ASIMA - Asteroid Impact Analyzer: A proposed close-to-home planetary mission to probe the diversity of comets and asteroids.
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Summary: The proposed Asteroid Impact Analyzer (ASIMA) is a Partner Mission of Opportunity that will use a simple, small ultraviolet and visible camera package on the nadir port of one of the next generation Iridium satellites to spectroscopically measure how the bulk carbon-to-metal ratio varies among predictable meteor showers. ASIMA takes advantage of the Earth's atmosphere as a "detector", to sample the diversity in composition of a number of comet (and asteroid) fragments in a cost-effective, low-risk approach. The showers that ASIMA targets are uniquely traceable to specific parent comets [1], which in turn sample a variety of specific source reservoirs that stretch from the main asteroid belt, through the Edgeworth-Kuiper Belt, to the Oort Cloud.

Scientific rationale: ASIMA uses meteor spectra to measure the variation of carbon abundance within and among different comet source reservoirs. Meteoroids contain the bulk of all cometary carbon, which is known to be in a refractory 'tar'-like substance, intimately mixed with silicates [2-4]. Meteor spectra, a form of impact induced breakdown spectroscopy, measure the elemental composition from atomic line emission ratios [5]. Atomic carbon emission is strong only at 165.7 and 193.1 nm in the ultra-violet, which can not be observed from the ground, and only in relatively bright meteors (hot component emission).

Also, ASIMA will determine the size scales of cometary building blocks by observing bright meteors (the impact of the smallest asteroids) systematically and in large numbers. Finally, by investigating the penetration depth and light curve characteristics of the meteors, ASIMA will determine what fraction of Earth impactors are cometary vs. asteroidal in origin.

ASIMA will investigate the distribution of carbon in the early solar nebula, a reflection of mixing processes as well as thermal and chemical evolution, and key to understanding how the Sun's family of planets and minor bodies originated and evolved to its current state. ASIMA will characterize exogenous sources of organic matter and how they are delivered to potentially habitable environments in the Solar System. ASIMA will also study the prevalence of sub-meter and meter-sized asteroids and cometary fragments in streams, to better understand the size distribution of cometary building blocks. Finally, ASIMA will help constrain the flux of volatile material into the inner solar system as a potential resource, which may affect the extension of human presence in space.

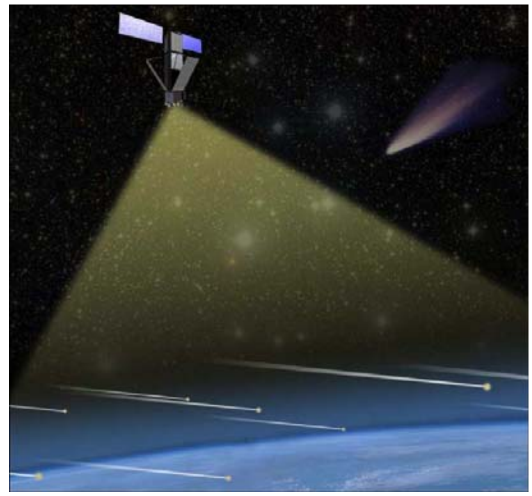

FIGURE 1. ASIMA mission concept.

The instrument: The ASIMA instrument package, developed by Ball Aerospace, will consist of three co-aligned cameras, based on Ball's CT633 star trackers, each with modified optics to provide a full Earth disk field of view (128º). They will be deployed on the nadir port of an *IridiumNEXT* satellite (Figure 1).

One camera (Figure 2) will record images at a high 70 Hz rate in the wavelength range of 270 - 290 nm, where meteors have strong Mg+ emission. This camera will provide event detection, bolide size, and fragmentation patterns (light curves).

A second ultraviolet camera is equipped with an objective transmission grating and will take full disk images at a rate of 2 Hz in the wavelength range of 160 to 290 nm. Each bright source will produce a spectrum left and right of the zero-order image. This camera will provide elemental abundances (especially carbon), trajectory data, and penetration depth (from the extinction of emission lines in the 160 - 190 nm range).

A third camera will do the same in the optical range (400 - 800 nm). This camera will measure the elemental abundance of sodium and penetration depths below 50 km. Superior optics provide better orbits.

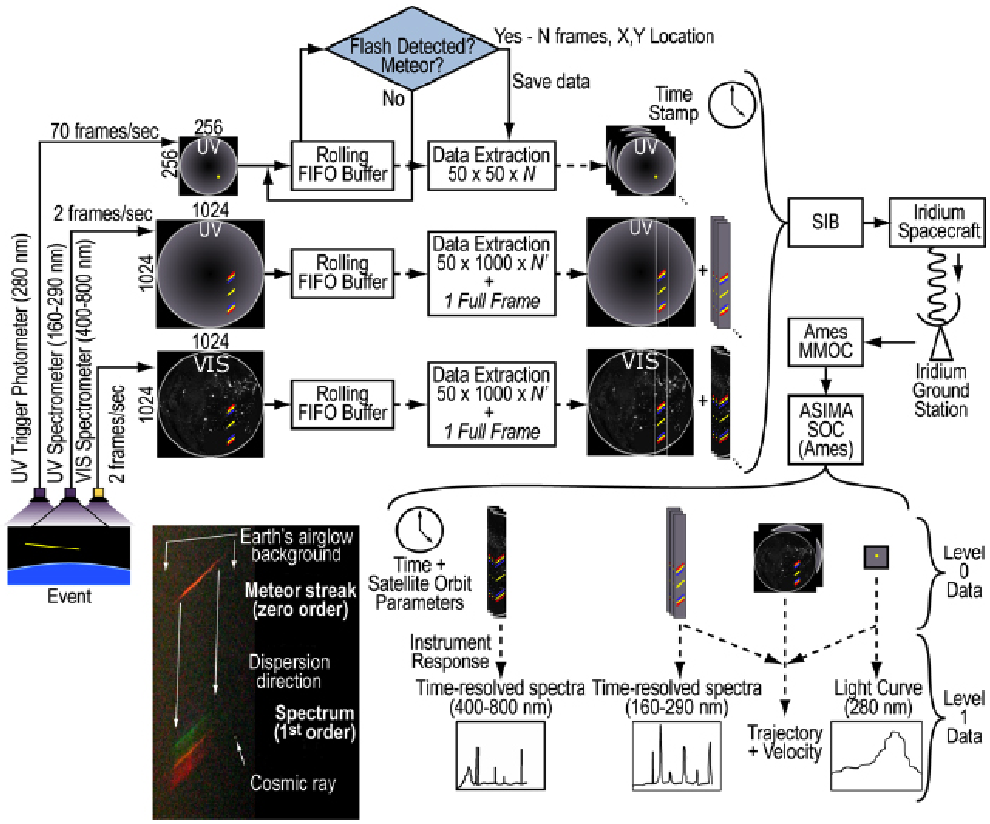

FIGURE 2. Instrument package concept and data flow.

The host satellite provides power, general pointing in the nadir direction, and communication for data download and for upload of modified detection algorithms. No active pointing is required. There are no moving parts to the instrument.

Mission overview: This instrument package would be deployed on one of the first *IridiumNEXT* satellites, scheduled for launch starting in late 2013 or early 2014, with multiple backup launches after that. These satellites move in a circular orbit, 780 km above Earth's surface, at any moment viewing 5% of the Earth's surface (size of continental USA). Orbital inclination is not important. The instrument would be operated only in nighttime conditions, to keep the instrument design simple. Only half of the available host mass, volume, and power are used, and the data transfer through the host will be relatively small and during low-use hours. The mission will operate nominally for two years. The Iridium satellite (and cameras) may be operational much longer.

The images (Level 0 Data, Figure 2) will be sent from the Iridium ground station to the Science Operation Center at NASA Ames Research Center. NASA Ames will provide project management, mission oversight, and science operations.

The Principal Investigator (P.J.), and lead of the science team, is with the SETI Institute. The science team includes three Co-Investigators, tasked to address the quantitative interpretation of the meteor spectra (I.B.), the analysis of light curves (D.R.), and the physical and chemical processes involving the interaction of meteoroids with Earth's atmosphere (J. N.).

The science team includes 22 collaborators with experience in the study of comets, asteroids, interplanetary dust, micrometeorites, impacts, meteors, and meteoroid dynamics. Because most fireballs will be observed above foreign countries, the science team also includes international collaborators, who will follow up with dedicated studies of interesting events.

References: [1] Jenniskens P. (2006) *Meteor Showers and their Parent Comets.* Cambridge Univ. Press, 790-pp. [2] Sandford S. A., *et al.* (2006) *Science, 314,* 1720-1724. [3] Festou M. C., *et al.* (2004) *Comets II.* Tucson: The Univ. of Arizona Press, 745 pp. [4] Rietmeijer F. J. M. (2002) *Chemie der Erde 62*, 1-45. [5] Jenniskens P. (2008) Quantitative Meteor Spectroscopy: elemental abundances. *Adv. Space Res. 39*, 491-512.

Additional Information: The ASIMA mission website is at: *http://asima.seti.org*.