

Note 304(4): Calculation of the Lyman series shift for the $n=1$ to $n=2$ Lyman line of Atomic Hydrogen.

The equation to be used is eq. (1) of Note 304(3)

$$\left(\frac{\omega}{\omega_0}\right)^3 \left(\frac{e^{y_0} - 1}{e^y - 1}\right) = \exp(-A\ell) \quad - (1)$$

where:

$$A = \left(\frac{N}{V}\right) \frac{|u_{fi}|^2}{6\epsilon_0 \hbar \omega} \quad - (2)$$

and

$$y_0 = \exp\left(\frac{\hbar\omega_0}{kT}\right), \quad y = \exp\left(\frac{\hbar\omega}{kT}\right) \quad - (3)$$

The Lyman series in atomic hydrogen is:

$n' = 1$	$n = 2$	122 nm	10.2 eV
	3	103 nm	
	4	97.3 nm	
	5	95.0 nm	
	6	93.8 nm	
	∞	91.2 nm	

where:

$$\frac{1}{\lambda} = R_0 \left(\frac{1}{n'^2} - \frac{1}{n^2} \right) \quad - (4)$$

(Google, "Transition Dipole Moment" for Atomic H).
Here R_0 is the Rydberg constant.

For the absorption from $n' = 1$ to $n = 2$:

$$n' = 1, \ell' = 0, n = 2 \quad - (5)$$

$$n = 2, \ell = 1, m = -1, 0, 1 \quad - (6)$$

and

So the transition electric dipole moment is

2) Worked out with these quantum numbers and their relevant wave functions. This has already been done by Dr. Horst Eckart.

We have:

$$10.2 \text{ eV} = 1.634220101 \times 10^{-18} \text{ J} - (7)$$

$$\text{and } h = 1.05459 \times 10^{-34} \text{ Js} - (8)$$

so the energy $h\nu$ corresponding to 10.2 eV is at the angular frequency:

$$\omega_0 = 1.549626 \times 10^{16} \text{ radians s}^{-1} - (9)$$

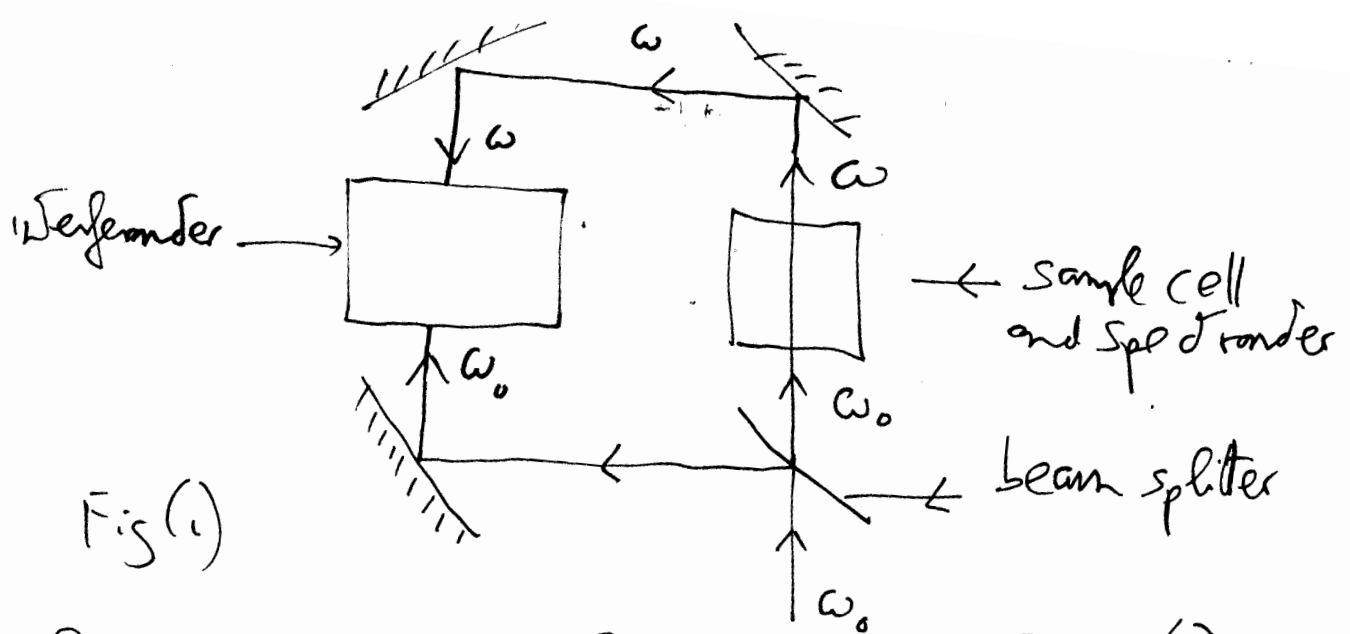
This is the incident frequency ω_0 in eq. (1). (Note n/v , and to Segi we assume that:

$$v = c. - (10)$$

$$\text{More accurately: } v = \frac{c}{n} - (11)$$

where n is the refractive index. The quantity n/v and the path length l can also be measured experimentally.

In order to measure the shifted frequency ω on a interferometric method can be used, by carrying reference between the incident frequency ω_0 and the frequency ω emerging from the sample.



This arrangement is sketched in Fig. (1). According to fundamental quantum theory in eq. (1), there should be an interference or pattern of interference between the constant frequency (ω) and the Evans / Morris frequency ω .

The left hand side of eq. (1) is the Planck distribution, and the right hand side is the Beer Lambert law. Both laws are over a hundred years old, but have never been tested like this before.
