Ultra-low-resolution spectra of lunar impact flash candidates

月面衝突閃光候補の超低分散スペクトル

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More than 300 lunar impact flashes have been reported. However, nothing on their color or spectra has been observed nor reported, and the source of the flashes is unknown. The radiation from the impact generated high-temperature gas and plasma is discarded, because it lasts only a millisecond whereas many of the observed flashes continue more than 1/60 s. On the other hand, thermal radiations from hot droplets ejected by meteoroid impacts or generated by the condensation of impact vapors are proposed. Spectral observation must shed light on this problem. We report here the first results of our ultra-low-resolution spectral observations.

We made a simple spectral camera by gluing a grating on the cover glass of an image sensor. The spectral resolution is very low because input lights to the grating are not parallel. During the observation on May 1, 2017, a flash was observed by the camera. Its brightness is about 7th in magnitude.

After dark and flat field corrections, the spectral images are compared between the flash and a comparison star whose effective temperature is 4800 K. Approximating that the star radiates as a blackbody, we obtained the spectrum of the flash. It should be mentioned that 100 frames were averaged to obtain the spectrum of the star, whereas the flash appeared only in a single frame. Then, we assume that the spectrum of the flash would be a blackbody one at an appropriate temperature. The best-fit was obtained at 3960 K.

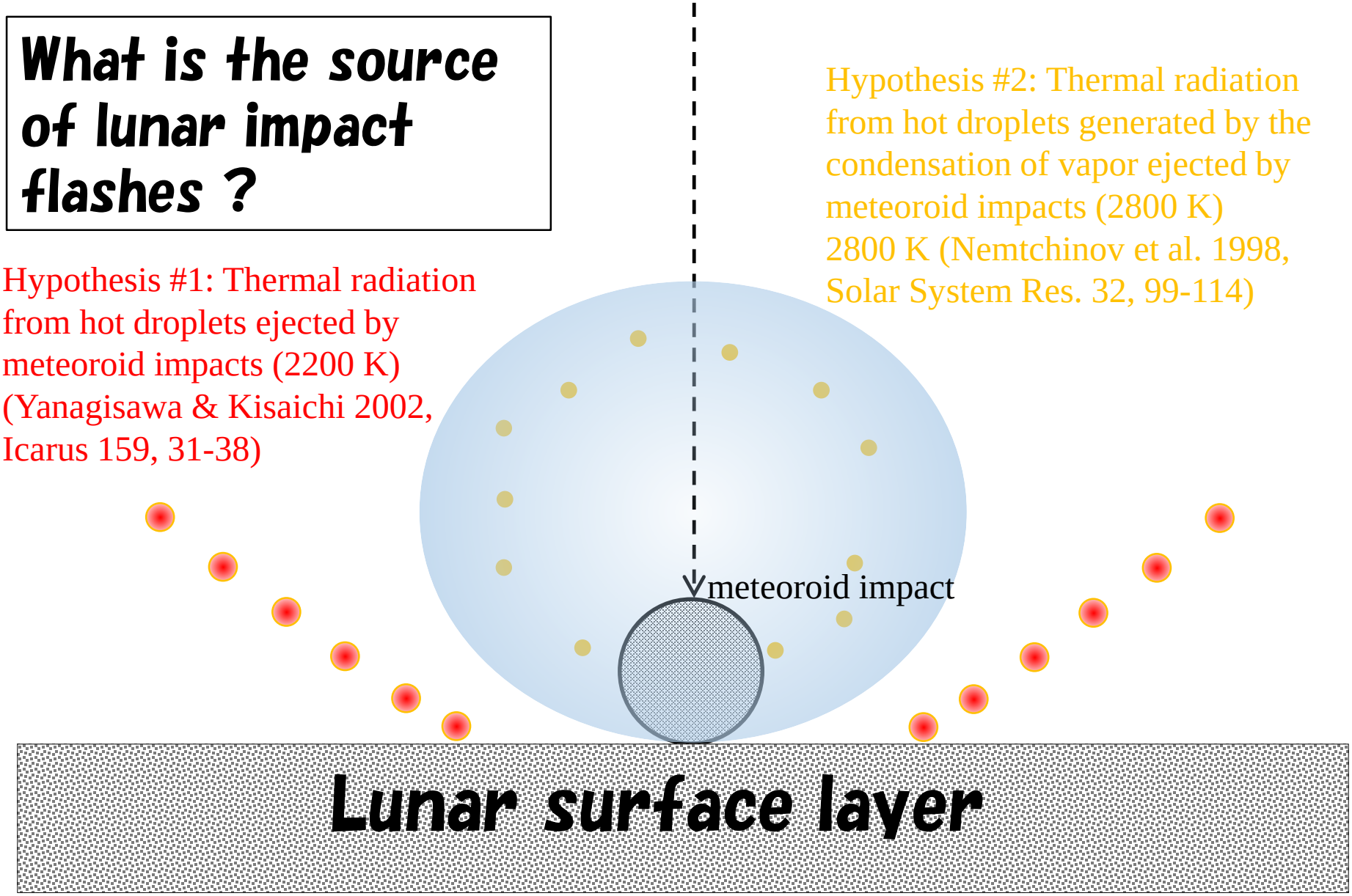
Atmospheric scintillations could affect the obtained temperature. We test this problem as follows. We derived temperatures for each frame of the comparison star. The temperatures should show 4800 K. They varied however quite a lot. This problem must be examined more in detail.

Nevertheless, the flash on Nov. 7, 2016 also observed by the camera was analyzed in the same way and shows 3800 K. The color temperature obtained for one of the 2007 Geminids lunar flashes by a two color observation also shows 4400 K for the initial phase of the flash. These findings suggest that the spectra of lunar impact flashes could be well approximated by a blackbody spectrum of about 4000 K.

What is the source of lunar impact flashes ?

Hypothesis #1: Thermal radiation from hot droplets ejected by meteoroid impacts (2200 K) (Yanagisawa & Kisaichi 2002, Icarus 159, 31-38)

Hypothesis #2: Thermal radiation from hot droplets generated by the condensation of vapor ejected by meteoroid impacts (2800 K)
2800 K (Nemtchinov et al. 1998, Solar System Res. 32, 99-114)

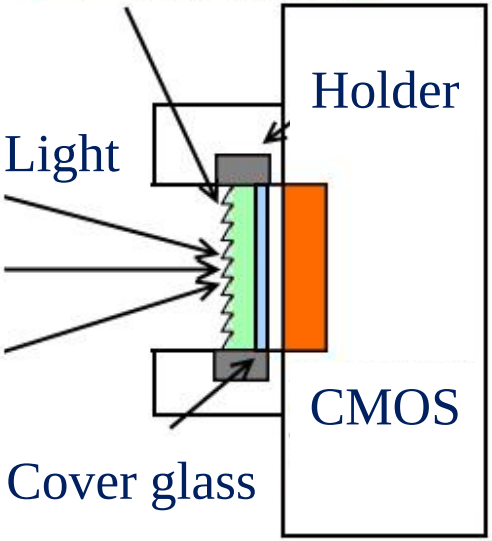


Newton
D = 450 mm
f = 2025 mm

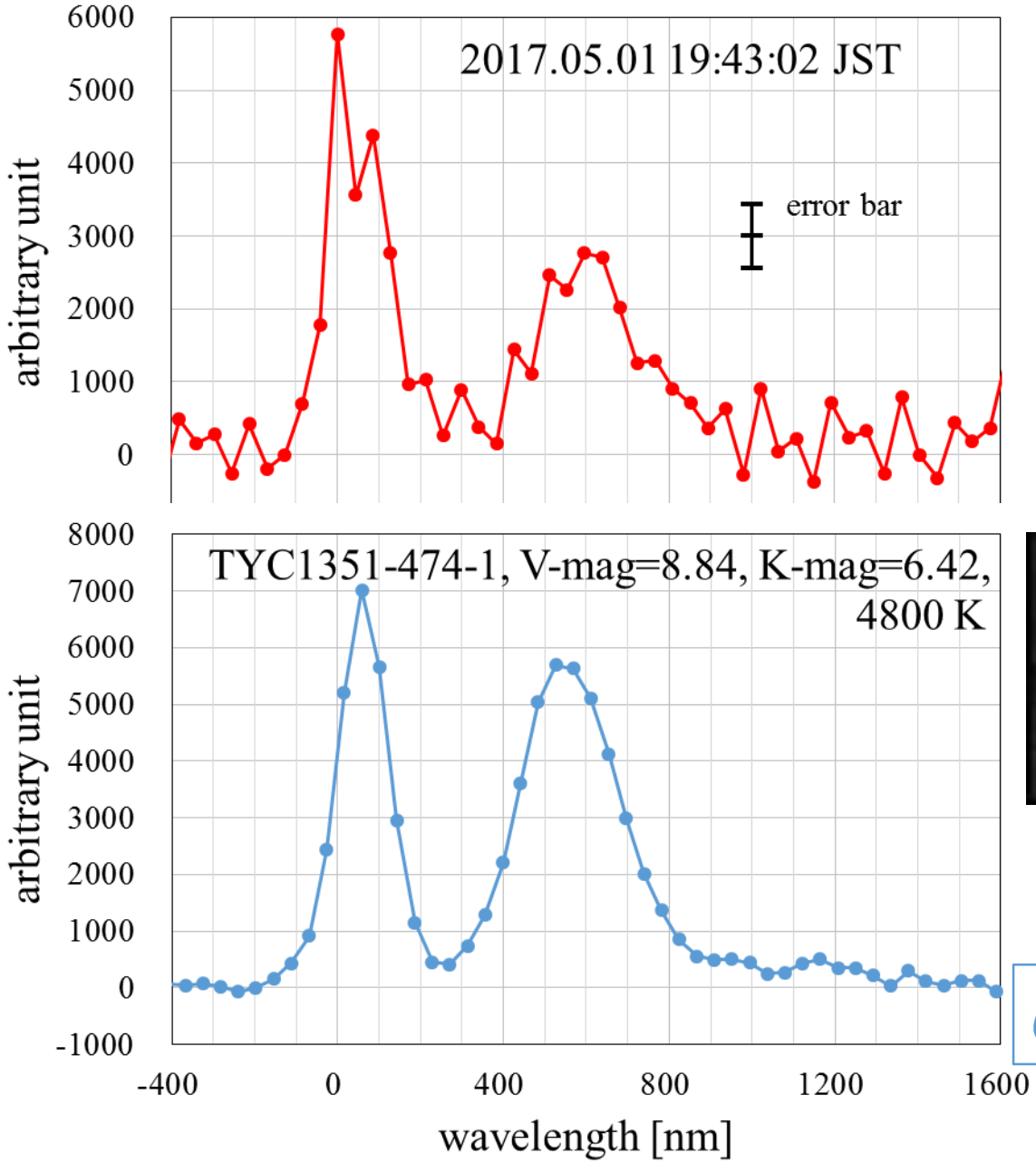
CMOS 11 mm x 7 mm
(1920 x 1200)

ASI174MM (ZWO)

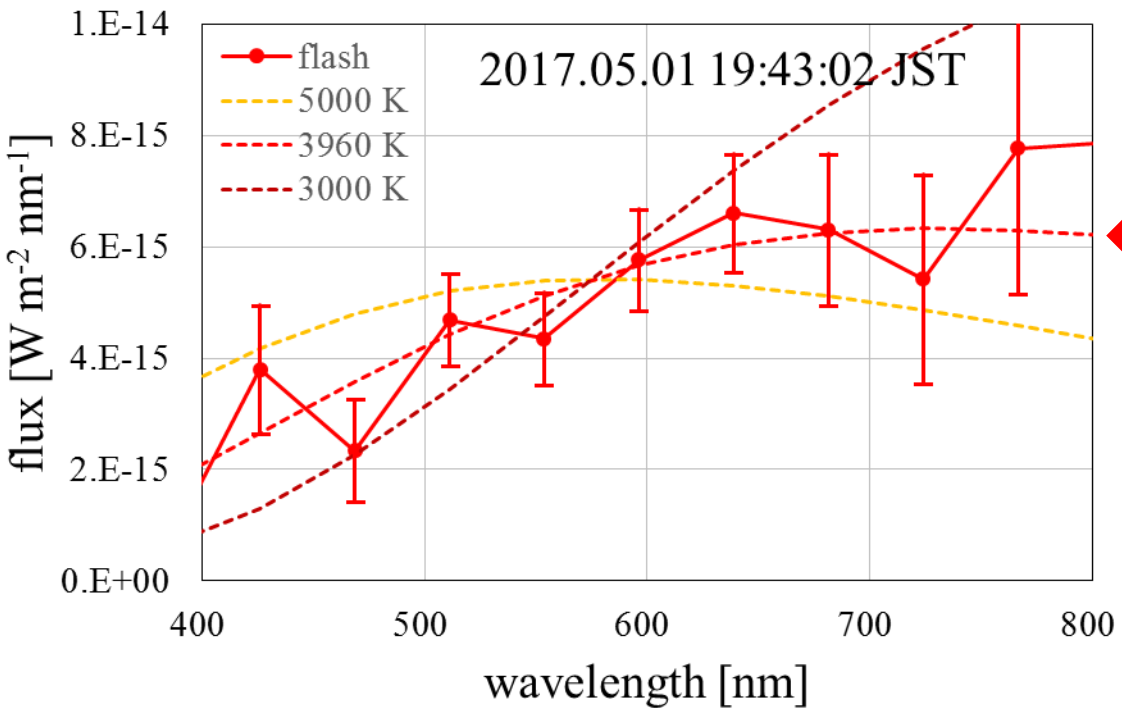
Blazed grating
70 grooves/mm



A lunar flash candidate recorded by the spectral camera
Mai 1, 2017 10:43:01 (UT) at Univ. Electro-Comm. (Tokyo, JAPAN)
50 frames/s
Brightness: about 7th in magnitude



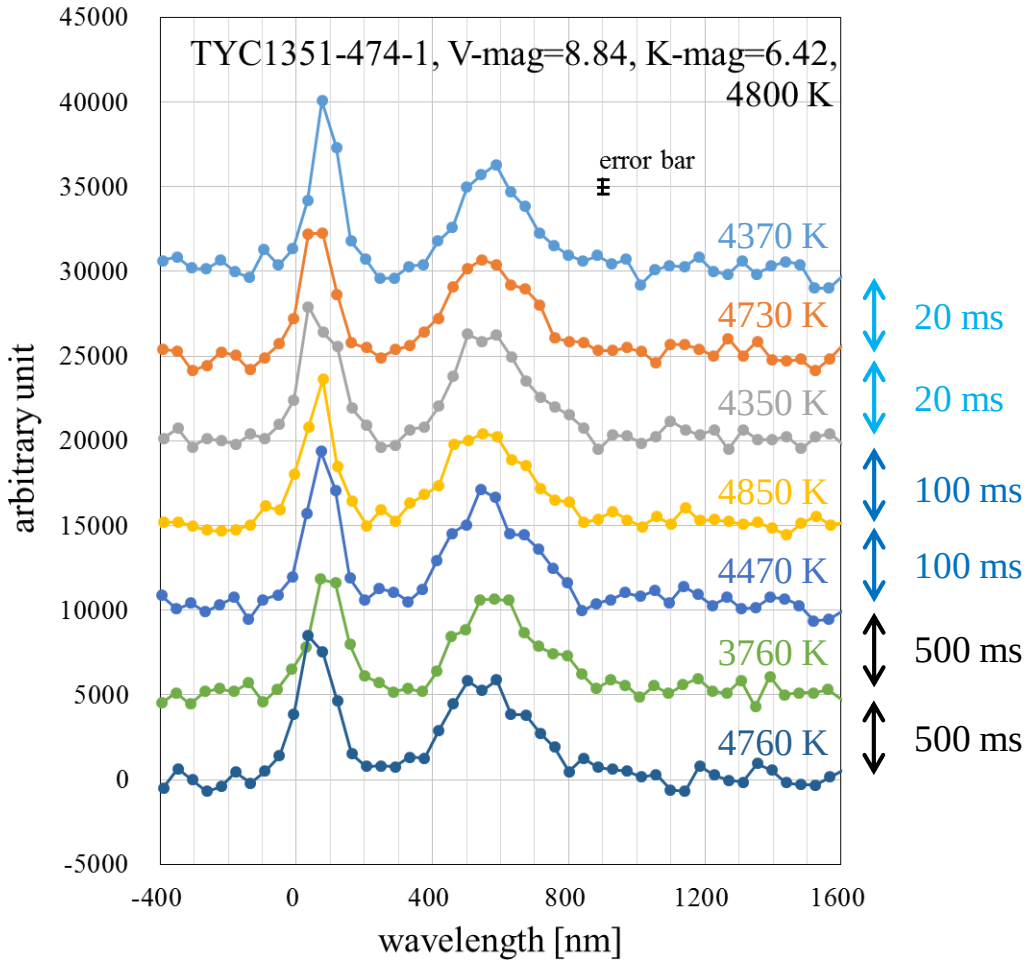
Blackbody temperature



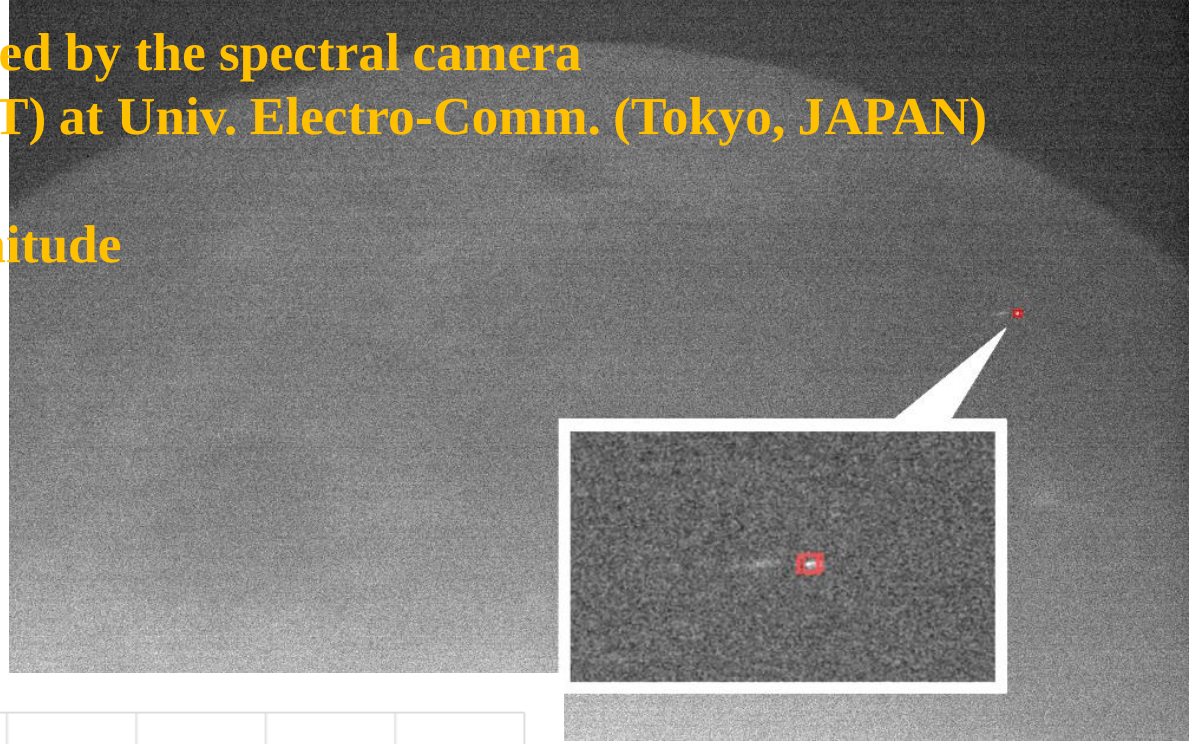
Best fit

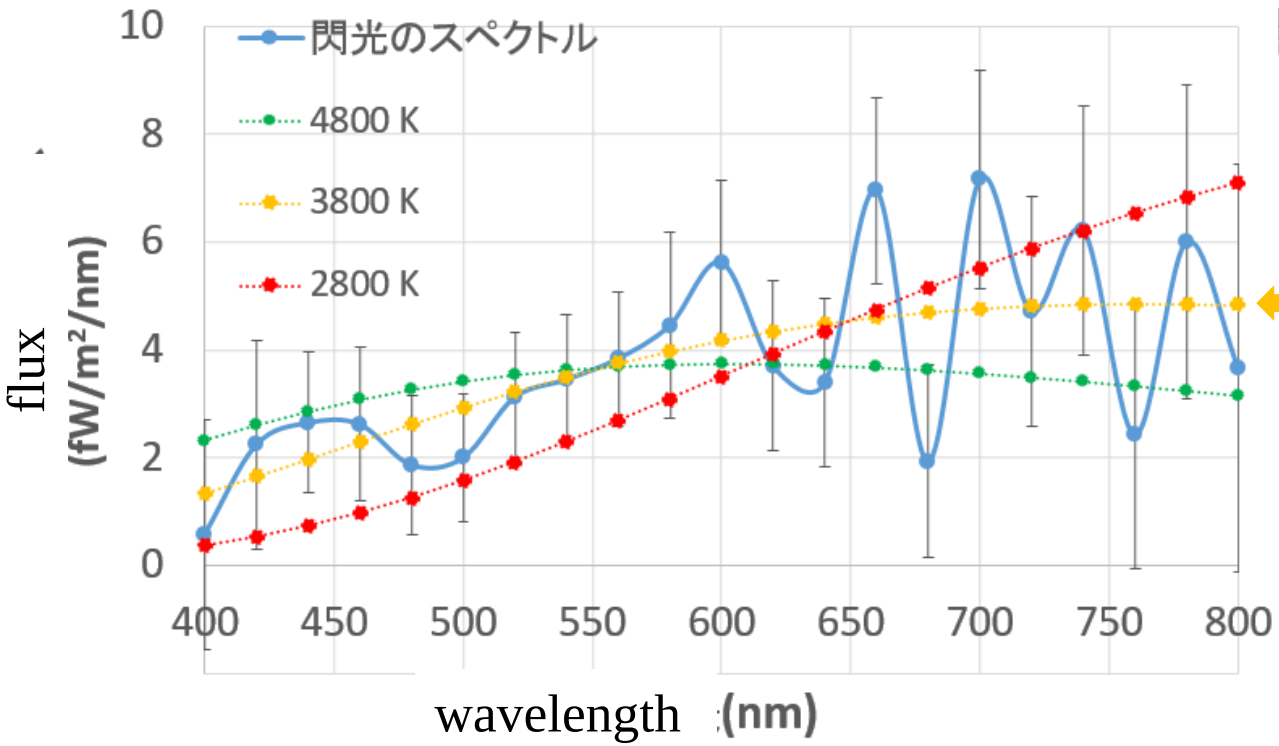
← 3960 K

Effect of atmospheric sintillation

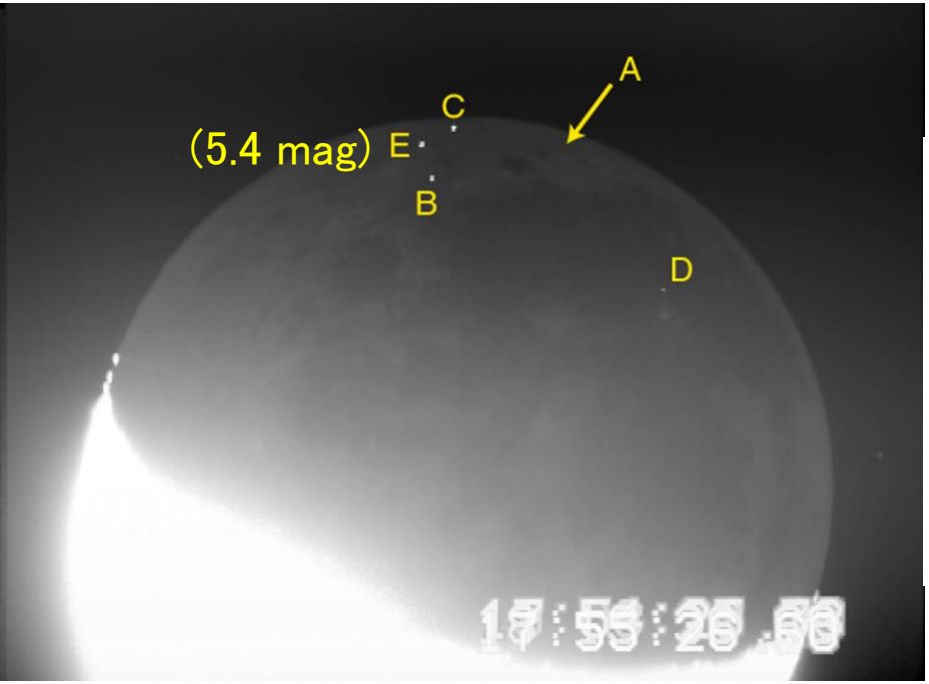


A lunar flash candidate recorded by the spectral camera
Novembre 7, 2016 10:15:54 (UT) at Univ. Electro-Comm. (Tokyo, JAPAN)
50 frames/s
Brightness: about 10th in magnitude



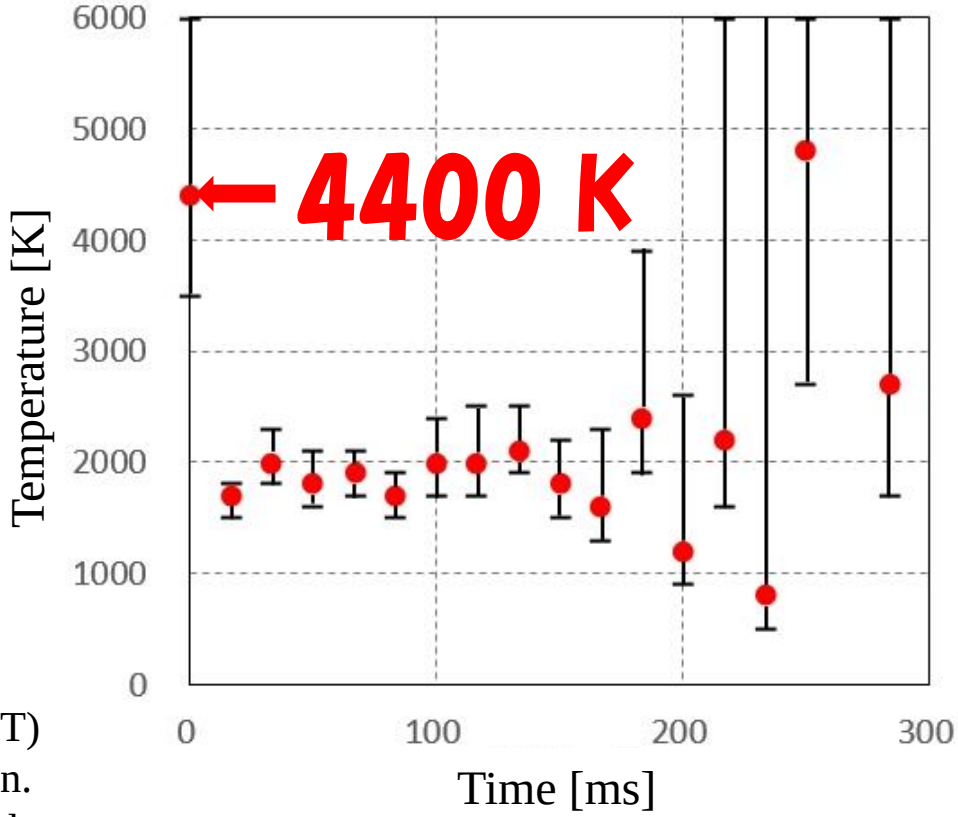


Best fit
← 3800 K



Five lunar impact flashes observed on 2007.12.15 (JST) from the Univ. Electro-Communications, Tokyo, Japan. They would be associated with the Geminid meteoroid stream.

Temporal variation of the color temperature of Flash E



Reference: Yanagisawa 2015, Workshop on planetary impact phenomena 2015, Hokkaido University.

Summary

1. Ultra-low-resolution spectra (20 nm/pixel) of lunar impact flash candidates were obtained by a handmade spectral camera.
2. Preliminary results are consistent with the 4000 K blackbody radiation.