MICHIGAN'S CYCLOTRON

BY

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The first basement of the Randall Physics Building houses the cyclotron which the Physics Department uses for nuclear research. The cyclotron consists of a large vertical magnet between whose poles is a tank evacuated to a pressure of one billionth of an atmospheric. Inside the tank are two hollow D-shaped electrodes called "dees" which are three inches apart. Connected to the dees is an oscillating circuit of high frequency, which can produce more frequency than the radio station WJR in Detroit. In the center of the tank is an electric arc which breaks apart heavy hydrogen (deuterium) molecules and strips the electrons off the resulting deuterium atoms. The remaining nuclei of these stripped atoms are called deuterons and are one type of particle accelerated in the cyclotron.

The oscillating voltage and the magnet cause the positively charged deuterons to make a semi-circular path in one dee. The deuterons are speeded up as they jump the gap betwen the dees and continue their circular path in the other dee. Each time around they make larger circles until they approach the outermost edge of the dee. There they are split off by a knife edge and are drawn out of the tank by a deflecting plate maintained at 50,000 volts.

In present experiments, the deuterons stream through an evacuated tube and into an evacuated chamber containing a target in the form of a thin foil of a substance such as vanadium. This target is bombarded by the stream of deuterons, and those deuterons getting close enough to a nucleus in a target break apart into their constituent proton and neutron. The neutron enters the target while the proton is scattered at an angle. One measures the numbers of protons scattered at the different angles. This "angular distribution" of protons is in turn the key to the behavior of the neutron entering the target. In particular, the rate of angular rotation of the neutron about the center of the nucleus can be deduced, and, therefore, something of the character of the particular nucleus in that it is willing to accept the neutron with rate of rotation. Not all rates of angular rotation are allowed for atomic and nuclear particles, but only multiples of a certain natural unit. For neutrons absorbed with the first few multiples of the natural unit, the proton "angular distributions" look as in the diagram.

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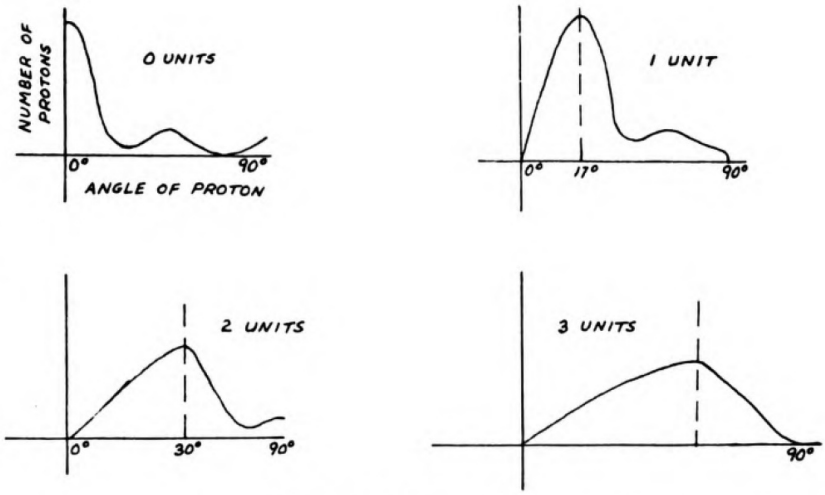
Evidently it is easy to decide, from a qualitative examination of the data, which case one is dealing with. These curves were first predicted theoretically by Dr. S. T. Butler of Cornell University and have subsequently been verified experimentally by the Michigan cyclotron group, and by other groups in England. The agreement is not perfect, but the type of disagreement is itself interesting and tells still more about the target nucleus.

The description of the nuclei obtained with the aid of these experiments to date agrees remarkably well with the simplified "shell model" of the nucleus devised by Maria Mayer, a nuclear physicist of the Argonne National Laboratory.

The "shell model" assumes at the start that any proton or neutron can travel anywhere within the nucleus of an atom without colliding with other protons or neutrons. Since this seems incompatible with other known facts about the neutrons and protons, the brilliant success of the "shell model' 'poses a fine paradox. The resolution of this paradox is certainly a primary aim of continuing research with the cyclotron.



Proton angular distributions.

Kind Lady (about to give a backdoor caller a coin): "Are you married?"

Tramp: "Pardon me madam, d'ye think I'd be relyin' on total strangers for support if I had a wife?"