Photometry of Celestial Fireballs

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Introduction

To protect space endeavors, more information is needed about meteoroid population distribution. We created a portable all-sky camera system that can potentially increase the amount of meteor data astronomers can collect. The first step is showing that our photometric data is just as accurate as other systems.

Objectives

- Create a program that can analyze photometric data from meteor video
- Test program against events with previously established light curves to test its validity
- Run program on events captured by our all-sky camera.

Our All-Sky Camera

Figure 1:The programs saves this plot for every frame.

Mathematical Methods

The photometric data we can extract from our camera is its pixel values, an uncalibrated measure of **intensity**. We use Equation 1 to turn that into an uncalibrated **magnitude**. We also apply Equation 1 on a star in that sky with a known magnitude in order to calibrate our camera.

$$m = -2.5\log(I) \tag{1}$$

From intensity, we can extrapolate out to get the object's total **luminosity**. We can then relate the luminosity of the event to its total **kinetic energy** to find its **mass** through integration of its light curve,

$$L = \tau \frac{v^1}{2} \frac{dM}{dt} \tag{2}$$

Computational Methods

Frame Data

Figure 2:The programs saves this plot for every frame.

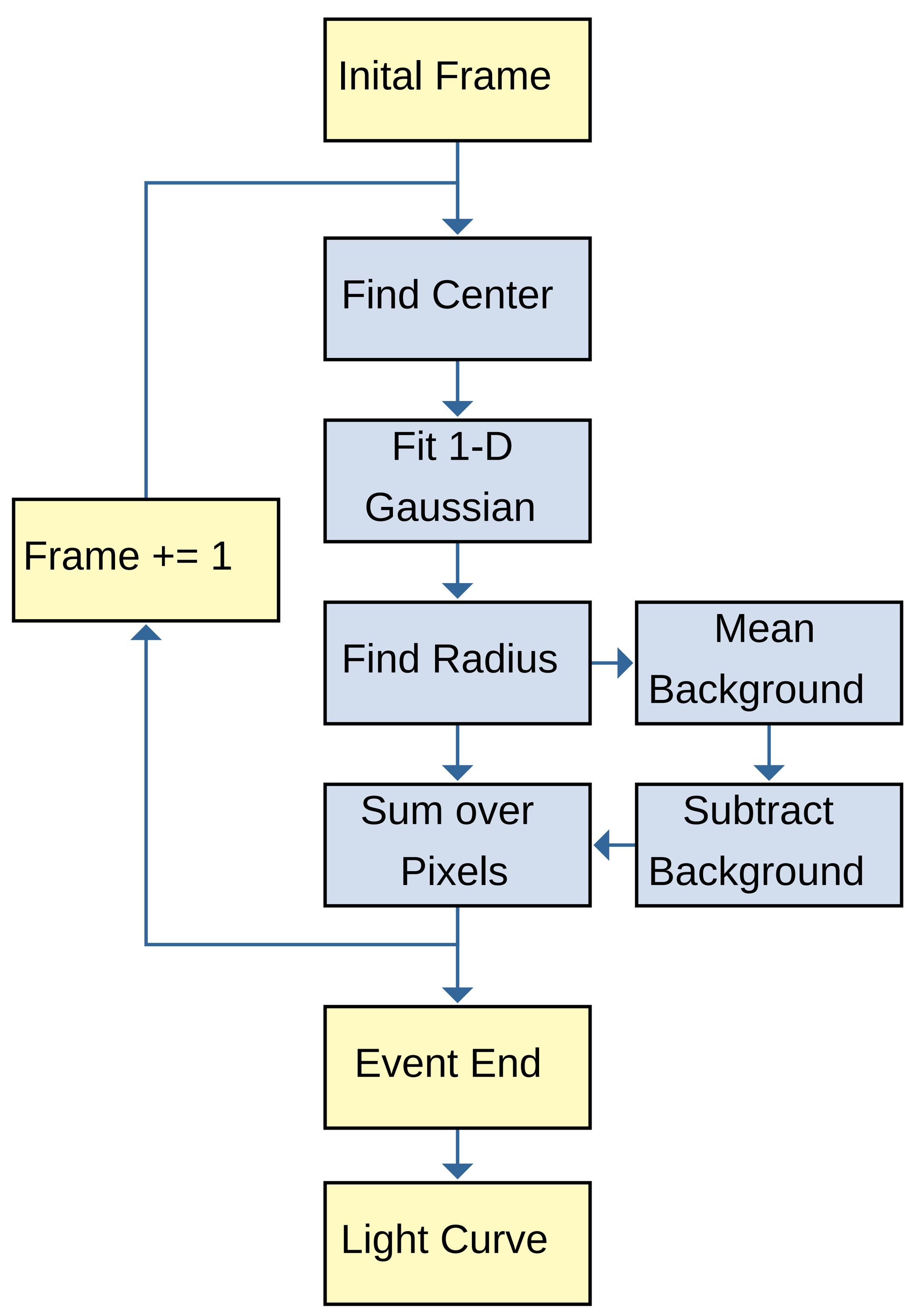

Figure 3:The programs saves this plot for every frame.

Frame Data

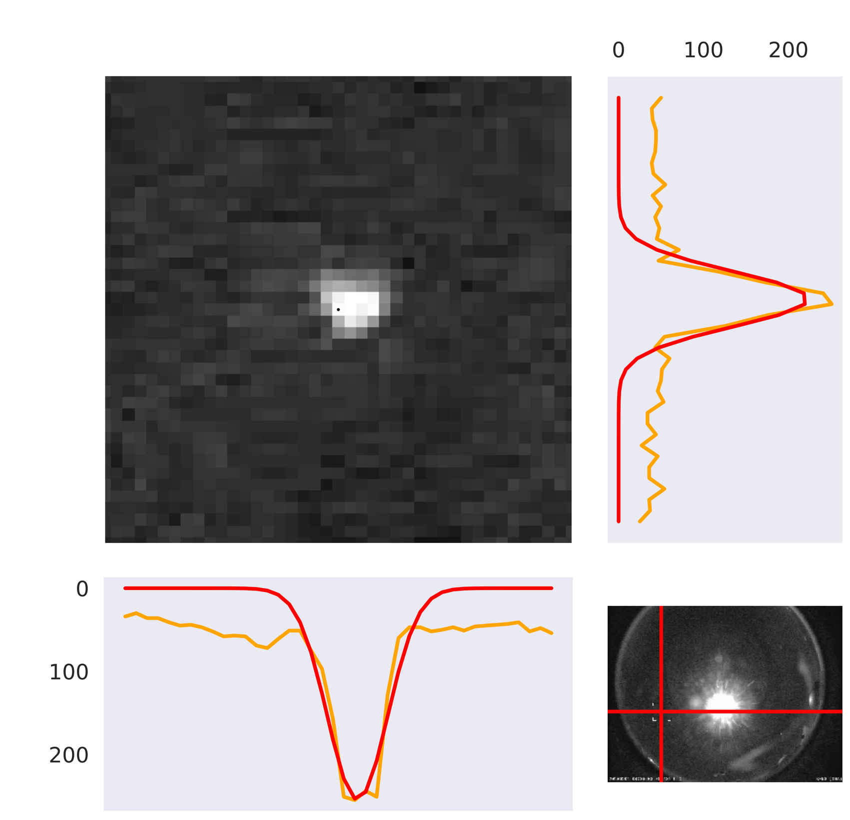

Figure 4:The programs saves this plot for every frame.

Results

The first object to test the program on was an iridium flare. They're good psuedo-meteors as their times are easily predictable and they have known magnitudes to compare to.

Iridium Flare

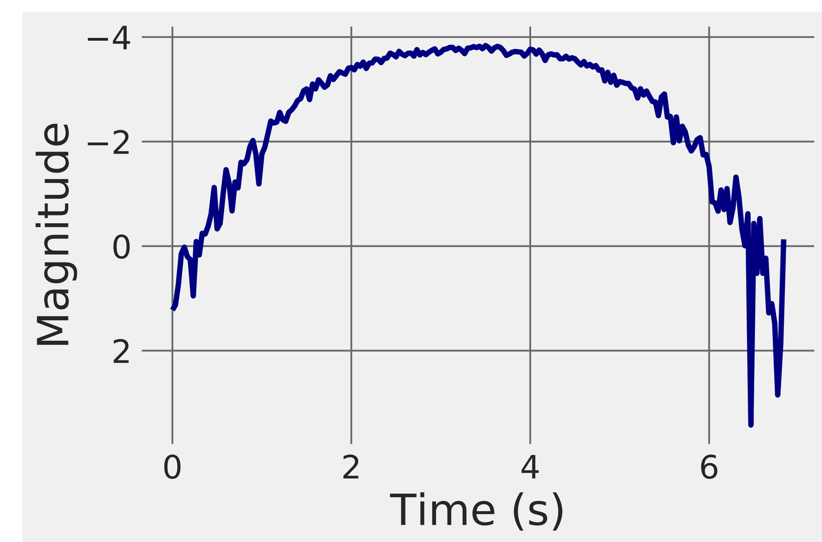

Figure 5:The iridium flare data matches quantitatively with the event, but a reference star couldn't be identified during the event, so calibration was not possible

The program was than ran on meteor events collected on NASA's all-sky network. NASA posts their uncalibrated light curves along with the videos, allowing easy comparison of light curves. This was done multiple times, each time providing solid evidence that the program was working correctly. An example of this can be in Figure 3.

The last step was to test the program on a fireball video detected by our own all-sky camera unit. Our all-sky camera unit's operating system is currently under repairs, so we only had old data, with a slower processor. This may possibly explain why the light curve in equation 4 looks so noisy, and is confirmed in the plot data of the event.

Meteors

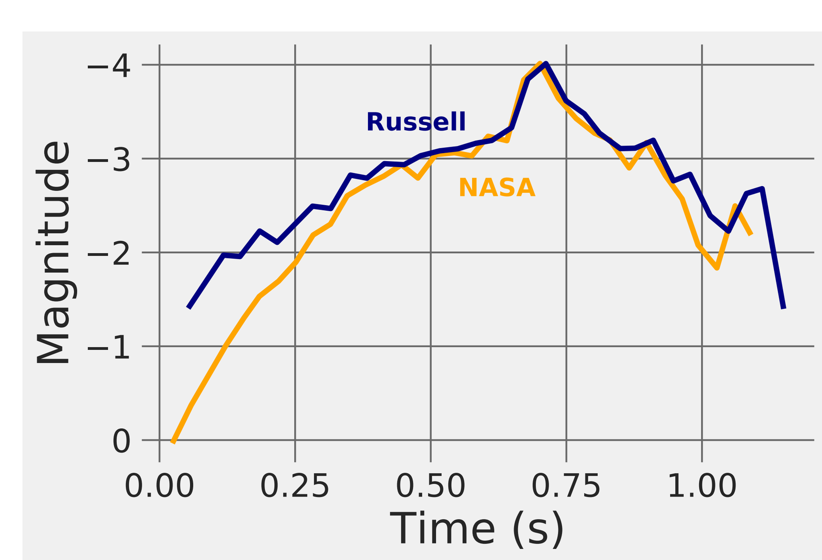

Figure 6:The light curves match well, except at the beginning. This may be due to unaccounted parameters such as atmospheric extinction

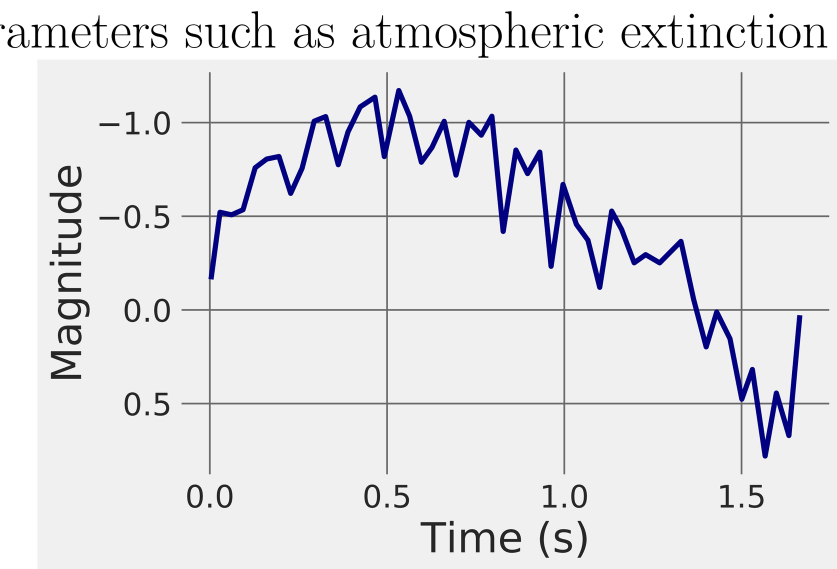

Figure 7:The light curves is noisy. Ideally, the peaks and valleys wouldn't be so apparent, but the general trend supports the success of the pho-