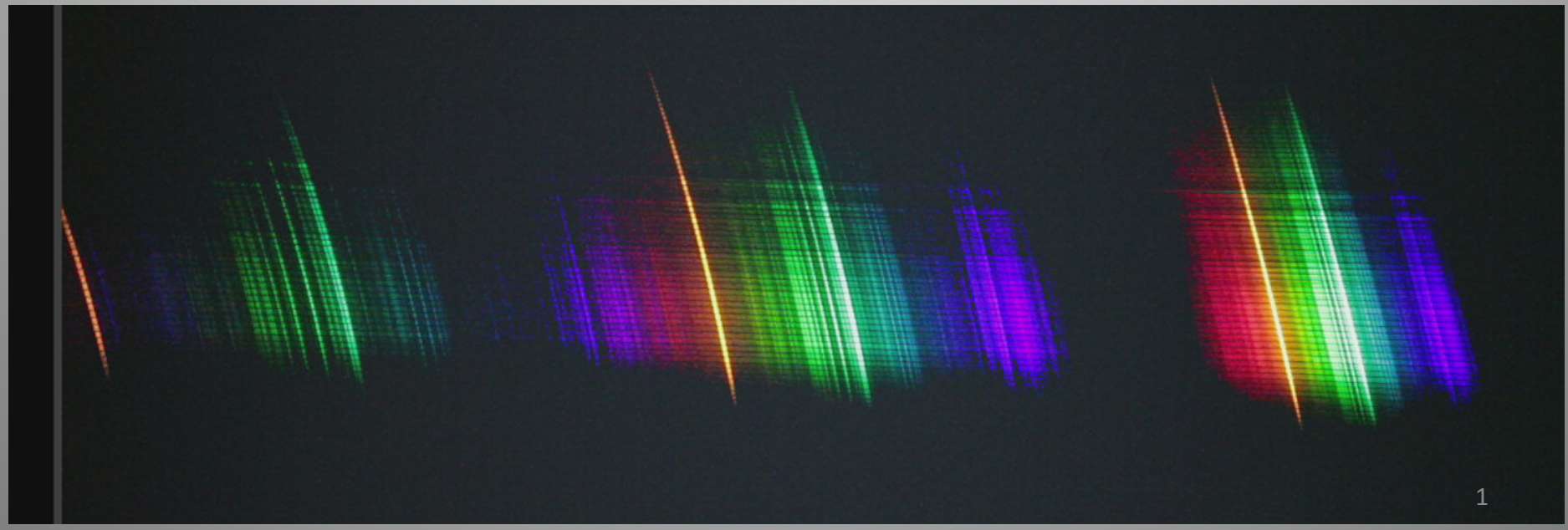
IMC, Egmond, 2016 June 3rd

Meteor spectra using high definition video camera



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Introduction

research objective

Meteor spectral observation is one of an important technic in meteor study. We hope to know the following subjects.

- Spectral classification in sporadic and shower meteor
- Statistical distribution of spectra in shower meteors
- Statistical distribution of the relation between meteor spectrum and the it's orbit in sporadic meteors

The technique of meteor spectral observation progresses rapidly.

We need to collect an unprecedented numerical spectrum in these studies.

We set up the a new equipment for high-sensitive and -definition video observational system.

In this poster we present the first results of our studies of meteor spectrum within one year.

System

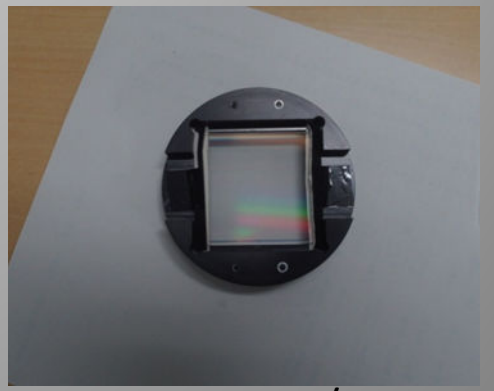
Table of observational conditions

station	Miyazaki (Maeda) 131.42 E, 31.83 N, 13 m	Osaka (Fujiwara) 135.48 E, 34.74 N, 10 m
Camera	SONY alpha 7s (normal)	SONY alpha 7s (remove the IR cut filter)
Video mode	4K (3840 x 2160), 30p	HD (1920 x 1080), 60p
Lens	Canon FD24mmF1.4L (sometimes FD50mmF1.4)	Canon FD50mmF1.4
Grating	600 grooves / mm, UV, Edmund opt.	300 grooves / mm, VIS, Edmund opt.
Software	UFOCaptureHD2 V4.10 UFOAnalyzer V2.42	UFOCaptureHD2 V4.10 UFOAnalyzer V2.42 UFOOrbit V2.34
observation wavelength	400 - 660 nm	about 400 - 800 nm
observation type	Single station	Multi stations

System outlook

Miyazaki
(Maeda)

Osaka
(Fujiwara)



Grating: 300 Grooves / mm, VIS,
Edmund opt.

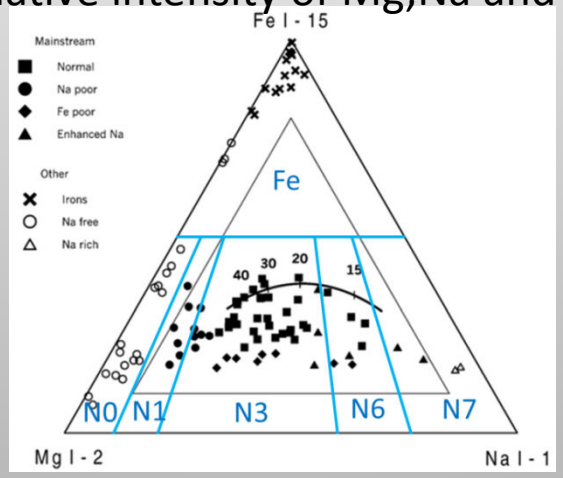
Spectral classification of meteors

Method

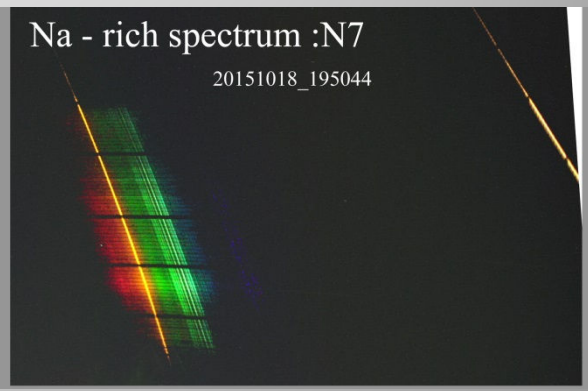
- Spectral lines (Mg,Na, Fe) were identified by the color and the length from 0th order line.
- Intensity ratio of spectral lines were evaluated by the naked eye and BASS software(*3).
- The spectra were classified by modeified Borovicka's standard (*4)show in Fig. (N0-N7andFe)

Na - free type spectra: N0

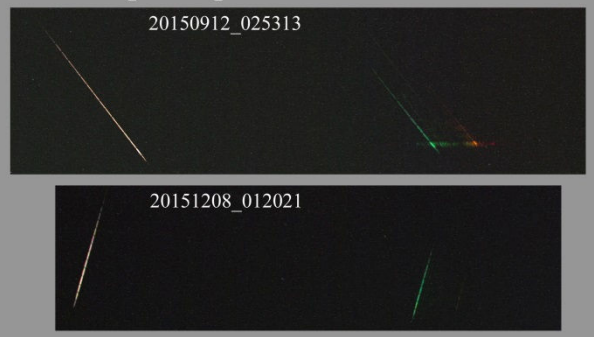
Relative intensity of Mg,Na and Fe



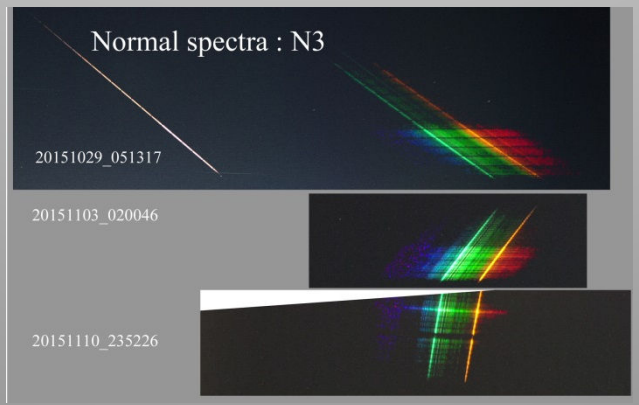
Na - rich spectrum :N7



Na - poor spectra :N1



Normal spectra : N3



Enhanced Na spectra :N6

Results

Miyazaki (Maeda)

Showers were evaluated by UFOAnalyzer software.
All spectra in 2015 could see and download at the SonotaCo Network Japan Forum (*1).

Year	Month	Number of Spectra	shower		sporadic
2015	July to Dec.	362	202	STA, NTA, PER, ORI, GEM, etc.	160
2016	Jan to Apr.	126	15	QUA LYR ETA	111
Total	10	488	217		271

Osaka (Fujiwara)

Orbits were computed from SonotaCo meteor database (***2**), where each meteor was individually measured by UFOAnalyzer software. UFOOrbit Software was used for the orbit computation. The orbits of 61 meteors out of 96 total detection (64 %) were obtained.

Year	Month	Obs. Nights	Number of meteors	Number of Spectra	Number of Orbits
2015	Dec	8	55	37	25
2016	Jan	4	24	15	11
	Feb	7	22	19	8
	Mar	4	12	9	5
	Apr	5	13	10	9
	May	4	11	6	5
Total	6	32	137	96	63

Ref.
*1 http://sonotaco.jp/forum/viewtopic.php?t=3650
*2 http://sonotaco.jp/forum/viewforum.php?f=15

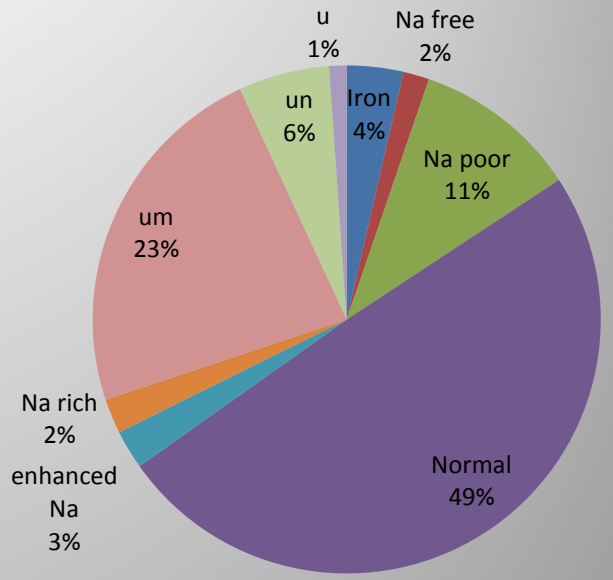
QR code of *1 , take picture ! →

Distribution of Spectral type

Table : spectral type distribution

classification				2015		
code	Na/(Mg+Na)	characterization (*)		number	%	%
Fe	-	Iron rich		13	3.6	5.2
N0	< 10%	Na free		6	1.7	2.4
N1	10-20%	Main - stream	Na poor	38	10.5	15.3
N3	20-60%		Normal	179	49.4	71.9
N6	60-75%		Enhanced Na	9	2.5	3.6
N7	> 75%	Na rich		8	2.2	3.2
subtotal				253	69.9	100
um		faint Mg line only		84	23.2	
un		faint Na line only		21	5.8	
u		unknown		4	1.1	
total				362	100	
This work		* Borovicka et al. (2005)		from Miyazaki results		

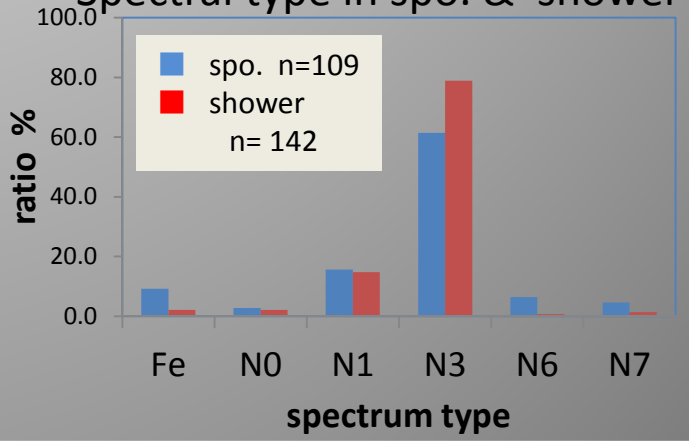
distribuiton of spectrum



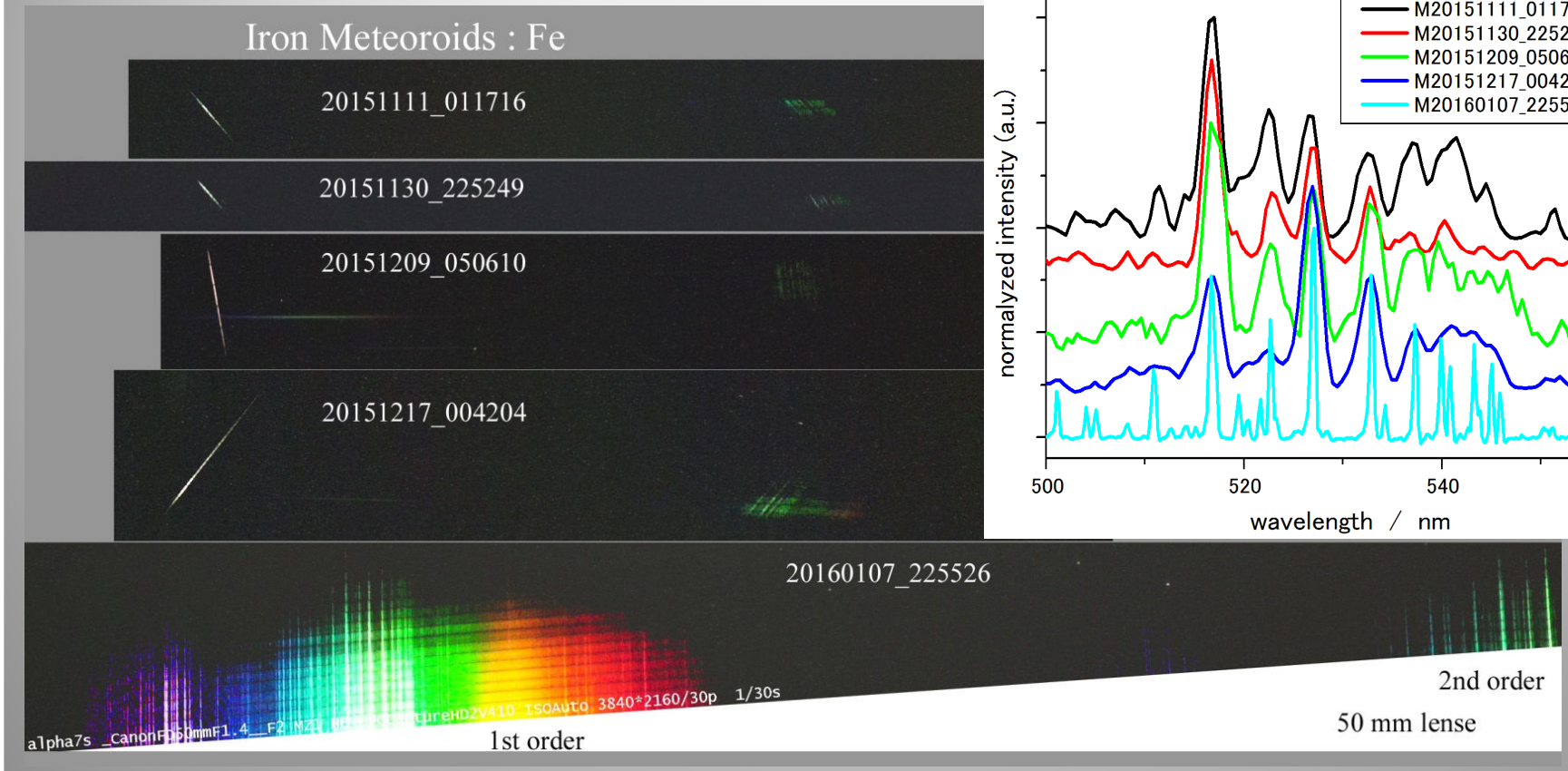
The ratio of main stream is 91% in classifiable spectra. Fe type is 5%.

The ratios of Fe, N6 and N7 types in sporadic meteor are larger than in shower.

Spectral type in spo. & shower



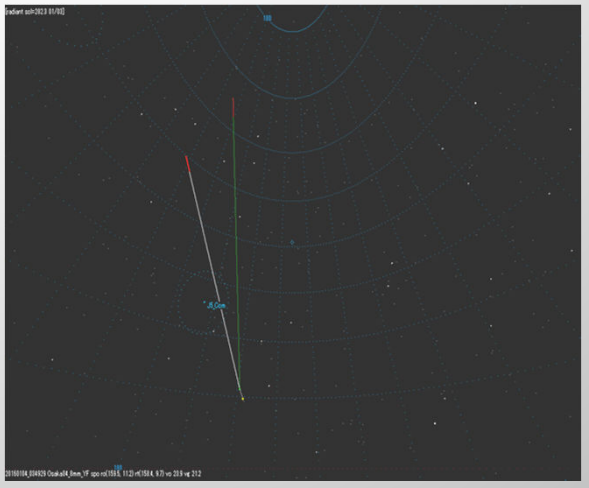
Spectrum of Iron Meteoroids



- Fe I (516.8, 523.3, 526.9, 532.8 nm) lines were clearly resolved. (These spectra were calibrated from these 4 lines)
- Mg I (516.8, 518.2 nm) could not detect in Fe type spectra.
- The spectral shapes of these Fe lines were almost the same in Fe type.

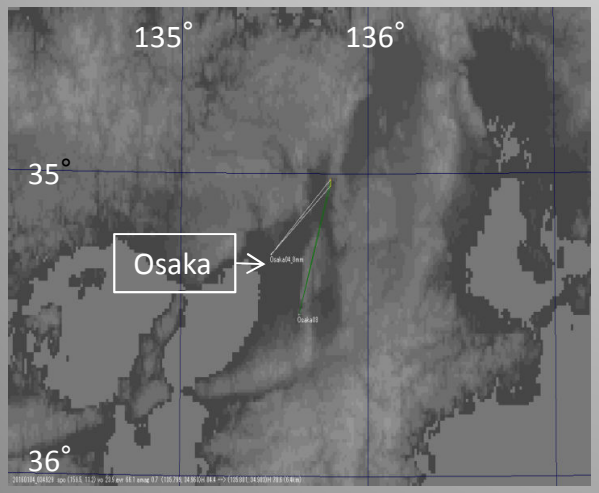
Orbit of Iron Meteoroids

2016 Jan. 4 03:49:29 (JST)

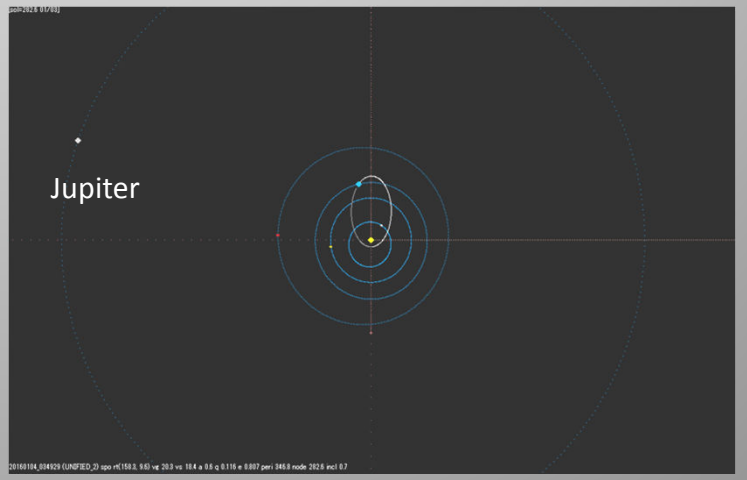


Geocentric Radiant

$\alpha = 153.3^\circ$, $\delta = +9.6^\circ$ Vg=20.3 km s^{-1}



Max. abs. brightness: 0.7 mag.
Beginning height: 84.4 km
Ending height: 78.6 km



Heliocentric Orbit (J2000.0)

a= 0.6, q = 0.116, e = 0.809

$\omega = 346.8^\circ$, $\Omega = 282.6,^\circ$ $i = 0.7^\circ$

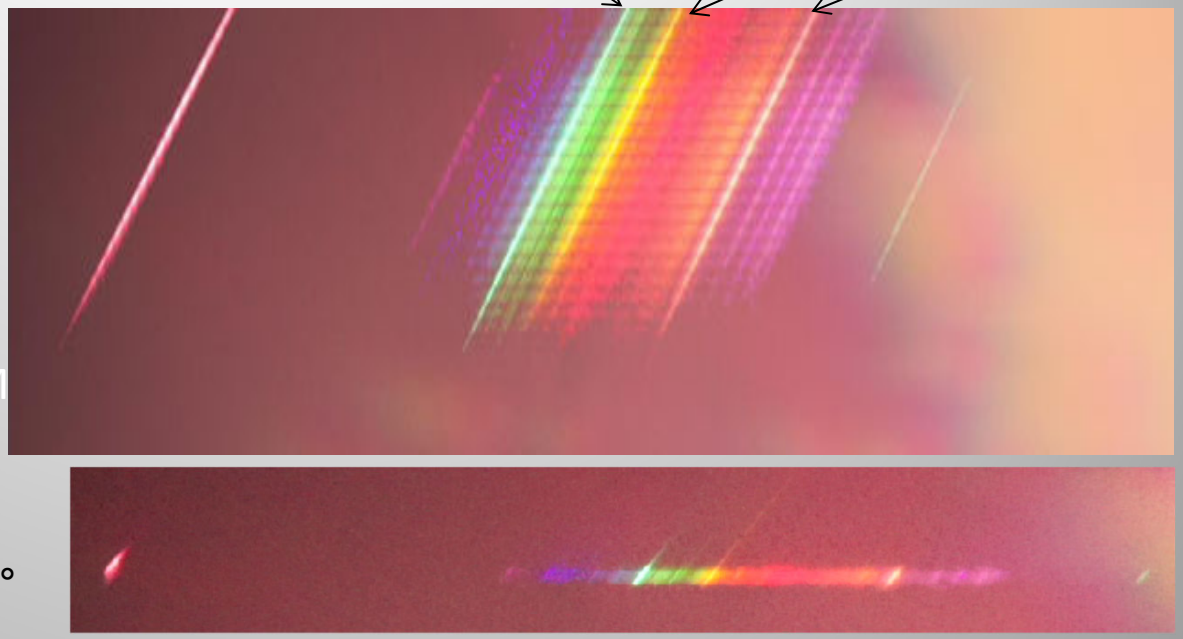
Spectrum & Orbit : December Monocerotids

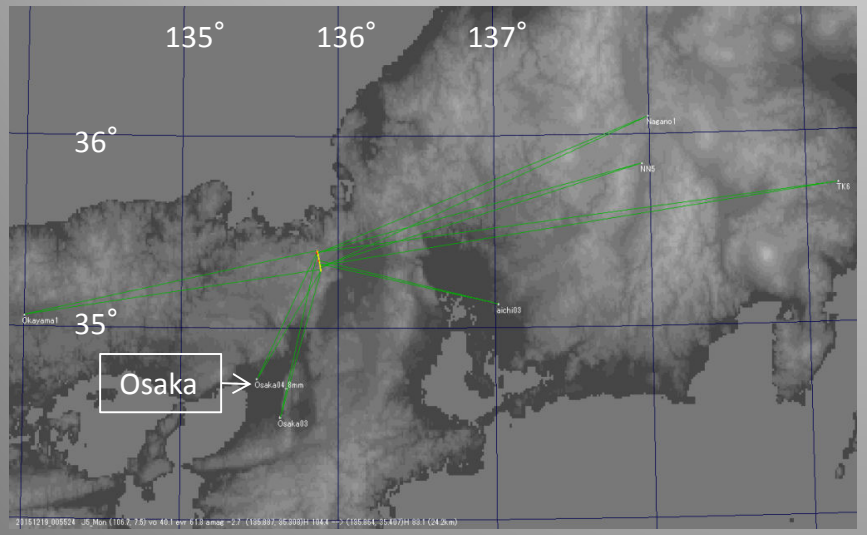
2015 Dec. 19 00:55:20(JST)

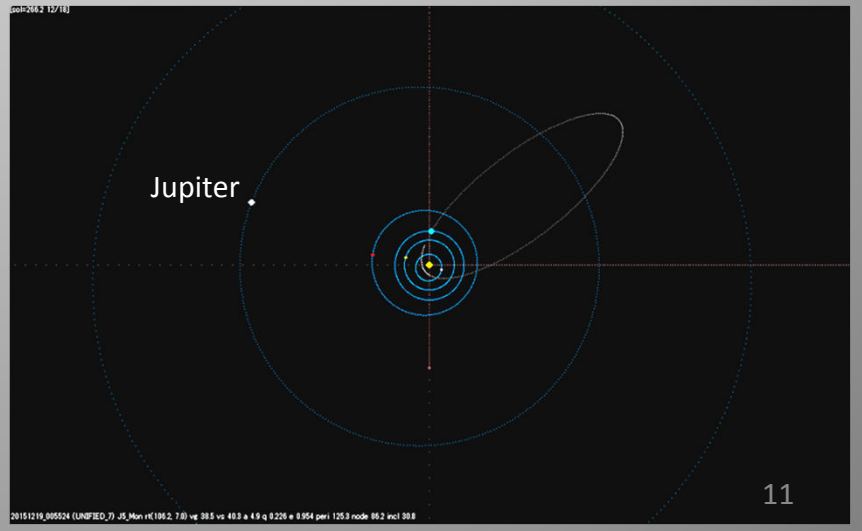
Wake
Mg(517nm),Na(589nm)

Geocentric Radiant
α =106.2˚ , δ = +7.0˚
Vg = 38.5 km s-1

Heliocentric Orbit (J2000.0)
a= 4.9, *q* = 0.226, *e* = 0.954
ω = 125.3˚ , Ω = 86.2,˚ *i* = 30.8˚





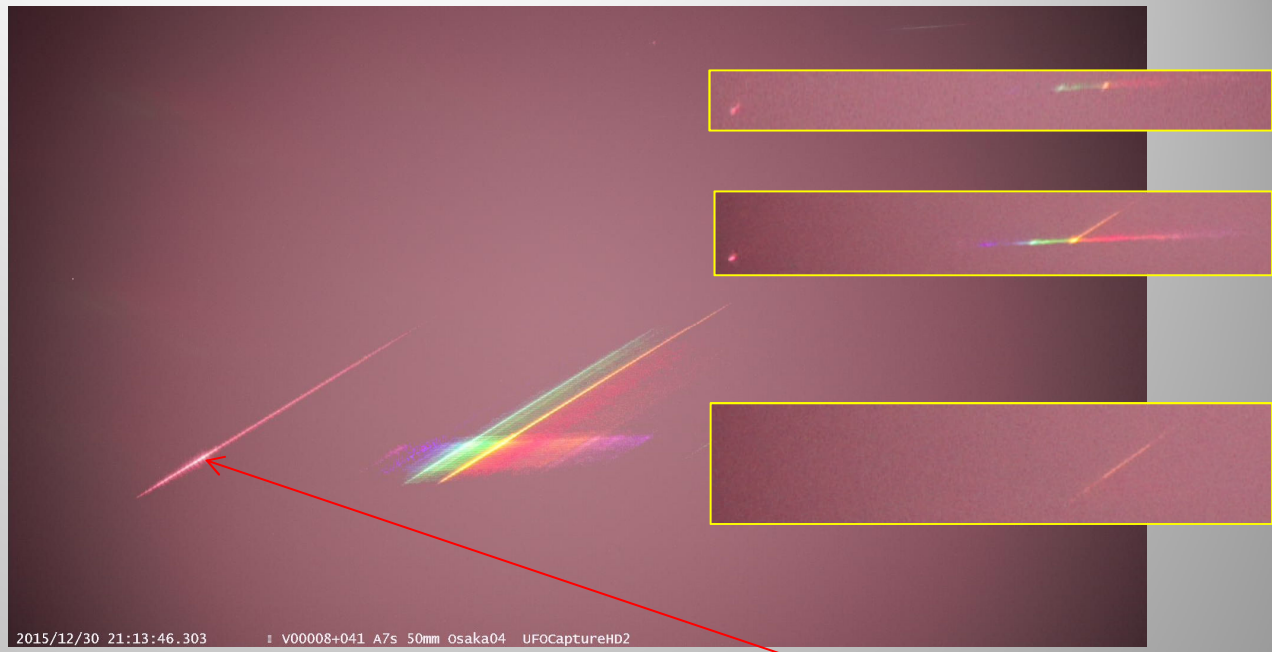


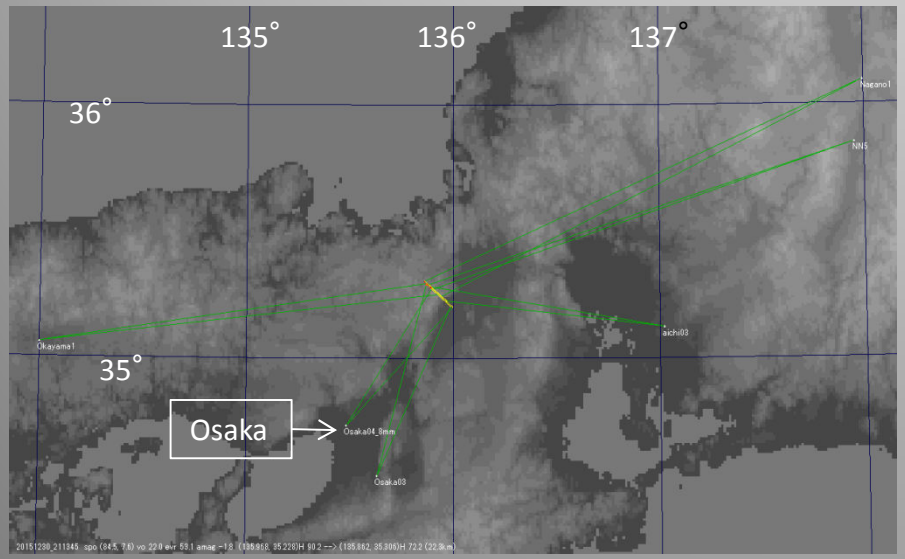
Spectrum & Orbit : Sporadic meteor

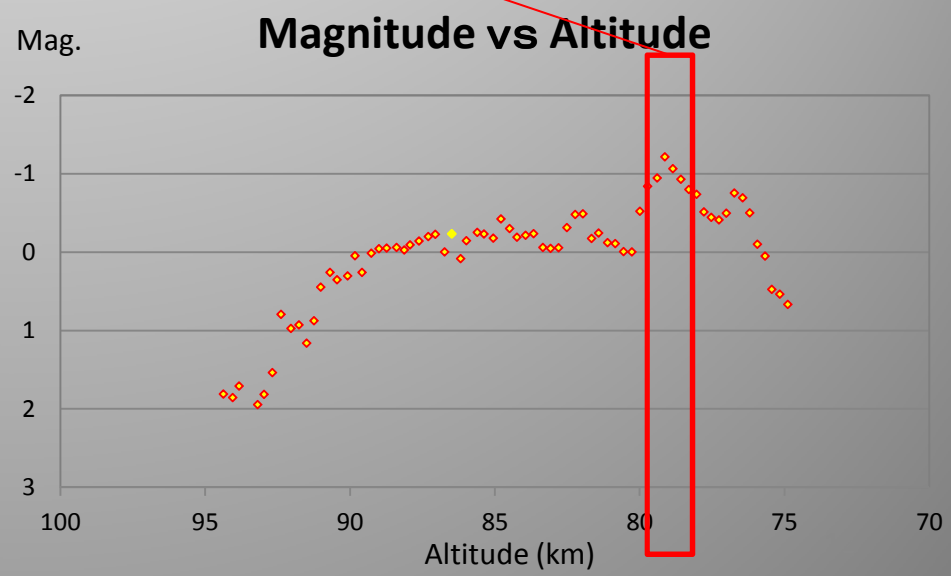
2015 Dec 30 21:13:46(JST)

Geocentric Radiant
$\alpha = 85.6^\circ$, $\delta = +4.7^\circ$
$Vg = 17.5$ km s^{-1}

A persistent emission of Na (589 nm) at peak brightness (altitude ~ 79 km)







Conclusions

- We obtained higher resolution meteor spectra (about 1 nm) than a typical SD video camera system. Fe lines could resolve clearly in 500 nm band.
- Our systems had a potential of getting about 500 spectra per year in a good condition.
- The 90 % of classifiable spectrum belonged to the main stream type spectrum.
- We obtained the meteor spectrum with their heliocentric orbit more than 60 per half year.

Acknowledgment

- We thank Shinsuke Abe for providing his camera and grating.
- We thank the following observers of SonotaCo network for their reports which are essential as determination of meteor orbits : Masayosi Ueda, Sadao Okamoto, Naoya Saito, T. Masuzawa, Hiroshi Kawakami and Junichi Yokomichi.
- We thank Sonota Co and K. Sugawara for numerous helpful advices in setting up our 4K and FHD video observations and analyzing in meteor spectrum.

References

＊3 Basic Astronomical Spectroscopy Software,
https://uk.groups.yahoo.com/neo/groups/astrobodger/info

＊4 Borovička, J., Koten, P., Spurný, P., Boček, J., & Štork, R. 2005, Icarus, 174, 15

＊5 Vojáček, J. Borovička, P. Koten, P. Spurný, and R. Štork, 2015, A&A 580, A67

Abstract

We have carried out the observations of meteor spectra using high-definition video camera systems in Japan and present initial results from the system. The camera, α7s (Sony) has a 35mm full- frame high sensitive CMOS sensor and can be taken a high definition video. It was equipped with 24mm-50mm lens and 300-600 grooves/mm grating. The detection of spectra was done by UFOCaptureHD2 software (SonotaCo). The limiting mag. of meteor spectrum was around magnitude 0. We obtained more than three hundred meteor spectra within partial spectra and classified the main element (Mg, Na, Fe) abundances of meteors.