Instrument for the detection of meteors in the infrared

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The flux of interplanetary particles in the size range 2 mm to 20 m is poorly constrained due to insufficient data — the larger bodies may be observed remotely by ground-based or space-based telescopes and the smaller particles are measured by in-situ impact detectors in space or by meteor cameras from ground. An infrared video rate imager in Earth orbit would enable a systematic characterization for an extended period, day and night, of the flux in this range by monitoring the bright meteor/fireball generated during atmospheric entry. Due to the low flux of meteoroids in this range a very large detector is required. With this method a large portion of the Earth atmosphere is in fact used as a huge detector. Such an instrument has never flown in Earth orbit. The only sensors of a similar kind fly on US defense satellites for monitoring launches of ballistic missiles. The data from these sensors, however, is largely inaccessible to scientists.

The knowledge on emission of light by meteors/bolides at infrared wavelengths is very limited while it can be suspected that the continuum emission from meteors/bolides have stronger emission at infrared wavelengths than in the visible due to the likely low temperatures of these events. At the same time line emission is dominating over the continuum in the visible so it is not clear how this will compare with the continuum in the infrared.

We have developed a bread-board version of an IR video rate camera, the SPOSH-IR. The instrument is based on an earlier technology development, SPOSH — Smart Panoramic Optical Sensor Head, for operation in the visible range, but with the sensor replaced by a cooled IR detector and new infrared optics. The earlier work has proven the concept of the instrument and of automatic detection of meteors/bolides in the visible wavelength range.

The new hardware has been built by Jena-Optronik, Jena, Germany and has been tested during several meteor showers in the Netherlands and at ESA's OGS telescope on Tenerife. In spite of some shortcomings in the optics the instrument works well and is able to operate up to 50 Hz frame rate. As the detector is fairly small, 320 by 256 pixels, and the field of view is large, 90 by 72 deg, events will only move through a small number of pixels. Therefore detection software previously used for meteor detection will need to be modified. This work is in progress. At the OGS also the capability of SPOSH-IR to detect objects impacting on the Moon was tested. Video sequences totaling 10 hours have been recorded and partly scanned. This has so far been done manually as the automatic scanning software is not yet optimized.

A suitable space-flight opportunity has been identified. The SPOSH-IR will fit well, with regard to science, physical accommodation and programmatics, into the suite of instruments in the ASIM package due to fly as a Columbus External Payload on the ISS in 2016. The ASIM (Atmosphere-Space Interaction Monitor) aims at studying upper atmosphere transient phenomena like sprites, elves and lightning — all related to and occurring in and above thunderstorms and therefore difficult to observe from ground. SPOSH-IR would complement the standard ASIM payloads very well as no infrared detectors presently are included. This has never been done at video rate before. It is expected that as a byproduct a large number of fireballs will be detected during this mission.