LSST - a unique window into microphysics of meteoroid-atmosphere interaction

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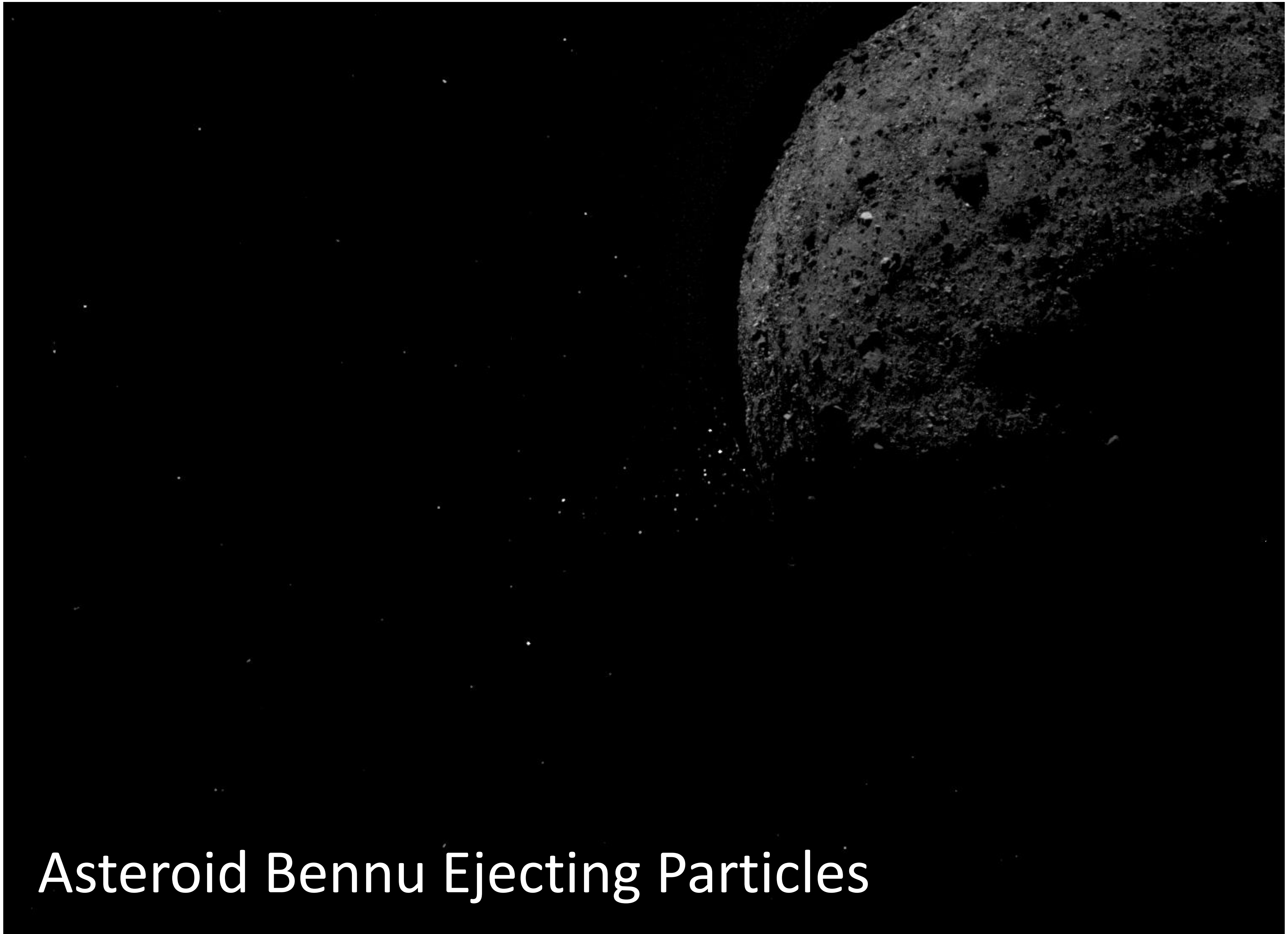
Meteors are difficult to explore:
- Brief transient events
- Large angular size
- Radom spatial position
- Three different flow regimes

Meteors are important to explore:
- Originate from comets and asteroids
- Provide insights into the physics of hypervelocity impacts
- Enable astrobiological research on transfer of organics from space to planets



OSIRIS-Rex mission

meteoroid impacts?

thermal stress fracturing?

released water vapor ?

Meteoroids: the extreme tail-part of the NEOs distribution

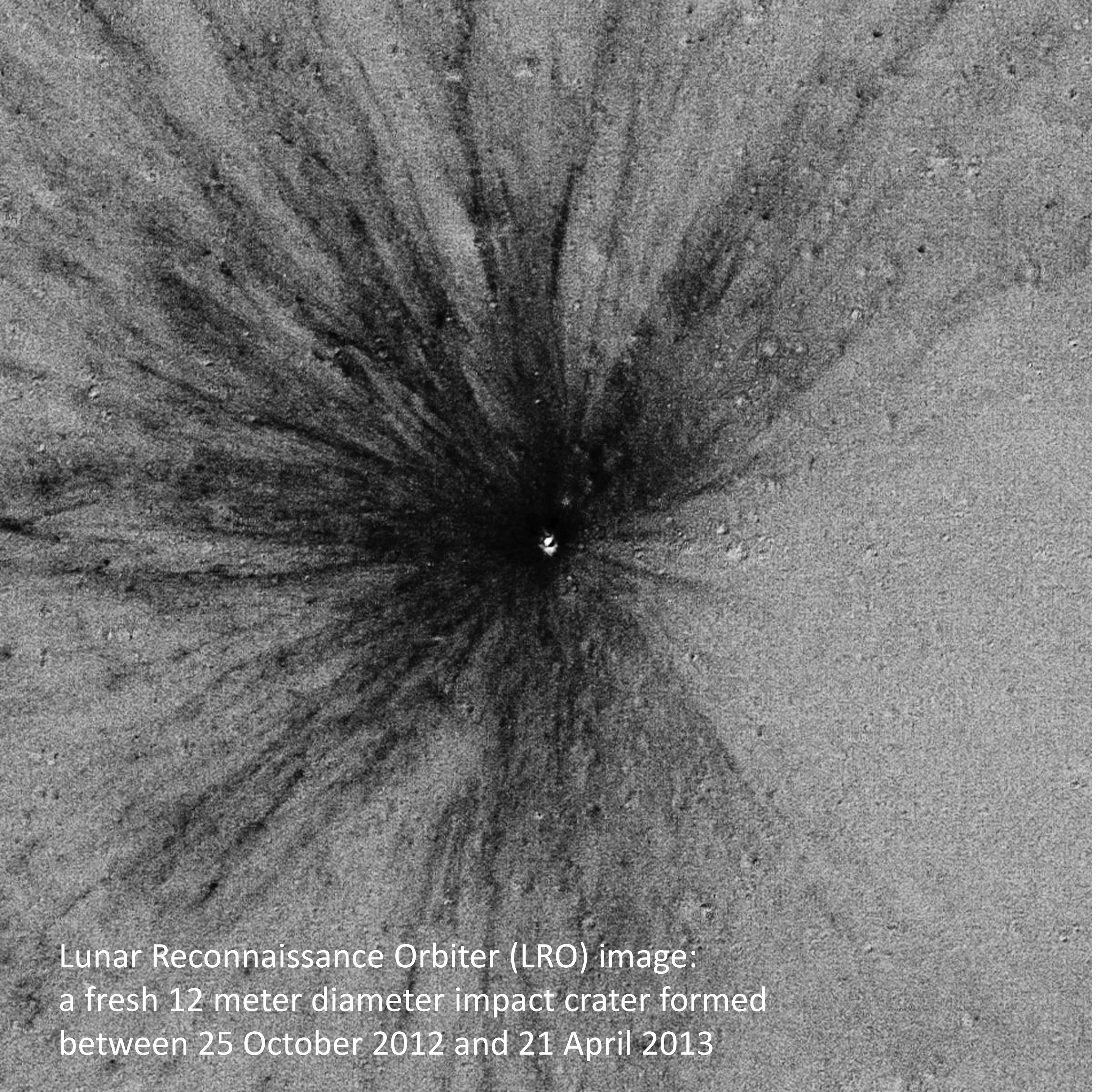
total number of meteoroids with mass between M_1 and M_2

$$N(M, \alpha) \propto \int_{M_1}^{M_2} M^{-s} \mathrm{d}M = \frac{1}{\alpha} \left[M_2^{-\alpha} - M_1^{-\alpha} \right],$$

where α is the cumulative mass index distribution exponent and $\alpha = s - 1$.

Sporadics: s≈2 (from radar & optical)

Pokorný & Brown, A&A 592, A150 (2016)


Lunar Reconnaissance Orbiter (LRO) image:
a fresh 12 meter diameter impact crater formed between 25 October 2012 and 21 April 2013

Moon impacts:

99% of the Moon surface would be overturned by small impacts (and their secondary impacts) formation after about 81,000 years.
This rate is over 100 times faster than previous models

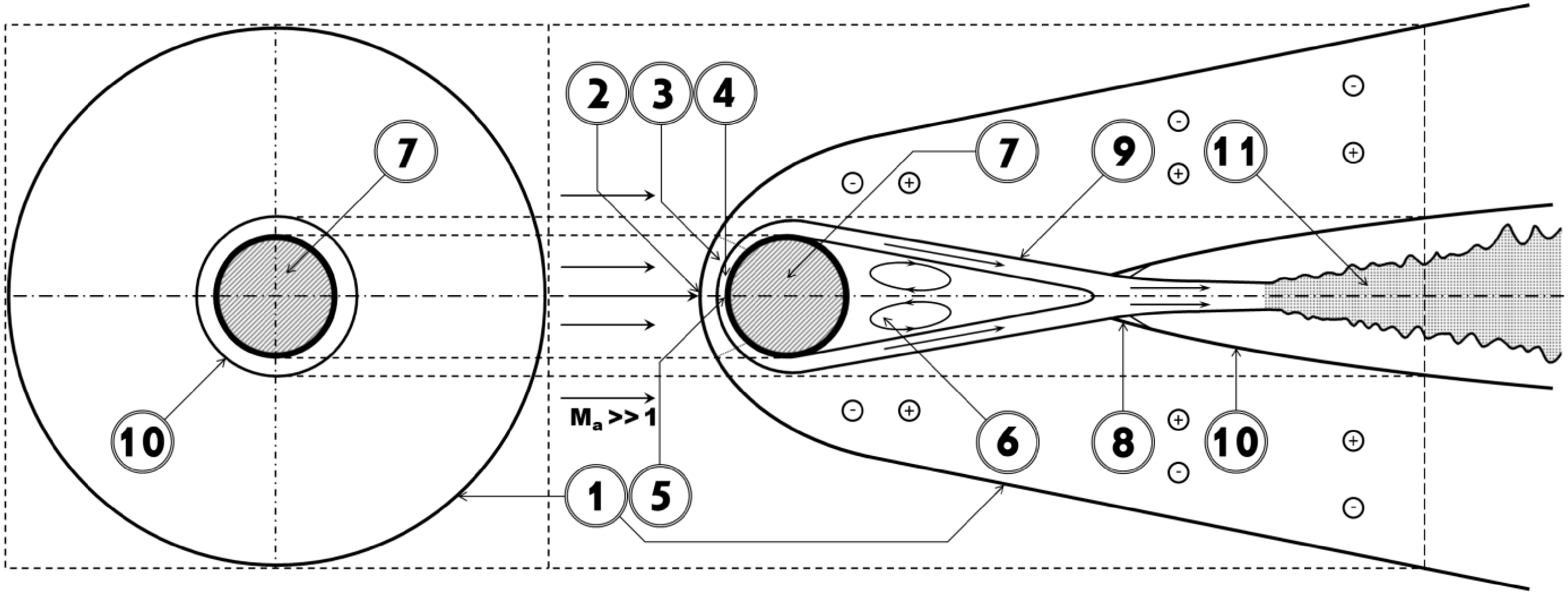
Speyerer et al. Nature 538, 215–218; 2016

Hazard to artificial satellites:

Olympus-1 satellite probably damaged by a Perseid impact in 1993.

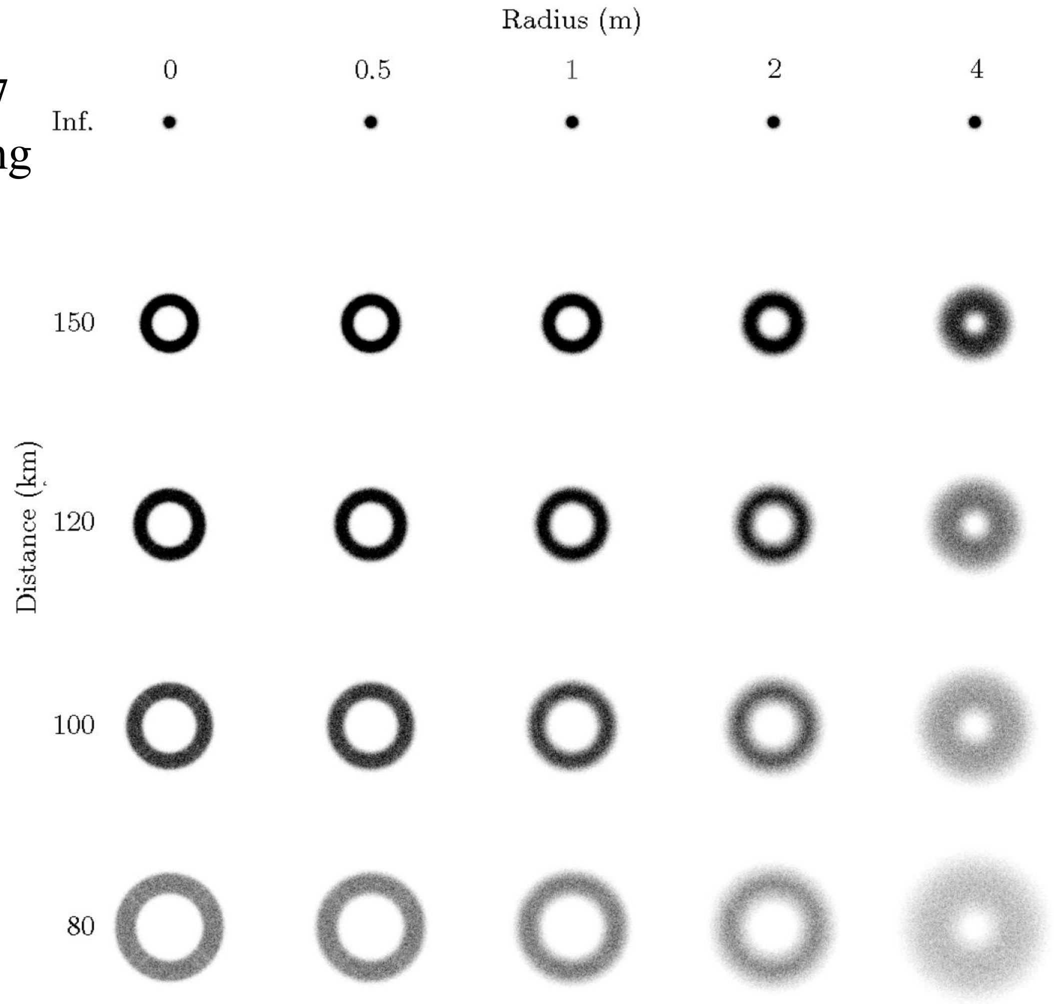
https://www.nap.edu/read/13244/chapter/6#32

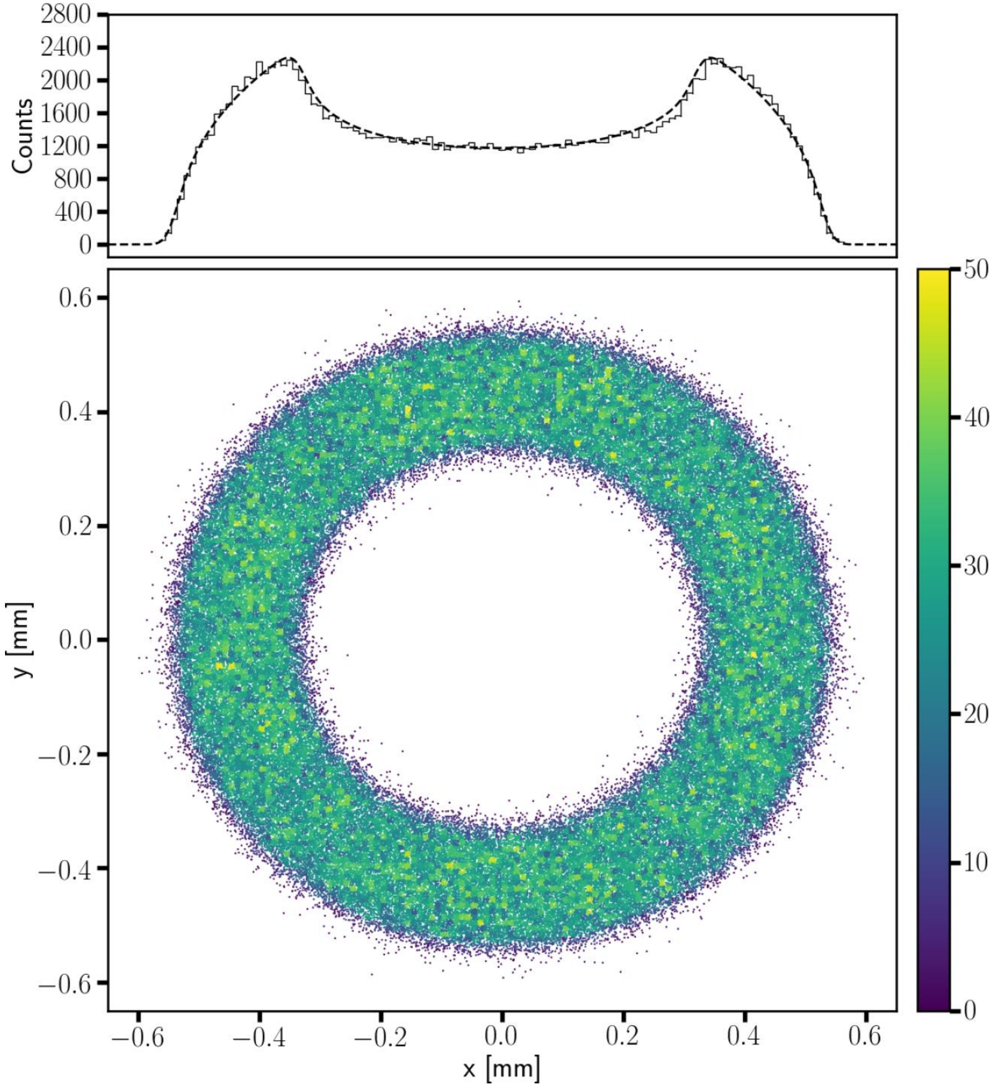
Silber E.A. et al, MNRAS, **469,** 1869–1882 (2017)



Our understanding of meteor plasma and hypervelocity shock physics in rarefied partially ionized and partially magnetized ionospheric plasma is NOT complete.

0″.67
seeing

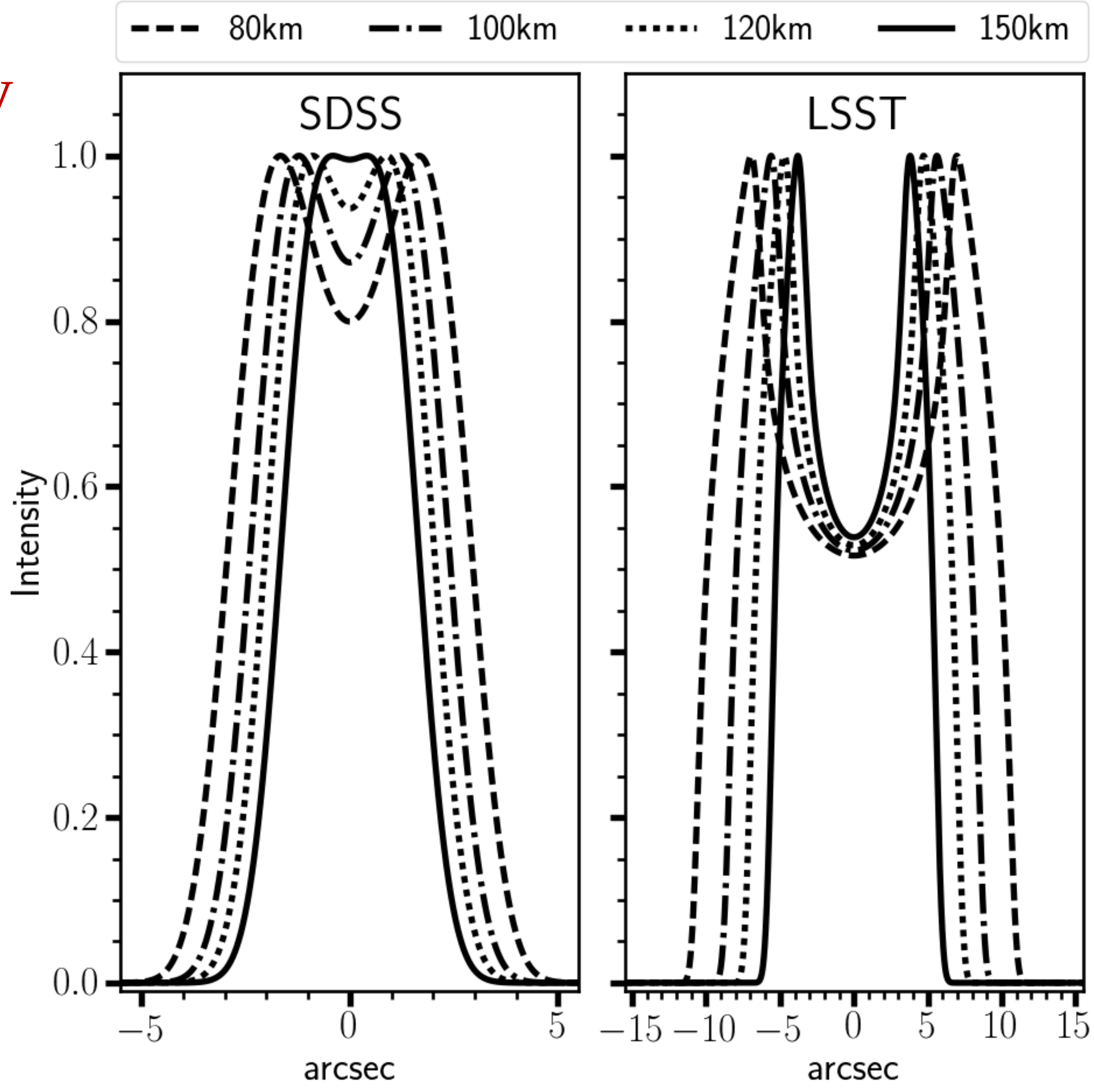




Bektesevic et al. 2017, MNRAS, 474, 4837-4854

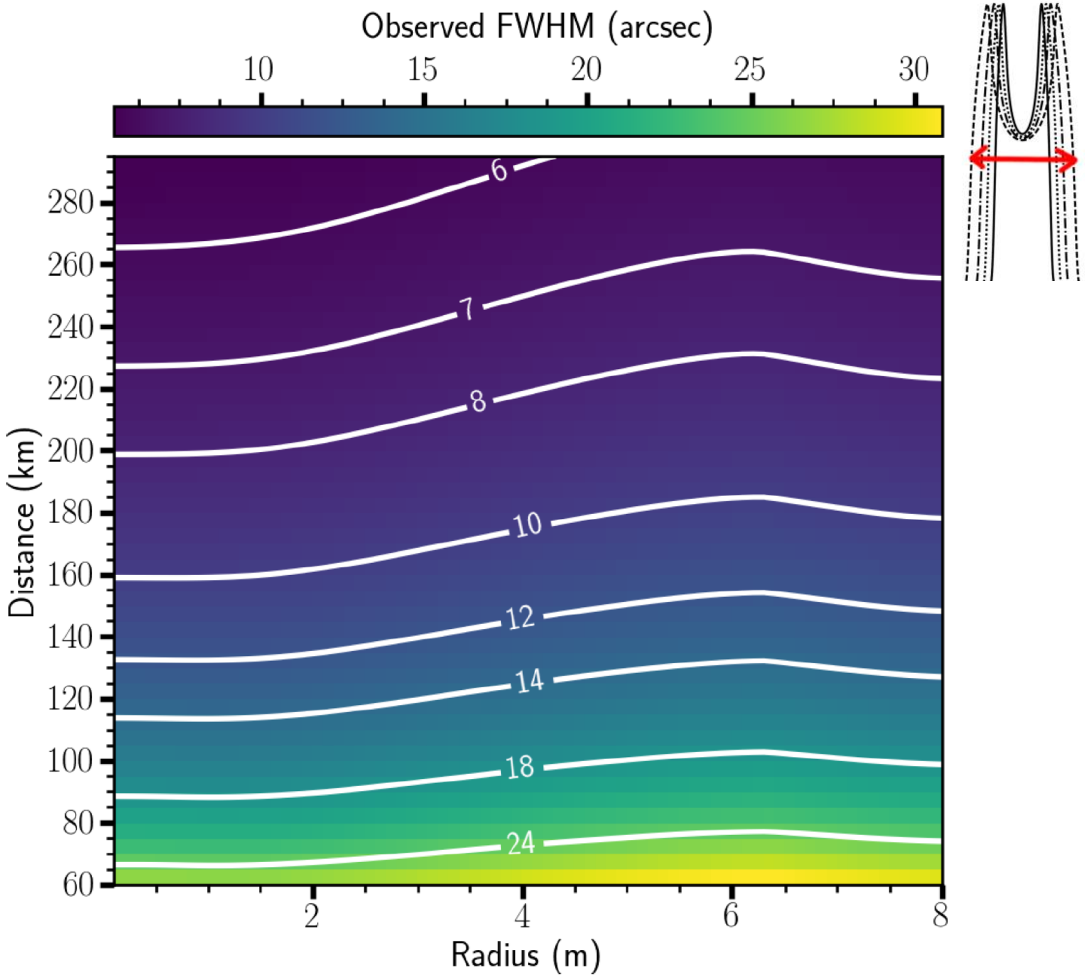
meteor detections on images from sky survey telescopes

high-resolution
&
high-sensitivity
&
high-precision photometry
&
resolved (defocused)

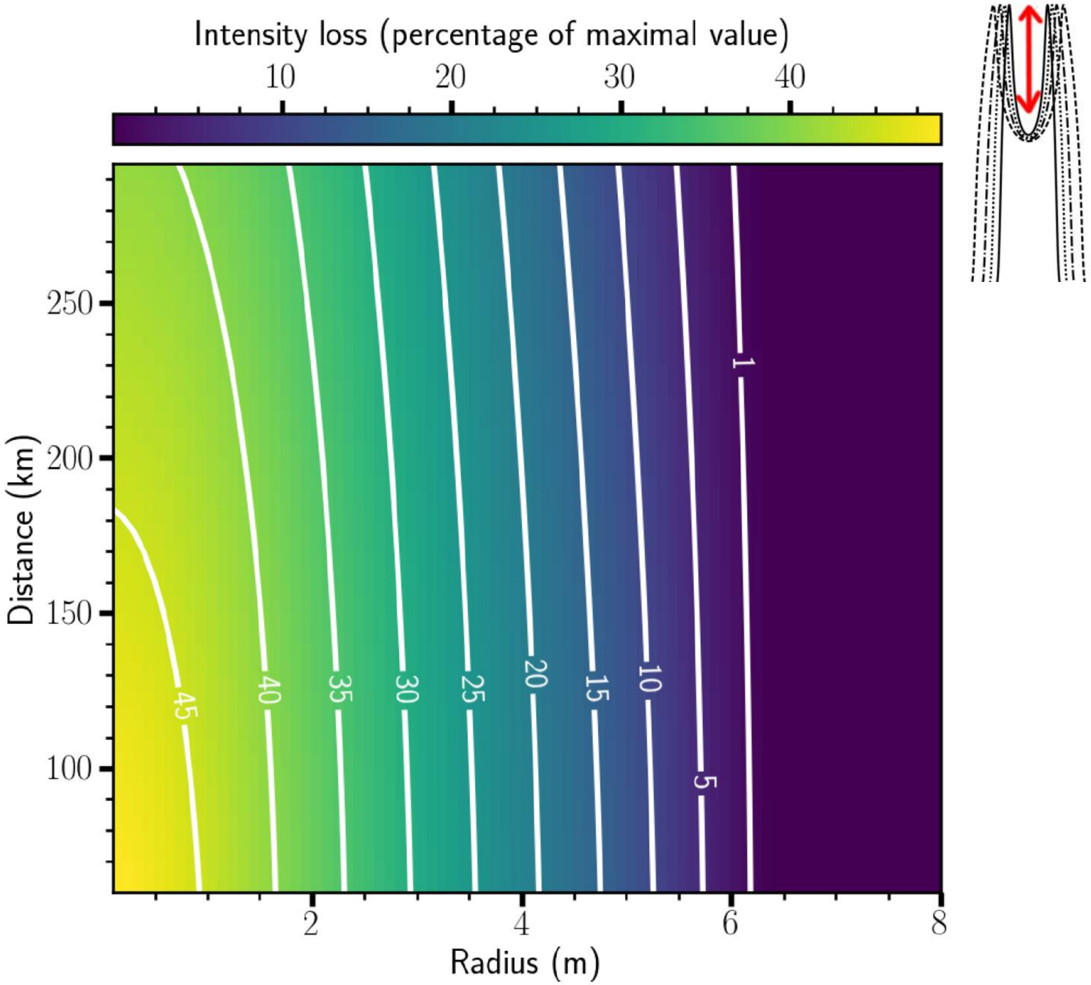


defocused point sources

Bektesevic et al. 2017, MNRAS, 474, 4837-4854

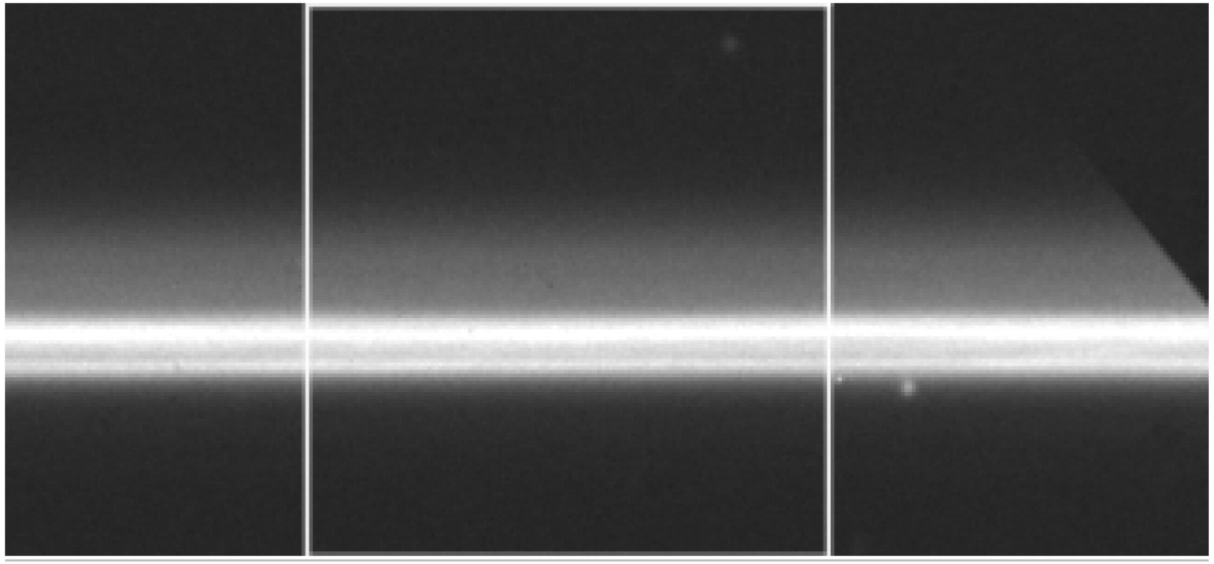


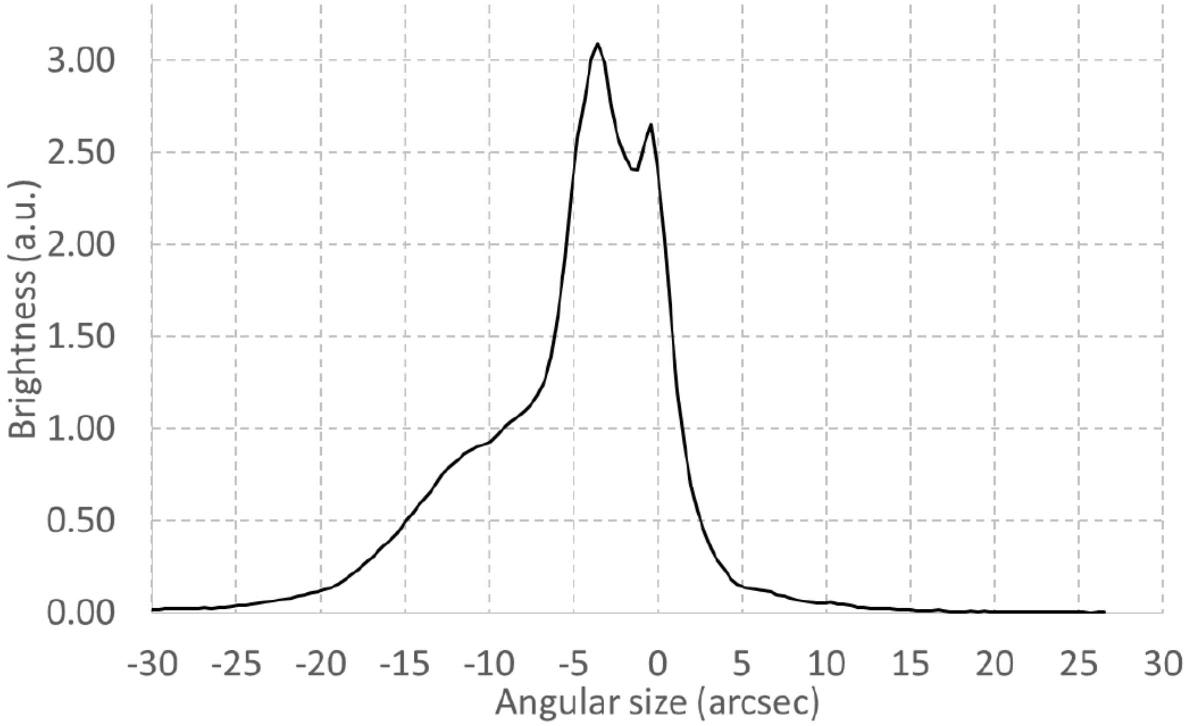
The observed FWHM (colour scale and contours) as a function of a uniform brightness disc radius and meteor distance to the telescope (seeing is 0″.67).

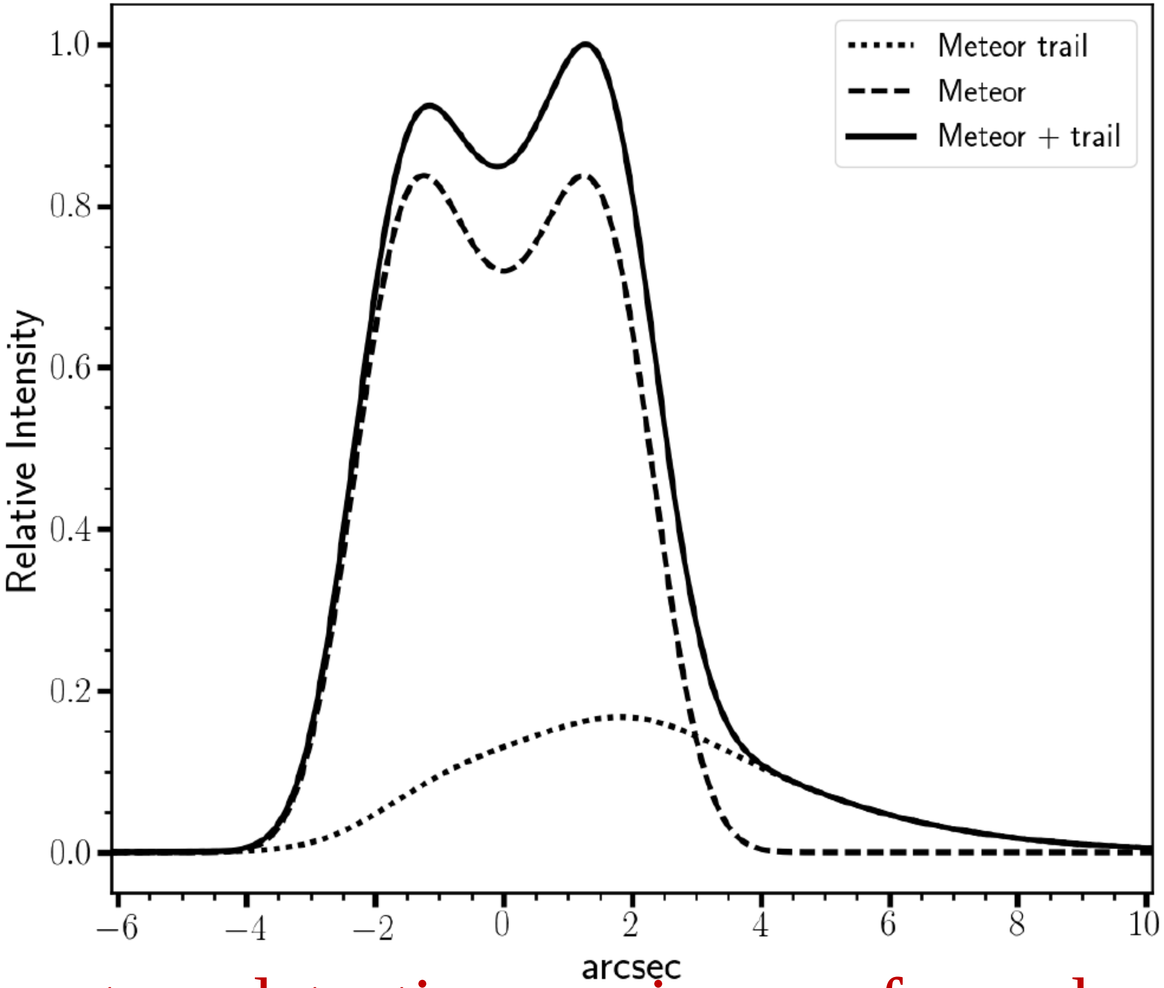


The strength of the central dip for a uniform disc source in the observed image profile measured as the intensity loss (colour scale and contours) relative to the maximum brightness value in the profile (seeing is 0″.67).

Bektesevic et al. 2017, MNRAS, 474, 4837-4854







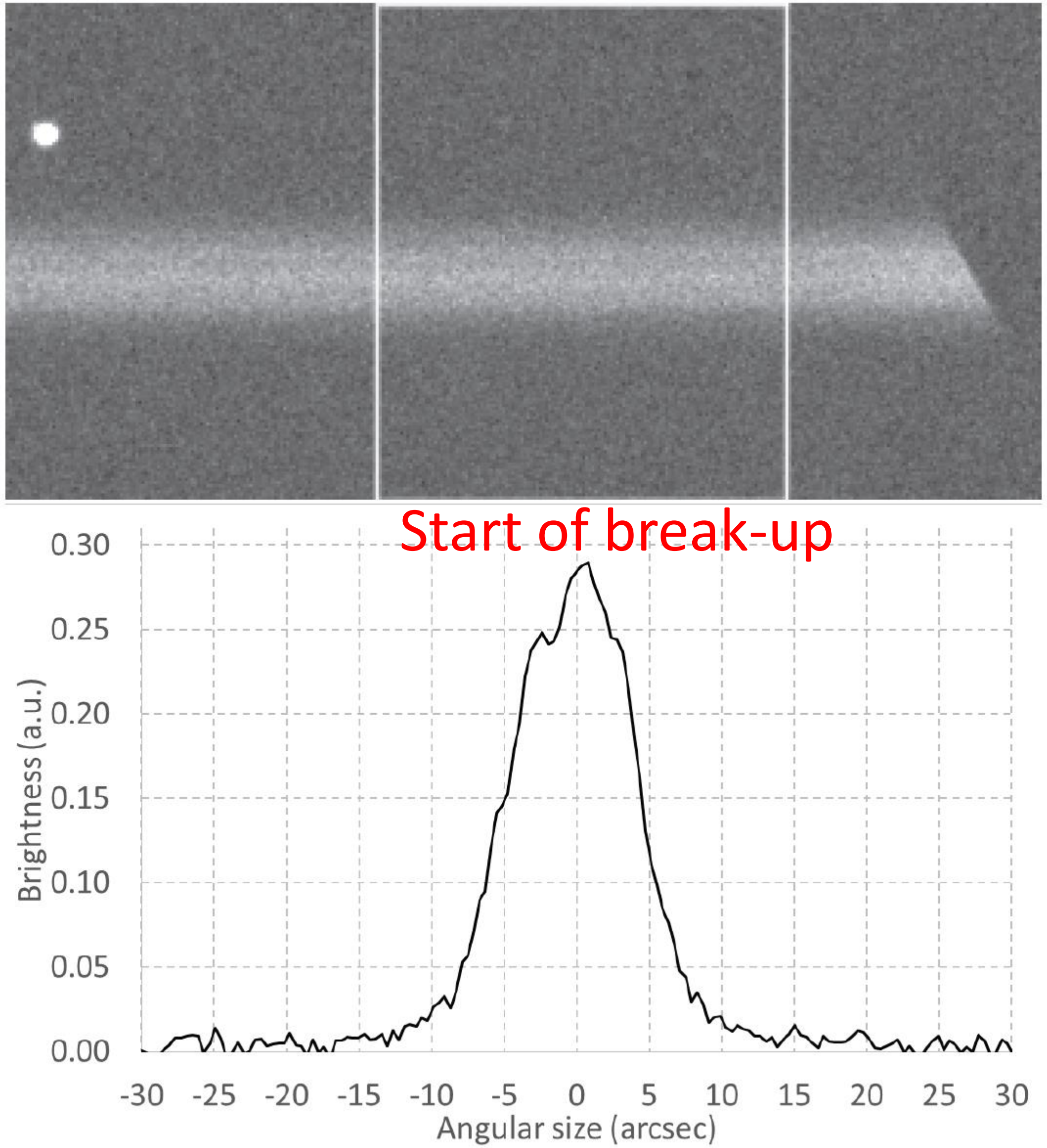
meteor detections on images from sky survey telescopes (SDSS example)

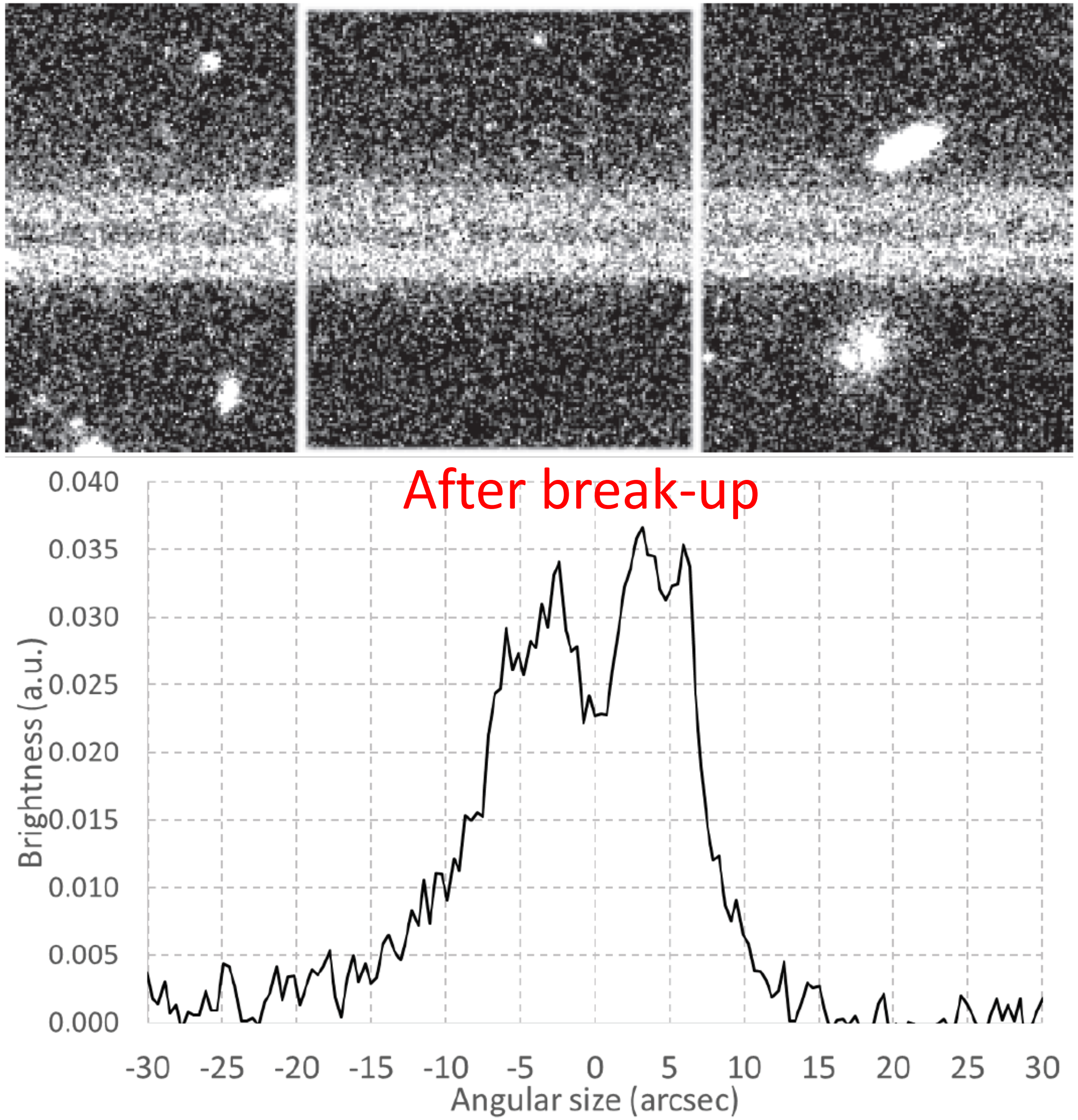
high-resolution & high-sensitivity & high-precision photometry & resolved (defocused)

Bektesevic et al. 2017, MNRAS, 474, 4837-4854

November 18, 2001, at 04:57:21.39 TAI.
probably a Northern Taurid meteor

Bektesevic et al. 2017, MNRAS, 474, 4837-4854

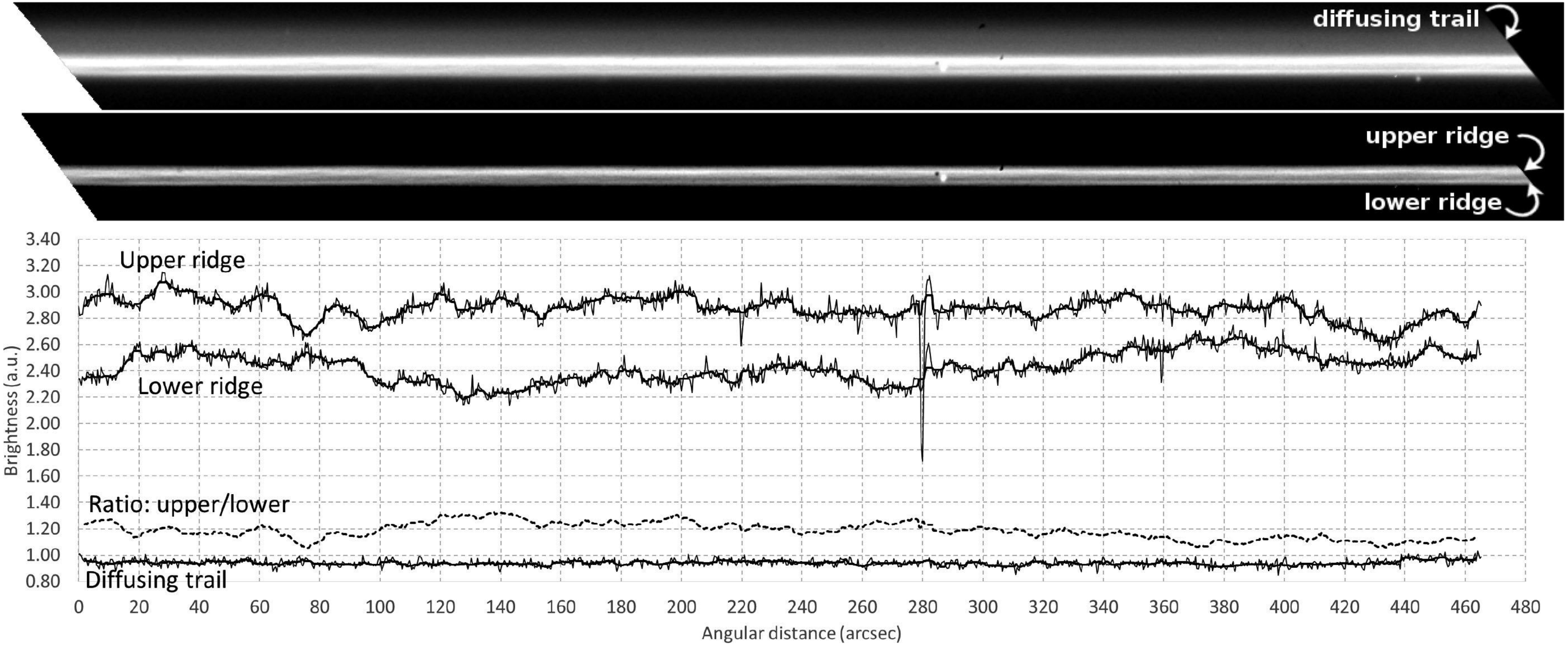




SDSS *u* filter

~2km later

SDSS *g* filter: 2 objects <1m; separated ~6m



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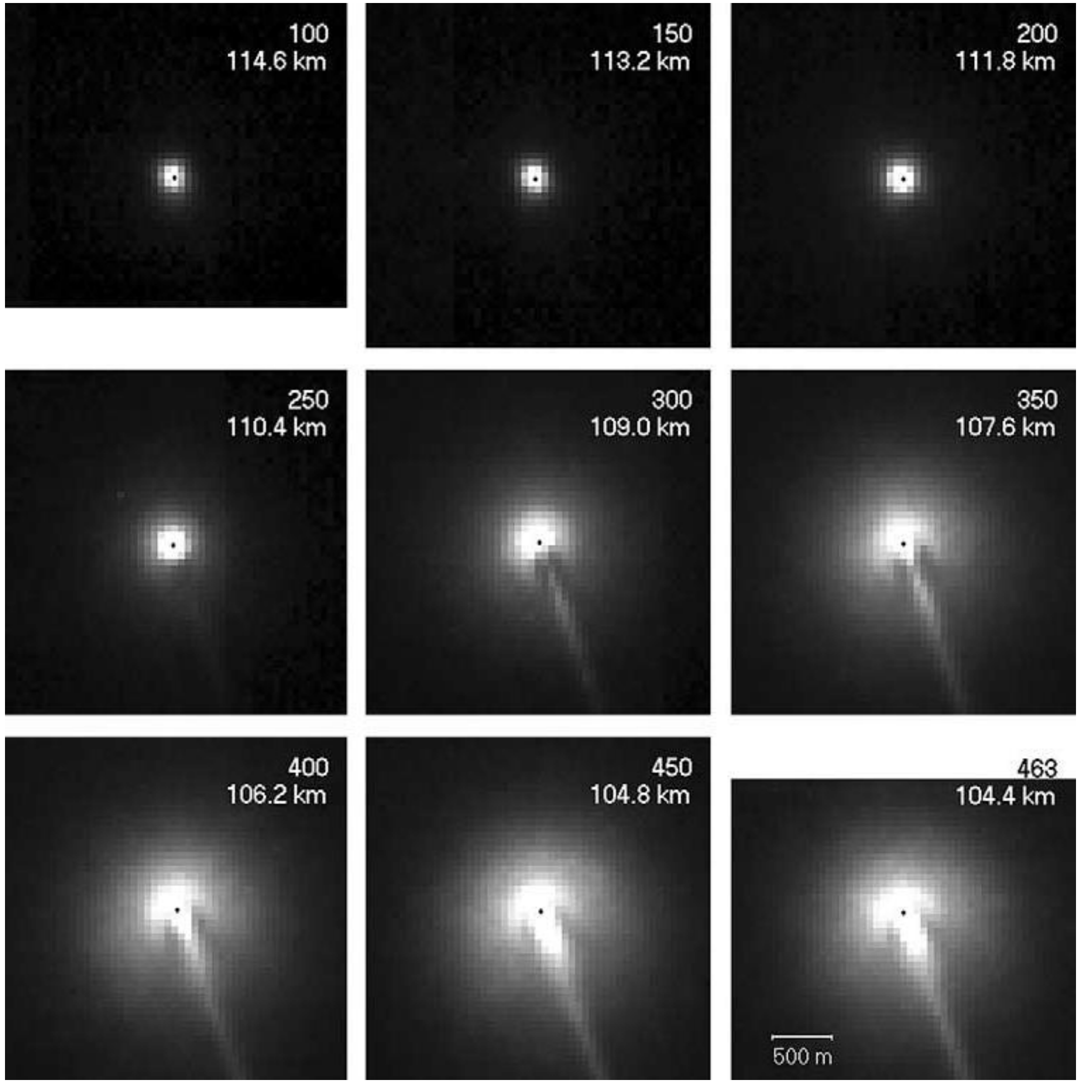
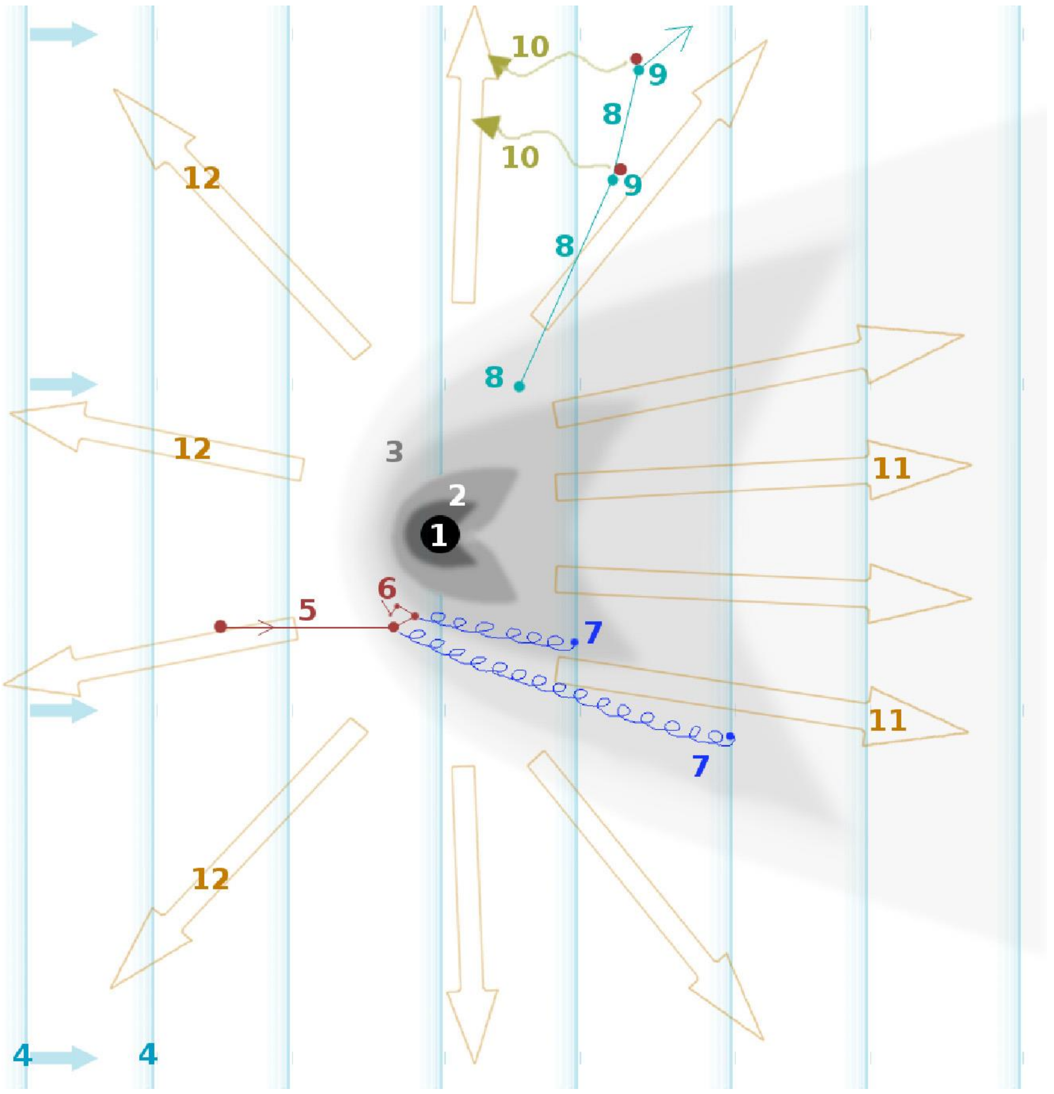
OTHER PHENOMENA RELATED TO METEORS?

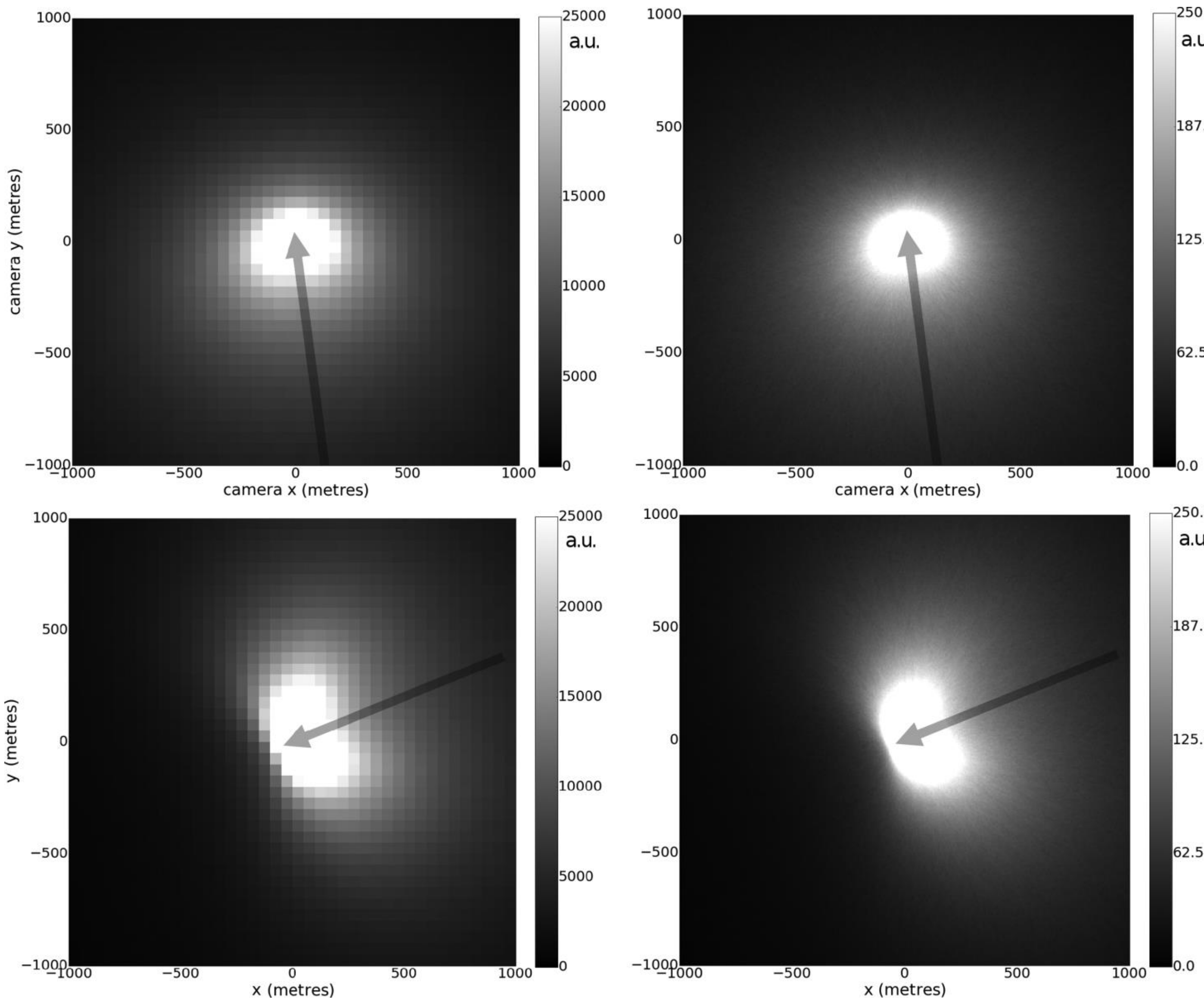


large halo around a meteor detected in a high-speed recording 1000 fps
(Stenbaek-Nielsen and Jenniskens, 2004)

Proton-induced halo formation in charged meteors

Šiljić et al, MNRAS, 481, 2858 (2018)





Combining the LSST data stream with other instruments and disciplines:

- Cameras on the ground (images, spectra, triangulation, photometry)
- Detectors in orbit (images, spectra – UV)
- Radio scattering
- ELF/VLF/LF radio signals
- Ionosphere monitoring
- Etc.

A quest for new dana analysis algorithms, meteor plasma models, advancements in observational techniques