

# **PHOTOMETRY OF CELESTIAL FIREBALLS**

Luke Galbraith Russell • Willamette University

# SATELLITES IN ORBIT

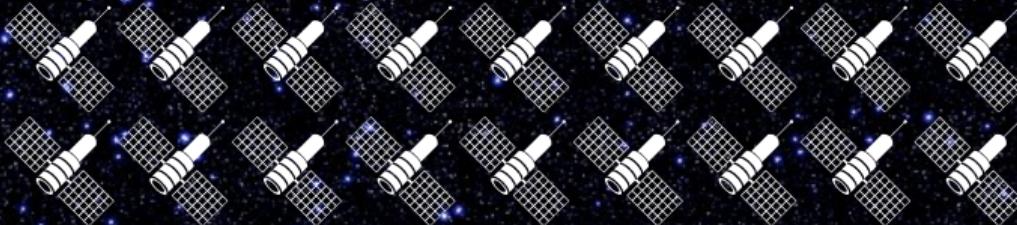
2006



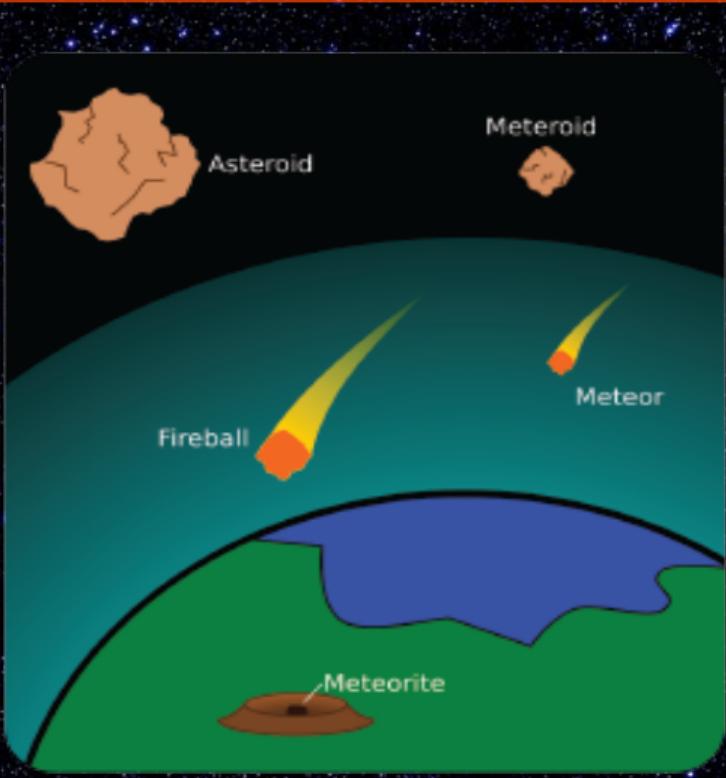
2017



2022



# NEAR-EARTH OBJECTS



**large rock in orbit**



**small rock in orbit**

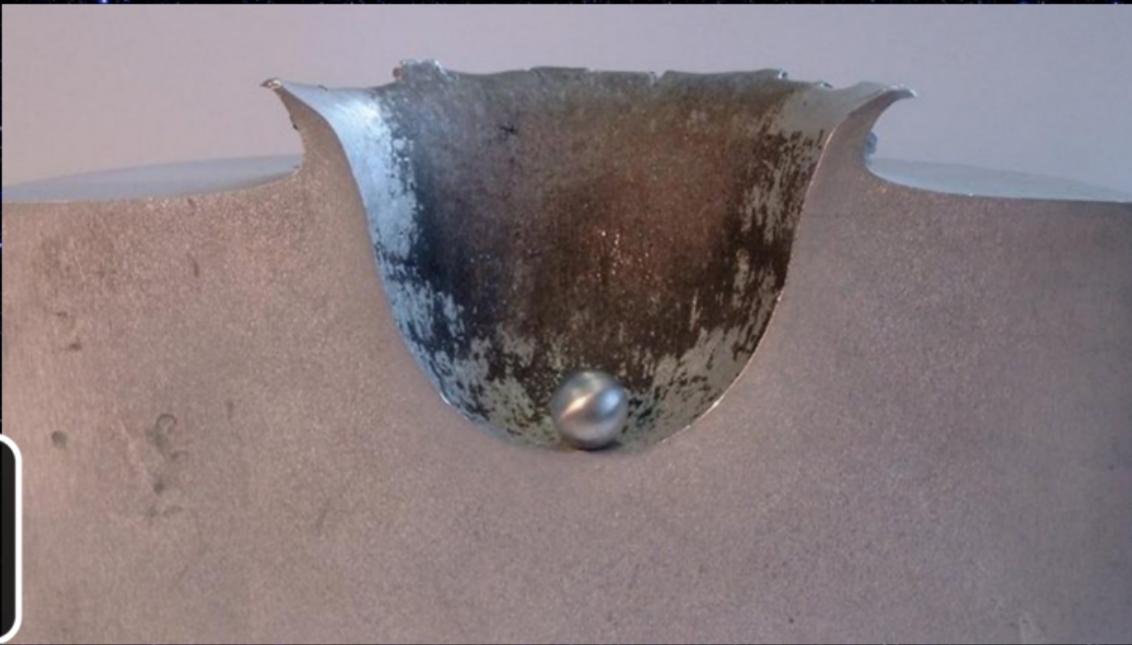


**small rock  
entering atmosphere**



**large rock  
entering atmosphere**

# NEAR-EARTH OBJECTS



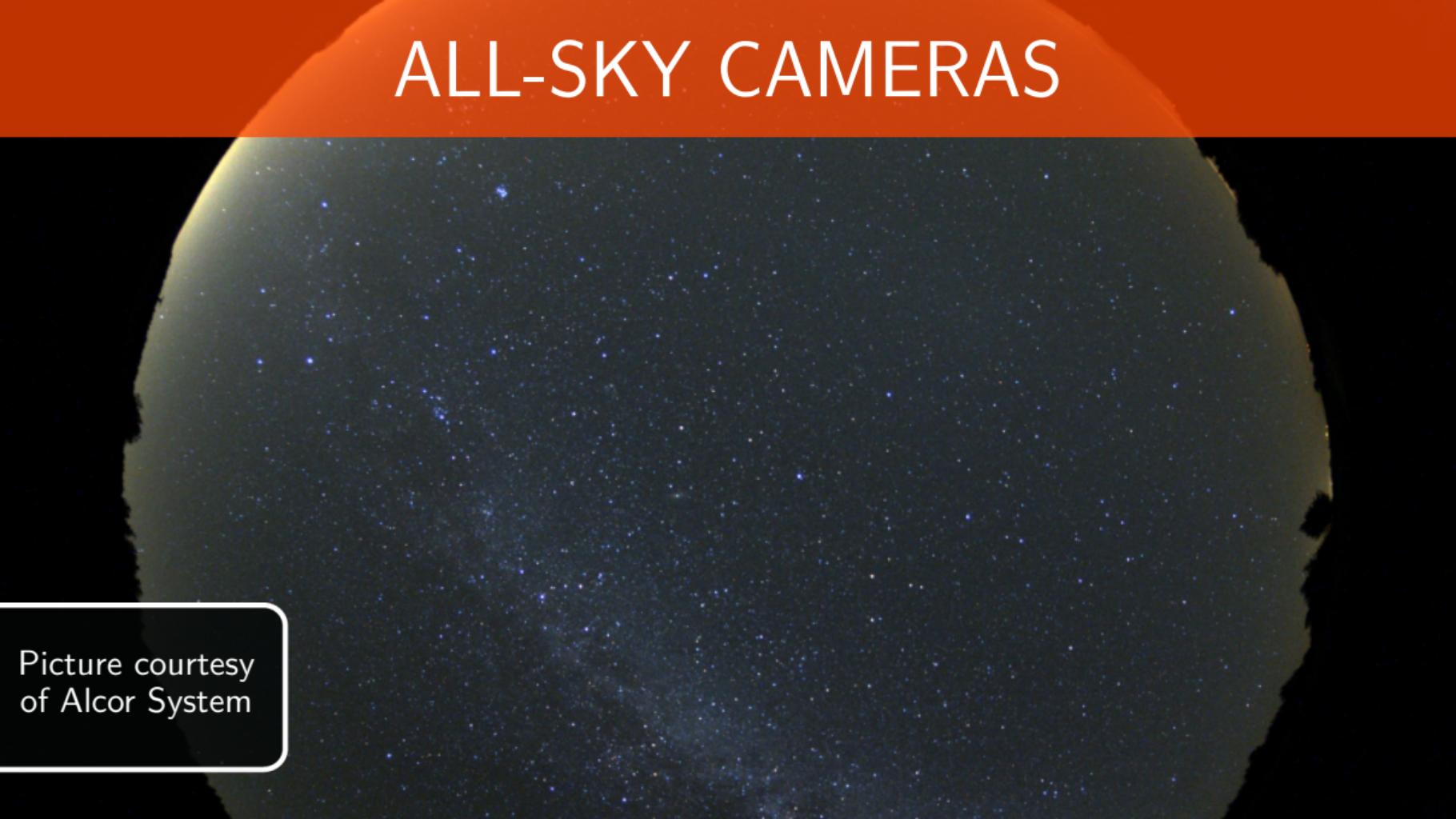
Picture courtesy  
of ESA

# ALL-SKY CAMERAS



Picture courtesy  
of Alcor System

# ALL-SKY CAMERAS



Picture courtesy  
of Alcor System

# OUR ALL-SKY CAMERA



Picture courtesy  
of SBIG

# FROM BRIGHTNESS TO MASS



$$m = -2.5 \log(I)$$



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



$$M = \int \frac{2L}{\tau v^2} dt$$

# FROM BRIGHTNESS TO MASS



$$m = -2.5 \log(I)$$

$m$  = magnitude

$I$  = sum of object's pixel values



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



$$M = \int \frac{2L}{\tau v^2} dt$$

# FROM BRIGHTNESS TO MASS



$$m = -2.5 \log(I)$$

$m$  = magnitude

$I$  = sum of object's pixel values

$L$  = luminosity

$v$  = velocity

$M$  = mass

$\tau$  = luminous efficiency

$t$  = time

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



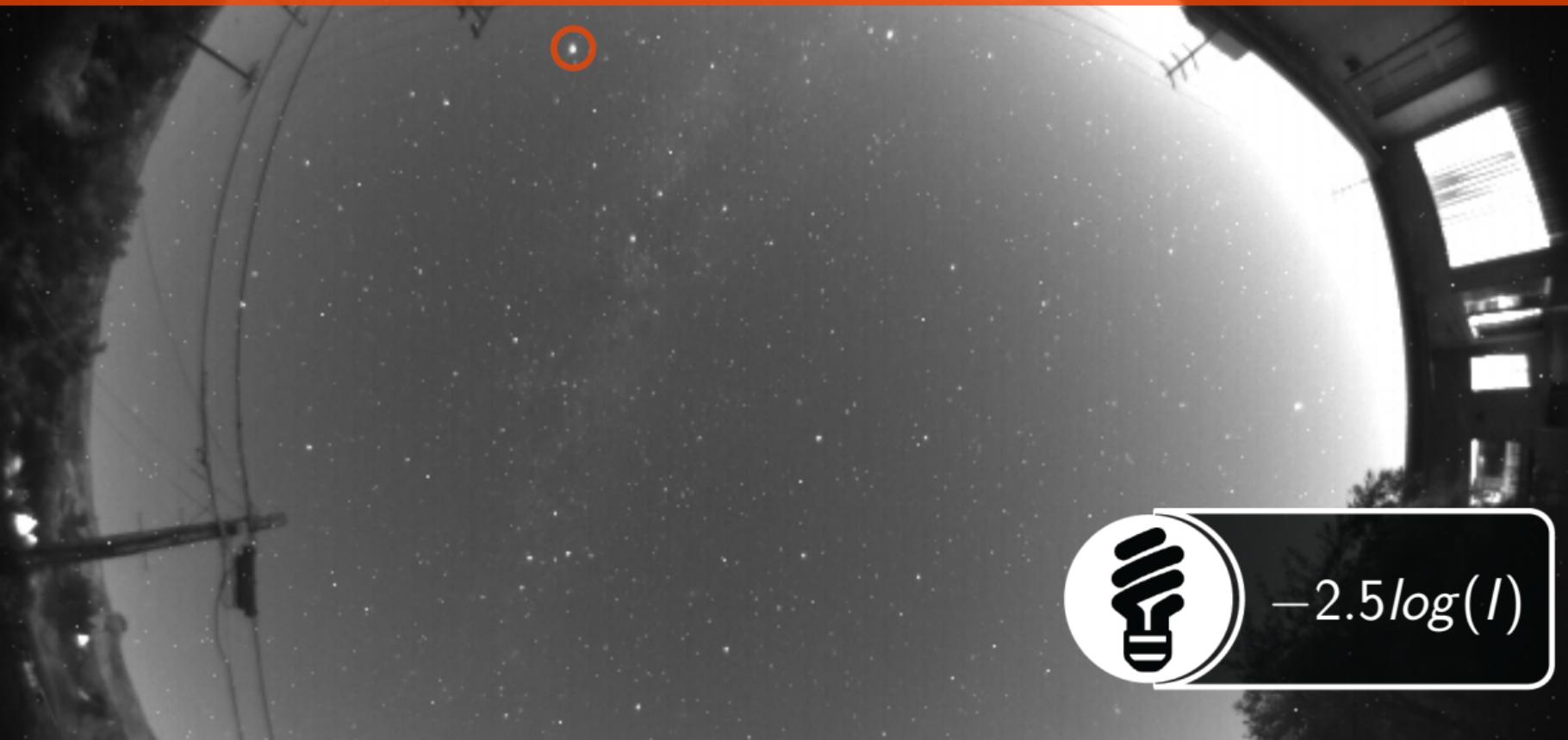
$$M = \int \frac{2L}{\tau v^2} dt$$

# DETERMINING MAGNITUDE



$$-2.5 \log(I)$$

# DETERMINING MAGNITUDE



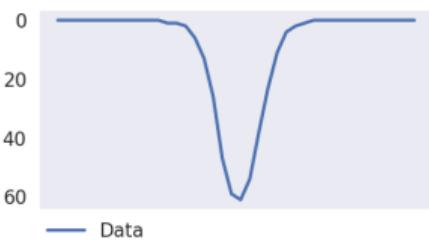
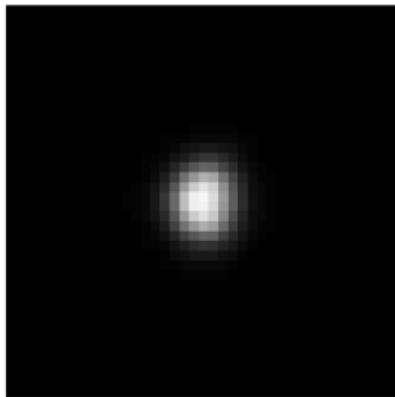
$$-2.5 \log(I)$$

# DETERMINING MAGNITUDE

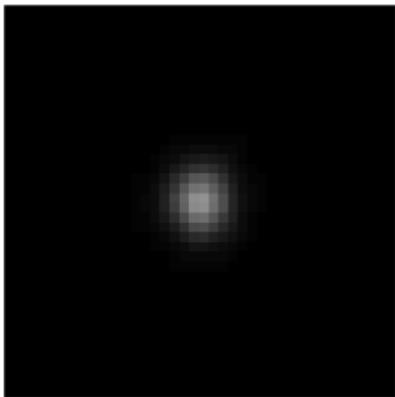


# RAW DATA

Reference Star



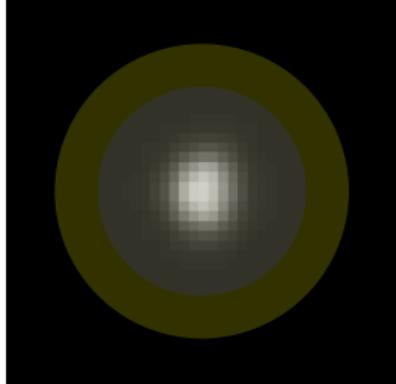
Object



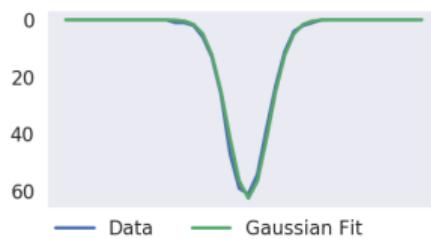
# PHOTOMETRIC VALUES

Reference Star

Magnitude of 2.0

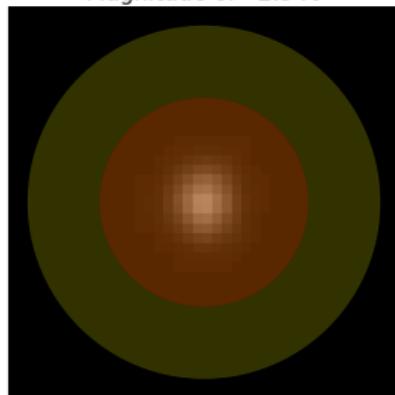


0 25 50

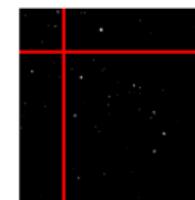
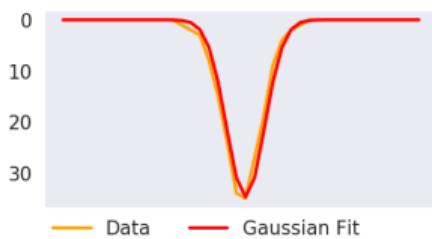
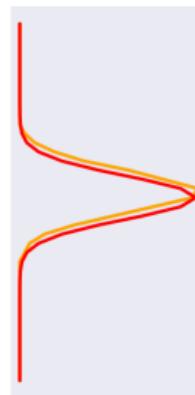


Object

Magnitude of 2.546



0 20

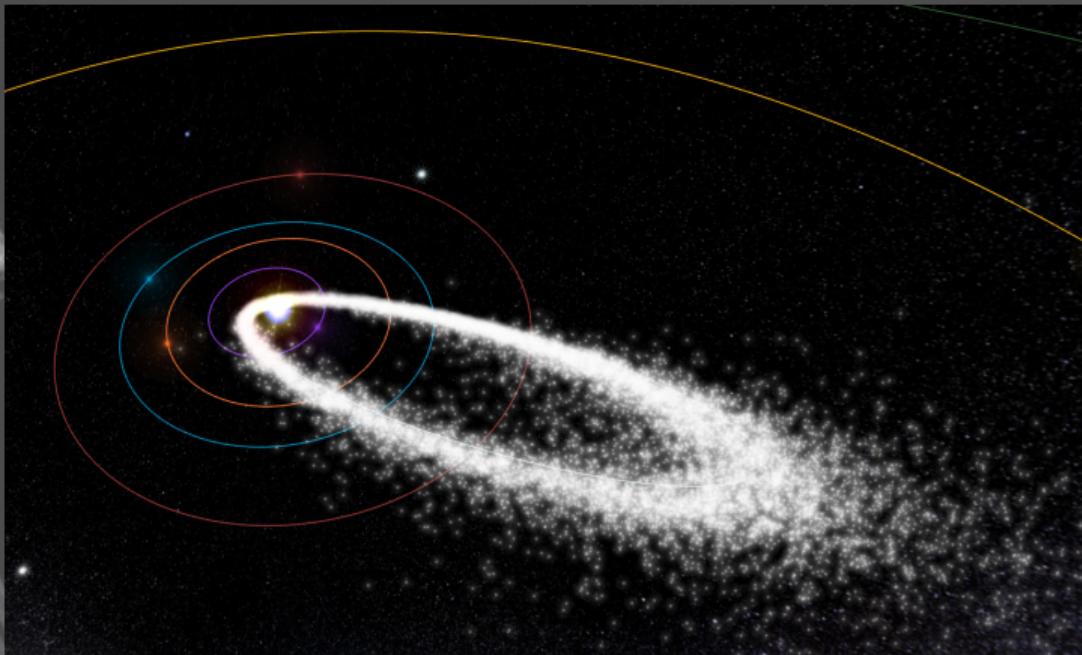


# MOVING TARGETS: IRIDIUM FLARES



CU Boulder logo  
$$M = \int \frac{2L}{\tau v^2} dt$$

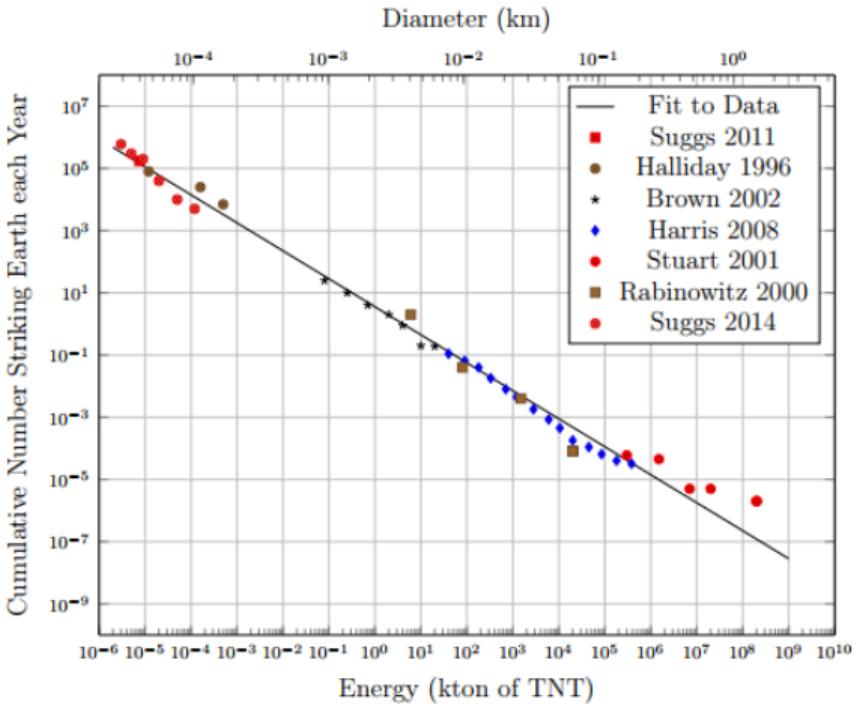
# MOVING TARGETS: METEOR SHOWERS



The Geminids  
December 15

Picture courtesy  
[meteorshower.com](http://meteorshower.com)

# OUR GOAL



Graph made by  
Dr. J. Rembold

# REFERENCES

- Background picture 1: [alcor-system.com](http://alcor-system.com)
- Background picture 2: [sbig.com](http://sbig.com)
- Whitehead, James. "The North American All-Sky Camera Database." (2009).
- Suggs, Rob M. "The NASA Fireball Network All-Sky Cameras." (2011).
- All icons made by Freepik

# QUESTIONS?

FOR MORE:

[GITHUB.COM/LUKEGALBRAITHRUSSELL](https://github.com/lukegalbraithrussell)

TO GET SOURCE CODE AND CONTINUOUS UPDATES