Micromirror Magic: A New Era for Multi-Object Spectroscopy

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INTRODUCTION

Goal: Integrating and testing a Digital Micromirror Device (DMD) based Multi-Object Spectrograph (MOS) that can simultaneously image a target field and configure to obtain the spectra of multiple objects near instantaneously.

Current MOS systems suffer from long setup times, mechanical complexity, and limited slit customization. The DMD-MOS addresses these issues by enhancing efficiency and flexibility, making it ideal for high-throughput surveys, detailed spectral mapping, and rapid, adaptable spectroscopy.

Advantages over existing MOS technologies:

- **Programmable Slits:** Real-time customization for flexible spectroscopy.
- **Efficiency:** Instant reconfiguration, faster setup.
- **Simplicity:** Binary control reduces mechanical complexity.
- **Cost-Effective:** Reduced need for physical masks and maintenance.

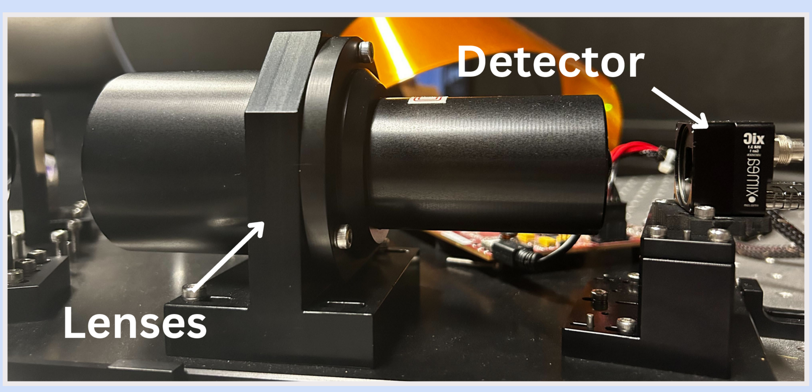
DIGITAL MICROMIRROR DEVICE (DMD)

A DMD is a grid of 786,000 microscopic mirrors that can be programmed to point ±12° from its flat state. This allows it to be used as a programmable slit for spectroscopy.

- Assembled all the lenses, mirrors, and mounts to the DMD-MOS baseboard.
- Acquired and set up a DLP7000, and gained familiarity with its operating software.
- Created binary masks in Python to direct selected mirrors to the imaging or spectral channels.

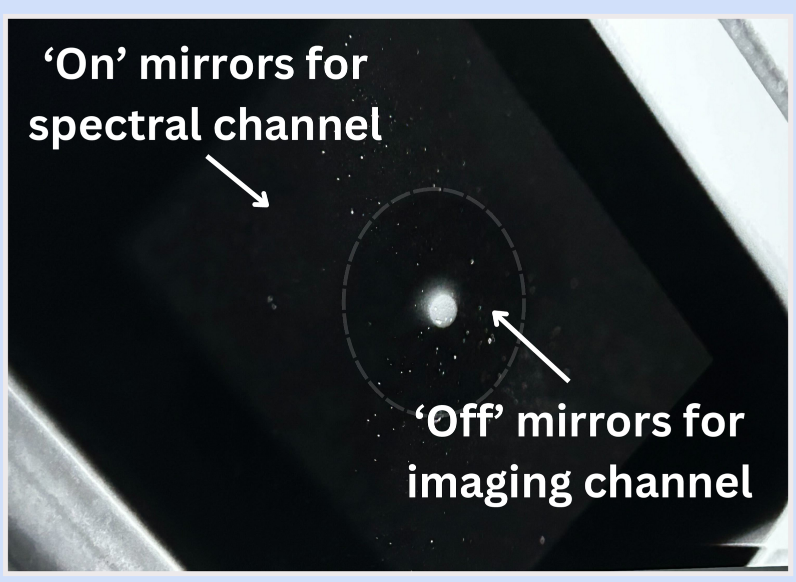
Kirby on DMD!

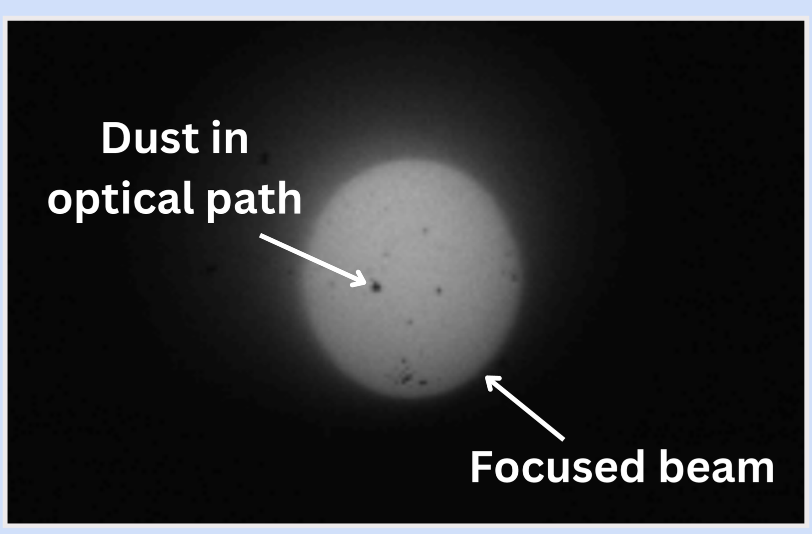
IMAGING CHANNEL



This channel uses a system of lenses and a Ximea xiC sCMOS camera to capture detailed images of the target field. These images will be used to identify the targets and actuate the respective DMD mirrors.

- Focused collimated light from a 697 nm LED onto the DMD in the 'off' position.
- Redesigned DMD mount to ensure proper alignment.
- Adjusted the positions of all optical components to achieve the sharpest image.



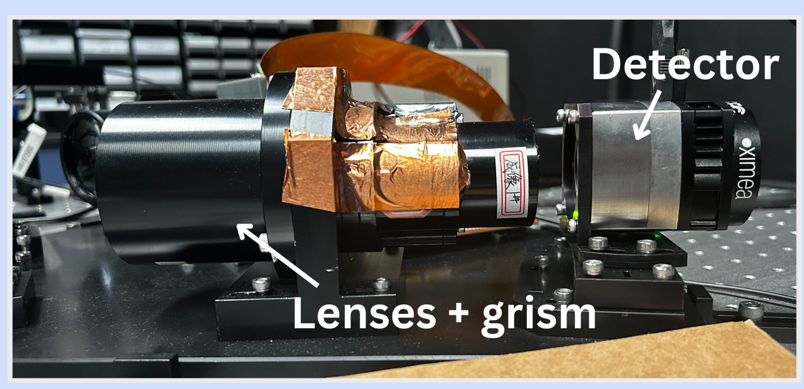


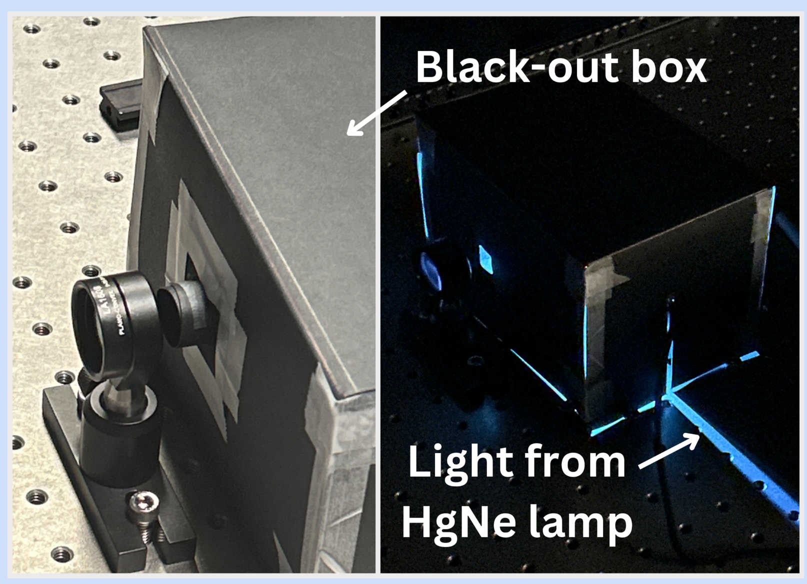
Next steps:

- Improve focus using an alignment telescope.
- Create a Python pipeline for automatically detecting targets and switching on corresponding mirrors on the DMD.
- On-sky testing.

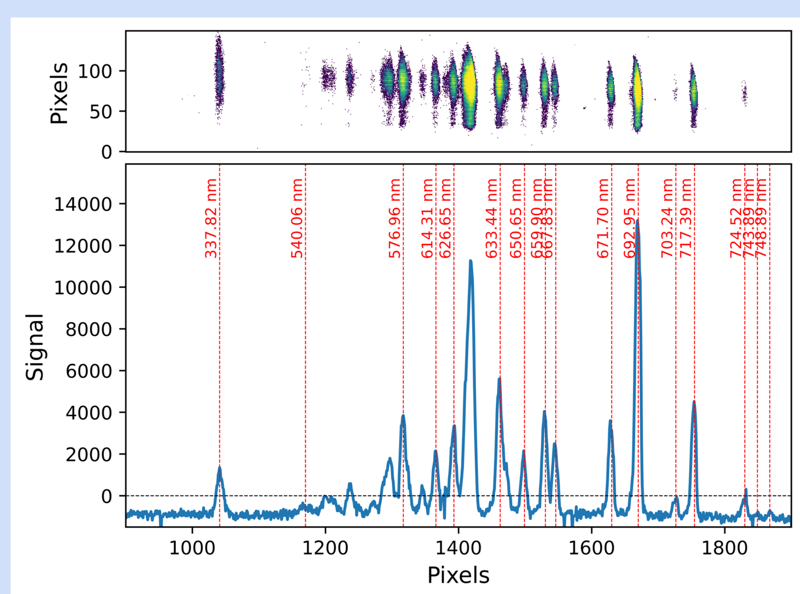
SPECTRAL CHANNEL

This channel uses a system of lenses with a grism and a Ximea xiJ sCMOS camera to acquire spectral data from multiple target objects. It has a target wavelength range of 450-700 nm.





- Focused collimated light from a HgNe lamp onto a thin slit on the DMD in the 'on' position.
- Designed a blackout box to minimize stray light from lamp.
- Developed a test wavelength solution using HgNe lines.



Next steps:

- Use Ne and Xe lamps to build a wavelength solution.
- Get a test spectrum of the Sun.
- Create a Python pipeline for simultaneous detection and analysis of multiple spectra.
- On-sky testing.