



VIVEKANANDA COLLEGE
THAKURPUKUR
KOLKATA-700063

NAAC ACCREDITED 'A' GRADE



Topic: Beta decay Energy spectrum and Neutrino hypothesis

Course Title: Elements of Modern
Physics

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Name of the Teacher: Dr. Nirmalya
Pahari

Name of the Department: Physics



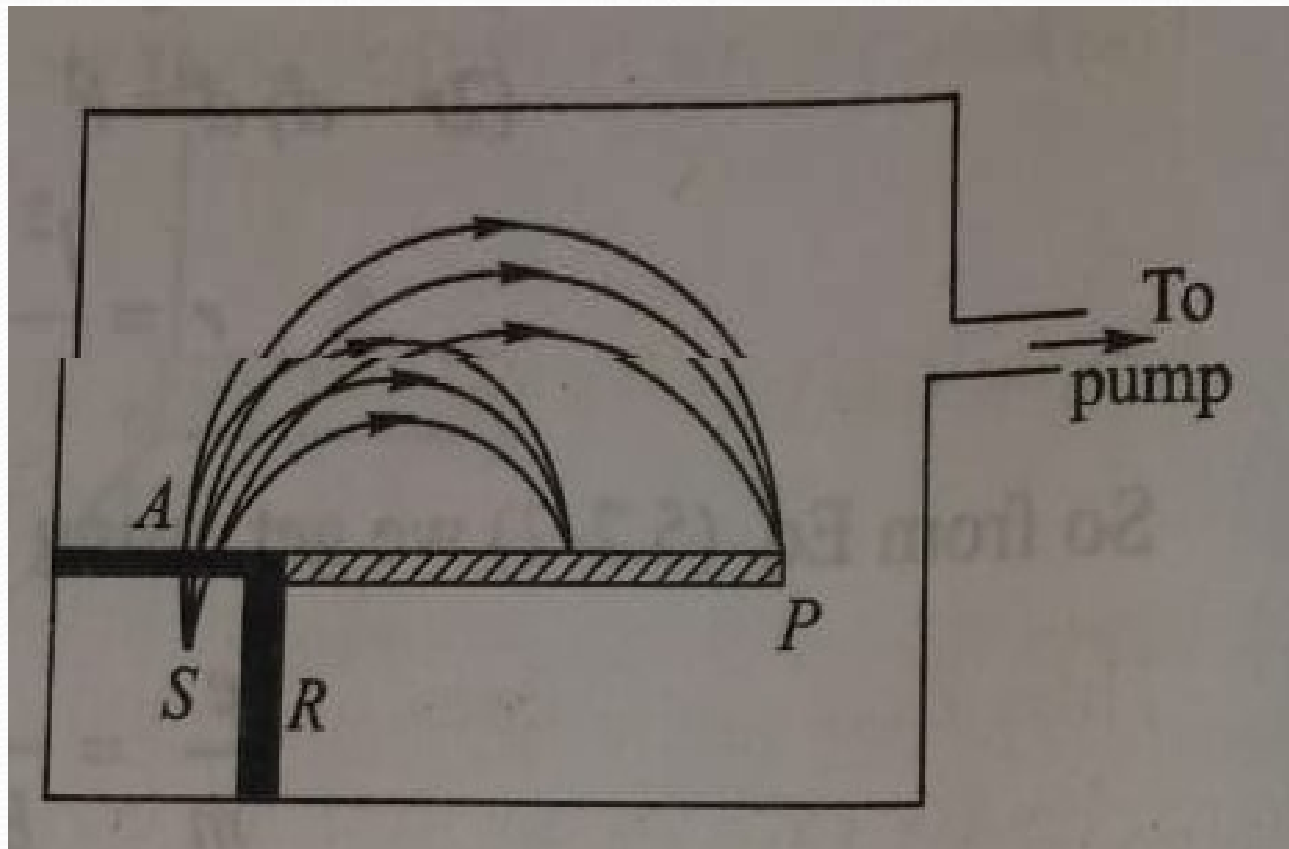
Beta decay

Beta ray spectrometer

Energy spectrum

Neutrino hypothesis

Disintegration energy of beta decay:



Beta ray spectrometer

$$qvB = \frac{Mv^2}{r} \quad p = Be r$$

$$r = \frac{mv}{Be} = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \frac{v}{Be}$$

$$(2r)^2 = h^2 + x^2 \quad r^2 = \frac{h^2 + x^2}{4}$$



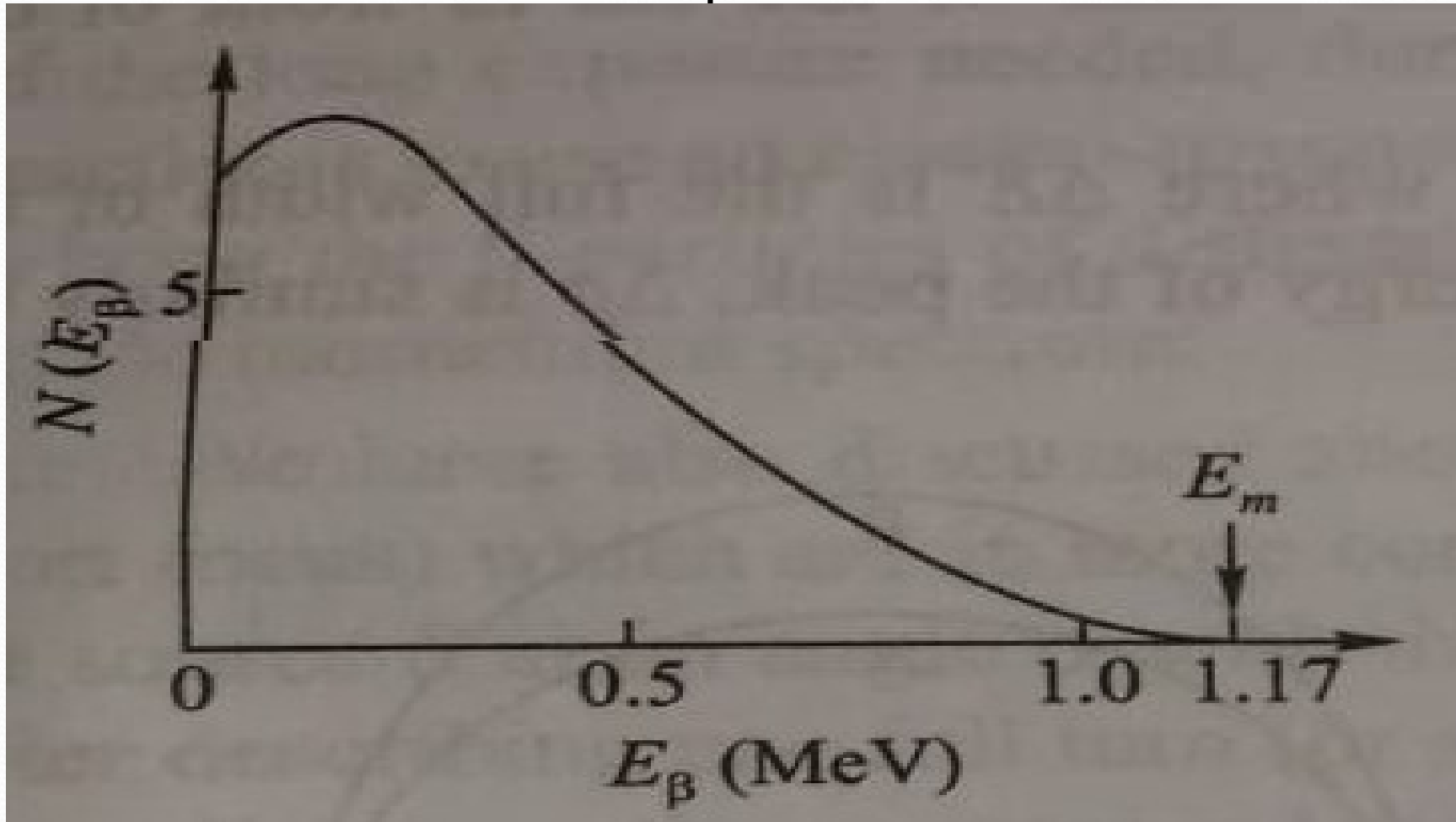
Magnetic mass spectrometer measures the momentum P . From this the total energy W can be found using the relation

$$W^2 = p^2 c^2 + m_0^2 c^4$$

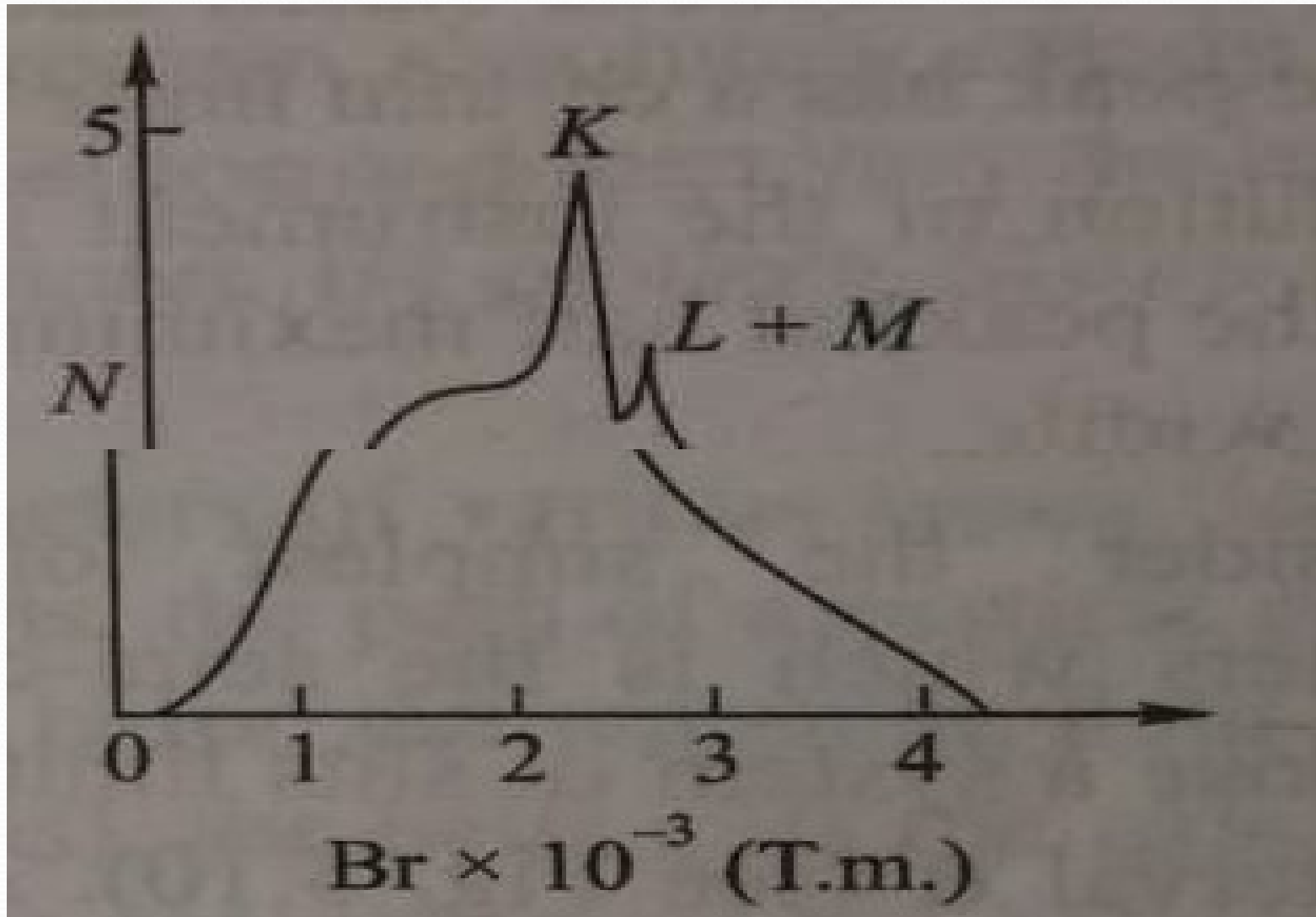
∴ Kinetic energy of the β particle

$$\begin{aligned} E_\beta &= W - m_0 c^2 = \sqrt{p^2 c^2 + m_0^2 c^4} - m_0 c^2 \\ &= \sqrt{B^2 e^2 r^2 c^2 + m_0^2 c^4} - m_0 c^2 \end{aligned}$$

Measuring B and r , E_β can be determined.



Continuous beta spectrum



Line spectrum of the beta ray




The puzzling feature of the Beta Decay

In beta decay process it is seen that there is a violation of


1. Energy conservation law
2. Angular momentum conservation law
3. Linear momentum conservation law

To explain these apparent inconsistencies Pauli in 1930 proposed that at the time of beta decay an unobserved second particle



is emitted, which carries away the balance energy $E_\nu = E_m - E_\beta$. When the electron is emitted with zero K.E the second particle is emitted with maximum energy $E_\nu = E_m$. On the other hand, when the Electron the electron is emitted with the energy E_m , the other particle has energy $E_\nu = 0$.

This new particle proposed by Pauli is Neutrino.



It must have such physical properties that it would be very difficult to detect it.

Some properties of neutrino:

1. The neutrino (ν) is charge less neutral particle.
2. It has zero rest mass or very nearly so.
3. It is an intrinsic spin $\frac{1}{2}$ particle so they obey Fermi-Dirac statistics.