McLeanゼミ

4.5 exercise 2&8

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2. Explain the difference between a Faint Object Spectrograph and a High Resolution Spectrograph. Give an example of a project that would require one or other of these instruments.

Faint Object Spectrograph

- Low spectral resolution ($R \sim 500$)
- This class of spectrographs is basically a CCD camera capable of imaging a spectrum of a faint object with low spectral resolution so as not to "spread out" the available light too much.
- The less the spectrum is spread out, the more light there will be on any given pixel of the CCD and the fainter the source that can be detected.
- Instruments like this are often used to study the most distant objects in the Universe, such as galaxies and quasars at high redshift, supernovae, and the after-glow of gamma-ray burst counterparts.

2. Explain the difference between a Faint Object Spectrograph and a High Resolution Spectrograph. Give an example of a project that would require one or other of these instruments.

High Resolution Spectrograph

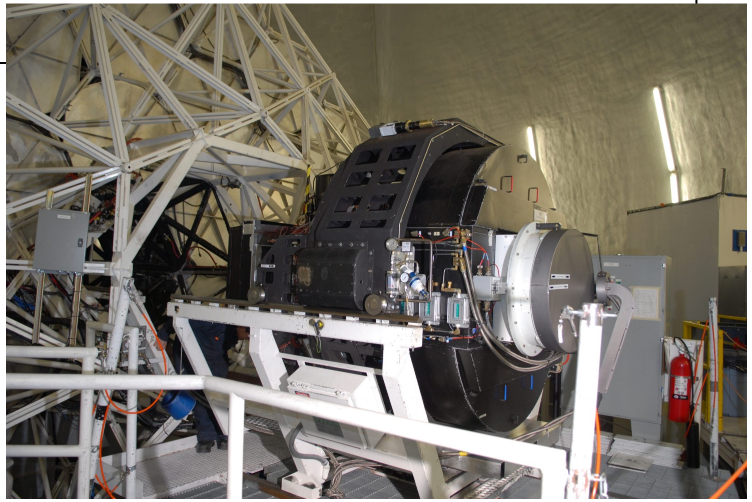
- High spectral resolution (R > 25,000)
- It tends to be very large. Some of these instruments are so large that you can even walk "inside" the instrument.
- It is used for the study of the subtle spectral differences between chemical isotopes, in particular hydrogen and deuterium.
- To properly resolve the weak deuterium line requires high resolution (R=30,000~60,000) .
- It's also used to find the planets orbiting another star with doppler spectroscopy.

2. Explain the difference between a Faint Object Spectrograph and a High Resolution Spectrograph. Give an example of a project that would require one or other of these instruments.

Keck Telescope

LRIS (Low Resolution Imaging Spectrograph)

- R=300~5,000
- Used for almost any type of research, such as studying distant galaxies, active galactic nuclei, quasars, planets, and asteroid



https://www.keckobservatory.org/?s=LRIS

HIRES (High Resolution Echelle Spectrograph)

- R=25,000~85,000
- Known as Keck Observatory's exoplanet finder, HIRES was one of the first instruments in the world to confirm an exoplanet orbit.

https://www.keckobservatory.org/?s=HIRES

8. What is meant by integral field spectroscopy? Explain the different approaches and their advantages and disadvantages.

Integral field spectroscopy

- Spectroscopy technique to obtain spatial information (x, y) and spectral information (λ) simultaneously.

- There are three different methods of integral field spectroscopy.

1. Method with an image slicer
2. Method with a microlens array
3. Method with optical fibers

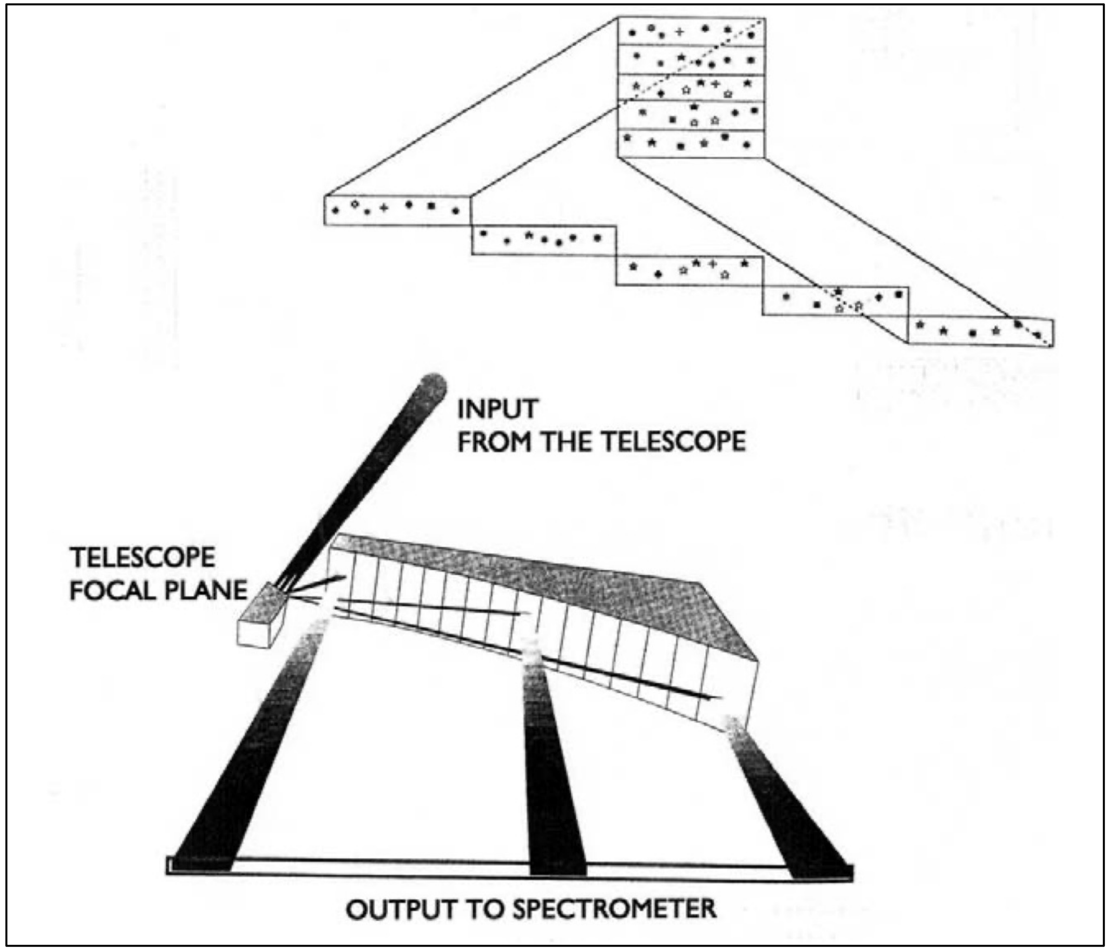
8. What is meant by integral field spectroscopy? Explain the different approaches and their advantages and disadvantages.

1. Method with an image slicer

- Use a complex mirror with many tilted facets to divide the input image.
- Use another mirror to reflect those divided images to enter spectrometer so as not to overlap.

Advantage: Easy to cool because it consists of only mirrors (suitable for IR)

Disadvantage: Hard to design and manufacture complex mirrors



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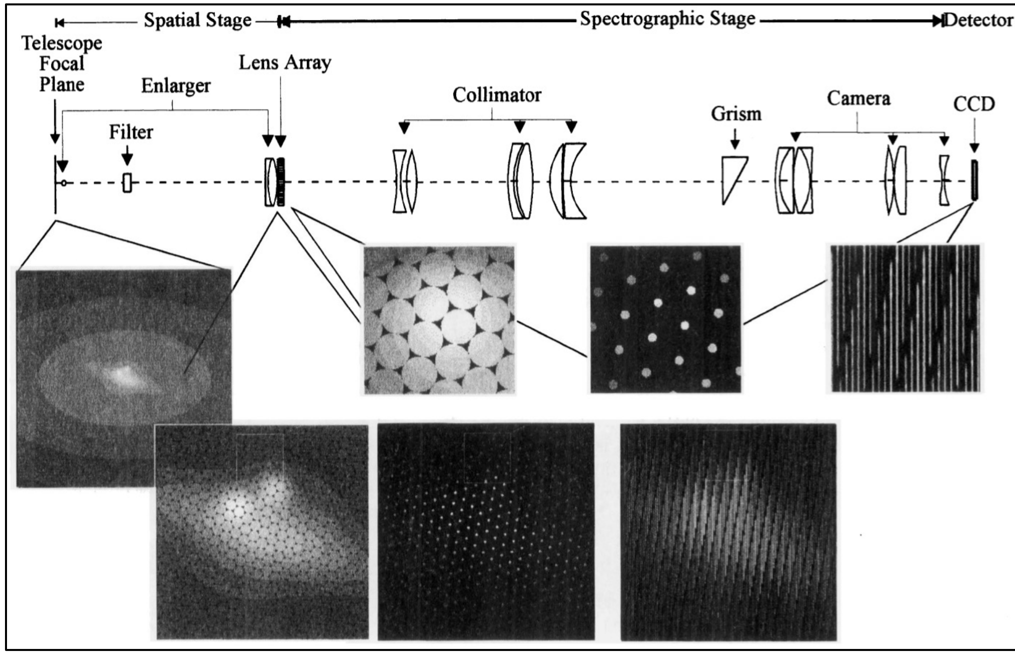
2. Method with a microlens array

- The input image is greatly magnified and enters a microlens array.
- This array effectively slices up the image (spatial sampling) , then those images goes into the spectrometer.

Advantage: Easy to design and manufacture because this system is a collection of lenses

Disadvantage: Inefficient use of the light receiving surface of the detector to prevent contamination between nearby spectra



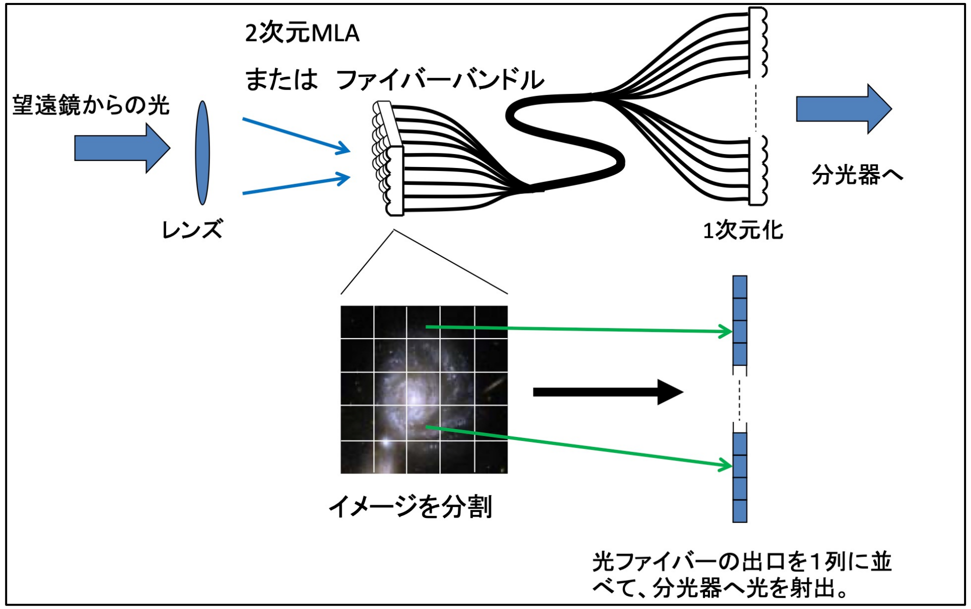
TIGER optical design (Bacon et al. 1995)

8. What is meant by integral field spectroscopy? Explain the different approaches and their advantages and disadvantages.

3. Method with optical fibers

- Divide the focal plane with numerous optical fibers in a 2-D pattern and place other ends of the fibers in a 1-D stack, that is, in a row, which can be input directly to the long slit of a spectrometer.

Advantage: The flexibility of the fibers allows us to deal with various shapes of field-of-view



http://www.oao.nao.ac.jp/stockroom/extra_content/um13/O28_Ohta.pdf

Disadvantage: The focal ratio of the light traversing fibers decreases, (focal ratio degradation; FRD) which makes calibration hard