The Space Telescope Ultraviolet Facility (The STUF)

Future space-based multi-object spectrographs (MOS) in the Ultraviolet (UV), as those envisioned for LUVOIR, have the potential to enable studies of the chemistry of protoplanetary disks in nearby star forming regions, of mass accretion in young stars, of massive star formation in the Local Volume, of the inter-galactic and circum-galactic media, of spatially resolved feedback throughout star-forming galaxies, of Lyman escape photons in nearby star forming galaxies, of AGN and their host galaxies, and more.

Technological advancements are required to improve the performance of space-based MOS. A crucial component of a MOS is the object-selection device. Digital Micromirror Devices (DMDs) are currently the only alternative to micro shutter arrays (MSAs) as slit selection mechanisms for space-based MOS. DMDs consist of an array of mirrors that can be individually tilted in 2 different states. "ON"-mirrors can send light to a spectrograph, "OFF"-mirrors reflect it away (see Figure 1). NASA-funded tests have concluded that DMDs are highly-reliable systems, resilient to heavy radiation and with outstanding response to vibration testing. DMDs have been used in visible and near-IR astronomical instruments. One of such instruments, SAMOS, is currently being developed by our joint STScI/JHU group.

We recently obtained a large grant that will enable testing of the DMDs optical performance in the near- and far-UV. Our optical bench will be hosted within the Makidon Lab at STScI. The Instrument Development group at Hopkins (JHU/IDG) has a very importnat role in designing, building, and conducting the necessary experiments. Thanks to our study, we will achieve significant progress toward a Technology Readiness Level that will make DMDs a viable alternative to MSAs for NASA explorer, probe or even flagship class missions.

While our main goal is to characterize the UV properties of the DMDs in the lab, there is potential for further development. Our mid-term (5-10 years) goal is to build NUV and FUV DMD-based MOS for small-sized satellite missions. Our project will contribute to making future UV MOS more likely, and thus help increasing access to the UV sky for the coming decades.

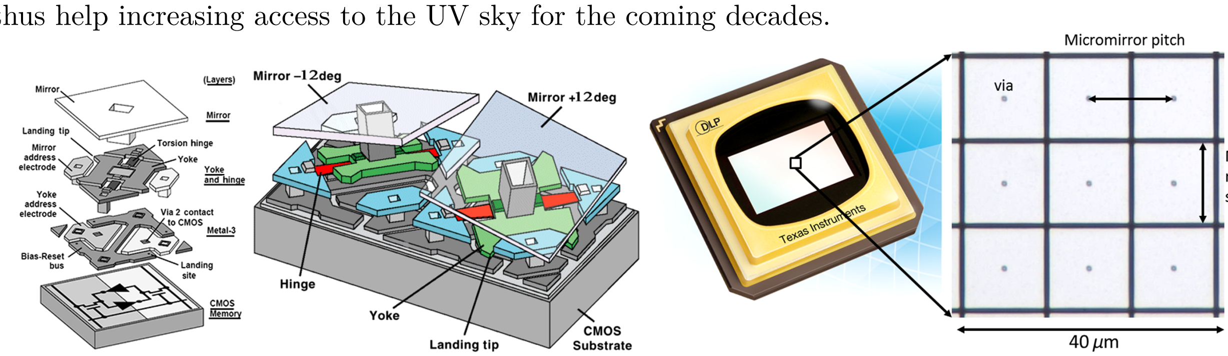

Figure 1, Left: Exploded view of a DMD pixel consisting of the micromirror itself, two electrode layers, and a CMOS memory layer; **Center:** two DMD pixels in opposite operational states. **Right:** DMD array chipset.

The student role

We expect that an enthusiastic and well motivated student will be able to contribute to all stages of the project. We are currently setting up the optical bench in the Makidon lab. The student has the opportunity of participating in these initial stages of equipment testing and initial hands-on setup.

There are two main lab experiments that we will conduct, organized in two subsequent stages: a reflectometer test and a benchtop imager/spectrograph test (see Figure 2). The student will be involved in the design, hardware installation, software development, experimental setup, data taking and data analysis steps, i.e. basically in all stages of the project. They will also be involved in future proposals related to the main project (e.g. NASA proposals seeking funds for small space missions and further technology development).

We envision the two stages of the main project to require about one year each for completion, thus there is definitely the potential for this work to become a substantial fraction of a thesis project. At a minimum, we expect that the student will be leading the two papers describing the results of the two main experiments. We also expect that the student will be presenting their work at relevant conferences (e.g., SPIE photonics, AAS). We have already allocated funds for the latter.

Our group is committed to creating an inclusive, diverse environment. We especially welcome expressions of interest from women, minorities, veterans, LBGTQ+ people, and other members of underrepresented groups. All interested students are welcome to reach out to Dr. Mario Gennaro (gennaro@stsci.edu) with specific questions and/or with requests to find a suitable time to talk in person and go over the project in more details.

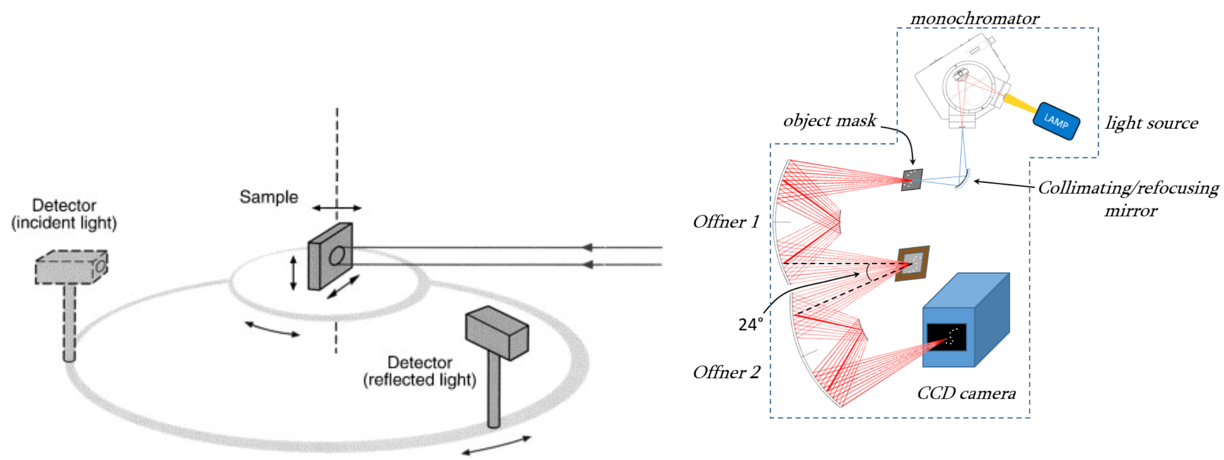

Figure 2., Left: Cartoon rendition of a reflectometer setup, with the rotating sample (the DMD, in our case) and detector illustrated. This setup will allow, in stage 1, to characterize scattering, diffraction, total efficiency of the DMDs as a function of angle of incidence and wavelength. **Right:** Schematic view of the bench-top instrument simulator. This setup will allow, in stage 2, to measure the DMDs properties while the DMD is used in an optical layout similar to what we expect for a real space DMD-based multi-object spectrograph

The team

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Further readings

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