4.4 Spectroscopy of Hydrogen Atom

When a body, such as a blackbody, is heated, the body emits radiation in all wavelengths. We say that th eblack body spectrum is a continuous spectrum. However, when a tube filled with a gas such as hydrogen gas is discharged they emit light of certain wavelengths that is a characteristic of the gas as shown for hydrogen gas in Fig. 4.7. The spectrum is called a discrete spectrum. Table 4.1, called the **Balmer Series**, lists some wavelengths of light emitted by the hydrogen gas. The discreteness of the atomic spectra was a mystery in late 1800s and early 1900s.

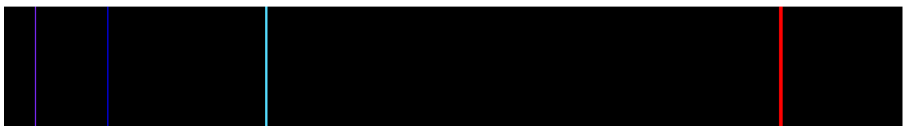

Figure 4.7: The visible part of the discrete spectrum of hydrogen gas. **********To the publisher: We should have more pictures like this one.

Table 4.1: Balmer Series of Hydrogen Spectrum

Name of spectral line	H-α	H-β	H-γ	H-δ	H-ϵ	H-ζ	$\cdots$
Wavelength (nm)	656.3	486.1	434.1	410.2	397.0	388.9	$\cdots$

In 1888 Rydberg was able to guess a formula that could fit the data properly. For the Balmer series given in the Table 4.1, the following formula worked quite well as you can verify by plugging in various values of n.

$$\frac{1}{\lambda} = R_H \left(\frac{1}{2^2} - \frac{1}{n^2} \right), \qquad n = 3, 4, 5, \cdots, \tag{4.21}$$

where R_H is called the **Rydberg constant** for Hydrogen which has the following value.

$$R_H = 10,973,731.57\,\mathrm{m}^{-1}. \tag{4.22}$$

The physical reason for Rydberg formula eluded physicists for a number of years until in 1913 Neils Bohr deduced the Rydberg formula based on rather bold and ad-hoc assumptions, which we will discuss next.