THE OSIRIS-REx SAMPLE RETURN CAPSULE RE-ENTRY: PLANS FOR A COORDINATED INFRA_SOUND OBSERVATIONAL CAMPAIGN.
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Introduction: Upon entering the Earth’s atmosphere at hypervelocity, meteoroids and asteroids (>1 m in diameter) undergo complex processes (e.g., sputtering, heating, ablation, fragmentation, hyperthermal and equilibrium chemical reactions with the ambient atmospheric gas) as they encounter denser regions of the atmosphere [1,2]. The resultant visual phenomenon is called a meteor, with very bright meteors known as fireballs and bolides [1]. In the transitional and continuum flow, sufficiently large and fast meteoroids generate shockwaves, which decay to very low frequency acoustic waves (below human hearing), or infrasound. Depending on atmospheric conditions and acoustic propagation paths, infrasound may reach the ground where it could be detected by very sensitive microphones [1,2]. Meteoroids and asteroids are of great scientific interest. However, impacts into the Earth’s atmosphere, especially by asteroids in a meter-size range, are sporadic and unannounced, making it impractical to plan a dedicated multi-instrument observation campaign aimed at studying and characterizing these objects. Thus, well-documented scientific observations of asteroids are rare and generally happen by chance [3]. In these cases, many parameters of interest (e.g., composition, size, porosity, rotation, ablation rate, shock characteristics, hyperthermal chemical processes) remain poorly defined, and scientific analyses largely rely on assumptions and predictions derived from the theoretical domain [1,2].

Artificial Meteors: Since the end of the Apollo era, only four instances of a hypersonic re-entry of an artificial body from interplanetary space with an incident speed of 11-12 km/s have been observed and studied. These were the Sample Return Capsules (SRCs) that brought physical samples of extraterrestrial material back to Earth. Arriving from interplanetary space at hypervelocity, SRCs are considered analogues for low velocity meteoroids and asteroids impacting the Earth’s atmosphere [e.g., 4], and as such provide unprecedented and unique opportunities to perform detailed studies of meteor phenomena, test and calibrate sensors, and validate and improve models. The next opportunity will present itself on 24 September 2023 with the re-entry of OSIRIS-REx SRC that will bring samples of the carbonaceous near-Earth asteroid Bennu [5].

OSIRIS-REx: The OSIRIS-REx asteroid sample return mission was launched in 2016 with the aim to collect samples from the near-Earth asteroid Bennu and bring those samples back to Earth in pristine condition [5]. In design, the OSIRIS-REx SRC is nearly identical to that of the Stardust SRC. Landing is planned for 24 September 2023, over the region enclosed by an 80km long and 20km wide ellipse at the Utah Test and Training Range (UTTR), Utah, USA [5]. The re-entry flight will consist of several phases, including the hypersonic, transonic, main parachute, and landing phases.

Seismo-acoustic observational campaign: The OSIRIS-REx re-entry presents a unique and exceptional opportunity to observe a well-defined artificial meteor, to perform detailed studies of hypersonic entry and event characterization, to test sensors, and validate and improve models. We will organize and lead multi-instrument observations of the OSIRIS-REx SRC re-entry. The instruments will include seismic and infrasound sensors strategically positioned in the immediate and extended region around the projected re-entry trajectory to maximize the scientific output. Data collected during this observational campaign will be made freely available to the broad scientific community following publication.


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