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Question 1: Plowing Snow; Question 2: Wasted Food

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Fig. 4. An image of the 735-nm LED in the now discontinued Alta-II Reflectance Spectrometer. Note the bright red color.

purple color of digitally imaged infrared LEDs and the observed Paschen lines of hydrogen.⁶

Students can investigate the differences in infrared transmission by the different color filters for themselves. This can be achieved by imaging a remote LED with their own cell phone

camera and then using a free software for image analysis. SalsaJ, free astronomical imaging software for analysis of JPEG images, is an excellent choice for such a project because it is student friendly and well documented.⁷

Figure 1 is a close-up of the remote control's infrared LED bulb. When opened in SalsaJ, we can employ the "RGB split" function to separate the channel into three color images: red, green, and blue. As seen in Fig. 2, the infrared LED imaged in the green channel is not nearly as bright as the red and blue channels. SalsaJ also has a photometry feature that allows a user to plot pixel intensities in a selected region of an image. Figure 3 displays the pixel intensities for the infrared LED in each color. The red and blue intensities are nearly identical while that of green is about 60% of the intensity of the other two channels. All of this is consistent with the discussion immediately above.

The final question, "Do all infrared sources appear purple

when imaged with a digital camera?" can be answered in one of two ways. The easiest method is to examine the spectral response plot: wavelengths of infrared between 700 and 800 nm should appear red since the red spectral response dominates in this region. Another method is to examine the infrared emission of an LED with a wavelength between 700 and 800 nm. You could purchase a single 5-mm infrared LED with a wavelength of 720 nm for about \$7; however, you will need to build a simple circuit.⁸ Alternatively, if you happen to own an Alta-II Reflectance Spectrometer,⁹ you have access to four infrared LEDs: 735, 810, 880, and 940 nm. When you image the 735-nm LED it glows red, as in Fig. 4, while the others are all purple when imaged.

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Fermi Questions

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► Question 1: Plowing snow

How much snow is shoveled or plowed in the U.S. in a typical winter?

► Question 2: Wasted food

How much food is wasted at school cafeterias every year in the U.S.?

Look for the answers online at tpt.aapt.org under "Browse," at the very end of the current issue.

Question suggestions are always welcome!

For more Fermi questions and answers, see *Guesstimation 2.0: Solving Today's Problems on the Back of a Napkin*, by Lawrence Weinstein (Princeton University Press, 2012).

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