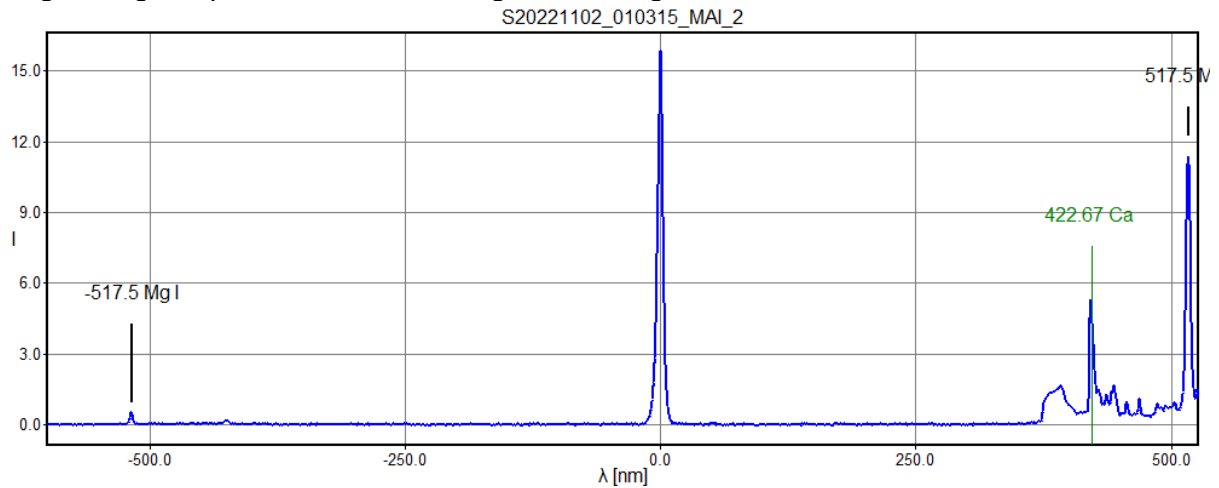
spectrum 221102\r_add17cal.dat saved



M20221102_010315_MAI_2, AND, -2.1m



Registering all spectra cuts off the longer wavelengths:



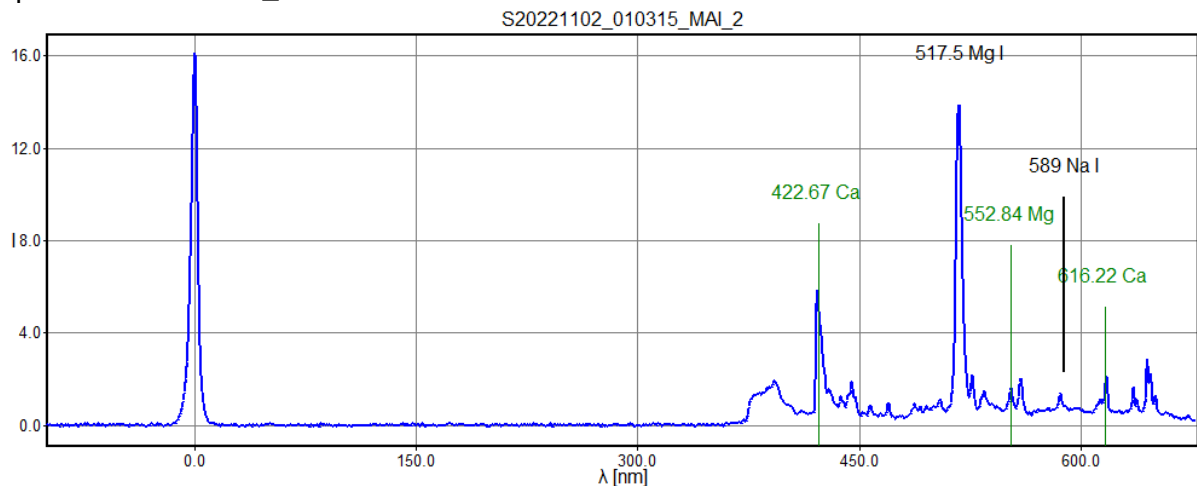
Registering the second half of spectra gives a wider range:

polynom for fit lambda c: [0.5979 -467.4205]

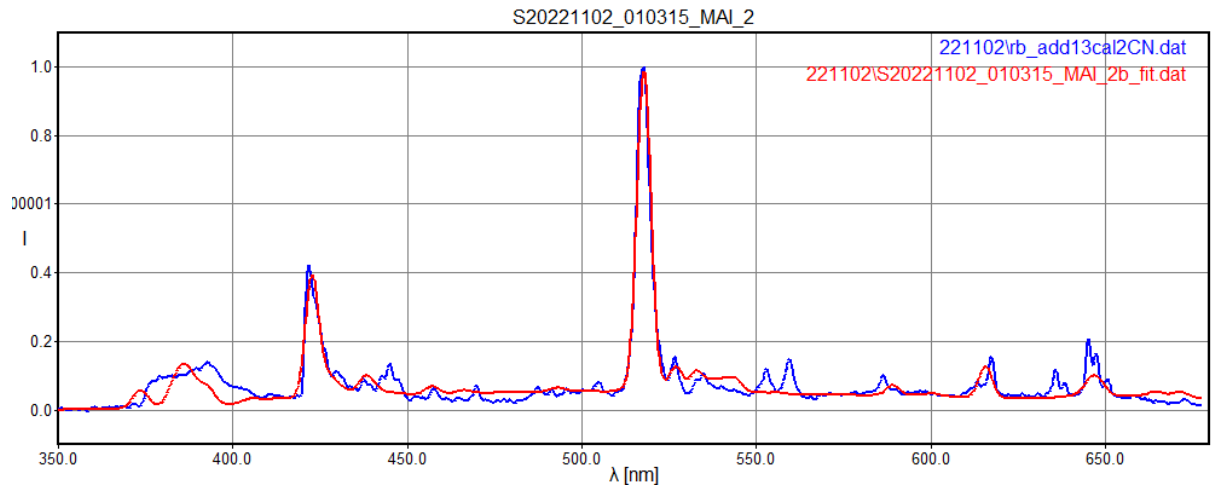
pixel	lambda	fit	error
781.78,	0.00,	-0.00,	-0.0000
1647.32,	517.50,	517.50,	0.0000

rms_x = 0.0000

spectrum 221102\rb_add13cal.dat saved



Notice the almost vanishing Na-line and the strong Ca-line:



M20221108_002330_MAI_2, STA, -4.0m

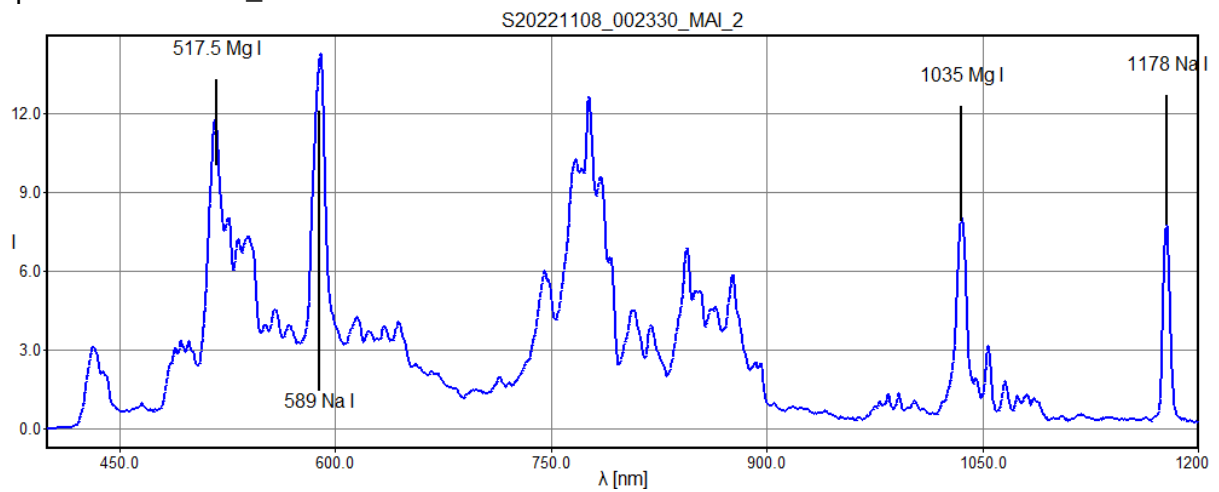


polynom for fit lambda c: [6.0102e-06 5.8708e-01 3.8945e+02]

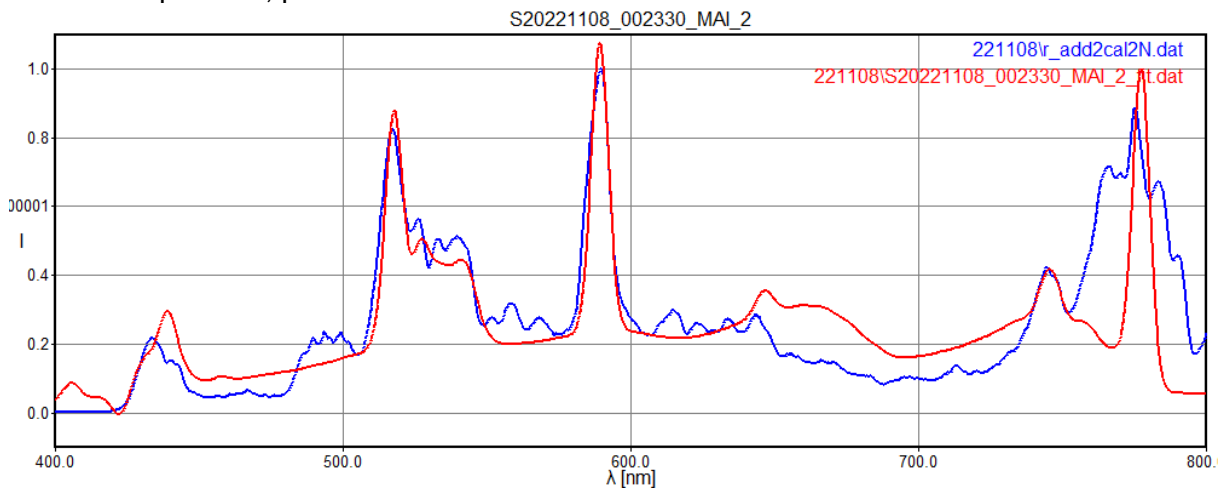
pixel	lambda	fit	error
216.95,	517.50,	517.10,	-0.3965
339.60,	589.00,	589.52,	0.5189
1086.98,	1035.00,	1034.70,	-0.3024
1325.49,	1178.00,	1178.18,	0.1799

rms_x = 0.3709

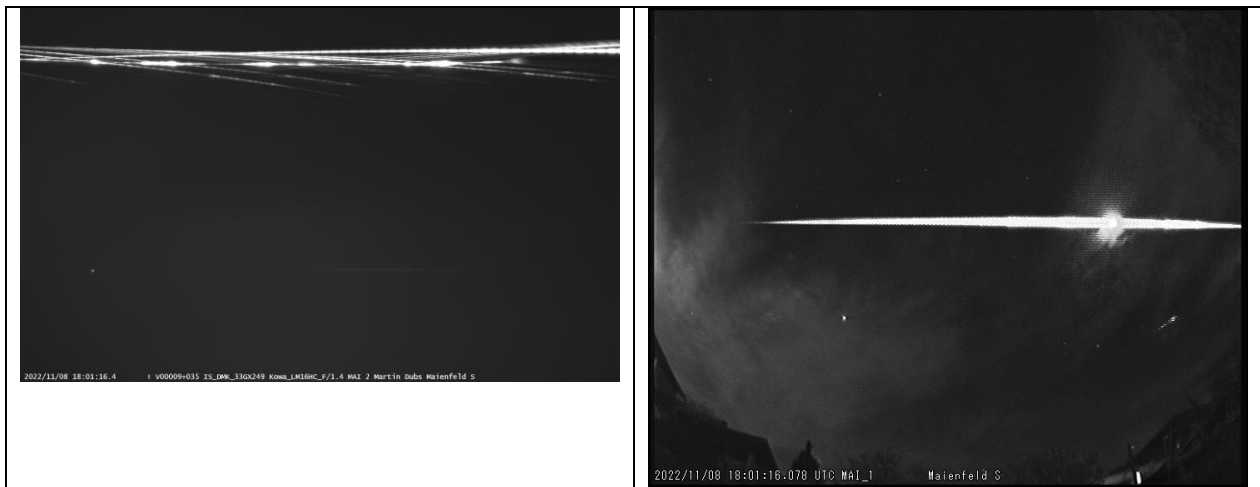
spectrum 221108\r_add2cal.dat saved



Saturated spectrum, poor fit:



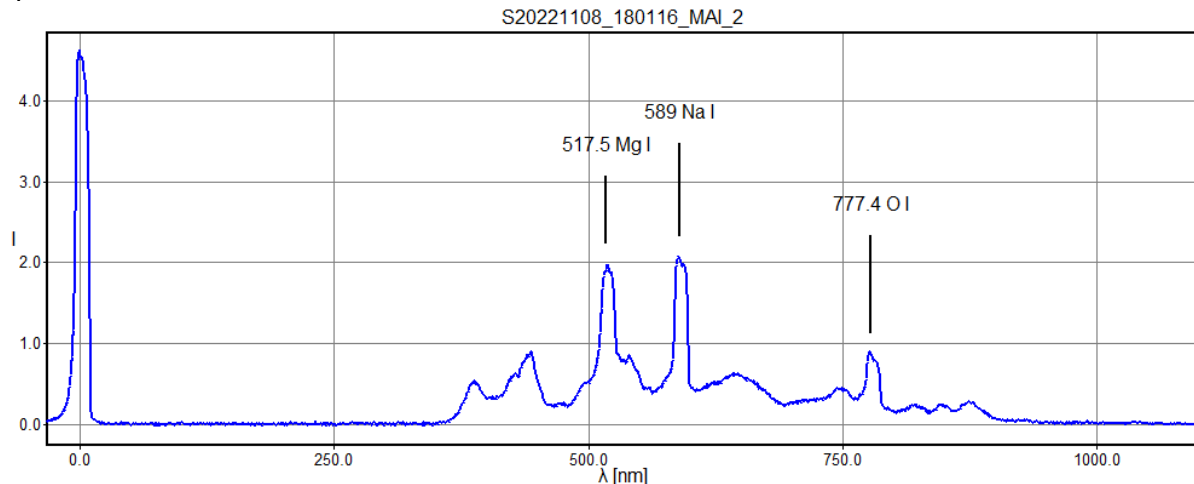
M20221108_180116_MAI_2, NTA, -7.5m



1st order spectrum, start mdist24, 13 images
 polynomial for fit lambda c: [0.5976 -33.5336]

pixel	lambda	fit	error
55.52,	0.00,	-0.35,	-0.3541
924.32,	517.50,	518.85,	1.3512
1041.05,	589.00,	588.61,	-0.3896
1355.94,	777.40,	776.79,	-0.6075

 rms_x = 0.7861
 spectrum 221108\ra_add13cal.dat saved

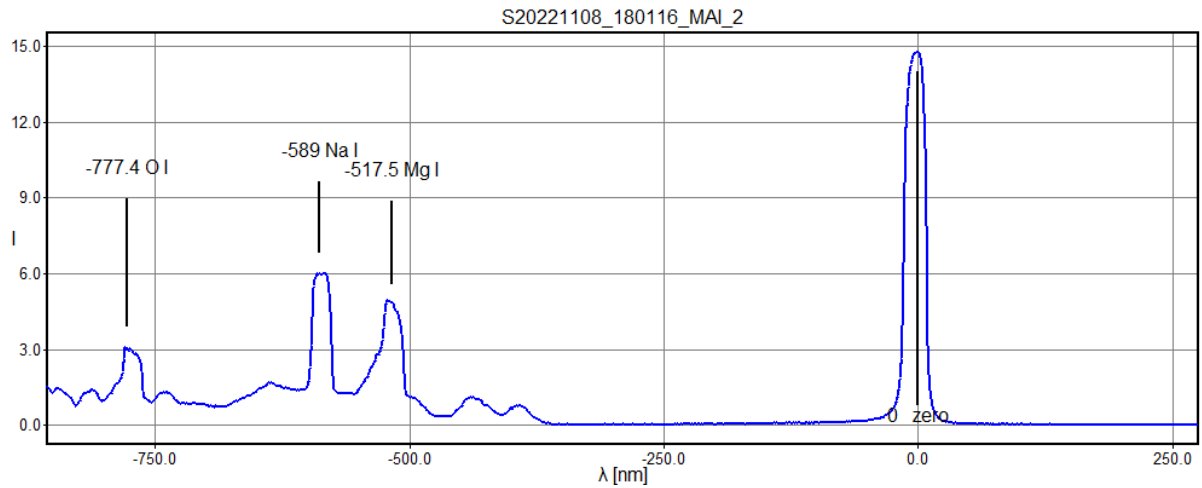


Lines broadened by meteor movement parallel to dispersion, no slant correction possible

-1st order spectrum, start image mdist75, 13 images
 polynomial for fit lambda c: [5.9143e-01 -8.5752e+02]

pixel	lambda	fit	error
132.55,	-777.40,	-779.13,	-1.7292
463.77,	-589.00,	-583.23,	5.7651
568.38,	-517.50,	-521.37,	-3.8651
1449.62,	0.00,	-0.17,	-0.1708

 rms_x = 3.5775
 spectrum 221108\rb_add13cal.dat saved



Flash, -1st and -2nd order, single image mdista101
 polynomial for fit lambda c: [5.9951e-01 -1.3293e+03]

pixel	lambda	fit	error
1355.33,	-517.50,	-516.74,	0.7629
1238.74,	-589.00,	-586.63,	2.3665
911.41,	-777.40,	-782.87,	-5.4700
493.81,	-1035.00,	-1033.22,	1.7760
253.26,	-1178.00,	-1177.44,	0.5647

rms_x = 2.8134

spectrum 221108\mdista101cal.dat saved

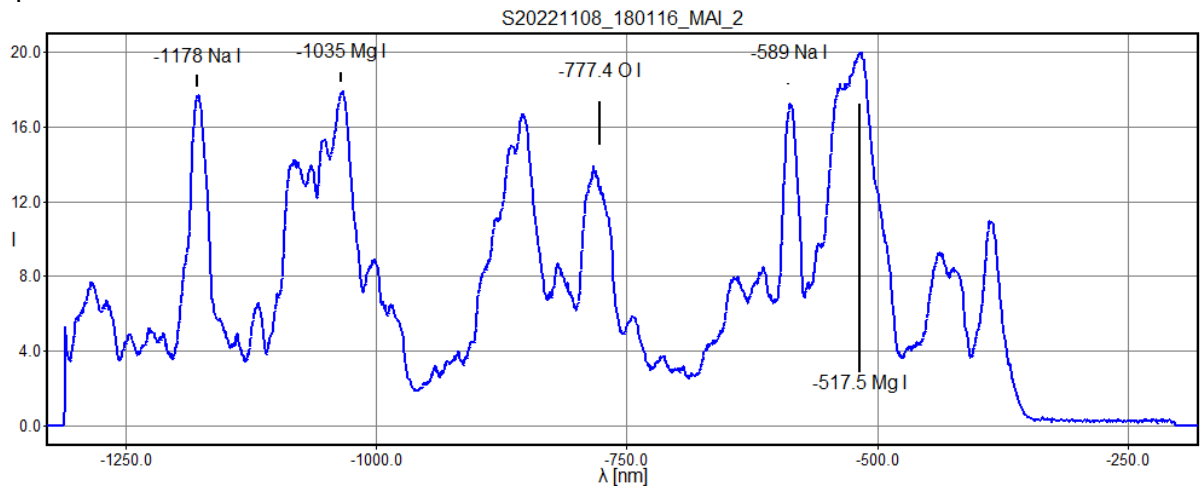


Image overexposed, main lines saturated (-7.5m)

M20221111_005228_MAI_2, DAD, -3.4m

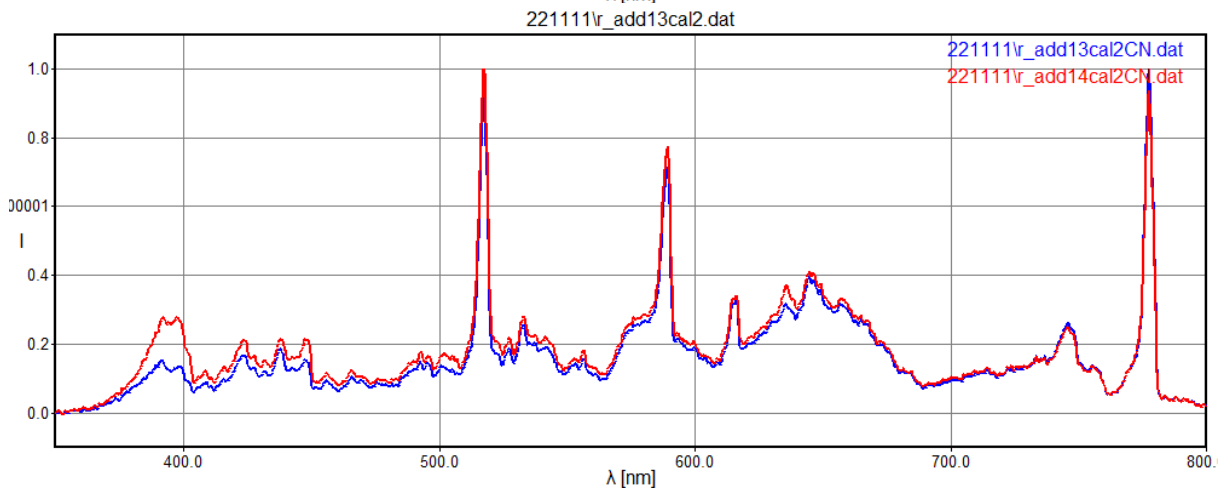
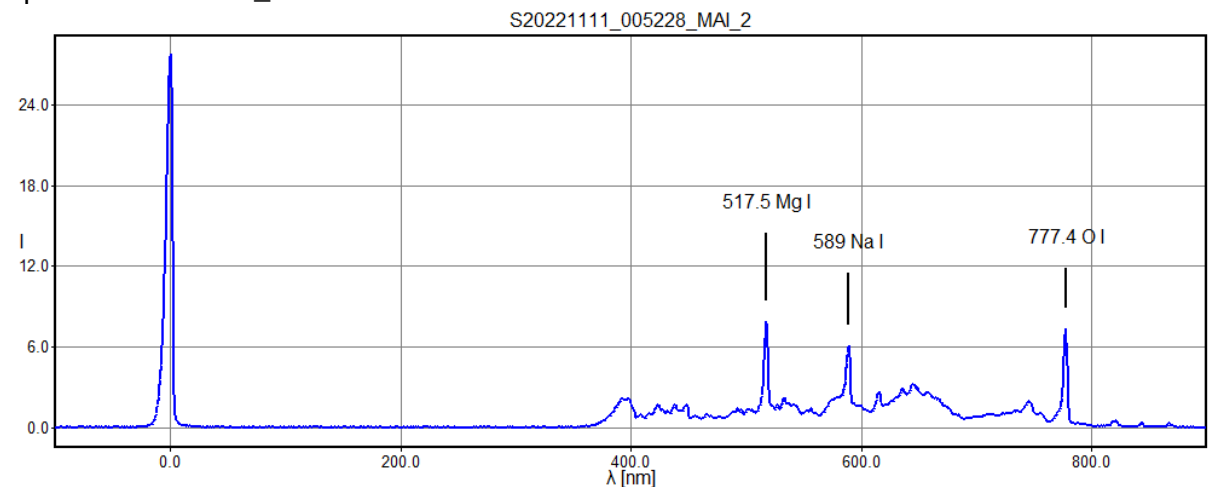


polynom for fit lambda c: [-4.4669e-06 6.0478e-01 -1.9151e+02]

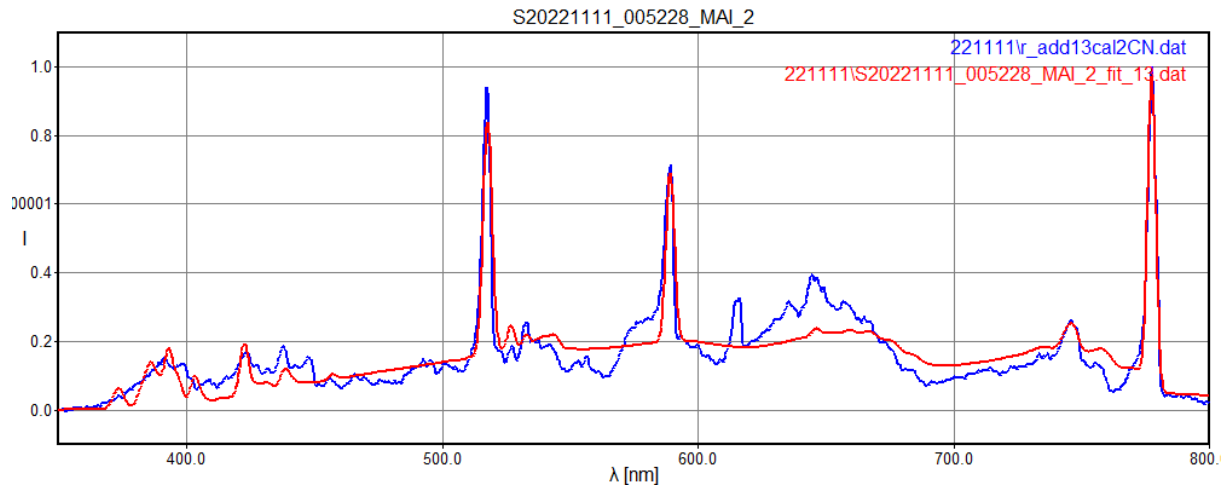
pixel	lambda	fit	error
317.41,	0.00,	0.00,	0.0025
1182.58,	517.50,	517.44,	-0.0600
1303.24,	589.00,	589.07,	0.0726
1621.49,	777.40,	777.38,	-0.0151

rms_x = 0.0477

spectrum 221111\r_add14cal.dat saved



The two curves show the difference of including the flash (image r14, red curve) and omitting it (blue curve). The difference is mainly in the strong intensity of the Ca-line during the flash.



Fit of spectrum excluding flash (image r14)

M20221112_001850_MAI_2, NOO, -1.2m

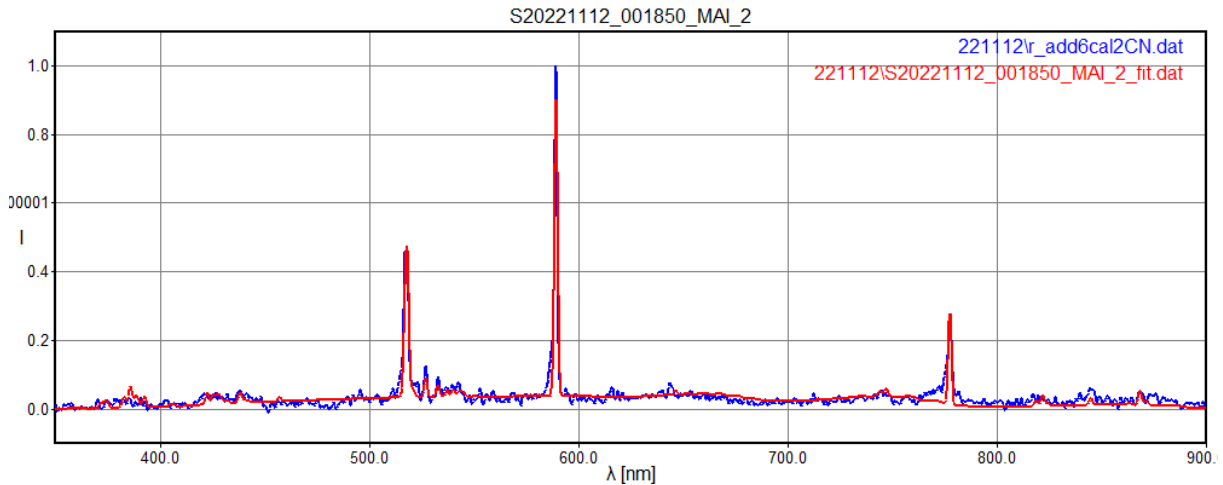
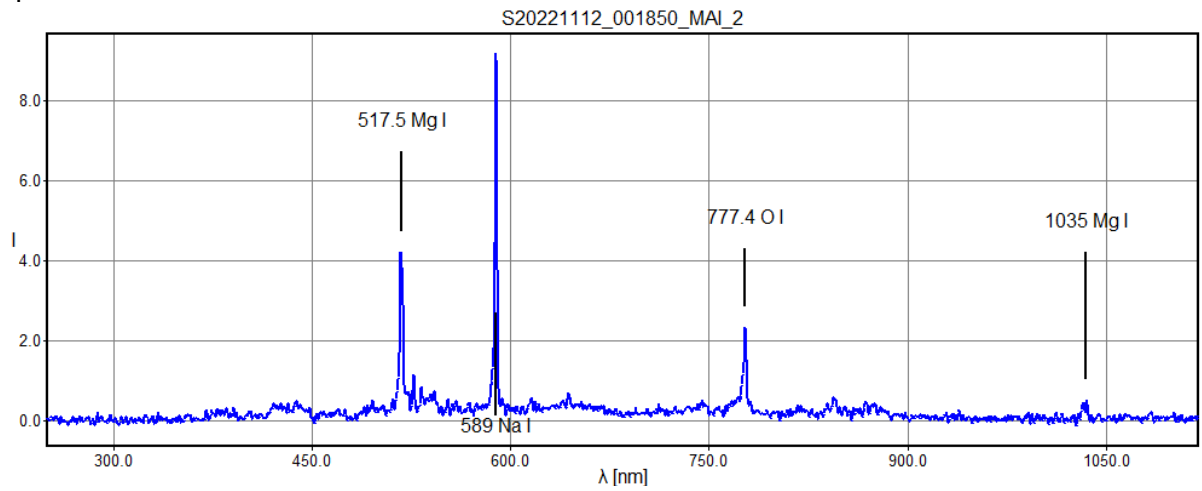


polynom for fit lambda c: [0.597 227.9118]

pixel	lambda	fit	error
485.08,	517.50,	517.51,	0.0125
604.93,	589.00,	589.06,	0.0650
920.16,	777.40,	777.26,	-0.1376
1351.97,	1035.00,	1035.06,	0.0601

rms_x = 0.0820

spectrum 221112\r_add6cal.dat saved

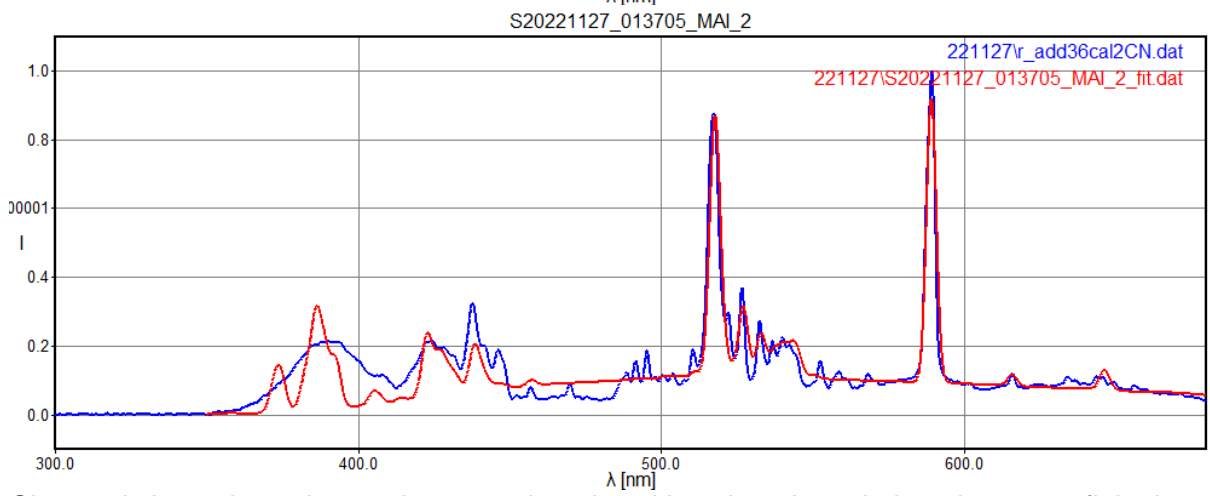
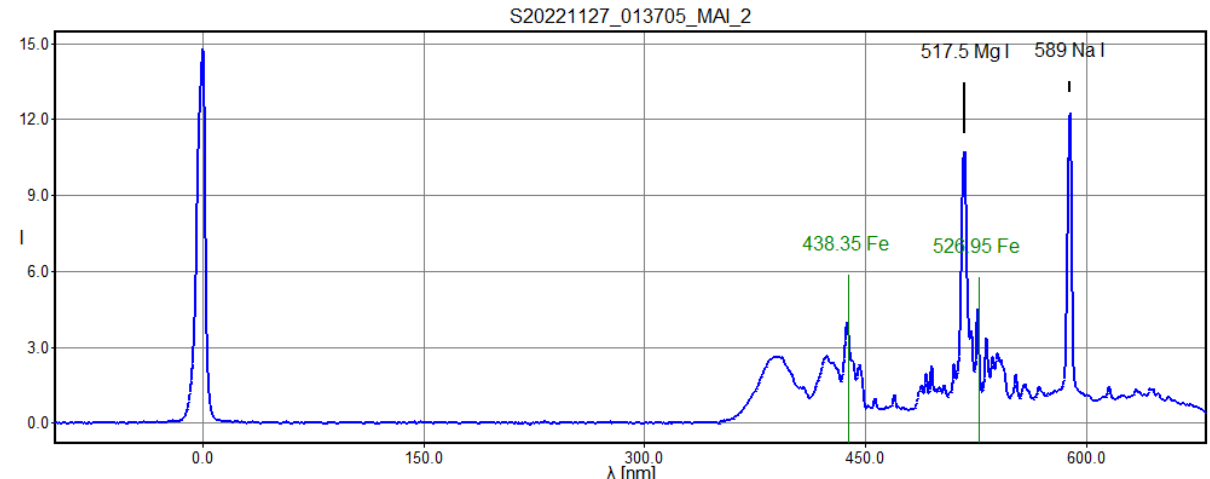


Iron-poor spectrum

M20221127_013705_MAI_2, NOO, -4.4m



polynom for fit lambda c: [0.597 -462.2937]
 pixel lambda fit error
 774.41, 0.00, 0.03, 0.0277
 1640.82, 517.50, 517.27, -0.2270
 1761.30, 589.00, 589.20, 0.1993
 rms_x = 0.1752
 spectrum 221127\r_add36cal.dat saved



Chromatic lens aberration at short wavelengths with reduced resolution gives poor fit in that area.
 Bright flash not used in registered spectrum.Used mdist 4 to mdist40, 36 images.

M20221203_005117_MAI_2, NTA, -1.3m



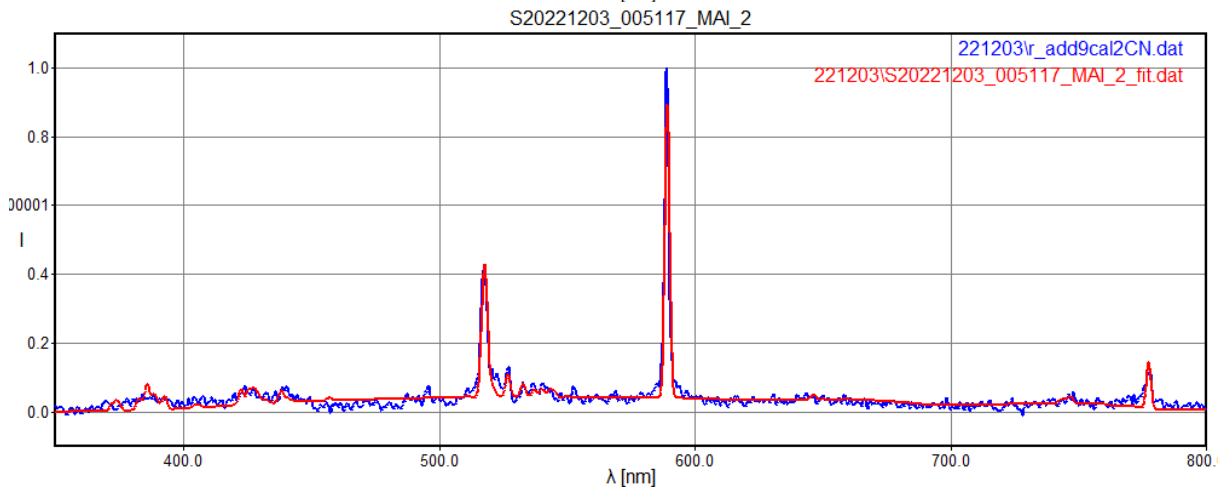
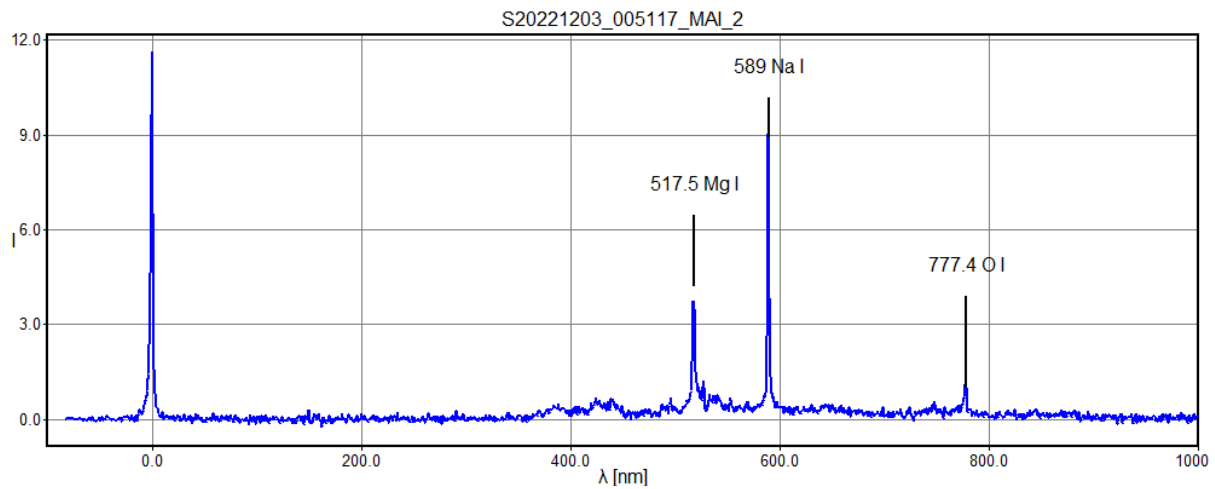
polynom for fit lambda c: [-1.7349e-06 5.9978e-01 -8.4945e+01]

pixel	lambda	fit	error
141.68,	0.00,	-0.00,	-0.0033
1007.52,	517.50,	517.58,	0.0813
1127.17,	589.00,	588.90,	-0.0985
1443.84,	777.40,	777.42,	0.0204

rms_x = 0.0647

spectrum 221203\r_add9cal.dat

saved



M20221207_224735_MAI_2, NTA, -3.1m

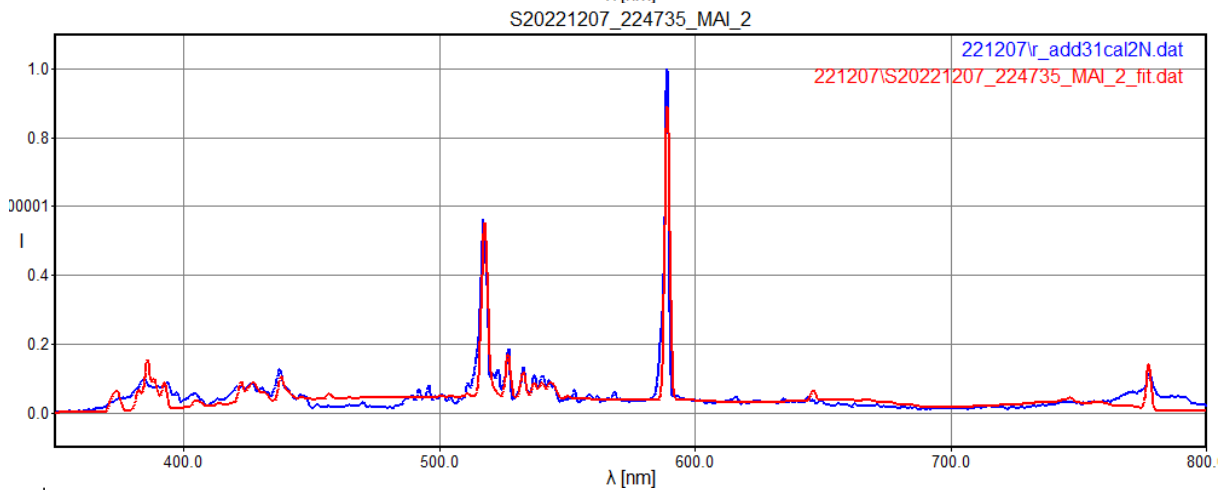
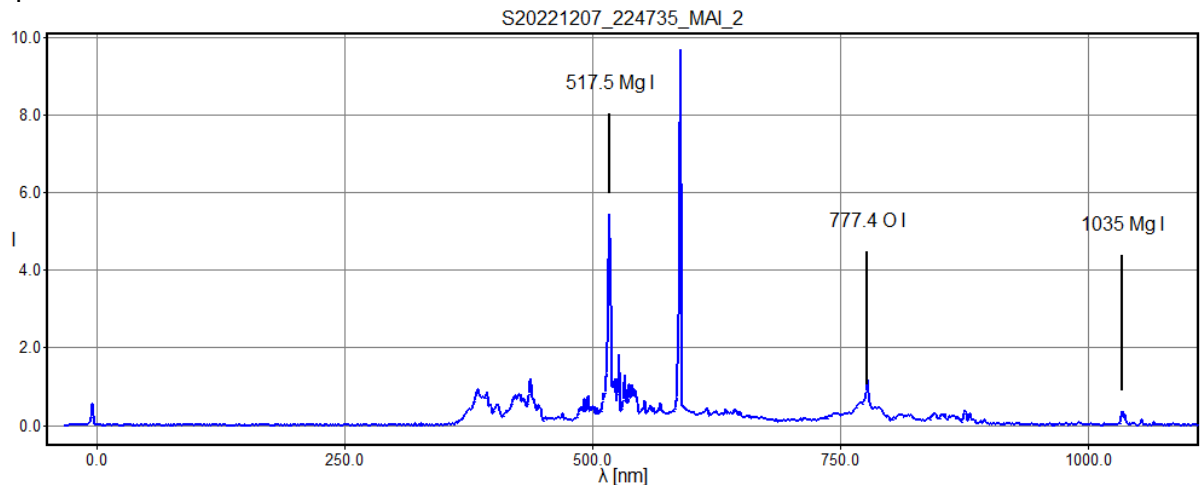


polynom for fit lambda c: [0.5986 -34.8125]

pixel	lambda	fit	error
922.48,	517.50,	517.42,	-0.0849
1042.01,	589.00,	588.97,	-0.0302
1357.15,	777.40,	777.62,	0.2232
1786.91,	1035.00,	1034.89,	-0.1080

rms_x = 0.1319

spectrum 221207\r_add31cal.dat saved



2nd order overlaps OI 777.4nm

M20221208_171957_MAI_2, DAD, -2.1m

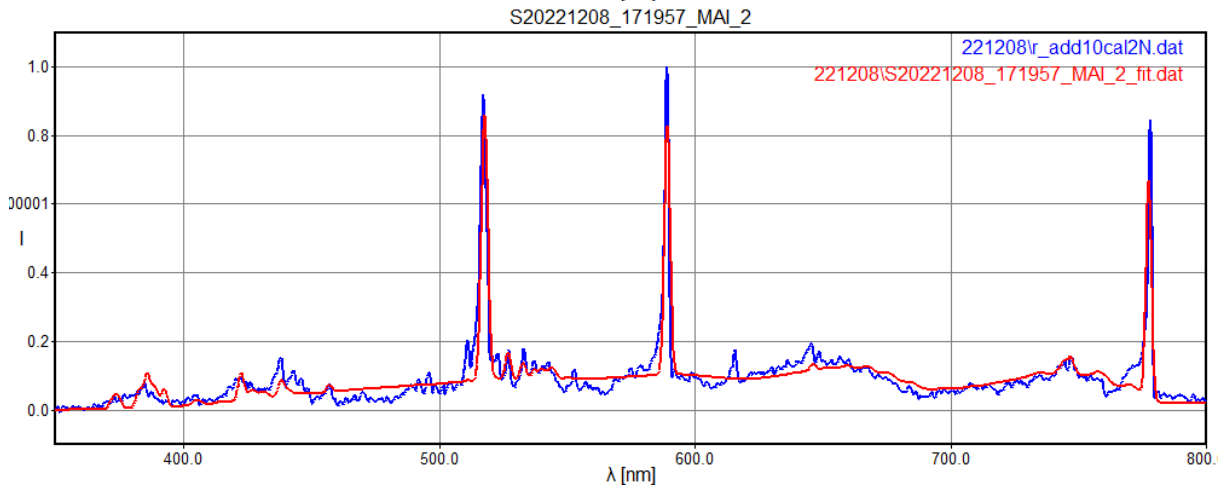
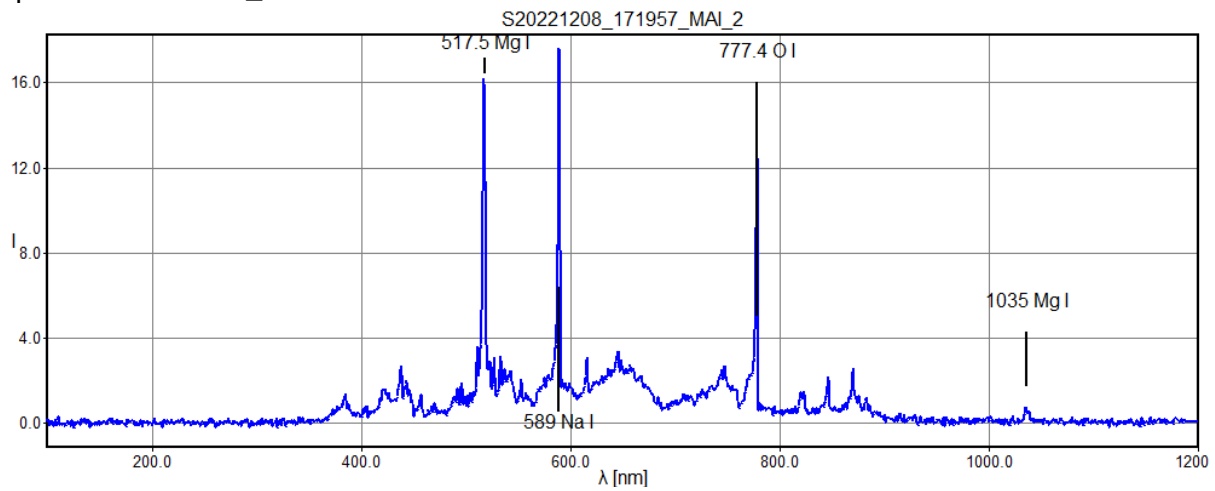


polynom for fit lambda c: [0.5973 68.6137]

pixel	lambda	fit	error
751.13,	517.50,	517.30,	-0.1997
871.02,	589.00,	588.92,	-0.0836
1187.47,	777.40,	777.95,	0.5475
1617.35,	1035.00,	1034.74,	-0.2642

rms_x = 0.3226

spectrum 221208\r_add10cal.dat saved



M20221212_034520_MAI_2, HYD, -2.1m

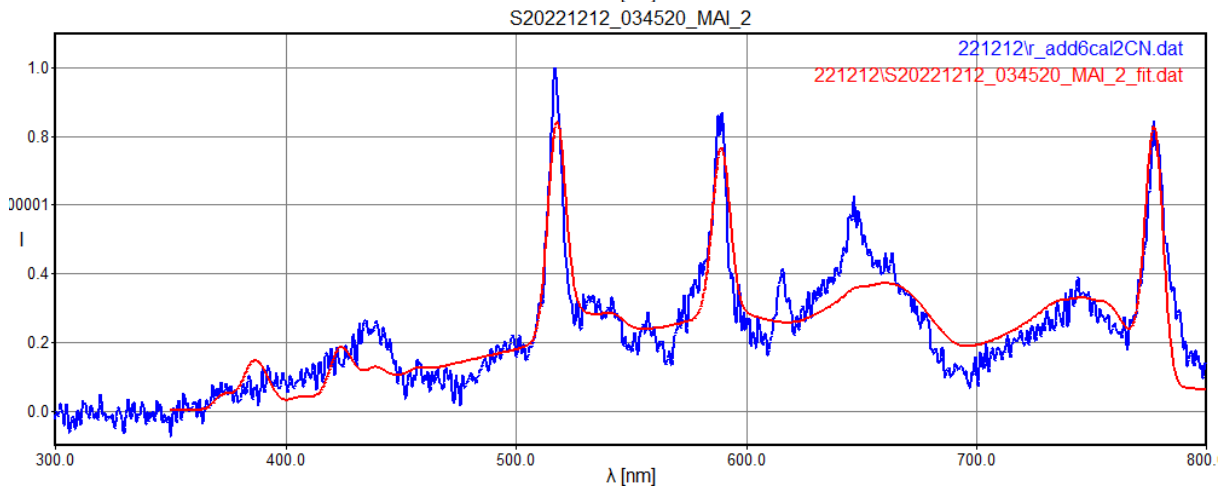
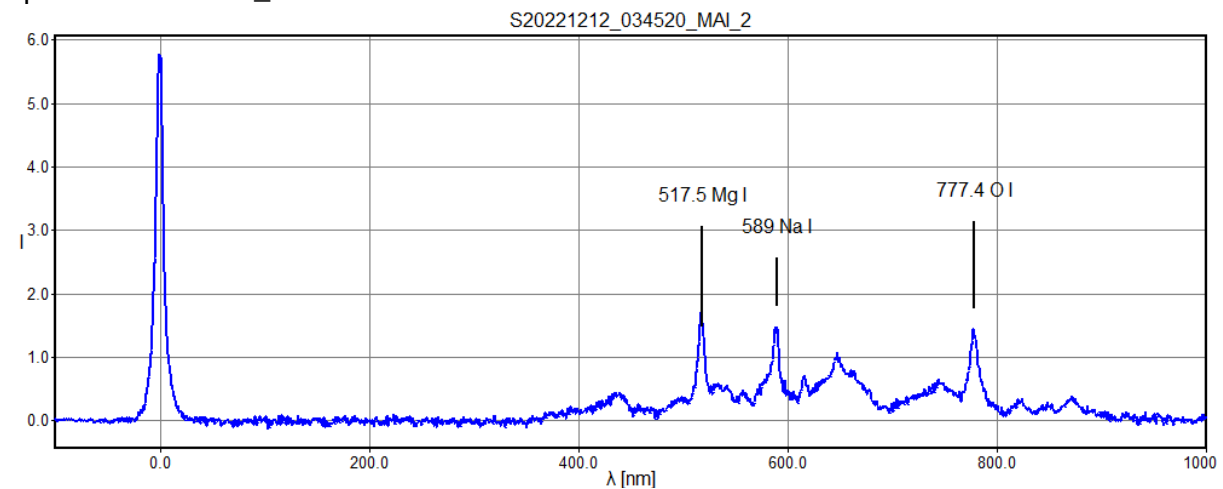


polynom for fit lambda c: [1.4414e-05 5.7799e-01 -1.1657e+02]

pixel	lambda	fit	error
200.71,	0.00,	0.01,	0.0142
1067.97,	517.50,	517.14,	-0.3598
1186.40,	589.00,	589.44,	0.4397
1491.09,	777.40,	777.31,	-0.0940

rms_x = 0.2880

spectrum 221212\r_add6cal.dat saved



Poor resolution caused by meteor movement parallel dispersion.

M20221218_035025_MAI_2, GEM, -1.6m



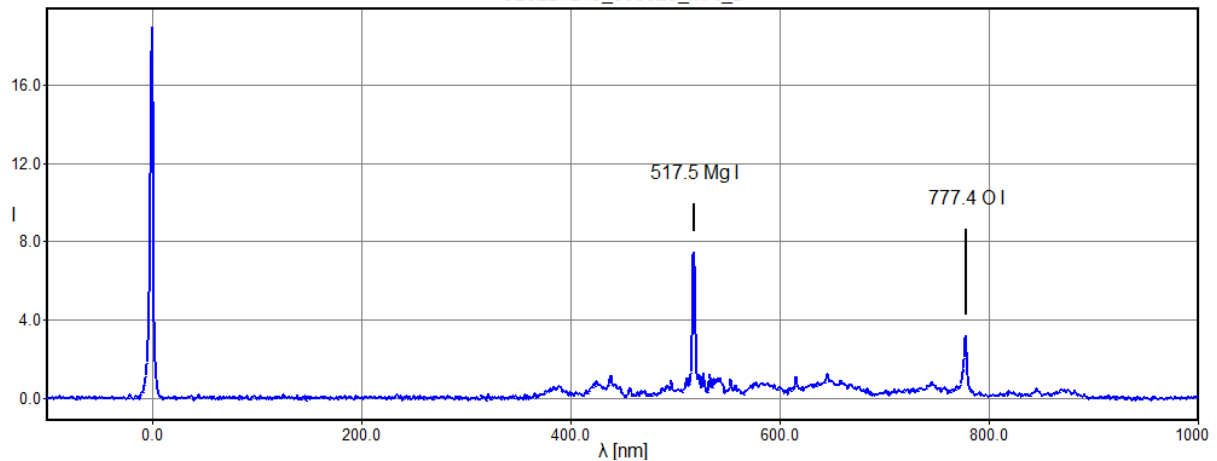
polynom for fit lambda c: [0.5962 -138.8352]

pixel	lambda	fit	error
232.77,	0.00,	-0.06,	-0.0643
1101.24,	517.50,	517.69,	0.1927
1536.65,	777.40,	777.27,	-0.1283

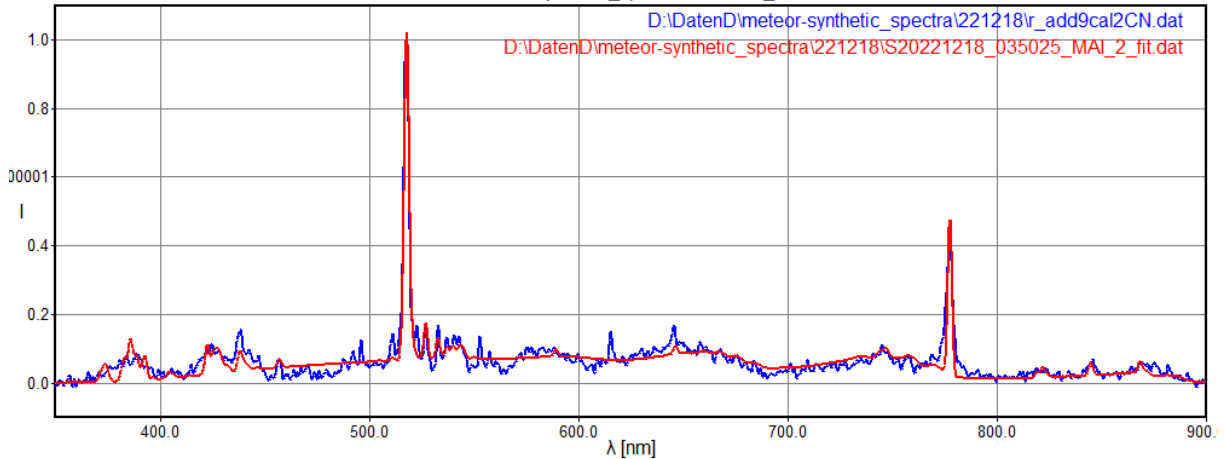
rms_x = 0.1387

spectrum D:\DatenD\meteor-synthetic_spectra\221218r_add9cal.dat saved

S20221218_035025_MAI_2



D:\DatenD\meteor-synthetic_spectra\221218r_add9cal2.dat



Practically no Na I detected, typical for some GEM!

M20221226_031939_MAI_2, DAD, -2.0m



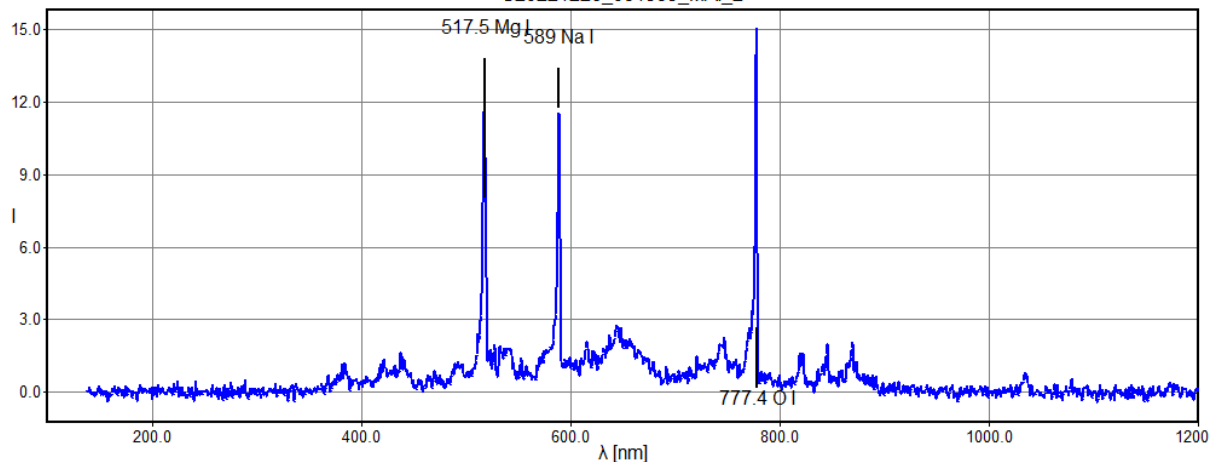
polynom for fit lambda c: [0.5977 137.6274]

pixel	lambda	fit	error
635.75	517.50	517.62	0.1168
754.91	589.00	588.84	-0.1609
1070.46	777.40	777.44	0.0441

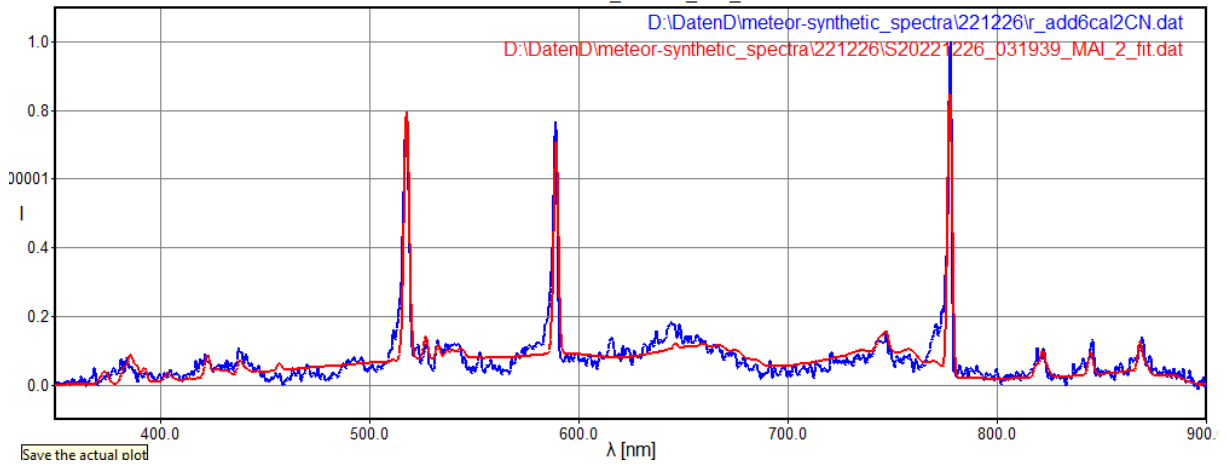
rms_x = 0.1176

spectrum D:\DatenD\meteor-synthetic_spectra\221226\ir_add6cal.dat saved

S20221226_031939_MAI_2

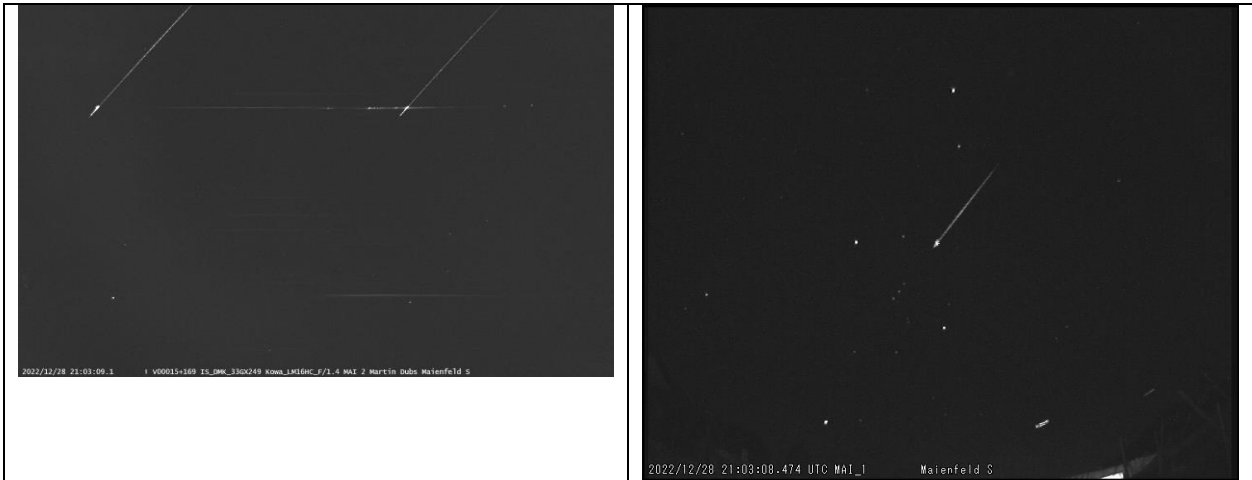


S20221226_031939_MAI_2



Save the actual plot

M20221228_210309_MAI_2, spo, -2.9m



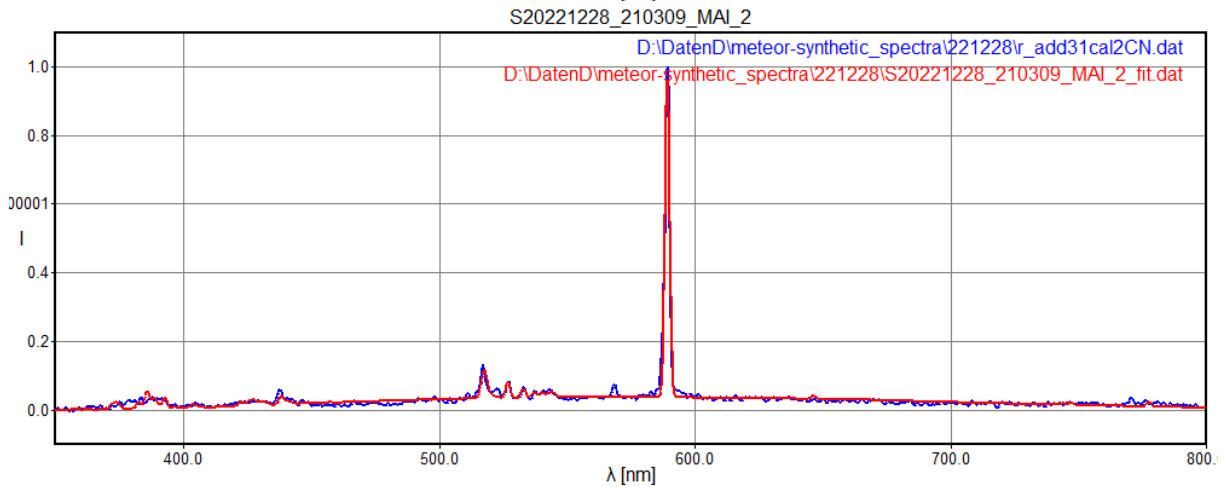
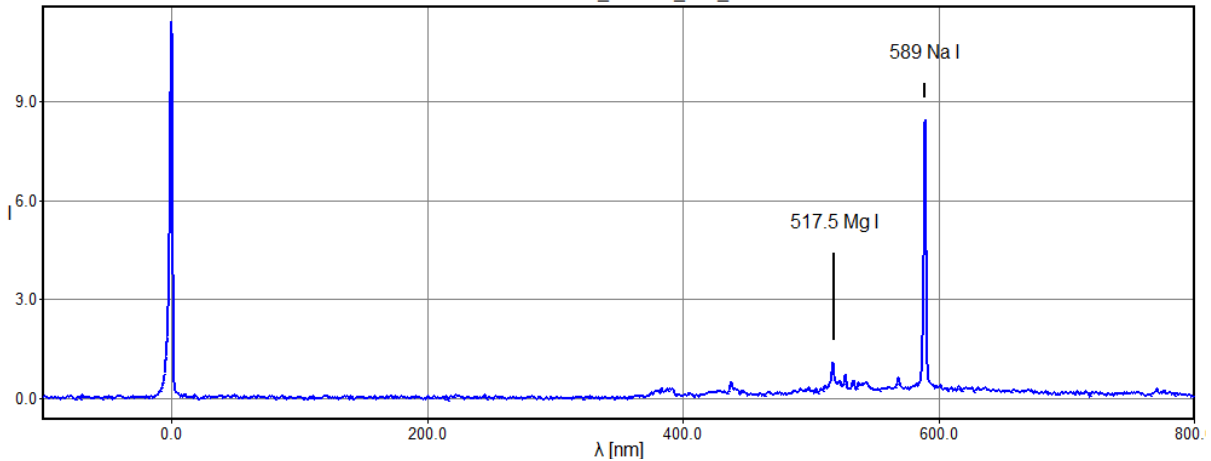
polynom for fit lambda c: [0.5997 -329.1852]

pixel	lambda	fit	error
548.99,	0.00,	0.04,	0.0412
1411.30,	517.50,	517.16,	-0.3362
1531.58,	589.00,	589.30,	0.2951

rms_x = 0.2594

spectrum D:\DatenD\meteor-synthetic_spectra\221228r_add31cal.dat saved

S20221228_210309_MAI_2



Meteor spectral lines

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

Laboratory data			ident. number	Laboratory data			ident. number
λ_{lab} , [Å]	atom/ion	intensity		λ_{lab} , [Å]	atom/ion	intensity	
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 Photographic Handbook 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
<i>Low temperature lines</i>			<i>Wake lines^a</i>		
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	<i>Atmospheric lines</i>		
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
<i>High temperature line</i>			<i>Train line</i>		
4481	Mg II 4	36	5577	[O I] 3F	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

Overview.....	1
M20220101_045057_MAI_2, URS, -2.0m	2
M20220101_233216_MAI_2, spo, -1.5m	3
M20220107_010629_MAI_2P, URS, -1.7m	4
M20220107_014017_MAI_2, GEM, -0.7m.....	5
M20220112_050353_MAI_2, COM, -1.6m.....	6
M20220112_061043_MAI_2, spo, -1.6m	7
M20220114_191845_MAI_2, spo, -0.4m	8
M20220116_040458_MAI_2, spo, -1.6m	9
M20220119_043233_MAI_2, spo, -1.5m	10
M20220125_200402_MAI_2, spo, -2.0m	11
M20220126_025236_MAI_2, spo, -1.5m	12
M20220126_050032_MAI_2, spo, -3.2m (-5.8m).....	13
M20220209_235435_MAI_2, spo, -0.7m	15
M20220210_031302_MAI_2, spo, -1.2m	16
M20220223_223347_MAI_2, spo, 0.6m	17
M20220227_030550_MAI_2, spo, -1.7m	18
M20220228_020130_MAI_2, spo, -2.1m	19
M20220306_011939_MAI_2, spo, -2.7m	20
M20220308_020844_MAI_2, EVI, -9m	21
M20220325_221129_MAI_2, spo, -2.5m	22
M20220327_023708_MAI_2, spo, -2.2m	23
M20220328_213451_MAI_2, spo, -2m	24
M20220328_222226_MAI_2, spo, -4m	25
M20220414_025530_MAI_2, spo, -3.0m	26
M20220418_012807_MAI_2, spo, -1.2m	27
M20220531_001358_MAI_2, spo, -1.0m	28
M20220603_233110_MAI_2, spo, -2.0m	29
M20220708_233717_MAI_2, spo, -1.3m	30
M20220713_001311_MAI_2, spo, -1.6m	31
M20220717_235647_MAI_2, PER, (-1.7m)	32
M20220808_202517_MAI_2, PER, -3.3m.....	33
M20220808_210927_MAI_2, PER, -2.5m.....	34
M20220809_010732_MAI_2, CAP, -2.5m.....	35
M20220810_210141_MAI_2, PER, -4.6m.....	36
M20220816_212256_MAI_2, spo, -0.8m	37
M20220821_191252_MAI_2, KCG, -1.6m	38
M20220905_001410_MAI_2, spo, -1.2m	39
M20221004_194554_MAI_2, spo, -1.8m	40
M20221005_224217_MAI_2, spo, -0.2m	41
M20221018_211317_MAI_2, spo, -1.5m	42
M20221019_032903_MAI_2, spo, -1.3m	44
M20221020_042100_MAI_1, ORI, -2.8m.....	45
M20221023_024017_MAI_2, NTA, -3.2m.....	47
M20221023_034839_MAI_2, spo, -3.0m	48
M20221026_200153_MAI_2, spo, -2.5m	49
M20221027_205433_MAI_2, spo, -1.9m	50
M20221028_014341_MAI_2, NTA, -2.0m.....	51
M20221028_190504_MAI_2, NTA, -1.2m.....	52
M20221029_034751_MAI_2, NTA, -3.7m.....	53
M20221030_034734_MAI_2, NTA, -2.5m.....	54
M20221030_194051_MAI_2, NTA, -1.3m.....	55
M20221031_014551_MAI_2, STA, -7m.....	56

M20221031_195813_MAI_2, NTA, -2.8m.....	57
M20221031_222452_MAI_2, AND, -3.0m	58
M20221031_231557_MAI_2, STA, -1.6m.....	59
M20221101_011254_MAI_2, -2.8m.....	60
M20221102_000159_MAI_2, NTA, -2.0m.....	61
M20221102_010315_MAI_2, AND, -2.1m	62
M20221108_002330_MAI_2, STA, -4.0m.....	64
M20221108_180116_MAI_2, NTA, -7.5m.....	65
M20221111_005228_MAI_2, DAD, -3.4m	67
M20221112_001850_MAI_2, NOO, -1.2m.....	69
M20221127_013705_MAI_2, NOO, -4.4m.....	70
M20221203_005117_MAI_2, NTA, -1.3m.....	71
M20221207_224735_MAI_2, NTA, -3.1m.....	72
M20221208_171957_MAI_2, DAD, -2.1m	73
M20221212_034520_MAI_2, HYD, -2.1m	74
M20221218_035025_MAI_2, GEM, -1.6m.....	75
M20221226_031939_MAI_2, DAD, -2.0m	76
M20221228_210309_MAI_2, spo, -2.9m	77
Meteor spectral lines.....	78