

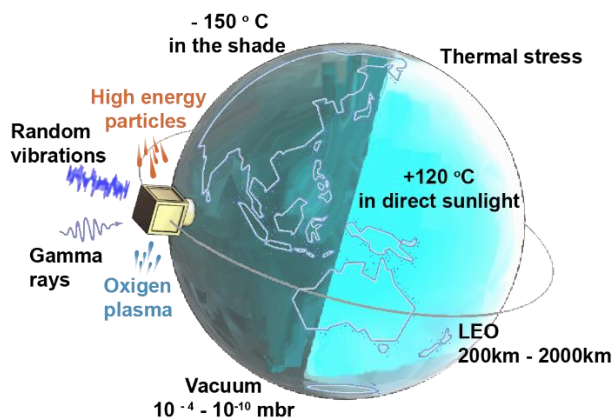


Физически факултет на
СУ "Св. Климент Охридски"
Общофакултетски семинар
27.04.2026, 16:00, А415 (Заседателна зала)

Meta-optics for space applications: space environment stress testing and nonlinear imaging applications

доц. д-р Христо Илиев

The growing demand for enhanced fast and reliable remote sensing from space requires new solutions that allow engineering and extended functionality as well as a reduction in size and weight of space-borne optical devices. One promising candidate is the so-called meta-optical elements, a technology that could enable the replacement of the bulky and heavy glass objectives with lightweight, thin-film-based optical systems and allows for the development of custom, multi-purpose designs, without cascading multiple optical elements, tailored to particular space mission requirements or specific applications. However, the integration of meta-optical elements with Short Wave Infra-Red sensors is yet a challenging task when designing space system payloads, mainly because of their low Technology Readiness Level, and it is still not well known whether the meta-material nanostructures can retain their optical characteristics in a space-born mission and withstand the harsh space environment.



Space environment stress testing of optical systems. Schematic illustration of space environmental effects and their typical levels during and after insertion of an instrument into Low Earth Orbit (LEO).

To assess the durability and the potential for space applications, in this work we present the design, fabrication, and optical characterization of 1550-nm silicon-based diffractive metalenses on a sapphire substrate, exposed to various common space-environment stresses, in accordance with ECSS-E-ST-10-03C Rev. 1 and the European Space Agency recommendation guide. We first performed optical characterization of the fabricated structures, including measurements of the diffraction efficiency, optical transmission, focal length, the Point Spread Function and the Modular Transfer Function. Then, different samples were exposed to the most common stresses in orbit, such as radiation (including gamma rays and low-energy proton radiation), atomic oxygen, random vibrations, thermal stress, etc. For each test, metalenses were characterized before and after the stress, and the results were compared.