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Physics General

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Summary of the Research Progress Meeting

September 2, 1948

Margaret Foss Folden

Berkeley, California

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New Techniques in Nuclear Moment Measurements. Professor Norman F. Ramsey.

Professor Ramsey remarked in opening his talk that, although the Harvard cyclotron was originally designed for 140 Mev operation, it is hoped that it will approach 175 Mev in order to achieve mesons. Operation is expected in about six months.

With regard to nuclear moments the molecular beam method for measuring nuclear moments was described, and various improvements to the method were explained. A rough diagram of the apparatus is shown in Figure 1.

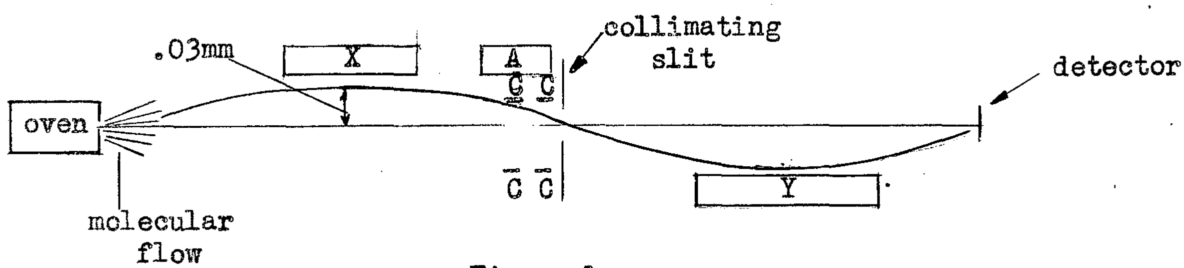

Figure 1

A represents the homogeneous fixed field; C is the oscillating or rotating magnetic field; X is the inhomogeneous magnetic field for net deflection; and Y is the second inhomogeneous field.

The torque effect and methods of applying the oscillating or rotating magnetic field were discussed.

Proton Conversion. J. Vale.

It is expected that the proton conversion project will be completed by November 1. It has been found that the current is flowing in the variable condenser along the stator and the rotor blades. The tips of the stator blades are copper clad, but the bodies are not. By winding the bodies with copper foil 260 kv was obtained. Discussion ensued in regard to disassembly of the rotor and copper cladding at 3 mil thickness of the blades or soldering between stator blades and copper cladding the solder insert.

High Energy Nuclear Reactions. M.L. Goldberger.

The Monte Carlo method is one which follows in detail, collision by collision, the passage of a large number of particles through the nucleus until the particles either escape or lose sufficient energy to be captured. If a sufficiently large number is chosen, an exact solution to the problem is obtained. Whenever it is necessary to make a choice of a number of equally probable events, this choice is made by a random process. The method can be most easily explained by actually describing the successive steps involved in following a particle. Bombarding a heavy nucleus with high energy neutrons at 90 Mev was used as an example.

The first problem to be faced is that of how far the nucleon travels into the nucleus before making a collision. One imagines that the nucleon has penetrated the nucleus; as far as this nucleon is concerned it is immersed in an infinite medium of nuclear matter. The geometry of the sphere is taken into account later. Then the total interval from zero to infinity is divided into regions of equal probability. Evidently the division is made according to the law

$$P = e^{\frac{-x}{\lambda}}$$

where P is the probability of penetrating a distance x from the surface without suffering a collision, and λ is the mean free path not taking account of the Pauli principle. The path lengths are found to be

$$x_{\hat{n}} = \lambda_{\hat{n}} \ln \frac{1}{P_{\hat{n}}}$$

where $P_{\hat{n}}$ designates which one of the equally likely intervals in which the collision has taken place and is given by $\frac{n}{N}$ where N is the total number of divisions of the total interval from zero to one $(0 \leq n \leq N)$. The value of $P_{\hat{n}}$ is chosen at random and a path length is obtained.

The next decision to be made is that of the momentum of the struck target particle. The whole allowed region of momentum space is divided into regions of equal probability, i.e. equal volume. The number of these divisions should be sufficient to cover the region in a reasonably representative way. Since the probability of making a collision with a particle in the ith region is proportional to $P_{\hat{ri}}\,\sigma(P_{\hat{ri}})$ where $P_{\hat{ri}}$ is the relative momentum and $\sigma(P_{\hat{ri}})$ is the total cross-section for a collision with relative momentum $P_{\hat{ri}}$, it is clear that the appropriate division into equal probability intervals is obtained by computing the partial sums

$$S_n = \frac{\sum_{i=1}^{n} P_{\hat{ri}}\,\sigma(P_{\hat{ri}})}{\sum_{i=1}^{N} P_{\hat{ri}}\,\sigma(P_{\hat{ri}})}$$

where $N_{\hat{}}$ is the total number of divisions of the momentum space. Then a random number, m, between zero and one is chosen and if $S_{\hat{n}} \leq m \leq S_{\widehat{n+1}}$ the collision is taken to be with a particle in region n.

Having decided on a collision partner, the scattering angle must be found. It is most convenient to work in the center of gravity system for this purpose. It is supposed that the differential cross section $\sigma(P_{\hat{ri}}, \vartheta)\, d\Omega$ is known. The appropriate values of $\vartheta_{\hat{j}}$ are computed from

$$\frac{1}{\sigma(P_{\hat{ri}})} \int_0^{\vartheta_{\hat{j}}} \sigma(P_{\hat{ri}}, \vartheta)\, d\Omega = \frac{j}{N_{\hat{2}}}$$

where $1 \leq j \leq N_2$ and N_2 is the total number of intervals chosen for division. The final vector momenta of the collision partners are determined from the conservation laws. Then one must see if the collision is permitted by the Pauli principle. If it is permitted, the whole procedure is repeated for the two final particles until they have escaped from the physical sphere or been captured. If the collision is forbidden the particle is given a new path length along its original trajectory.

This method may be applied to cosmic ray showers or to any problem of a diffusion - like process.

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