22-2022 R3-0011

Appendix G: SMD Astrophysics: Proportional Counter for Absolute X-Ray Flux Calibration

Iowa State University - Iowa Space Grant Consortium

Dr. Tomas Gonzalez-Torres

The accuracy of fundamental cosmological constraints derived from X-ray observations of clusters of galaxies is limited by the accuracy of the flux calibration. We propose to build and demonstrate a proportional counter for absolute X-ray flux calibration in collaboration with NASA/GSFC. This work will support the active development of mission concepts for X-ray flux calibration by researchers at NASA/GSFC and lead to future partnerships on related research.

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Appendix K: Metalized Ceramic Nanoparticle Containment Filter Systems for Mars Missions (Nanofiber Filters)

Louisiana State University

Prof. Gregory Guzik

Our approach for microbial growth mitigation in spacecraft environments and on planetary surfaces focuses on the dual-threat of the entry of Martian pathogens and the release and spread of earth microbes into the Martian environment. We have developed a metalized nanofiber-based, and 3D printed air filtration unit and systems. Our filtration unit protects against the entry of pathogens and particulate material (dust/DNA/particulates). The porosity of our filter membrane (50 nanometers) prevents the entry of pathogens and uses embedded metal ions to enhance entrapment, containment, purging, and analysis of entrapped material.

Pilot studies have confirmed their containment potential for preventing microbial disease transmission and preventing bacterial colonization and biofilm formation. Furthermore, we believe this technology can enhance life support systems in crewed spacecraft and habitats.
Our technology can be employed in filtration systems throughout the spacecraft to prevent pathogen entry or exit, ensuring astronauts' safety in space. In addition, in airlock environments of future space habitats (Mars), there is a need to limit planetary dust, debris, and airborne pathogens into the living portions of the habitat. Furthermore, there is a coordinated need to prevent the escape of earth microbes/DNA and other material of terrestrial origin.

Metal-coated (Ag, Cu, and Zn) halloysite nanotubes (mHNTs) were developed to produce air-tight and interchangeable filters and filter housings. Our method offers a one-step and low-cost process with many other advantages. With solution blow spinning, the deposition of mHNTs or dual-coated mHNTs can be sprayed on a 3D printed framework as a fibrous membrane or film coating. On human-crewed space missions, our ventilation systems will protect against airborne pathogens by deactivating a virus, reducing or eliminating bacterial adhesion, preventing bacterial growth, eliminating airborne particulates. Our filter units can be further coated with materials that mitigate the entry of particles smaller than 50 nanometers on crewless spacecraft. Funding is requested for further prototype development, testing, and validating our air filtration capabilities and antimicrobial/viral potential. This project will require one year to accomplish proposal objectives.

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Appendix J: Improving Estimates of Land-to-Ocean Carbon Flux Through Characterization of Colloidal Inherent Optical Properties

Maine Space Grant Consortium

Dr. Terry Shehata

The retrieval of dissolved organic carbon (DOC) concentrations from ocean color remote sensing reflectance (Rrs) is a key step in the monitoring and prediction of carbon fluxes from land to ocean. However, its retrieval has traditionally been challenging in estuarine and coastal ocean systems, because at visible and near-ultraviolet wavelengths, colored dissolved organic matter (CDOM) absorption coefficients (ag) and DOC are often not well-correlated, and because sensors with high spatial and temporal resolution are required. Further complicating matters is the typical, operational partitioning of carbon and inherent optical properties (IOPs) by size, through filtration with size cutoffs ranging from 0.2-1 m. In the transition from land to ocean, this size range encompasses an important pool of colloidal material whose optical properties are not well-characterized. The estuaries that empty into the western Gulf of Maine will serve as the site for this research, because these watersheds generate a high dynamic range in CDOM sources, and because climate-driven changes in precipitation are expected to drive greater export of terrestrial organic carbon to the Gulf of Maine.

This proposal has three main objectives. The first is to adapt a generalized algorithm for the retrieval of CDOM optical properties and DOC concentration from ocean color for use in coastal Maine estuaries, and with imagery from the high resolution Landsat 8/9 and Sentinel 2a/b sensors. Our second objective is to determine the influence of colloidal matter (< 0.2 m) on the optical properties of DOC in transitional waters between the land and the ocean, and to conduct a sensitivity analysis of the DOC retrieval algorithm to natural variability in colloidal IOPs. The third objective is to estimate fluxes of DOC through coastal Maine estuaries to the Gulf of Maine using high resolution ocean color observations, as well as uncertainties in fluxes that arise from variable carbon-specific IOPs of DOC in the source waters.

We will use opportunistically-collected surface water samples from three contrasting estuaries (Penobscot, Damariscotta, and Sheepscot) to characterize sub-micron, colloidal optical properties. A flow-field flow fractionator coupled to a volume scattering sensor and offline long-path UV-visible absorption measurements will provide detailed information on the size dependence of colloidal IOPs, and how these covary with organic carbon (OC) concentration. We will then test the agreement of size-fractionated colloidal IOP and OC measurements with the assumptions of an existing, DOC algorithm