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## High-speed UV imaging of elves and lightning from space: first simultaneous detections from the Mini-EUSO and ASIM instruments

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The search for the physical mechanisms of lightning, transient luminous events and terrestrial gamma-ray flashes is receiving an extraordinary support by new space observations that have recently become available. Next to lightning detectors on geostationary satellites, new low orbit experiments are giving an unprecedented insight in the very source of these processes. Looking at the physics behind these new observations requires however to have a variety of different instruments covering the same event, and this is proving extremely challenging. Here, we present observations of UV emissions of elves and lightning taken for the first time simultaneously from the two instruments Mini-EUSO and ASIM operating on the international space station. Mini-EUSO was designed to perform observations of the UV-light night emission from Earth. It is a wide field of view telescope (44°x44° square FOV) installed for the first time on October 2019 inside the Zvezda Module of the ISS, looking nadir through a UV transparent window. Its optical system consists of two Fresnel lenses for light collection. The light is focused onto an array of 36 multi-anode photomultiplier tubes (MAPMT), for a total of 2304 pixels. Each pixel has a footprint on ground of ~5.5 km. The instrument is capable of single-photon counting on three different timescales: a 2.5 microsecond (D1) and a 320 microsecond (D2) timescale with a dedicated trigger system, and a 40.96ms timescale (D3) used to produce a continuous monitoring of the UV emission from the Earth. ASIM is an experiment dedicated to lightning and atmospheric processes. Its Modular Multispectral Imaging Array (MMIA) is made of an array of 3 high speed photometers probing different wavelength sampling at rates up to 100 kHz, and 2 Electron Multiplication Charge Coupled Devices (EM-CCDs) with a sub-km spatial resolution with an 80° FOV and recording up to 12 frames per second. Mini-EUSO detected several bright atmospheric events like lightning and elves, with a few km spatial resolution and different time resolutions, probing therefore different stages of the electromagnetic phenomena. Observations from Mini-EUSO were simultaneously

captured by ASIM instruments, allowing for the first time to compare and complement the capabilities of the two instruments with a time inter-calibration based on unambiguous series of lightning detections.

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