Radiation mechanism of the Chelyabinsk superbolide

*Masahisa Yanagisawa[1]

1.The University of Electro-Communications

On Feb. 15, 2013, a meteoroid with a size of about 19 m plunged into the terrestrial atmosphere at 19 km s^{-1} and burst at an altitude of about 30 km over the city of Chelyabinsk, Russia. Here we present light curves for the bolide in the red, green, and blue color bands, derived from an analysis of a video that was recorded by a dashboard camera and released on the Internet (Fig. 1). Our results demonstrate that the bolide was blue-green in color, which is inconsistent with the Planck spectrum before the meteor began to fragment. Fragmentation triggered a flare-up of the bolide and 90% of its radiation energy at optical wavelengths was released within a period of about 2 s after that. During the same period, the brightness ratios among the three bands became consistent with 4000 K blackbody radiation. Based on the peak luminosity, a surface area of several square kilometers would be required for a 4000 K blackbody. It is considered that the radiation source of the bolide was an elongated cloud of vapor and debris produced through severe fragmentation of the meteor.

Reference: M. Yanagisawa, Radiative characteristics of the Chelyabinsk superbolide, Planetary and Space Science., 118C, 79-89, 2015.

Figure 1. (a) Bandpass photometric intensities for the Chelyabinsk bolide plotted as functions of the bolide altitude. The thick, thin, and dotted lines respectively show the intensities in the R, G, and B bands. The black triangles indicate the altitudes at which meteor fragmentation occurred, with the upper two triangles corresponding to severe fragmentation events. (b) Color temperatures for the bolide as functions of altitude. The thick, thin, and dotted lines show the temperatures based on the R/G, G/B, and R/B intensity ratios, respectively. The error is expected to be about ± 400 K.

Keywords: Chelyabinsk, bolide, fireball, meteor, meteoroid, hazard