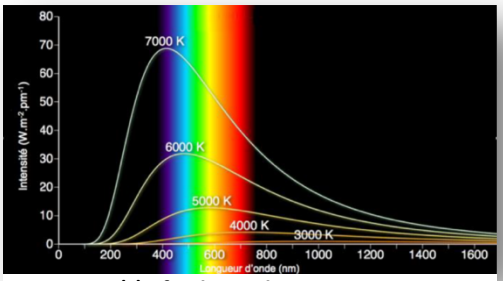
Introduction to spectroscopy

Spectrum and temperature

When heated, a gas at high pressure emits light. This is called thermal emission.
The spectrum of the light emitted is continuous.
When the temperature of the gas increases, so does the intensity of the light emitted, with a colour switching gradually from red to white. Its spectrum becomes richer in short wavelength radiations.



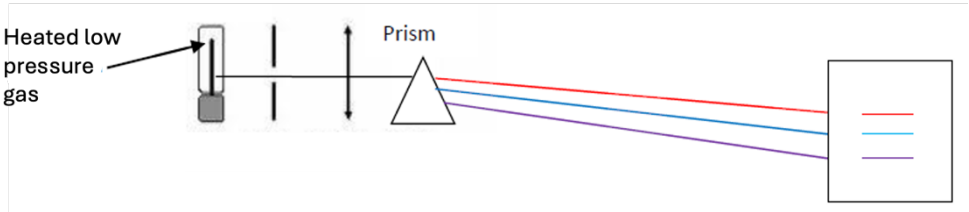
Aspect(s) of a thermal emission spectrum

The colour of the radiations emitted by a heated gas, and therefore its spectrum, depend on the temperature of this gas.

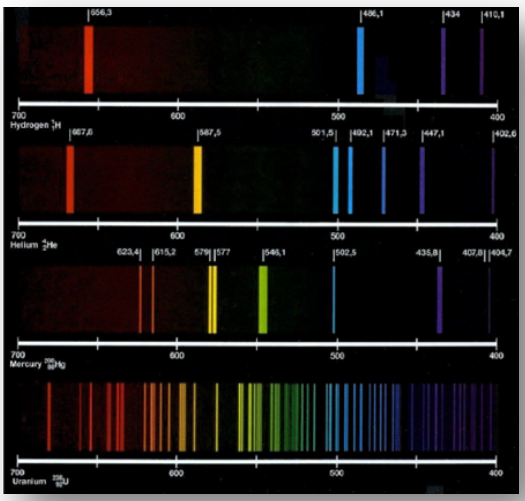
Line spectrum

1. EMISSION OF LIGHT BY A GAS AT LOW PRESSURE

A low-pressure gas emits light when heated, but its spectrum is not continuous. It is made up of individual colored lines corresponding to discontinuous monochromatic emitted radiation, depending on the chemical species contained in the gas. Such a spectrum is called an emission line spectrum

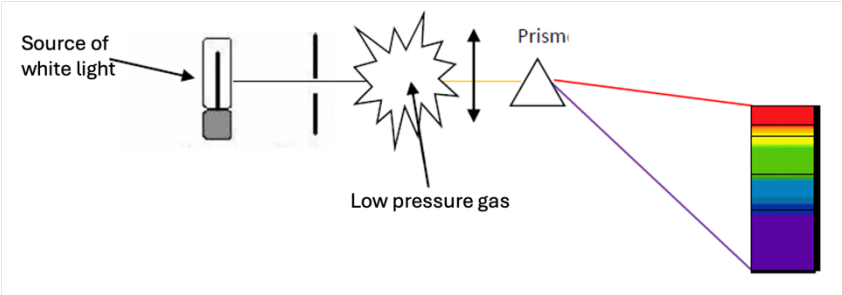


Emission line spectra of some elements:

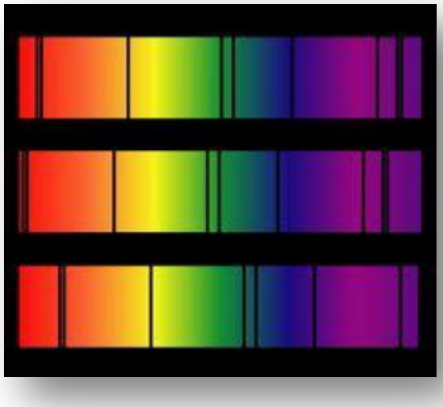


2. ABSORPTION OF LIGHT BY A LOW PRESSURE GAS

When white light travels through low-pressure gas, some of the radiations are absorbed. A "continuous » spectrum with dark lines can be observed. These lines correspond to missing monochromatic radiations, that have been absorbed by the elements constituting the gas. Such a spectrum is called an absorption line spectrum.

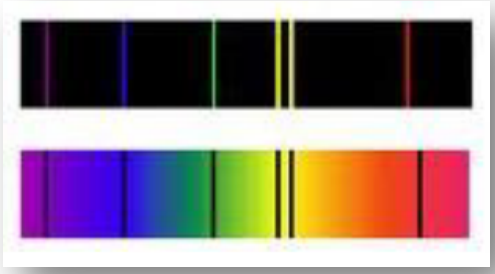


Absorption line spectra of a few elements:



3. LINE SPECTRUM AND ELEMENTS

The black lines of the absorption spectrum of an element are exactly on the same relative position than the coloured lines of the emission spectrum of this element. An element can only absorb the radiations that it can emit, and an element can be studied through the analysis of either its emission spectrum or its absorption spectrum.



No 2 elements have the same spectrum. Therefore, it is its signature.
Spectroscopy uses this to identify the presence of elements in the structure of distant stars and planets, by comparing the spectrum of the light coming from them to the known spectra of the elements.

Note: Helium has been discovered this way. The absorption spectrum of the Sun (observed by German scientist Joseph Fraunhofer, then interpreted by Robert Bunsen and Gustav Kirchoff) had a few unidentified dark lines. French scientist Jules Janssen proposed a explanation to these unsolved lines by the existence of a new element he called Helium (from Helios, the Sun)