Let us put $\frac{h}{8\pi^2 I} = B$.

$$\therefore E = Bh \cdot J(J+1) \quad \text{——— (8)}$$

The difference in energy between two rotational levels J and J' .

$$\Delta E = Bh\, J(J+1) - Bh\, J'(J'+1) \quad \text{——— (9)}$$

There are two restriction in such rotational transitions .

1) According to electrodynamic consid-erations, the absorption or emission of a radiation in rotational levels would occur only if a change in dipole moment of the molecule is associated with it. This means that the molecule must be polar, in order to produce a rotational spectrum. Homopolar molecules like H_2, N_2, Cl_2 - - - etc have no rotational band. This restriction also applies to vibrational quantum level charges.

2) The transition in rotational engy is limited to adjacent levels, i.e;

$$\Delta J = \pm 1 .$$

Since, $J - J' = 1$ eqn: (9) takes the form

$$\Delta E = BhJ(J+1) - Bh(J-1)J = 2BhJ \quad \text{——— (10)}$$

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where higher quantum level $J = 1, 2, 3$;
J cannot be zero. For in that case
J' becomes negative.

$$\therefore \Delta E = h\nu, \quad \therefore \nu = 2BJ \qquad (11)$$

putting $J = 1, 2, 3, \ldots$, the frequencies of the lines in rotational band are -

$\nu_{1 \to 0} = 2B$

$\nu_{2 \to 1} = 4B$

$\nu_{3 \to 2} = 6B$

$\nu_{4 \to 3} = 8B$, etc.

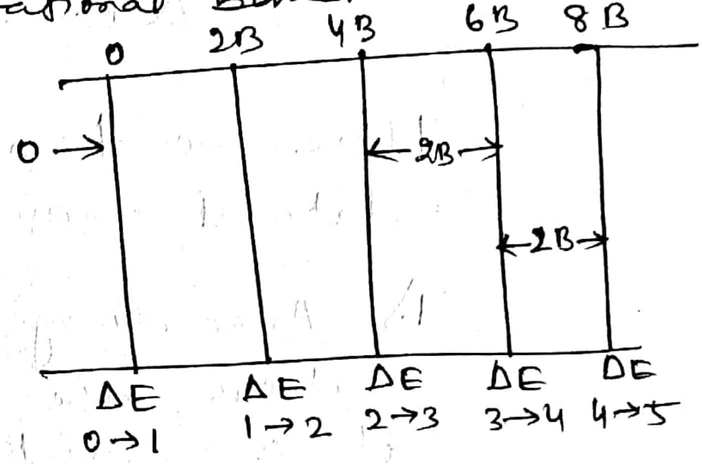

Fig (2)

The spectral lines are thus equispaced, the spacings $\Delta\nu = 2B$. The difference in wave number $\Delta\bar{\nu} = \frac{\Delta\nu}{c} = \frac{2B}{c}$.

The equidistant lines as shown in fig (2), have been experimentally confirmed and the magnitude of B ascertained.

A higher quantum levels of rotation
When the rotational energy is quite large the rigid character of the rotator is affected and there is tendency for the band to stretch. The energy of rotation is then expressed as,

$$E_r = BhJ(J+1) - DhJ^2(J+1)^2 \qquad (12)$$

Where D is a small constant of the order of 10^{-4}. The spectral lines will not then be exactly equidistant especially at higher levels.