Meteor spectra from AMOS video system

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August 28, 2015


2013/12/04 02:10:33.194 0033
V00033+248 AMOS-SPEC AGO MODRA SLOVAKIA UFOCaptureV2

AMOS-Spec

- In function since 15 November 2013
- Lens: 30 mm, f/3.5
- Grating: 1000 grooves/mm (since July 12)
- FOV: 140 x 100 deg

AMOS-Spec

- In function since 15 November 2013
- Lens: 30 mm, f/3.5
- Grating: 1000 grooves/mm
- FOV: 140 x 100 deg

11/2013 - 12/2014

- Meteors: 2361
- w/spectrum: 433
- /faint: 339
- Satellites: 59

Spectra reduction

1. Image processing
   - Dark current, flat-field, background

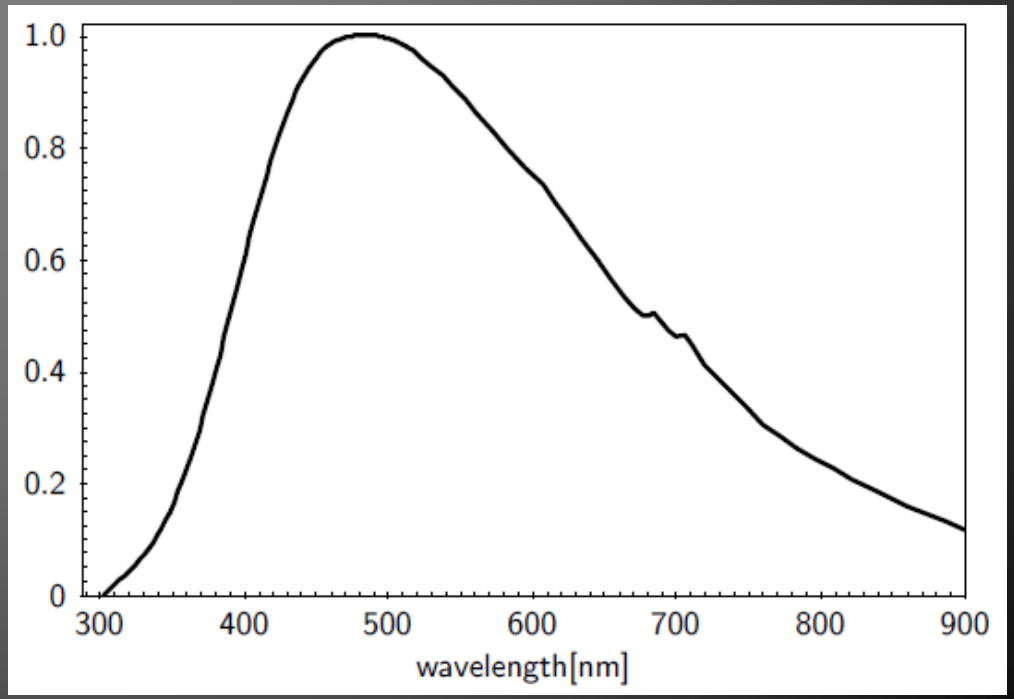
2. Line identification
   - Main lines (Na I, Mg I, Fe I), residual (Ca I, Cr I, Ca II, Mg II, Si II, ...)
   - Atmospheric lines (O I, N I, N II)

3. Polynomial adjust of 2nd degree

4. Calibration curve

5. Black-body radiation correction
   and reduction of atmospheric lines

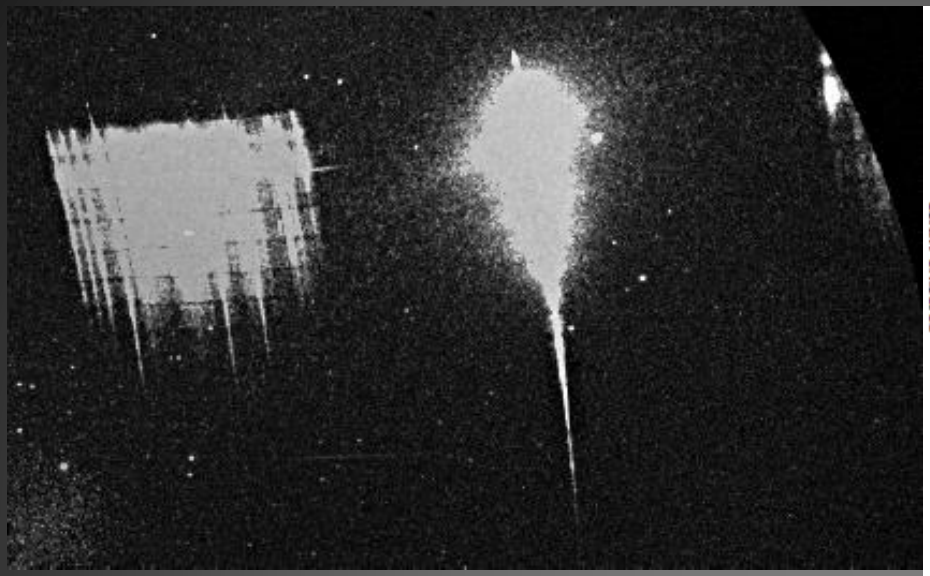
6. Find relative abundances

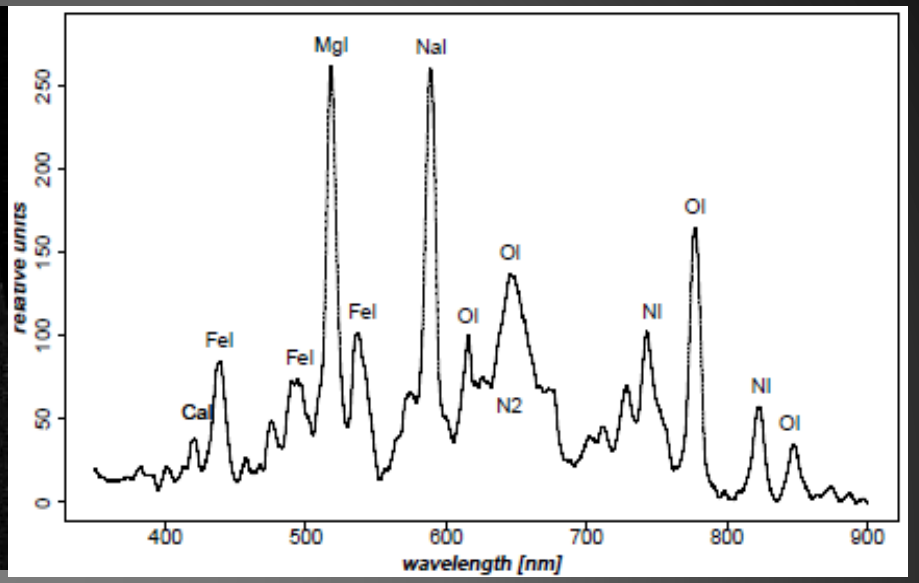



2013/12/04 02:10:31.413 0033 00001
00000 108 AMOS-SPEC AGO MODRA SLOVAKIA UFOCaptureV2

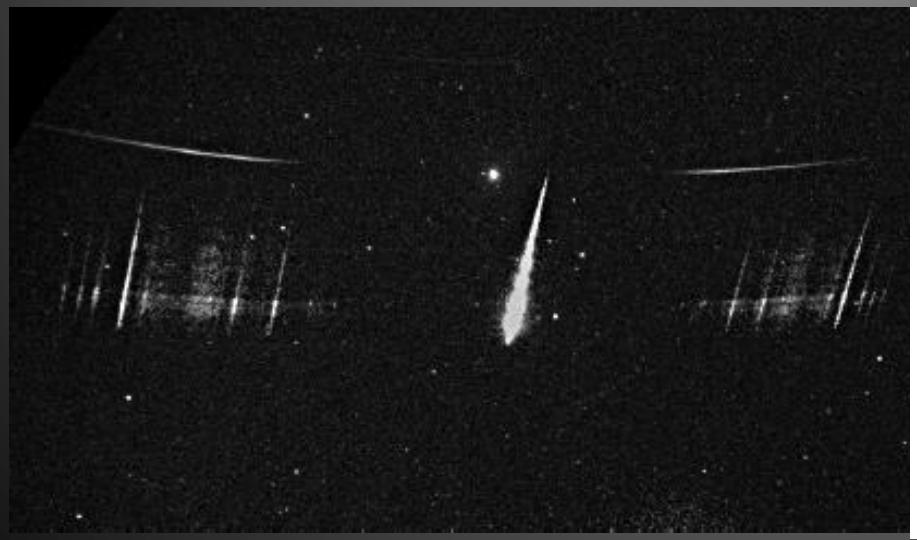

2013/12/02 23:08:33.501 0021 00001
00000+146 AGO SPECTRAL SLOVAKIA UFOCaptureV2

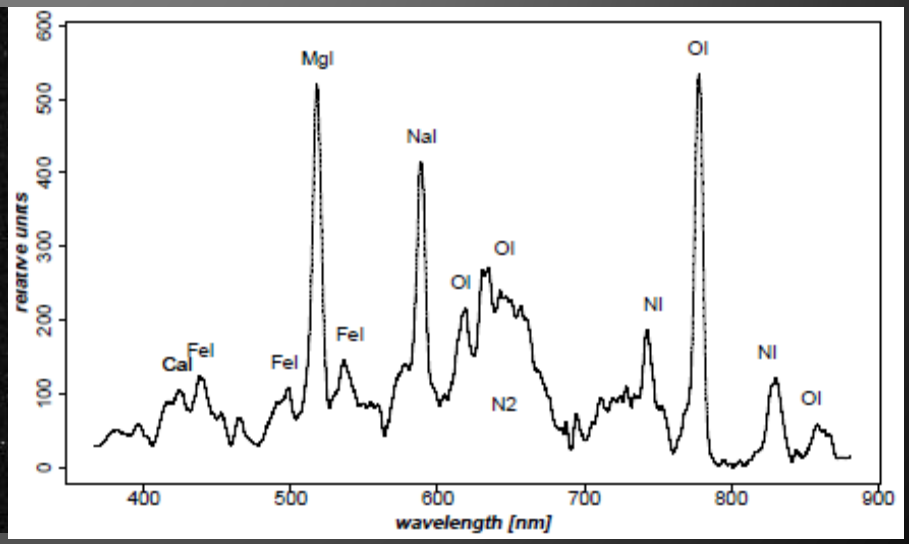
December 2, 2013
November lambda Draconids

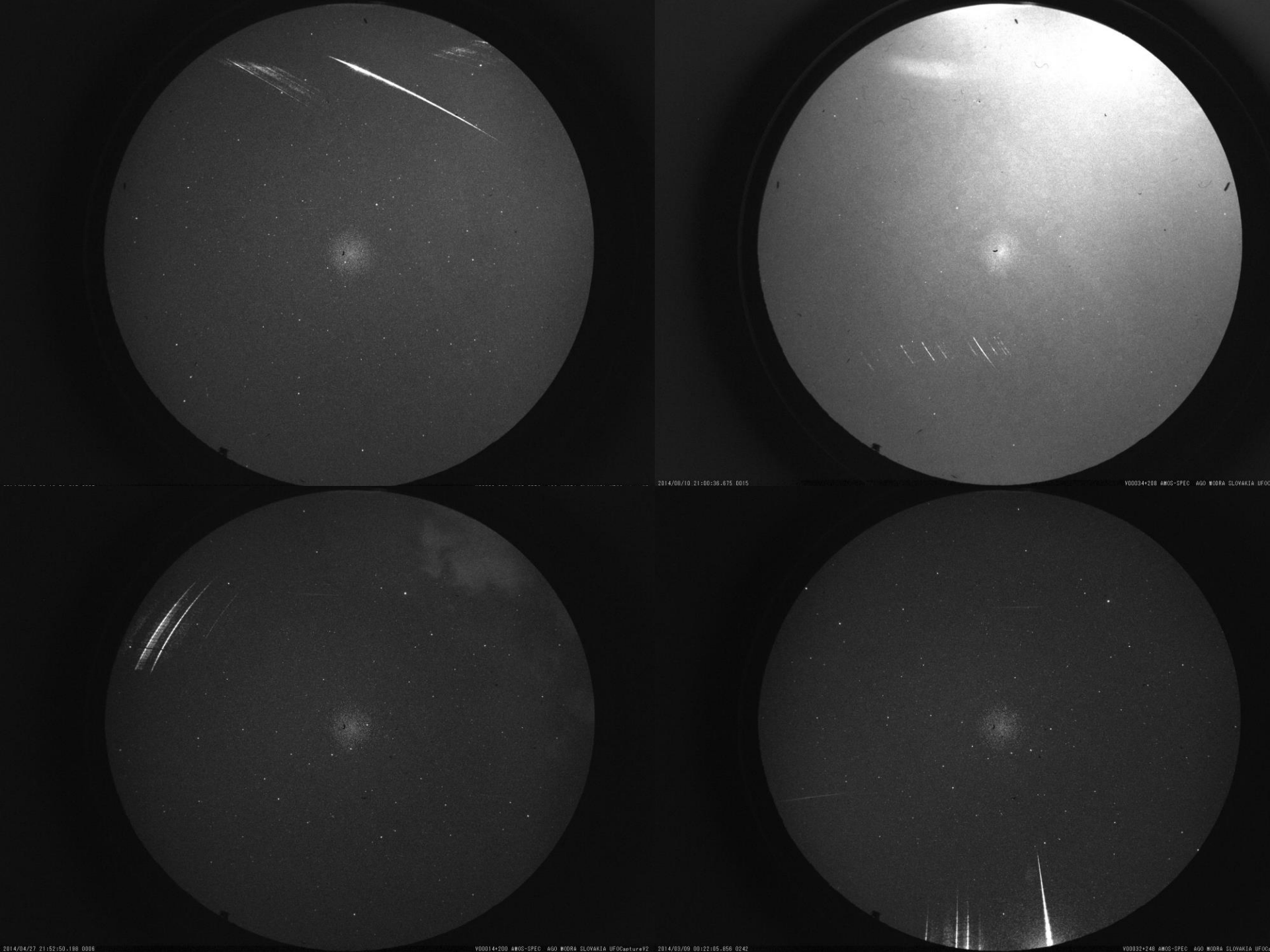




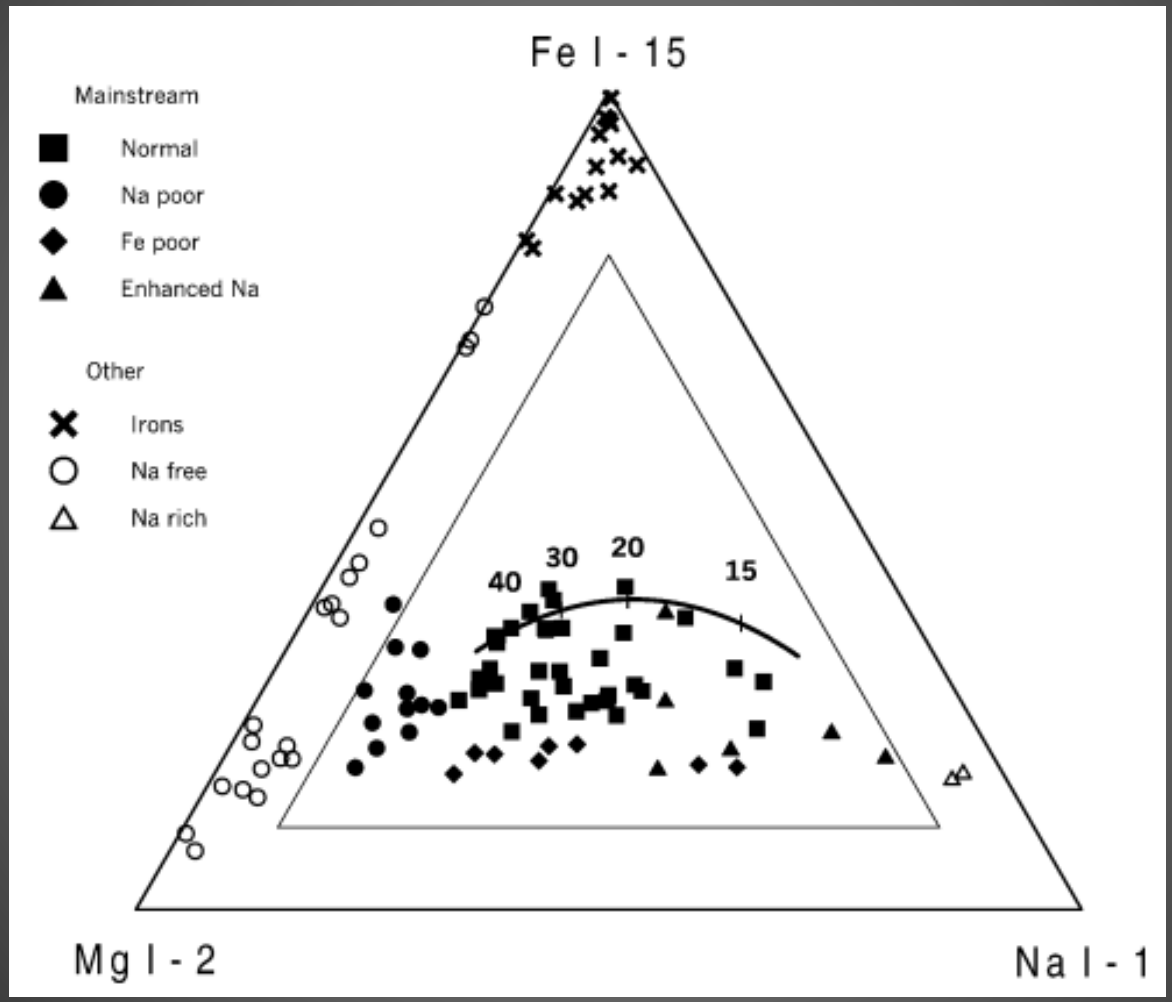
December 4, 2013
delta Hydrids



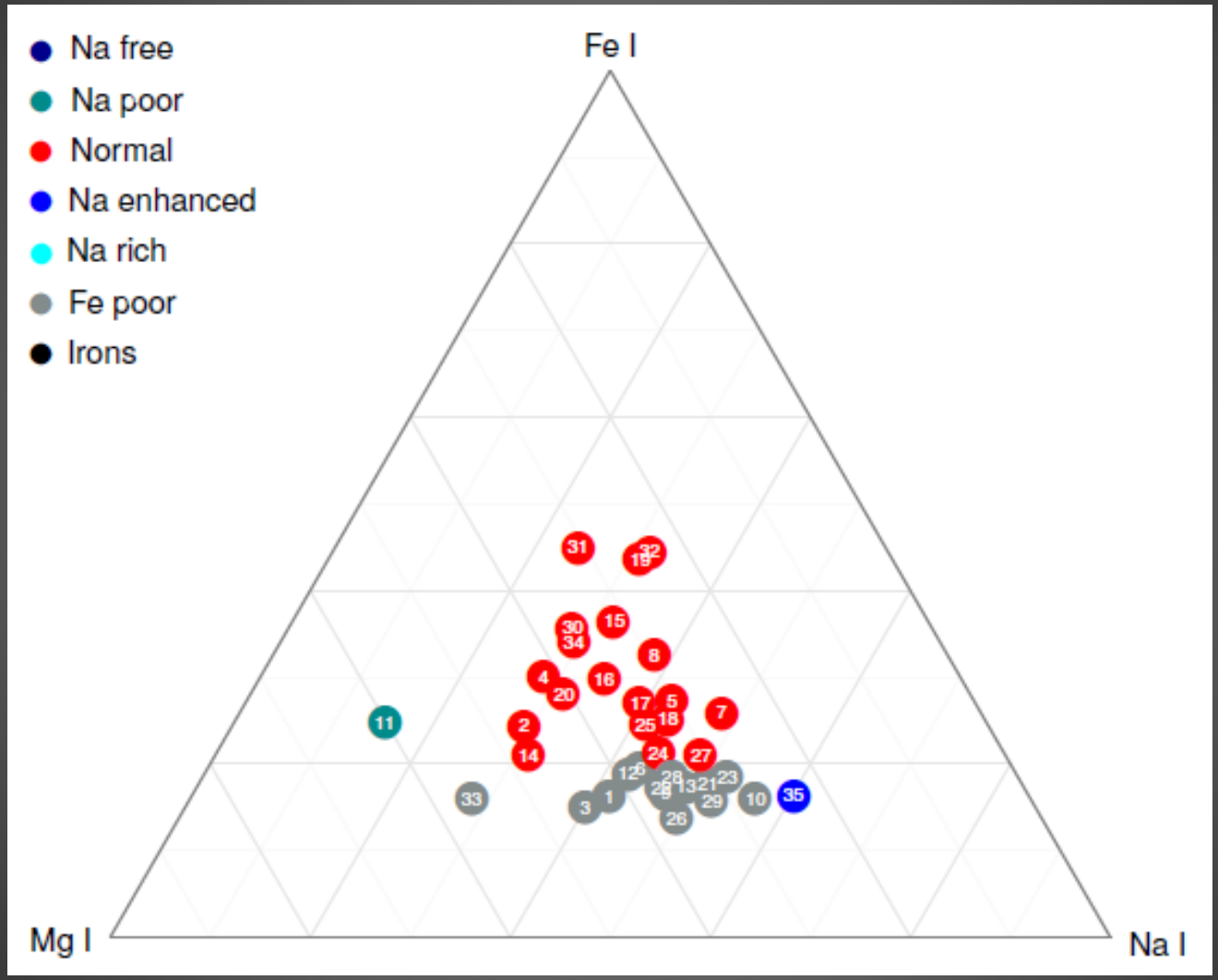



2014/08/10 21:00:36.675 0015
V00034+208 AMOS-SPEC AGO MODRA SLOVAKIA UFOC
2014/04/27 21:52:50.188 0006
V00014+200 AMOS-SPEC AGO MODRA SLOVAKIA UFOCaptureV2
2014/03/09 00:22:05.858 0242
V00032+248 AMOS-SPEC AGO MODRA SLOVAKIA UFOC

Spectral classification



[Borovička et al., 2005]


Na free
Na poor
Normal
Na enhanced
Na rich
Fe poor
Irons
Fe I
Mg I
Na I
31
32
19
30
34
15
8
4
16
20
17
5
18
7
11
2
25
14
24
27
12
6
28
23
13
21
33
3
1
29
10
35
26

Meteor spectrum vs. meteoroid orbit

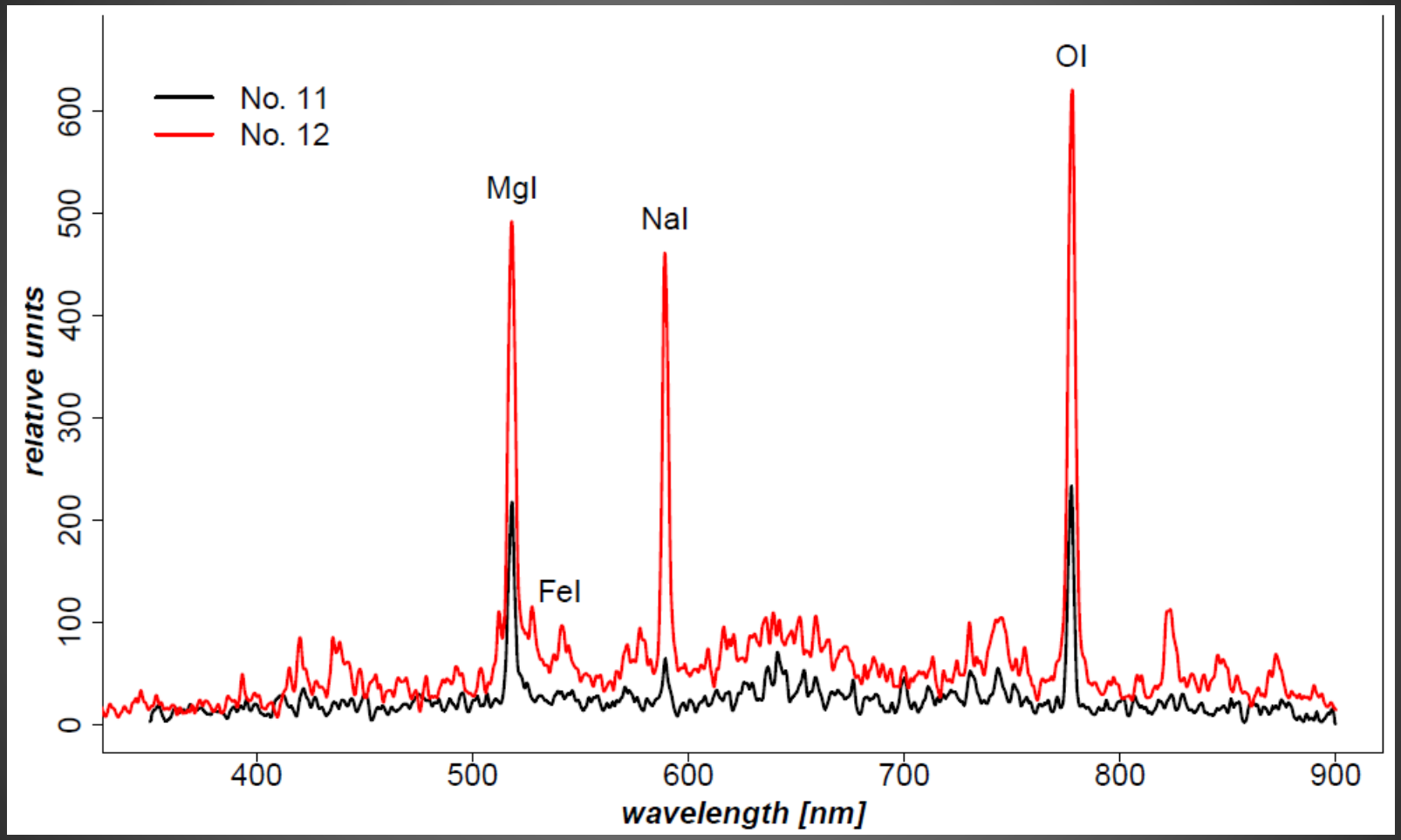
Meteor spectrum vs. meteoroid orbit

- Slovak Video Meteor Network - 22 multi-station orbits

No	Meteor ID	a [AU]	q [AU]	ω [°]	Ω [°]	i [°]	T_J	Shower	Code
1	M20131202_230835	10.6	0.923	210.5	270.8	81.0	0.70	NLD	#441
2	M20131203_050007	5.1	0.918	212.8	251.0	69.8	1.44	DKD	#336
3	M20131204_021033	15.5	0.249	120.8	71.9	128.7	-0.04	HYD	#016
4	M20140302_030933	11.7	0.683	249.1	341.3	125.9	-0.13	FMV	#516
5	M20140309_002205	2.7	0.200	311.1	348.2	3.4	2.47	NVI	#123
6	M20140312_033755	139	0.967	161.2	351.3	106.9	-0.29	spo	
7	M20140427_193525	4.4	0.762	242.4	37.3	17.8	2.23	ABO	#138
8	M20140427_215250	3.03	0.374	290.2	37.366	7.1	2.45	DLI	#047
9	M20140617_231251	3.5	0.905	138.0	86.5	138.3	0.68	spo	
11	M20140726_001002	2.5	0.058	155.3	302.8	27.6	2.35	SDA	#005
12	M20140803_010827	2.2	0.104	147.2	310.5	21.3	2.74	SDA	#005
13	M20140302_034033	9.4	0.941	153.3	341.3	61.9	1.13	spo	
15	M20140424_013244	2.1	0.377	292.8	33.6	5.5	3.20	GLI	#139
16	M20140429_000332	1.9	0.243	308.7	38.4	5.8	3.32	XLI	#140
20	M20140821_211827	7.9	0.665	253.6	148.5	72.5	0.98	spo	
22	M20140125_014156	13.8	0.638	253.8	304.8	105.2	0.14	spo	
23	M20140306_185249	2.1	0.990	186.6	345.9	29.5	3.43	spo	
24	M20140509_001833	1.6	0.935	138.3	48.1	122.1	2.74	spo	
25	M20140726_000917	0.6	0.021	355.5	122.8	168.8	8.50	spo	
32	M20141224_010952	2.1	0.807	238.1	271.9	33.6	3.32	spo	
34	M20140210_021052	3.1	0.986	176.5	321.1	113.0	1.26	spo	
35	M20140220_185430	2.2	0.892	222.4	331.9	15.8	3.38	spo	

Tisserand parameter

- 10 cometary Halley type meteors
- 6 JFC type meteors
- 5 asteroidal meteors
- 1 retrograde orbit with small q

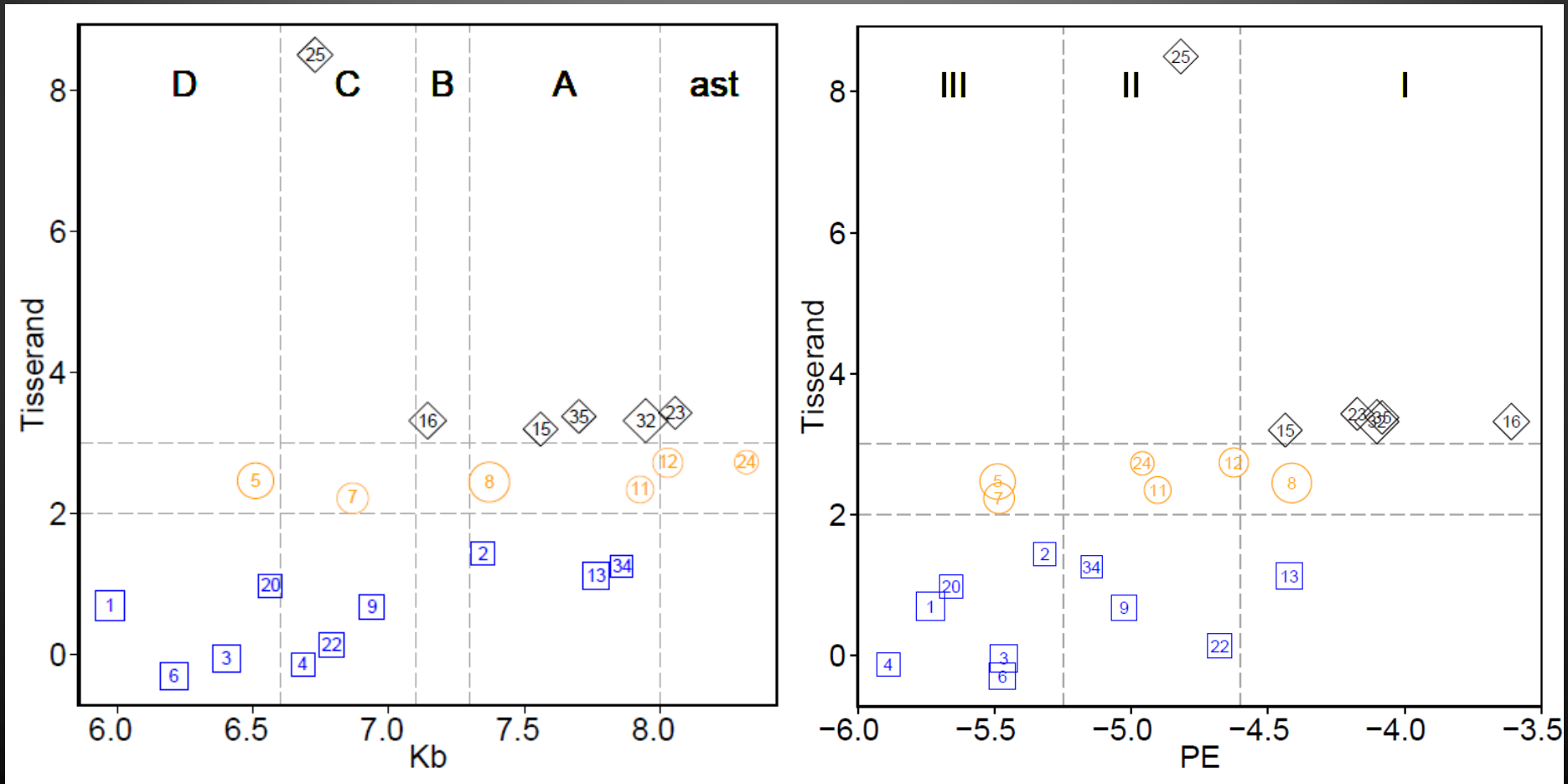

No. 11
No. 12
MgI
FeI
NaI
OI
relative units
0
100
200
300
400
500
600
400
500
600
700
800
900
wavelength [nm]

Material properties

- Beginning and termination height H_B a H_E
- Photometric mass
- Material strength parameters K_B and PE

$$k_B = \log \varrho_B + 2{\cdot}5 \log v_\infty - 0{\cdot}5 \log\cos z_R$$

$$PE = \log \rho_E + A \log m_\infty + B \log V_\infty + C \log(\cos Z_R)$$



Conclusion

What we achieved

- First AMOS-Spec station established
- Continuous spectral program to measure main element abundances
- First analysis of data confronted with orbital characteristics and material parameters

Future plans

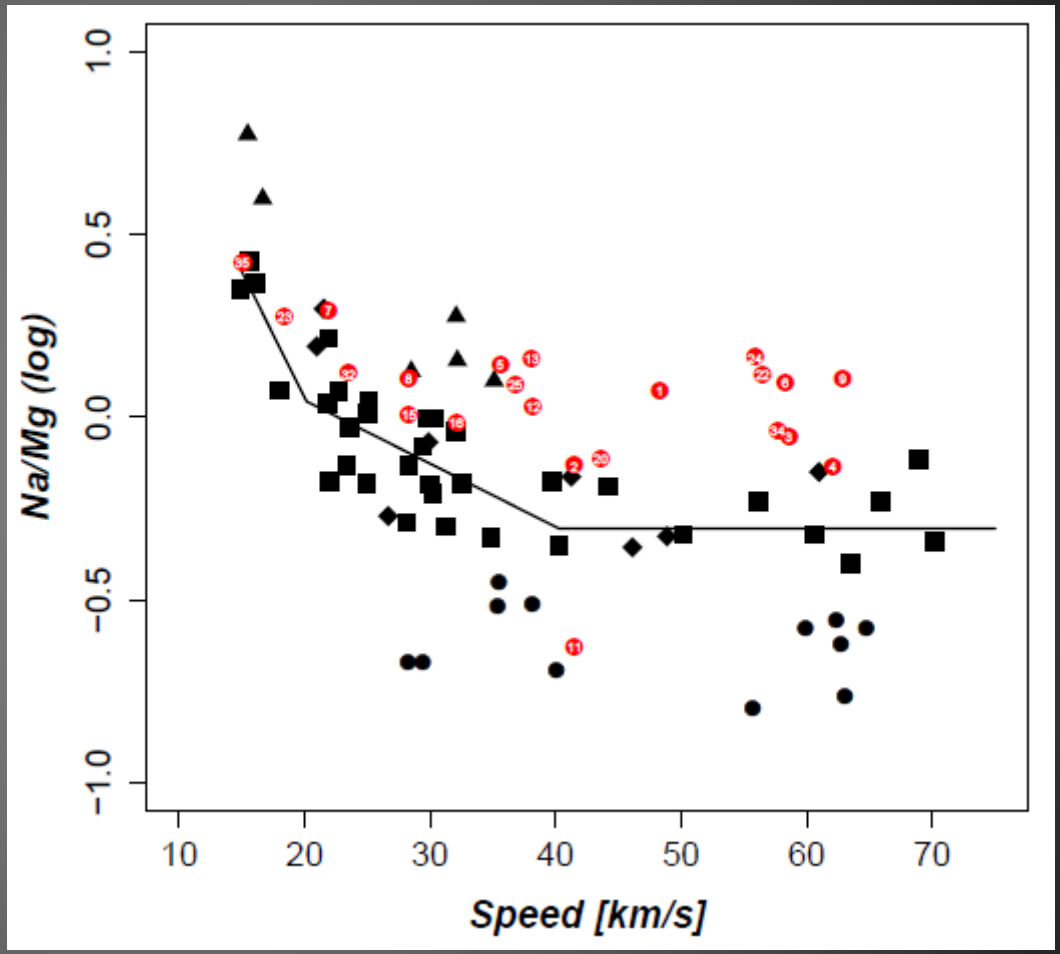
- Expanding spectral and orbital analyses of existing meteoroid streams
- New Amos-Spec stations in Slovakia and abroad
- Determining bulk densities of meteoroids

Thank you for your attention

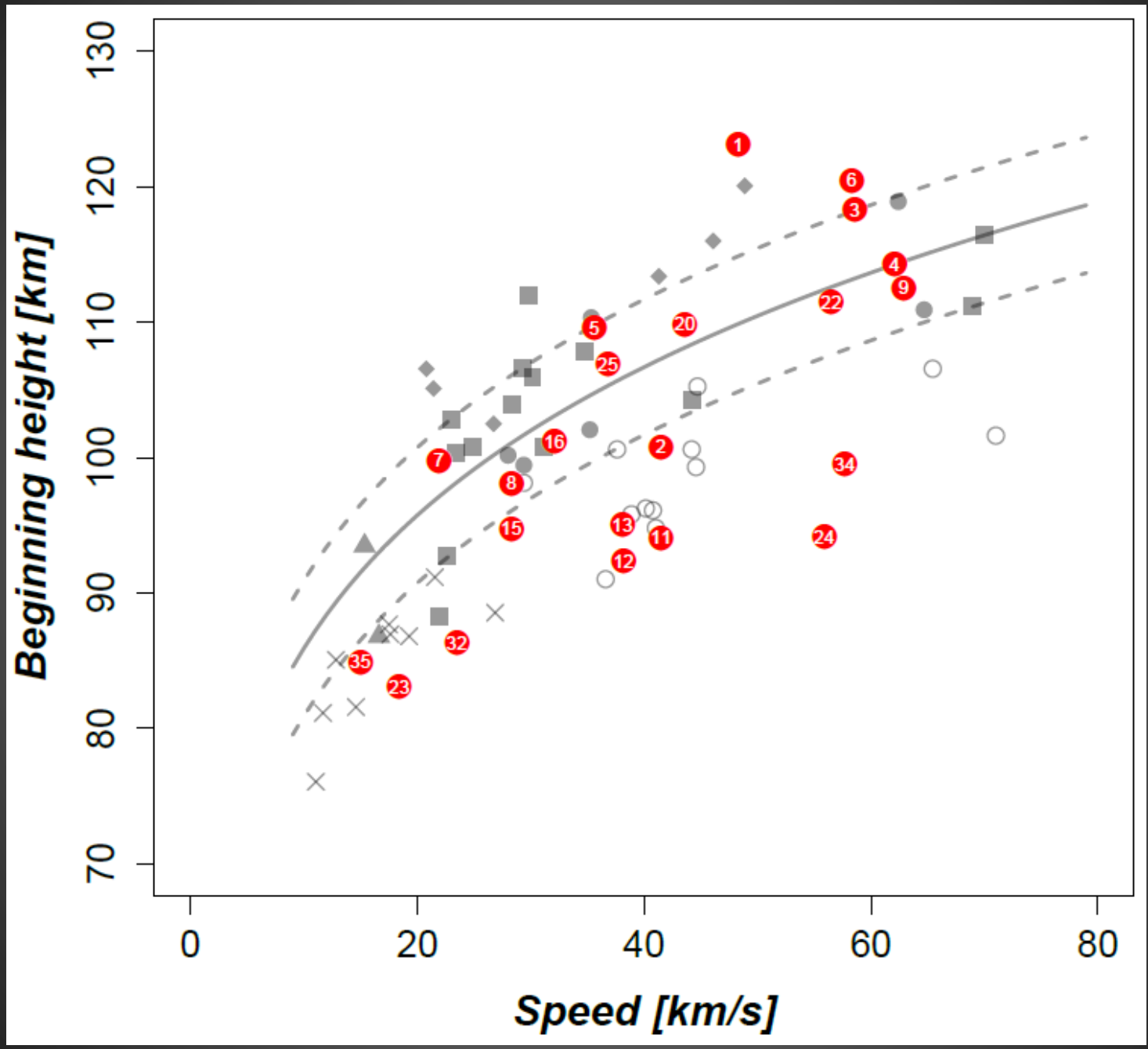
No	Meteor ID	Mag	m_p [g]	v_g [km/s]	H_b [km]	H_e [km]	Q	Na/Mg	Fe/Mg	K_B		P_E	
[d]1	M20131202_230835	-6	17.3±2.2	48.3	123.1	82.6	F0	1.18	0.36	5.97	D	-5.73	IIIB
[d]2	M20131203_050007	-2	0.22±0.05	41.5	100.8	83.7	F0	0.74	0.47	7.35	A	-5.32	IIIAi
[d]3	M20131204_021033	-5	4.9±0.7	58.6	118.3	82.7	F0	0.88	0.17	6.40	D	-5.47	IIIAi
[d]4	M20140302_030933	-3	0.4±	62.1	114.3	94.7	F0	0.73	1.06	6.68	C2	-5.89	IIIB
[d]5	M20140309_002205	-7	104±11	35.6	109.5	71.4	P0	1.39	0.75	6.51	D	-5.49	IIIA
[d]6	M20140312_033755	-5	4.6±0.6	58.3	120.5	81.9	F0	1.24	0.73	6.21	D	-5.47	IIIAi
[d]7	M20140427_193525	-3	4.1±0.4	21.9	99.8	76.2	P0	1.95	0.42	6.87	C1	-5.49	IIIA
[d]8	M20140427_215250	-8.7	1326±126	28.3	98.1	45.1	P	1.28	0.76	7.37	A	-4.41	I
[d]9	M20140617_231251	-3	1.0±	62.9	112.5	86.1	F0	1.27	0.65	6.94	C3	-5.03	II
10	M20140725_000836	-.-	-.-	-.-	-.-	-.-	F0	1.00	2.58	-.-	-.-	-.-	-.-
[d]11	M20140726_001002	-2	0.37±0.06	41.5	94.1	82.0	F0	0.24	0.33	7.93	A	-4.90	II
[d]12	M20140803_010827	-3	1.65±0.20	38.2	92.4	72.6	F	1.07	0.35	8.03	ast	-4.63	II
[d]13	M20140302_034033	-4	3.89±0.48	38.1	95.0	61.7	F	1.44	0.77	7.76	A	-4.42	I
14	M20140305_022134	-.-	-.-	-.-	-.-	-.-	F0	0.71	0.54	-.-	-.-	-.-	-.-
[d]15	M20140424_013244	-1	0.60±0.06	28.3	94.7	70.6	F0	1.02	1.15	7.56	A	-4.44	I
[d]16	M20140429_000332	-2	2.25±0.21	32.1	101.2	52.2	P	0.97	0.43	7.14	B	-3.61	I
17	M20140816_013622	-.-	-.-	-.-	-.-	-.-	F	1.20	0.64	-.-	-.-	-.-	-.-
18	M20140817_193127	-.-	-.-	-.-	-.-	-.-	F0	1.35	0.55	-.-	-.-	-.-	-.-
19	M20140817_195614	-.-	-.-	-.-	-.-	-.-	P0	1.22	1.64	-.-	-.-	-.-	-.-
[d]20	M20140821_211827	-2	0.28±0.05	43.6	109.9	87.7	F0	0.76	0.51	6.57	D	-5.66	IIIAi
21	M20140810_210036	-.-	-.-	-.-	-.-	-.-	F	1.62	0.50	-.-	-.-	-.-	-.-
[d]22	M20140125_014156	-3	0.7±0.1	56.5	111.4	74.3	P0	1.30	0.55	6.79	C2	-4.68	II
[d]23	M20140306_185249	0	0.35±0.04	18.4	83.1	60.9	F0	1.89	0.90	8.06	ast	-4.17	I
[d]24	M20140509_001833	-2	0.05±0.03	55.9	94.1	90.9	F0	1.46	0.91	8.32	ast	-4.96	II
[d]25	M20140726_000917	-2	1.0±0.1	36.8	106.9	75.4	F0	1.23	0.44	6.73	C3	-4.82	II
26	M20140815_230554	-.-	-.-	-.-	-.-	-.-	F0	1.25	0.41	-.-	-.-	-.-	-.-
27	M20140827_214638	-.-	-.-	-.-	-.-	-.-	F0	1.59	0.65	-.-	-.-	-.-	-.-
28	M20140623_011139	-.-	-.-	-.-	-.-	-.-	F0	1.16	0.51	-.-	-.-	-.-	-.-
29	M20140714_002000	-.-	-.-	-.-	-.-	-.-	F0	1.64	0.42	-.-	-.-	-.-	-.-
30	M20140808_021713	-.-	-.-	-.-	-.-	-.-	F0	0.76	0.84	-.-	-.-	-.-	-.-
31	M20141119_030211	-.-	-.-	-.-	-.-	-.-	F	0.75	1.41	-.-	-.-	-.-	-.-
[d]32	M20141224_010952	-6	92±9	23.5	86.3	39.5	F	1.31	1.78	7.95	A	-4.10	I
33	M20141226_002007	-.-	-.-	-.-	-.-	-.-	F0	0.31	0.52	-.-	-.-	-.-	-.-
[d]34	M20140210_021052	-2	0.11±0.03	57.7	99.5	88.5	F0	0.92	1.31	7.86	A	-5.15	II
[d]35	M20140220_185430	0	0.5±	15.0	84.9	52.6	P0	2.64	1.06	7.70	A	-4.08	I

Speed curve

- Na - highest intensity at lowest temperatures (low ionization potential)
- Excitation: Na (2.1 eV) vs. Mg (5.1 eV)
- Na/Mg ratio is speed independent over 40 km/s



[Borovička et al., 2005]


Beginning height [km]
130
120
110
100
90
80
70
0
20
40
60
80
Speed [km/s]
1
6
3
4
9
22
5
20
25
16
2
7
8
34
15
13
11
24
12
32
35
23