SURP 2021 week 3:
Digital Micro-mirror Device Multi-Object Spectrograph

Rosalind Liang

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Long-slit spectroscopy

In a traditional long slit spectrograph, a single slit is aligned with a long science object (such as the planar view of a galaxy or nebula). The filtered slit of light passes through a disperser, and the spectra along the length of the object is projected onto the sensor. The basic concept is illustrated in Figure 1 below.

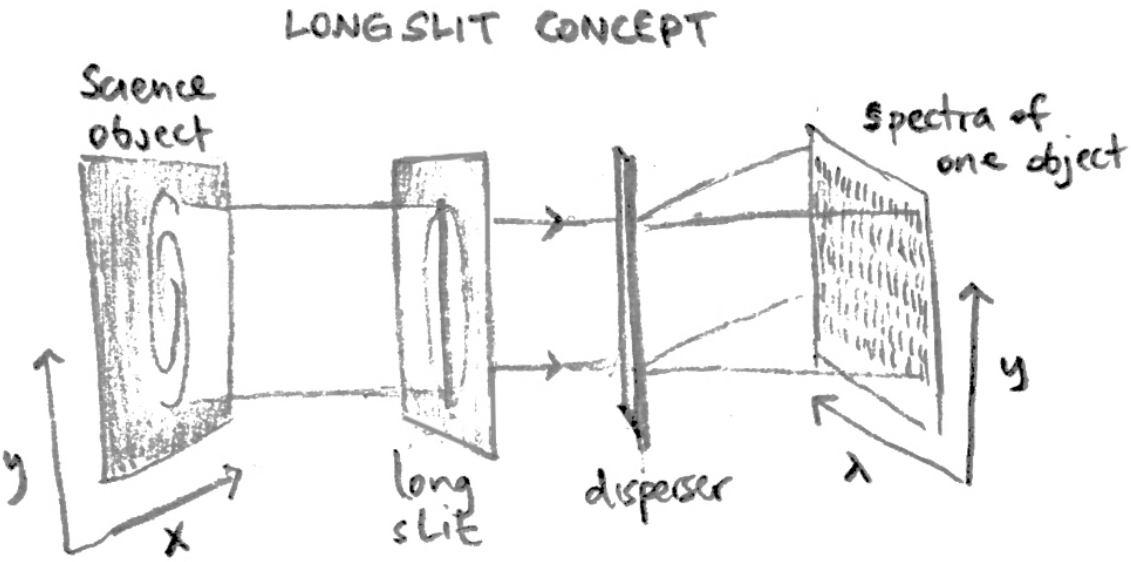

Figure 1: Conceptual diagram of long slit spectrograph

This technique is useful for studying the properties of such single, long objects. For instance, the redshift and blueshift observed along the plane of the galaxy provides insight on the velocity of rotation.

Multi-object spectroscopy

In a multi-object spectrograph (MOS), a programmable slit mask is used to control which particular objects in the field of view will be spectrally analyzed. This allows for the spectra of multiple objects to be captured simultaneously in one measurement.

A digital micro-mirror device (DMD) is an example of such a slit mask. In an array of micro-mirrors, each mirror can be programmed to be tilted either +x or -x degrees. For non science regions of the field off view, mirrors are turned in one direction will direct light from their corresponding coordinates to an absorber. For science objects, respective mirrors are turned in the opposite direction to direct their light towards the disperser, so that each of their individual spectra is projected onto the sensor. This basic setup is illustrated in Figure 2 below.

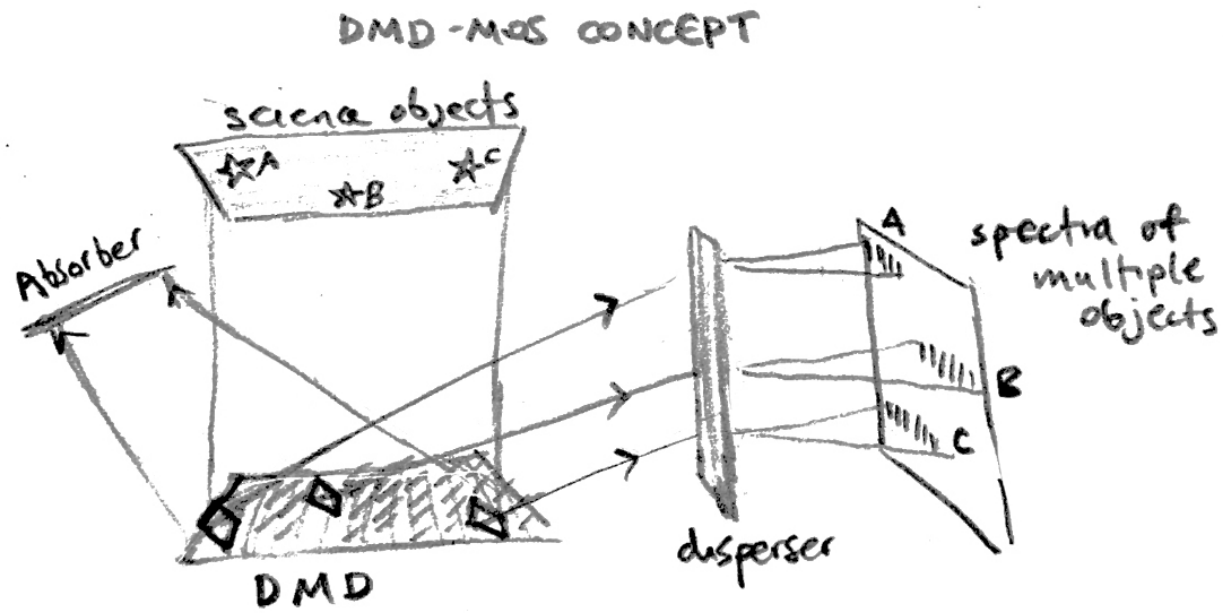

Figure 2: Conceptual diagram of DMD-MOS spectrograph

Unlike with traditional long-slit spectroscopy, the DMD allows isolation of precise regions in the field of view from which to extract spectra. This technique is useful for imaging a set of multiple objects, such as a cluster of stars distributed through the field of view.

Digital micro-mirror device

Within the DMD array, each micro-mirror is able to tilt back and forth via a yoke on a torsion hinge. The tilting in either the +x and -x direction is controlled by electrostatic pads aligned with either end of the yoke, and connected to a complementary metal–oxide (CMOS) semiconductor base. By applying a voltage through either pad, the mirror is tilted towards either the absorber or the disperser.

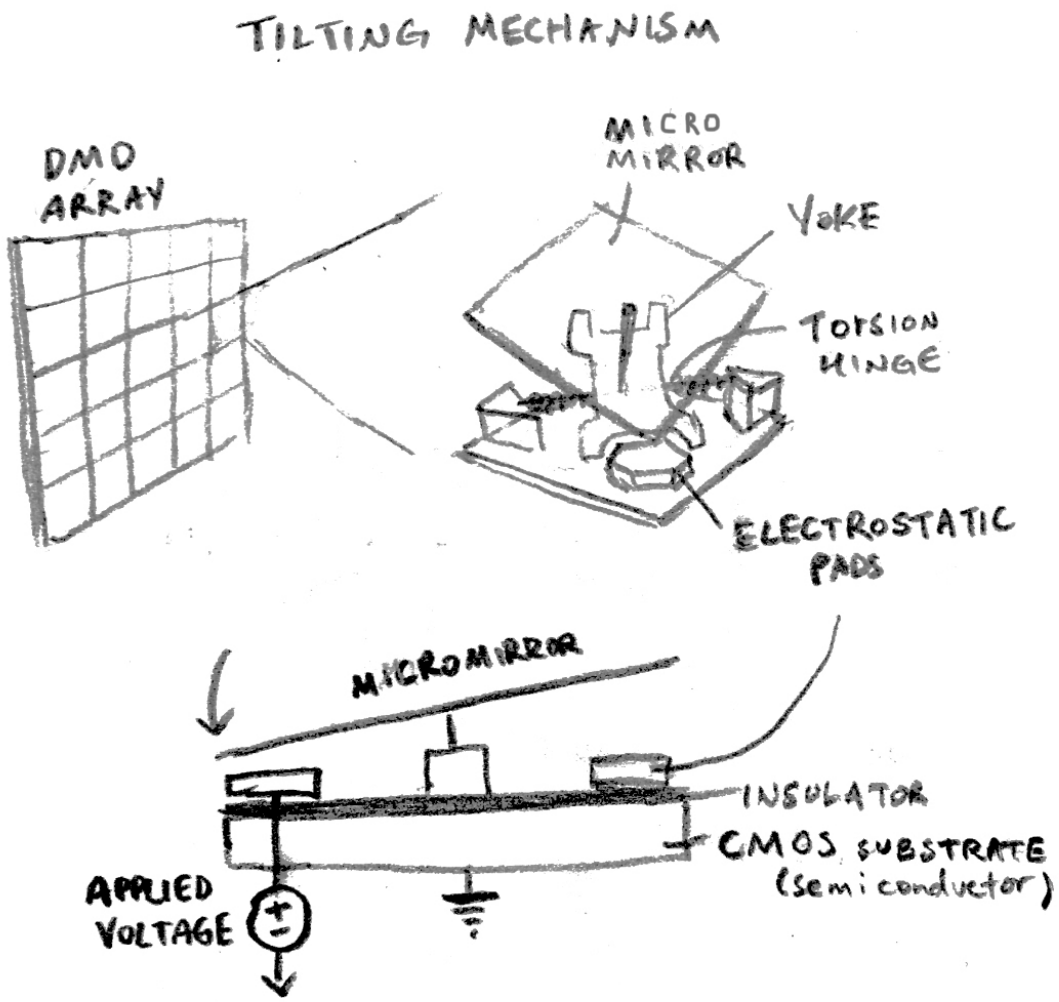

Figure 3: Conceptual diagram micro-mirror tilting mechanism within a DMD