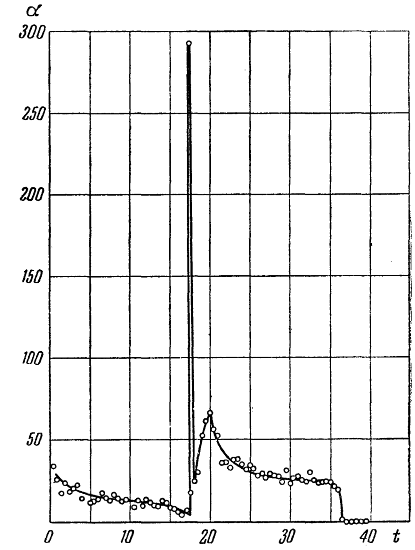
be used, and an emf will be induced by the decreasing magnetic field of the ring. The magnitude of the emf depends on the rate of change of current in the ring, i.e., on the rate of temperature rise which, for a constant heat input, is determined by the heat capacity of the system. This makes the use of a superconducting ring especially convenient for registering phase transitions.

We have used this system under conditions of a slow transition from He II to He I. In this experiment the current was induced in a tin ring fixed in a plexiglass vessel containing liquid helium[2] at 1.5° K, after which pumping of the helium vapor was stopped and the vessel was illuminated with a beam of light.



The results are shown in the figure, where the deflection (α) of the mirror of the galvanometer connected to the stationary coil is plotted as a function of the time (t) of warming of the helium (t = 0 corresponds to 1.5° K). Insofar as the heat influx to the system remained practically constant during the course of the experiment, the variation of $\alpha(t)$ determines the temperature dependence of the heat capacity of liquid helium. This explains the decrease in α with increasing temperature from 1.5° K to the λ point (from t = 0 to t = 17.5 min), the sharp increase in α at the λ point corresponding to the specific heat jump at this temperature, and the slow decrease in α in the He I region. At the transition temperature for tin the deflection must, of course, become zero (T = 3.73° K, t = 36.5 min).

We should point out that during the transition through the λ point there is a large and sharp peak superimposed on the variation of $\alpha(t)$ described, probably connected with the appearance of a small temperature difference between the ring and the helium under the conditions described. Such a temperature difference can perhaps be explained by a change in the mechanism of heat transfer in He II and He I. When the helium was heated electrically by a heater in the liquid, instead of by light, the change in α corresponded to the temperature dependence of the heat capacity of helium and the peak was absent. The sharp change in α makes it possible to record the transition through the λ point with great accuracy.

This method will be used to investigate the He II-He I transition in rotating helium and to determine the λ temperature of isotopic mixtures.

In conclusion we would like to thank Professor B. G. Lazarev for discussion of the results.

*A ring of tin was used by Galkin, Kan and Lazarev to study the properties of the superconducting transition[1] and to measure the thermal conductivity of copper.

[1] Galkin, Kan and Lazarev, J. Exptl. Theoret. Phys. (U.S.S.R.) **32**, 1582 (1957), Soviet Phys. JETP **5**, 1292 (1957).

[2] Esel'son, Lazarev, Sinel'nikov, and Shvets, J. Exptl. Theoret. Phys. (U.S.S.R.) **31**, 912 (1956), Soviet Phys. JETP **4**, 774 (1957).

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NUCLEAR REACTIONS INDUCED BY HEAVY IONS

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PARFANOVICH, Rabin, and Semchinova[1] have studied stars produced in nuclear emulsions by accelerated nitrogen and oxygen ions. Two interesting and unexpected effects were observed, one of which is a strong forward directional effect of protons and α particles in the stars. Secondly, the proton to α particle ratio is much smaller than would be expected according to Le Couteur's theory of evaporation of a compound nucleus. Both effects have been confirmed by qualitative observations in our laboratory at Birmingham.

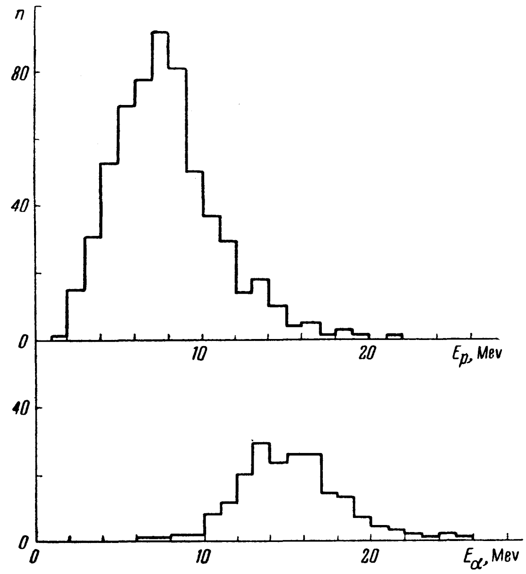

FIG. 2. Energy distribution of protons and α particles in c.m. system.

We are now conducting a detailed investigation of secondary particles emitted during collisions between nitrogen and silver nuclei and wish to report some preliminary results.

We directed an incompletely collimated beam of nitrogen ions accelerated by the Birmingham 150-cm cyclotron through a silver foil, and registered the secondary α particles and protons in a C-2 nuclear emulsion in the angular range 45° to 170° with respect to the beam. Details of the apparatus will be published elsewhere. The incident beam energy covered a broad range from 10 to 120 Mev, but because of the high potential barrier of silver only the fastest particles could participate in the reactions. Therefore the actual mean effective energy of the beam was 65 Mev and the effective halfwidth of the distribution was 12 Mev. The motion of the center of mass was easily taken into account.

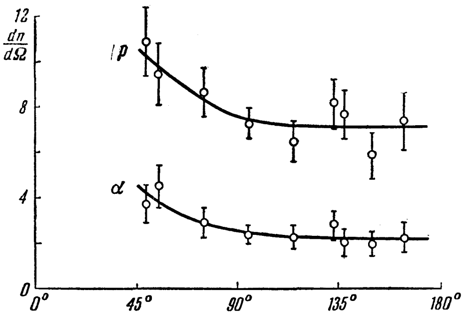

FIG. 1. Angular distribution of protons and α particles in c.m. system.

Figure 1 shows our preliminary results for the angular distribution, which confirm the strong forward peak of α particles and protons that was found by Parfanovich et al. On the other hand, we found that protons were more numerous than α particles, rather than the contrary. However, our results may not conflict entirely with those obtained in Moscow, since our observations did not extend to angles smaller than 45°, whereas Parfanovich et al. covered all angles. We also obtained qualitative indications that at angles below 45° the number of α particles increases much more rapidly than the number of protons.

Figure 2 shows the energy distribution of the particles, using mean values derived from observations at each of six given angles. A small increase of the mean energy was observed with increasing angle, but this can be entirely accounted for by translational motion of the center of mass, which was taken into account in calculating the mean values. The results therefore represent the distribution in the c.m. system or in the laboratory system at 90° with respect to the N^{14} beam. We note that the majority of both protons and α particles emerge with energy less than the potential barrier of a compound nucleus (Xe^{121} or Xe^{123}). This is in agreement with the conclusions of Parfanovich et al.,but the advantage of our work lies in the assurance that all reactions involved only silver. In work with nuclear emulsions it is impossible to separate reactions with silver from reactions with bromine.

We are continuing to obtain similar measurements for interactions of nitrogen with gold and with aluminum and expect to include reactions with C^{13} ions.

[1] Parfanovich, Rabin, and Semchinova, J. Exptl. Theoret. Phys. (U.S.S.R.) 31, 188 (1956), Soviet Phys. JETP 4, 99 (1957).

Translated by I. Emin
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