

The brightness and the color temperature of the Chelyabinsk bolide

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The bolide explosion on Feb. 15, 2013 over Chelyabinsk, Russia was the next most violent to the probable bolide explosion in Tunguska, Siberia in 1908. It was recorded by many dashboard movie cameras in a wide area around the city, and the movies are released on the Internet. We analyzed one of them and obtained the lightcurves of the bolide for three colors (see the figure for the temporal variations of the brightness). More than 95% of the radiant energy in the visible wavelengths was released in its flare-up for about 2 seconds. The luminosity ratios among the R (red), G (green), and B (blue) color bands are consistent with the 3500 K black-body radiation during the flare, while the pre-flare bolide was greenish-blue in color and the ratios do not agree to the black-body spectra. The maximum luminosity was 1.0×10^{15} W. The impact energy is estimated to be 1.9×10^{15} J or 450 kton in TNT equivalent ($1 \text{ kton} = 4.185 \times 10^{12}$ J), based on an empirical formula for the radiant efficiency of bolides. The lightcurves and the impact energy almost agree to the results reported thus far.

Figure caption: Temporal variations of the source luminosities of the bolide in logarithmic scales. The thick (red), dotted (green), and thin (blue) lines correspond to the RGB color bands. The calculated intensities are negative in the periods without plot. The vertical scale on the right side shows the luminosity integrated over the wavelengths assuming 3500 K black body radiation. Seconds of 3:20 on Feb. 15, 2013 (UT) are shown in abscissa.

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