Fourier Transform Spectroscopy

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[1]s1409123, [2]s1369644

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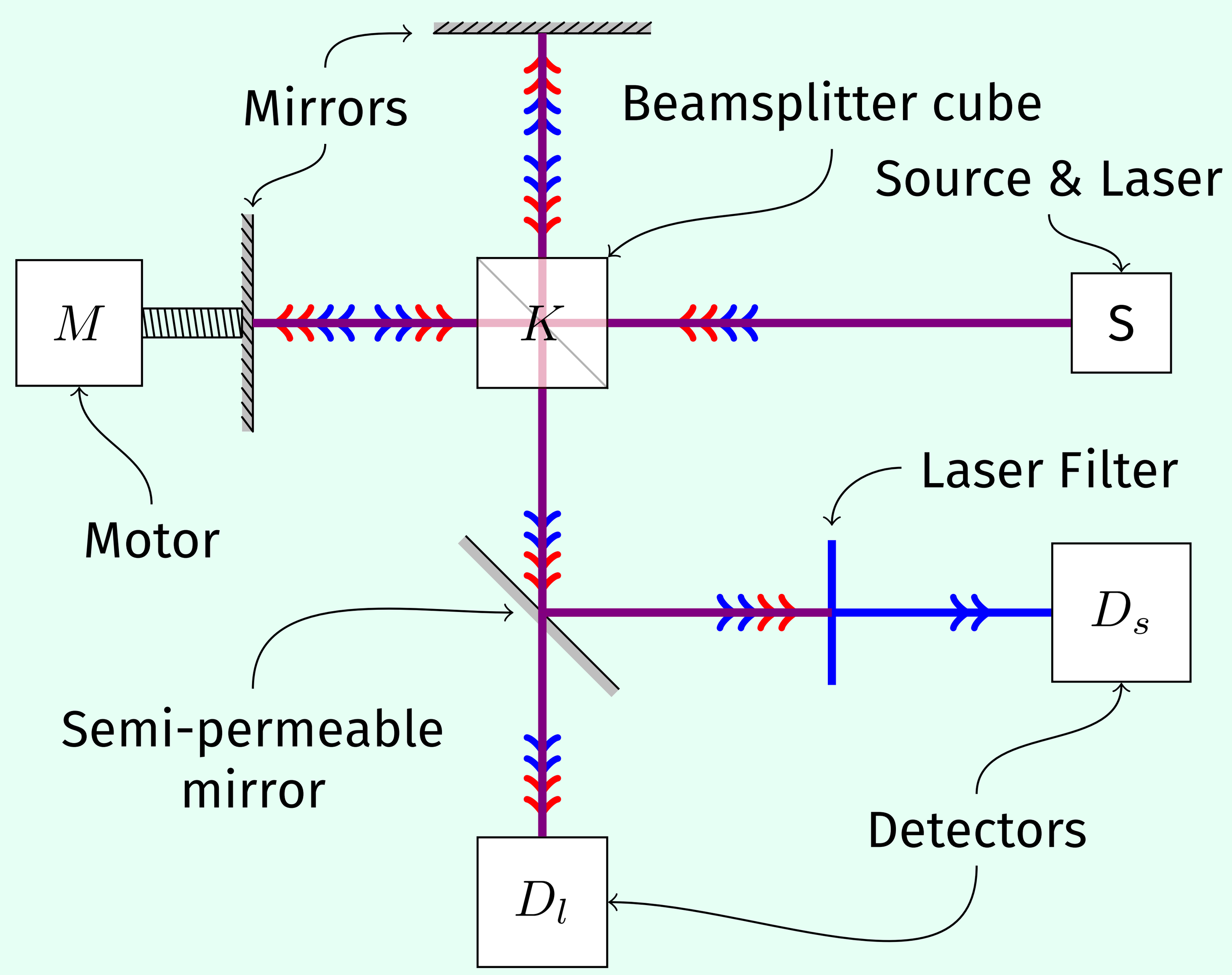
Introduction

In this experiment a Michelson interferometer was used to measure the emission spectra of several light sources and the transmission spectra of a selection of light filters. These spectra were then compared to known spectra.

Setup



Methods

The setup above shows the Michelson interferometer that was used. The two beams in the interferometer cause variable interference because one of the interferometer arms is variable in length. The frequency with which constructive interference occurs is proportional to the frequency of the light source. The fourier transforms from the two sensor signals are then compared and, using the known spectrum for the laser, the resulting spectrum is computed.

Results

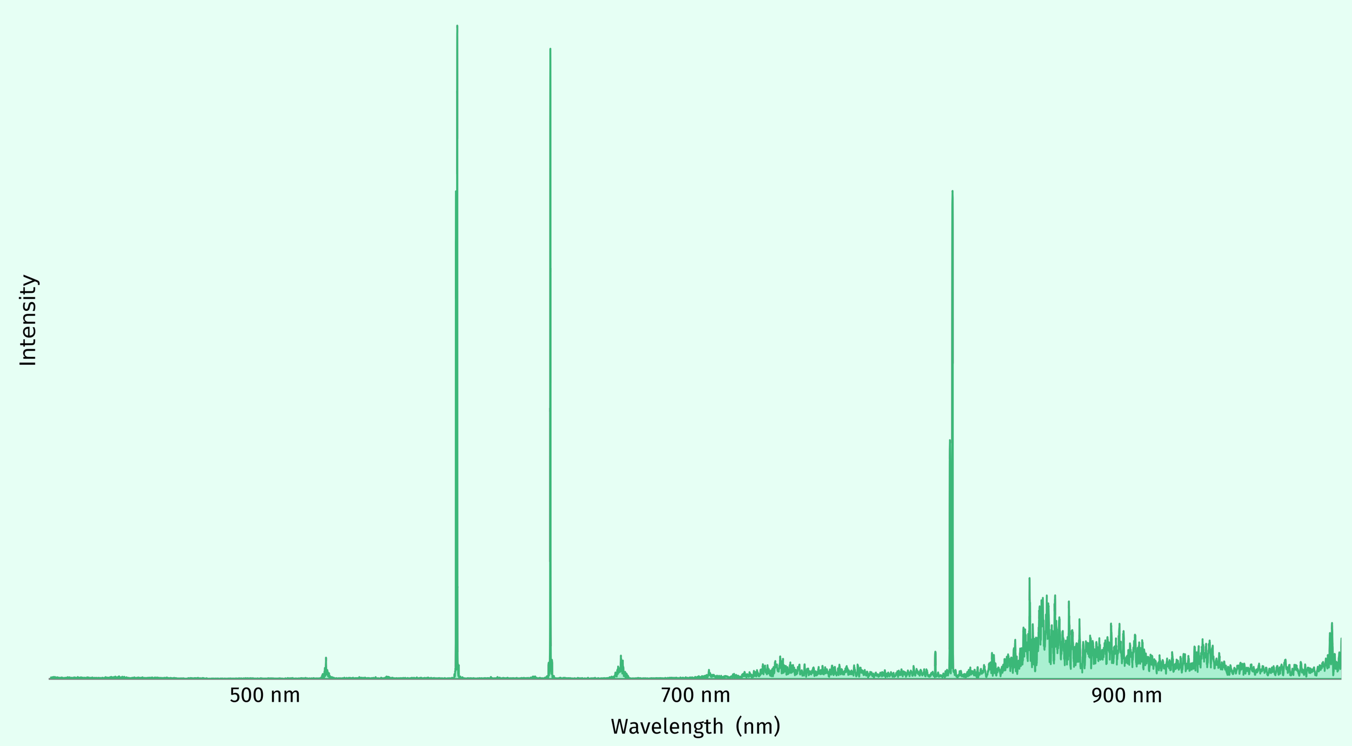


Figure 1: Emission spectrum of a sodium lamp.

Figure 1 shows the emission spectrum of atomic sodium. The spectral lines at 589.0 nm, 589.6 nm, 818.3 nm and 819.5 nm all correspond to known sodium emission lines as recorded by the NIST[1] to within a margin of 0.1 nm. Note the line at 632.8 nm, which is caused by the laser (This disturbance is also seen in the other spectra).

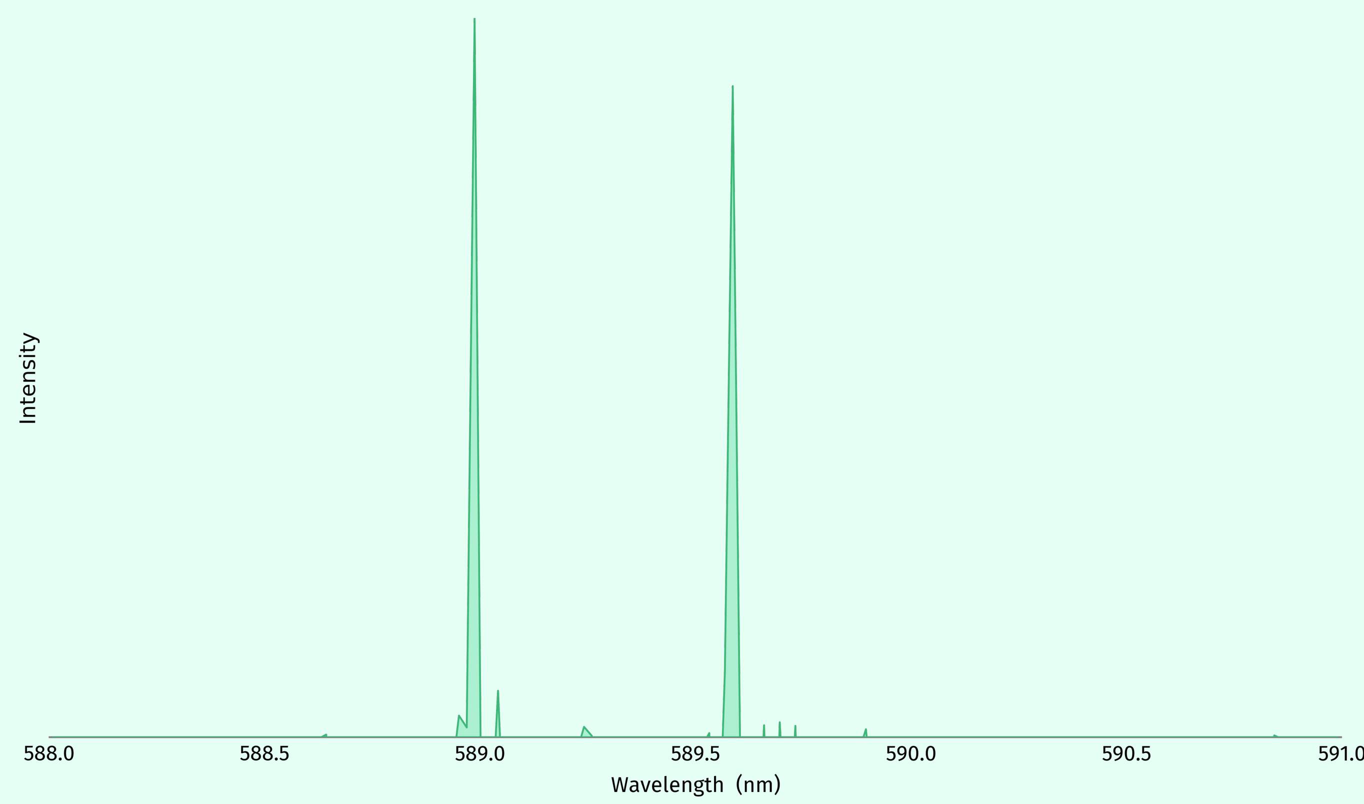


Figure 2: Doublet lines from the spectrum shown in figure 1.

The doublet in the sodium spectrum around 589 nm is shown in figure 2. This doublet is a result of a lifted degeneracy resulting in two sharp lines at 588.99 nm and 589.58 nm. Both lines match known NIST data[1] to within 0.01 nm.

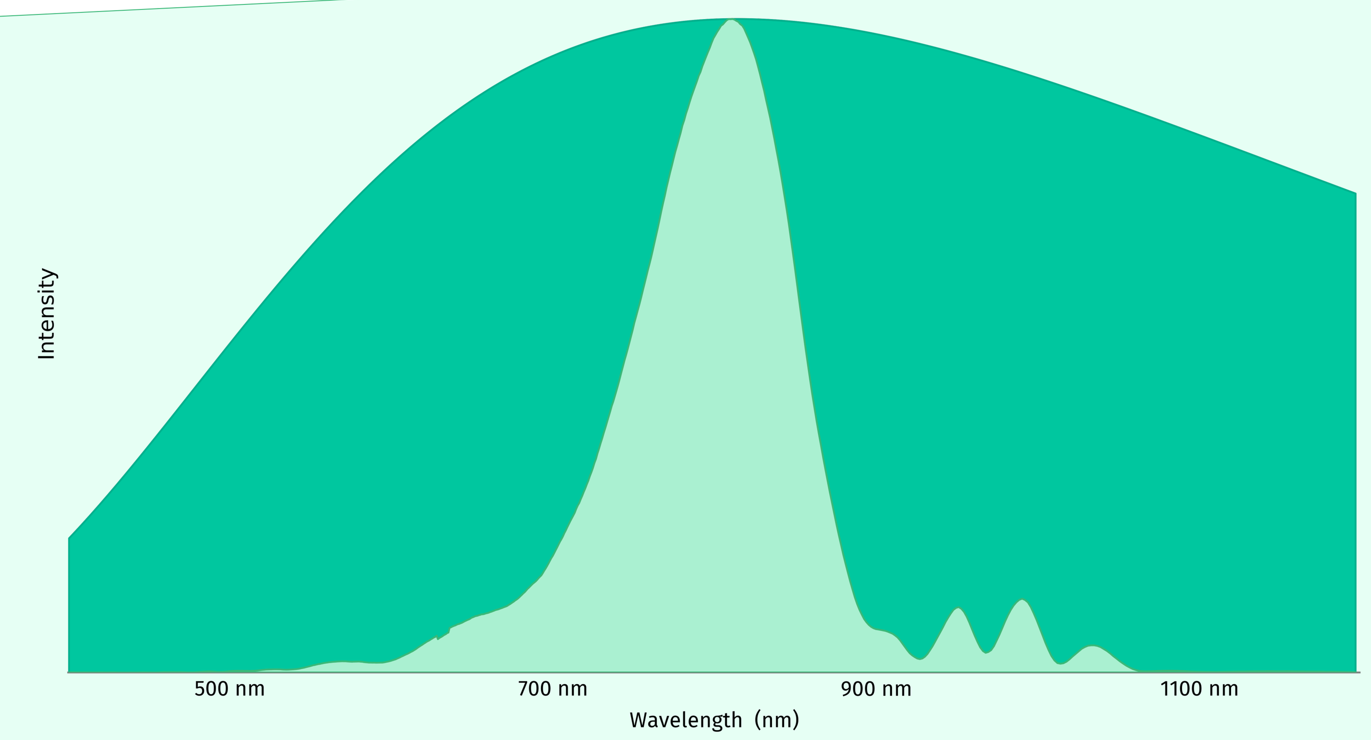


Figure 3: Emission spectrum of a tungsten light bulb. The dark region is the corresponding Planck curve.

The spectra of a tungsten lamp and a Planck curve with the same peak wavelength are compared in figure 3. The difference between the two curves is due to the wavelength-dependent sensitivity of the setup.

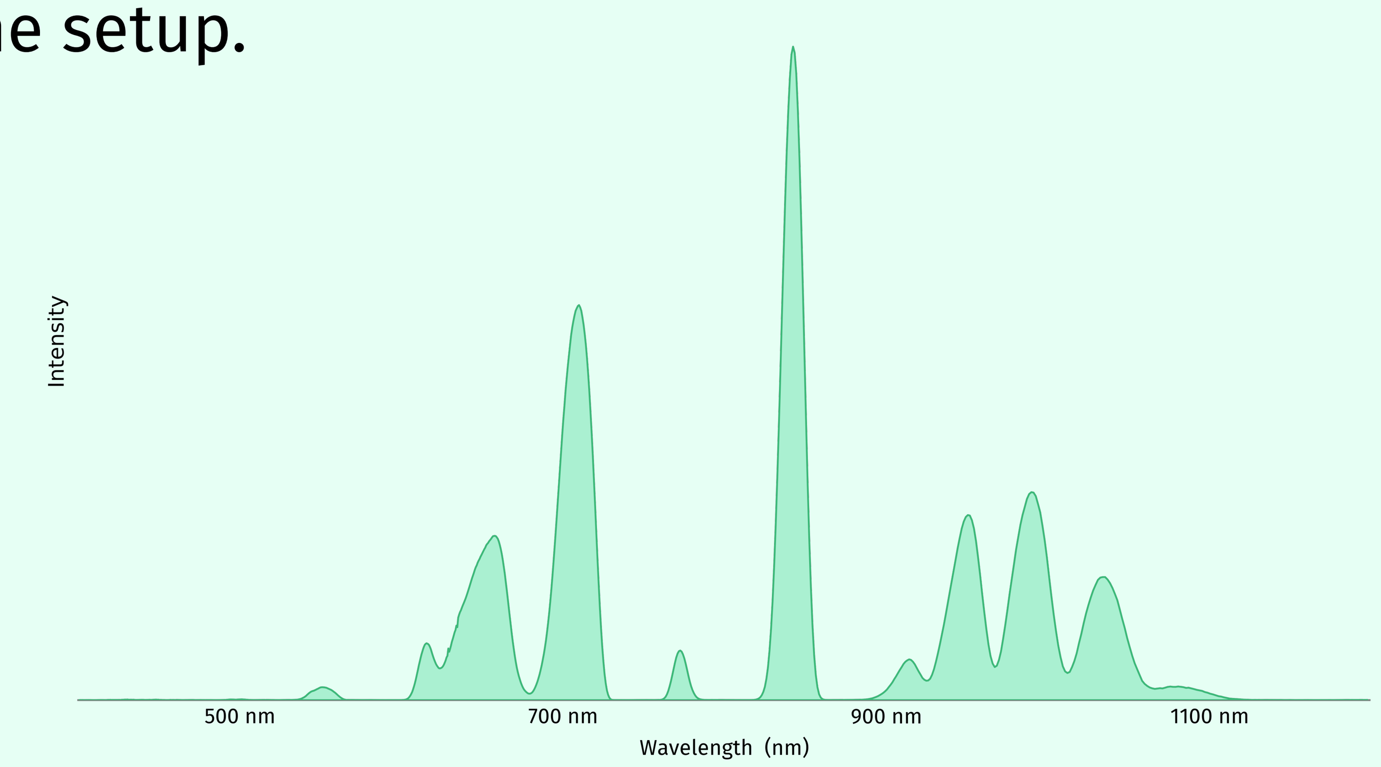


Figure 4: transmission of the tungsten spectrum from figure 3 through a BG-36 light filter.

Figure 4 shows the spectrum found by passing the tungsten lamp spectrum from figure 3 through a BG-36 filter. Note that the peaks around 1000 nm are also present in the tungsten lamp spectrum and that therefore they are not due to the filter.

[1]Kramida, A., Ralchenko, Y.U., Reader, J., and NIST ASD Team (2014). NIST Atomic Spectra Database (ver. 5.2), [Online]. Available: http://physics.nist.gov/asd [2015, May 6]. National Institute of Standards and Technology, Gaithersburg, MD.

Conclusion

Using the Michelson interferometer a high resolution in the wavelength domain was obtained and the spectra of a series of light sources and filters were analysed.