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# HOW HYPERVELOCITY IMPACTS CAN AFFECT THE LISA MISSION – THE MIRAD STUDY

**Abstract**

ESA's laser interferometer space antenna (LISA) mission is a space based gravitational wave detector under development with unprecedented accuracy and resolution. The mission requires that three spacecraft prevent external influences on the enclosed test masses, and maintain a laser link across circa 2.5 million km. Hypervelocity impacts of micrometeoroids may pose a threat to both these tasks.

While the protective properties of spacecraft structures are well known for many materials present at spacecraft exterior, the attitude disturbances induced by microparticle impacts onto spacecraft are only poorly understood. It is known that hypervelocity impacts cause target surface material to be ejected against the impact direction, causing an enhancement of the momentum transferred. This effect has been studied for geological materials and aluminum in the past, but not for relevant state-of-the-art spacecraft structure materials like carbon fiber reinforced plastic (CFRP) sandwich panels.

To characterize the microparticle impact related attitude disturbances (MIRAD) on the LISA spacecraft, ESA has initiated a dedicated study. This study comprises of hypervelocity impact experiments on spacecraft representative samples (mainly CFRP), modeling of the momentum transferred in such impacts, development of a software engineering tool for simulating the dynamic response of the satellite, validation of this software using in-flight spacecraft data of validation cases, and application of the software to the current baseline of the LISA mission.

The manuscript gives an overview on the MIRAD study and presents the experimental testing and momentum enhancement modelling approach. This includes identification of the size and momentum of relevant impacting particles based on the LISA mission parameters (orbit, expected duration), relevant test articles based on the preliminary LISA spacecraft design, description of available momentum transfer models, and description of the measurements planned to derive the momentum transmitted onto the spacecraft following a microparticle impact.