Looking for Meteors and Fireballs in the atmosphere of Mars from the Visual Monitoring Camera (VMC) on Mars Express

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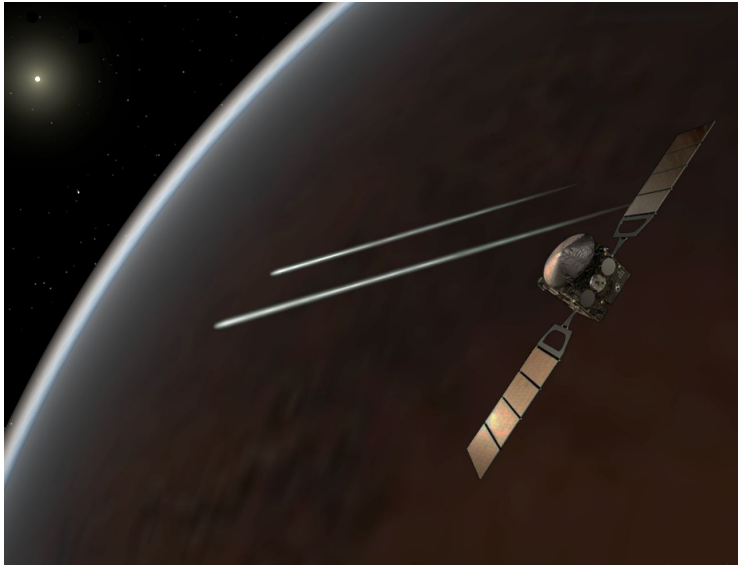

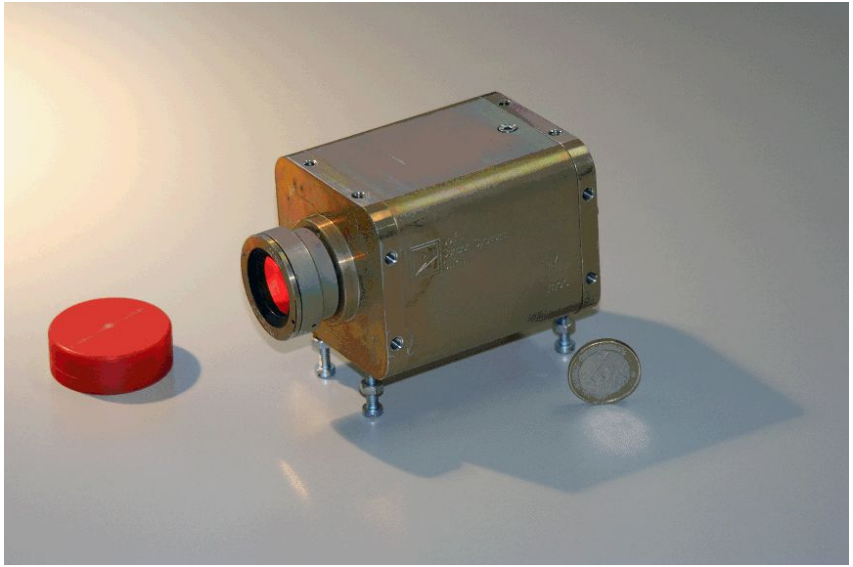

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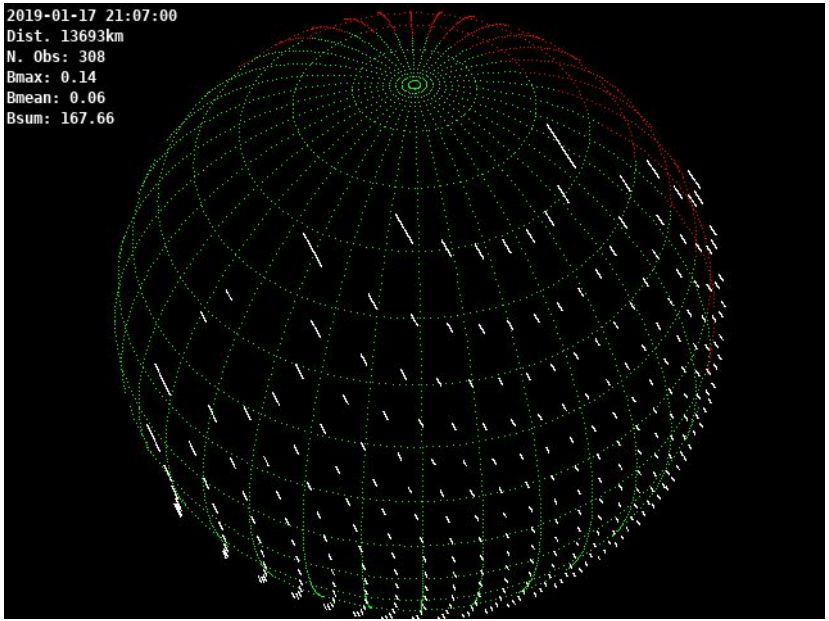
Meteors in extraterrestrial atmospheres

- Meteor showers are expected in other planets (e.g. Christou, 2005), however, observations of meteors are rare.
- Sparse meteors have been observed on Jupiter based on amateur observations (Hueso et al., 2018), and Juno observations (Giles et al. 2021)
- A ground based meteor shower survey was developed by Spirit on Mars, without conclusive detections (Domokos et al., 2007), and a meteor was probably imaged by a navcam (Selsis et al., 2005)

The systematic monitoring of meteors in other planetary atmospheres would provide new information about their upper structure, and about the distribution of planetary dust. However no specific instruments for this kind of observations have been launched.

Looking for meteors with MEX/VMC

The Visual Monitoring Camera (VMC) on Mars Express is an engineering camera recently upgraded to science instrument. It counts with a wide Field of View of 30ºx40º, which is uncommon among cameras in Mars orbit. This has proven to be useful for atmospheric science, and might provide a good orbit-based platform for the monitoring of meteor showers.



Looking for meteors with MEX/VMC

We planned a few testing campaigns when meteor showers were expected according to Christou (2010). However, VMC operations are very constrained by hardware limitations, and its photometric sensibility is very low. As result, there were no meteor detections.

Parent Comet	Ls	Velocity	SZA	Observations	Accumulated time
5335 Damocles	47.8	29.9 km/s	98.4º	2019-07-03_23.54-01.13	25 minutes
1P Halley	325.9	53.8 km/s	121.4º	2020-12-04_01.35-02.04 2020-12-15_02.53-03.21 2020-12-20_01.42-02.05	21 minutes

Planned observations. Meteor shower details from Table 2 in Christou (2010).

Ls: Solar Longitude, SZA: Solar Zenit Angle

Conclusions

- Systematic observations in search for meteors in other planetary atmospheres are of interest (Christou et al., 2019). However there are no suitable instruments for their observation at present.
- We tested with MEX/VMC, as an orbit-based platform, taking advantage of its wide FOV. Due to low sensitivity and operational constraints there were no positive results.
- Apart from ground based platforms, orbit-based platforms might also be considered for the investigation of extraterrestrial meteors in the future. Wide field cameras like VMC would be a good option, as already suggested by Christou et al. (2012)

References

Extraterrestrial meteor showers:

- Christou, A. A., "Predicting Martian and Venusian meteor shower activity." Modern Meteor Science An Interdisciplinary View. Springer, Dordrecht, 2005. 425-431.
- Christou, A. A., "Annual meteor showers at Venus and Mars: lessons from the Earth." Monthly Notices of the Royal Astronomical Society 402 (2010): 2759-2770.
- Christou, A. A., et al. "Orbital observations of meteors in the Martian atmosphere using the SPOSH camera." Planetary and Space Science 60 (2012): 229-235.
- Christou, A. A., et al. "Extra-terrestrial meteors." (2020). Chapter 5 in “Meteoroids: Sources of Meteors on Earth and Beyond”, Cambridge University Press (2019)
- Domokos, Andrea, et al. "Measurement of the meteoroid flux at Mars." Icarus 191 (2007): 141-150.
- Giles et al. “Detection of a bolide in Jupiter’s atmosphere with Juno UVS”. Geophysical Research Letters, 48 (2021).
- Hueso, Ricardo, et al. "Small impacts on the giant planet Jupiter." Astronomy & Astrophysics 617 (2018): A68.
- Selsis, Franck, et al. "A martian meteor and its parent comet." Nature 435.7042 (2005): 581-581.

MEX/VMC

- Hernández-Bernal, J., et al. "An extremely elongated cloud over Arsia Mons volcano on Mars: I. Life cycle." Journal of Geophysical Research: Planets 126 (2021a): e2020JE006517.
- Hernández-Bernal, J., et al. "A Long-Term Study of Mars Mesospheric Clouds Seen at Twilight Based on Mars Express VMC Images." Geophysical Research Letters 48 (2021b): e2020GL092188.
- Ormston, T., et al. "An ordinary camera in an extraordinary location: Outreach with the Mars Webcam." Acta Astronautica 69.7-8 (2011): 703-713.
- Sánchez-Lavega, A., et al. "Limb clouds and dust on Mars from images obtained by the Visual Monitoring Camera (VMC) onboard Mars Express." Icarus 299 (2018): 194-205.