Visible Spectrum

Purpose

Using "Borderless Lab 365" platform to study the visible spectra of various light sources.

Theory

- Radiation sources are everywhere and interact with our daily life. Among various radiation sources, those sources that emit visible light are intensely drawing our attention. A famous experiment by Sir Isaac Newton revealed that white light can be dispersed into a spectrum of visible light composed of different wavelengths (different colours).
- Through the development of quantum physics, it was discovered that electrons within an element can absorb certain amounts of energy and get excited to higher discrete energy levels. The exact amounts of energy required to excite an electron from an element can be assessed by the Planck's equation: $E = hf = h\frac{c}{\lambda}$, where h is the Planck's constant with a value of 6.63×10^{-34} Js.
- An **absorption spectrum** of an element can be obtained by passing a white light through the element. The unabsorbed wavelengths will be collected by a detector and showed on the spectrum while the absorbed ones will not.
- An **emission spectrum** of an element can be obtained when energy is provided to excite the electrons of an element, originally at a lower energy state to its other available higher energy levels, followed by the electrons returning to their ground state (or other lower energy states) to emit the characteristic wavelengths. In this experiment, an emission spectrum is observed by a **spectrometer** which is a scientific instrument used to separate and measure spectral components of a physical phenomenon. In visible light a spectrometer can separate white light and measure individual narrow bands of colour.
- Since every element composes different energy levels, the combination of emitted wavelengths is unique for each element. As scientists bookkeep the emission pattern (also known as fingerprints) of elements, light spectrometry is an effective way to identify the components from an unknown sample.

Apparatus

- "Borderless Lab 365" Platform
- Light source: White LED/ Blue LED/ Green LED/ Red LED/ Sodium Lamp/ Mercury Lamp
- Light sensor on a movable track

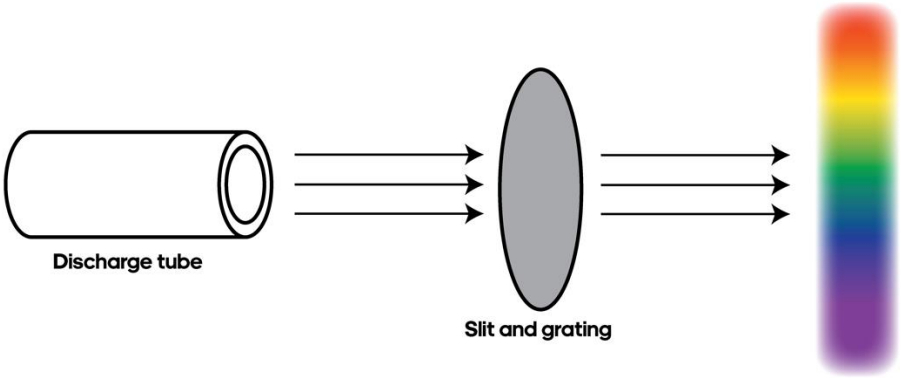
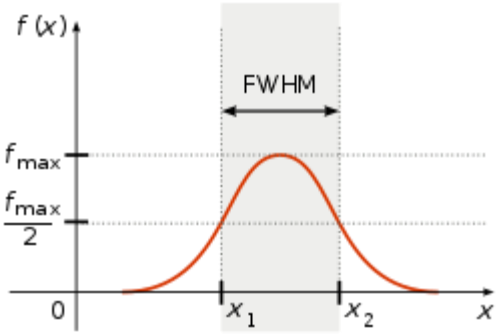


Fig 1

Procedure

1. Log in the experiment module "Visible Spectrum" on the Borderless Lab 365 platform. https://stem-ap.polyu.edu.hk/remotelab/
2. Six light sources are provided in this experiment. Choose a light source by pressing the corresponding button. Wait for the sensor to move to the desired position automatically.
3. Press "MEASURE" to measure the visible spectrum of the chosen source.
4. Download the graph by pressing "DOWNLOAD" in csv. file or clicking "Menu" and choose a format (.svg, .png, .csv) of your choice.
5. For each spectrum, try to locate the peak(s) and their full width at half maximum values.
6. **Full width at half maximum** (**FWHM**) is an expression of the extent of a function given by the difference between the two extreme values of the independent variable at which the dependent variable is equal to half of its maximum value. In other words, it is the width of a spectrum curve ($x_2 - x_1$) measured between those points on the *y*-axis which are half the maximum amplitude. In general, both the peak position and FWHM will give us a lot of information of the energy levels within the element.



7. Repeat steps 2 to 6 for another light source.
8. Turn off all the light sources and press "logout" button at bottom right corner.

Data

Light Source:		
Position of Peak/nm	**FWHM/nm**	**Intensity (strong/weak)**

Discussion

1. What do you expect the relation between an absorption spectrum and an emission spectrum?
2. Describe the similarities and differences between visible spectrum of different light-emitting sources.
3. Why do some light sources have multiple peaks?
4. Is there any unexpected peak(s) shown in the graph? If yes, why? How do you verify?
5. What are the possible errors of the experiment?