Engineering at the Extremes: NASA Technology Development Across 30 Orders of Magnitude

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Physics of the Cosmos Early Career Workshop
Nov 20, 2024

A Quick Introduction

Astrophysics PhD Student
Second-year grad student, MIT Physics
X-ray Polarimetry Lab

BA Astrophysics + Math
Columbia University
Science Research Fellowship

MSc Space Science and Technology
University College Dublin
Mitchell Scholar

Prior Research
Mechanical Engineering, Civil Engineering,
Biological Sciences, Gamma-ray astrophysics

Observations
Neutron Star and Black Hole X-ray Binaries
Spectropolarimetry

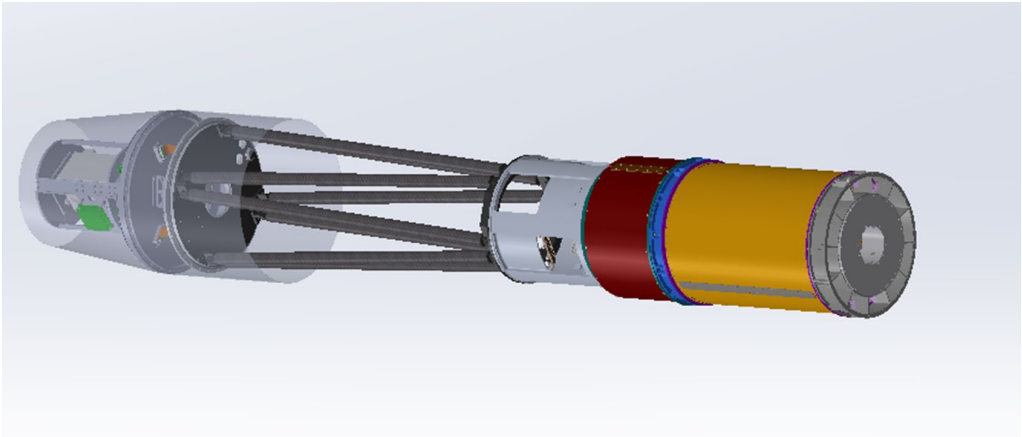
Soft X-ray Polarimetry
REDSoX sounding rocket mission
X-ray grating and detector instrumentation

Statistical Methods
Magnetic field rotations
Bayesian polarimetry analysis

High-Resolution X-ray Optics
Developing diffraction-limited Wolter I optics

The Rocket Experiment Demonstration of a Soft X-ray Polarimeter (REDSoX)

- Science Targets:
  - Blazars
  - Isolated NS
- Wolter-I Ni optics (MSFC)
  - 15-25” HPD
  - 80 kg
- CAT gratings (MIT)
- 3 polarimetry channels
  - LGML
  - CCD



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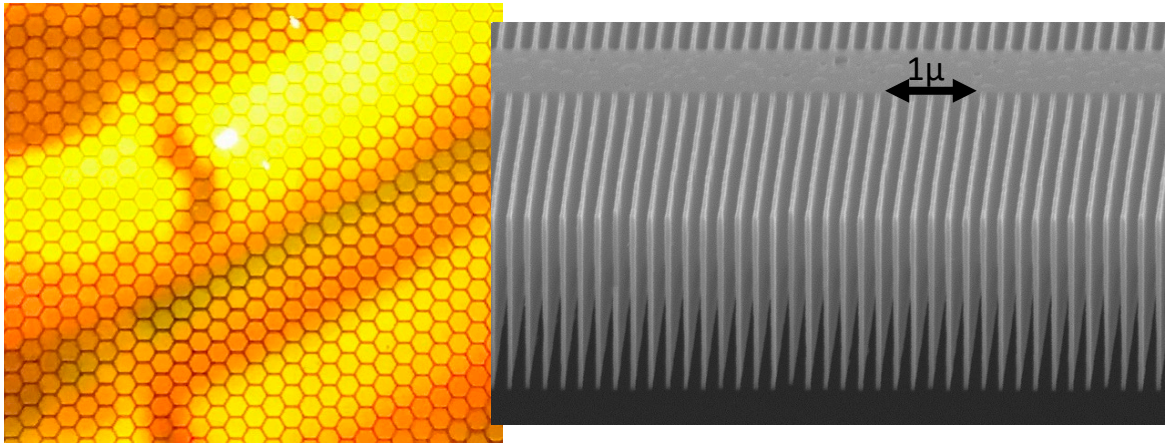

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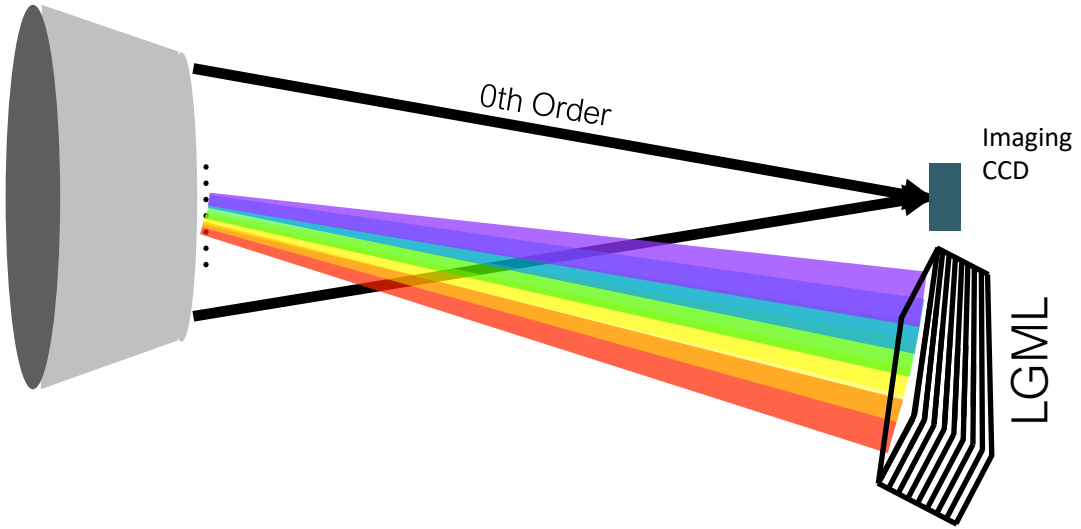

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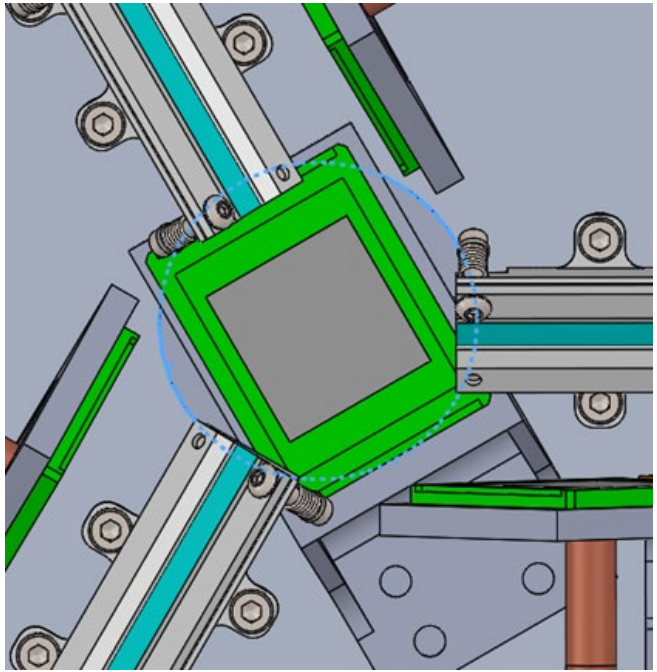
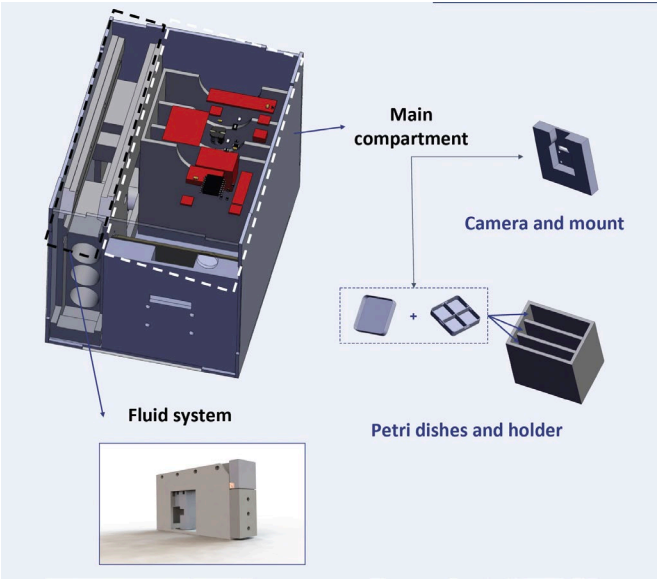


Characterizing Antibiotic Resistance in Microgravity Environments (CARMEn)

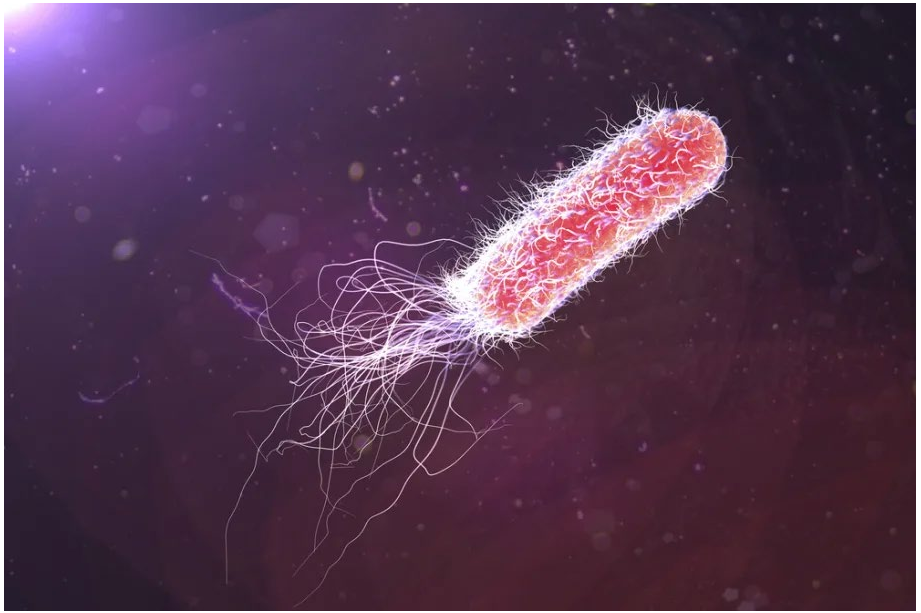
- 30-day NASA mission to the ISS studying how bacteria develop antibiotic resistance differently in microgravity
- 3U autonomous payload
- Flown on SpaceX CRS-24 Dec, 2021

Astronaut Raja Chari installing CARMEn on the ISS



Space-based technology development looks similar across scales

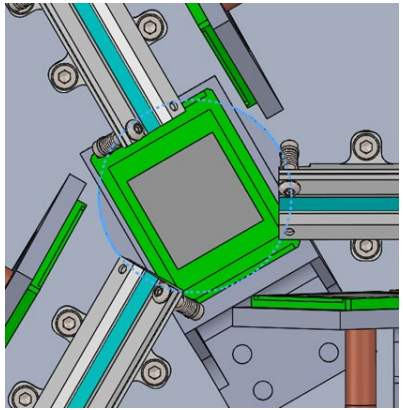
Mrk 421, ~10^{16} m
SDSS

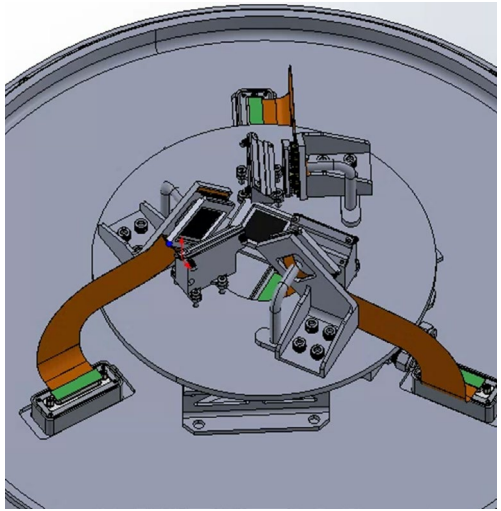


Pseudomonas Aeruginosa, ~1µm
Shutterstock

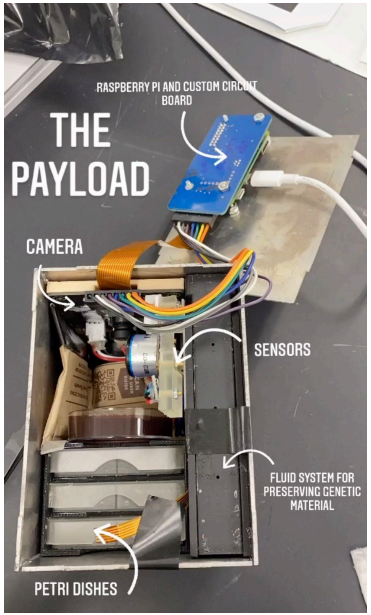
Thinking Small

REDSoX



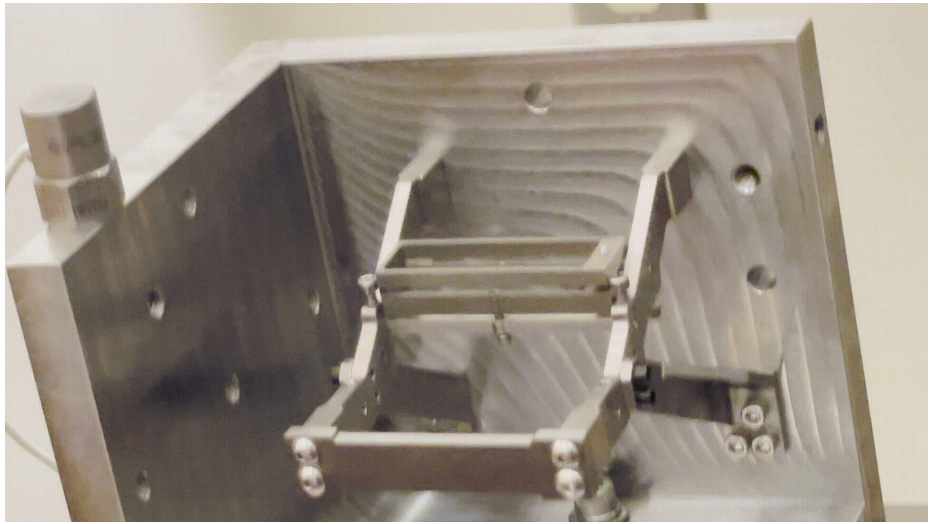


CARMEn



Surviving Launch

REDSoX



CARMEn