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letter of intention

PROPOSAL FOR SOME EXPLORATORY RUNS ON THE PRODUCTION OF ALPHA PARTICLES (AND HEAVIER FRAGMENTS) WITH 600 MEV PROTONS

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We should like to study the ejection of nuclear fragments heavier than nucleons from moderately large nuclei. The general purposes of such studies would be essentially two: i) to understand better the processes by which the fragments are emitted and, ii) to see whether there are good experimental evidences for granularity or clustering in nuclear matter.

There has been considerable experimental work on these questions largely with photographic plates and with radiochemical methods, but a number of fairly fundamental questions remain unanswered. With regard to fragments heavier than α particles it can be said that the production cross-sections are large (a few mb. at 600 MeV rising to values close to geometrical cross-sections at higher energies), that the charge distribution of emitted fragments and their energy spectra seem to be not too dependent upon the energy nor on the type of particle used in the bombardment, and that the forward excess of the emitted fragments indicates that they are produced in a relatively fast (direct) sort of process. Nothing clear has yet been said about the nature of this process. The experimental information has recently been reviewed by N.A. Perfilov (Soviet Physics, Usp. 3, 1, 1960).

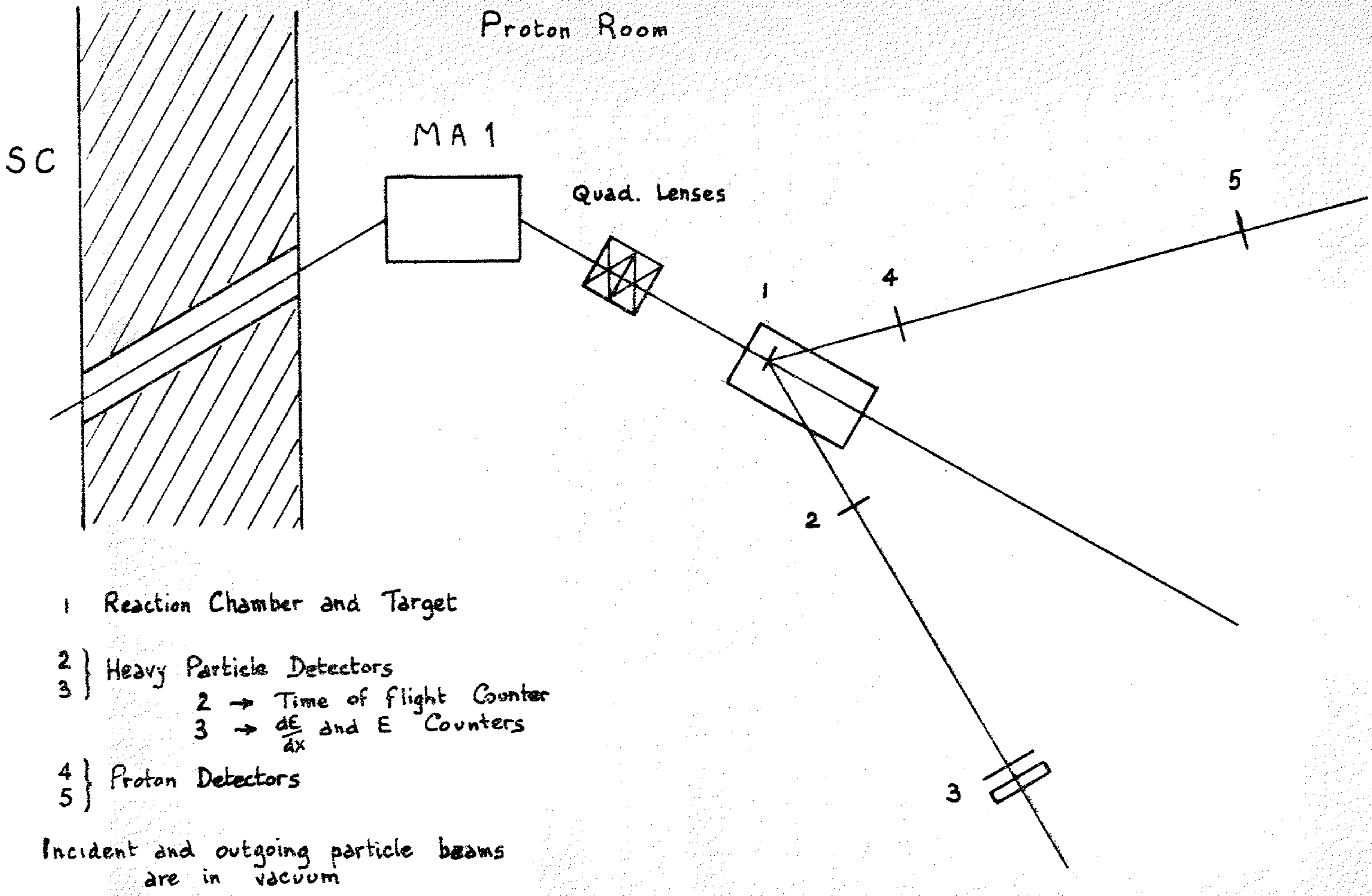
As regards the α particles, most of these seem to be evaporated, but coincidence studies have been performed on very light nuclei which show that alpha particles can be ejected from such nuclei by quasi-elastic collisions. It is difficult to do coincidence experiments in heavy nuclei because of the high probability that one or both of the collision partners is absorbed on its way out of the nucleus (G.Igo.UCRL report 10574). Yet it is perhaps more important to learn whether moderately heavy nuclei have any α-particle structure than it is to confirm the already well-established α-character of light nuclei like carbon. Probably the simplest experiment to do is to look for fast α particles ejected from heavier nuclei in high energy reactions. Such studies have already been started at Orsay (at ~ 150 MeV) and it is reported that one does see ample yields (~ 0.2 mb in gold) of high energy (> 80 MeV) alpha particles.

Very little is known about the production of fragments lighter than α particles such as H^3 and He^3. Most deuterons which are seen are presumably produced by pick-up, although there is some evidence that deuterons can be quasi-elastically ejected by 600 MeV protons.

The first contemplated runs will be devoted to measurements of spectra and angular distributions of He^3, He^4 and Li^6 at emission energies above those characteristic of evaporation. A special scattering chamber (~ 65 cm x 35 cm x 25 cm) is available at Orsay and electronic gear including photomultipliers and a multi-channel analyser can be obtained from Orsay. From measurements with photographic plates it can be estimated that with a $60 mg/cm^2$ copper target one would see in our detectors at a typical angle over a thousand particles with Z = 2 and E greater than 30 MeV per second. The production rate of lithiums is expected to be an order magnitude lower $[\sigma(E_p = 600) \cong 10 \text{ mb}]$.

One of the important problems will be to distinguish particles of the same Z and different A, for example He^3 from He^4, over a broad energy range. Before actual runs begin, some shifts will be desired to help us determine which type of system, ($^{dE}/dX$, E) or (time of flight, E) will be best. Both systems will use plastic scintilators and essentially the same electronic components. These components have been designed by L. Dick who will collaborate on the experiment in its early stages. One of the objects of exploratory runs will be to determine backgrounds in the heavy particle detectors which are produced by pions and protons in the scattering room. Such backgrounds may influence the ability of the electronic system to make the necessary particle identifications.

It is estimated that about 20 test shifts will be needed before a proposal can be submitted for the actual experiment (involving the measurement of spectra and differential cross-sections for the production of the heavy particles).


Proton Room
SC
MA 1
Quad. Lenses
1
2
3
4
5
1 Reaction Chamber and Target
2, 3 } Heavy Particle Detectors
2 → Time of flight Counter
3 → $\frac{dE}{dx}$ and E Counters
4, 5 } Proton Detectors
Incident and outgoing particle beams are in vacuum