Nuclear Interaction in Flight of a Σ Hyperon*

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(Received September 6, 1955)

In the course of a systematic study of K^--mesons produced by the Berkeley Bevatron,[1] an interaction in flight of a charged hyperon was found. A projection drawing of the event is shown in Fig. 1. The K-meson

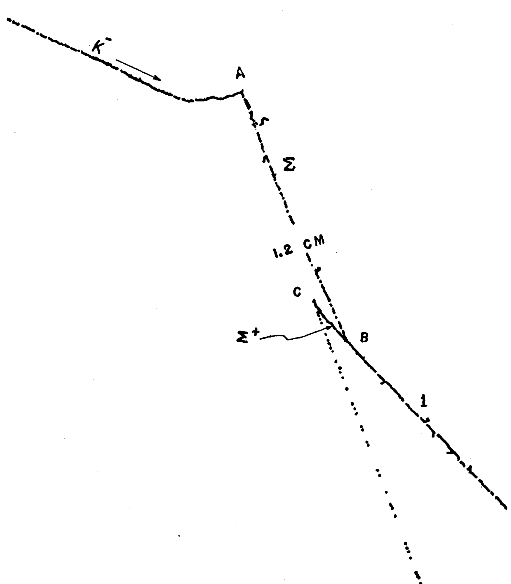

Fig. 1. A star produced by a stopped K^--meson is shown at point A. The hyperon from the K^--star caused a second star B after traveling a distance of 1.2 cm. The Σ^+ hyperon from star B decays from rest into a minimum-ionizing particle, presumably a π^+ meson.

star (point A in Fig. 1) has only one gray track, and a low-energy electron track. After 1.2 cm the particle which produced the gray track caused a star (point B in Fig. 1) with two outgoing tracks. One of these particles stopped after 22.5 microns and gave rise to a minimum-ionizing particle. The multiple scattering along the minimum track gives a $p\beta$ of 175±35 Mev/c which corresponds to a kinetic energy of 115±20 Mev for a π meson. This value for the energy identifies the short track from the interaction as a Σ hyperon. Since the hyperon decayed from rest we assume that it was positively charged. The gray track from the K^--meson star which caused star B did not have enough kinetic energy to produce a hyperon in the interaction B; therefore it was undoubtedly a Σ hyperon. From the grain density we estimate the kinetic energy of the hyperon to be about 80 Mev at the point of origin and about 40 Mev at the point of interaction. The kinetic energy of the Σ hyperon after the interaction was 1.5 Mev and the kinetic energy of particle 1 was 18.8 Mev, assuming that it was a proton. The residual momentum indicates that one or more neutral particles were involved.

Most probably this event is an example of an inelastic scattering of a positively charged Σ hyperon, although the possibility cannot be excluded that the hyperon from the K^--meson star was negatively charged and underwent two successive charge exchange scatterings in the nucleus.

This was the only interaction of a Σ hyperon that was found from a total hyperon track length of 9.8 cm. This length was observed in following 35 charged hyperons from 207 K^--stars.[1] It is obviously not possible to obtain an interaction cross section from one event; however, the event would suggest that Σ hyperons interact strongly with nuclear matter.[2] One other hyperon interaction event which is known to us is a disappearance in flight of a charged hyperon reported by Hill *et al.*[3]

We are grateful to Professor E. J. Lofgren for making the facilities of the Bevatron available to us and to Mr. Ray Kerth for his help in obtaining the exposures.

* Supported in part by the U. S. Atomic Energy Commission and by the Graduate School from funds supplied by the Wisconsin Alumni Research Foundation.
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[1] Fry, Schneps, Snow, and Swami, Phys. Rev. **100**, 950 (1955).
[2] It is interesting to note that not only can the Σ hyperon interact strongly with nuclear matter via the K-meson field, but also via the π-meson field because the isotopic spin is different from zero.
[3] Hill, Gardner, and Crew (private communication).

Nuclear Moments in *jj*-Coupling

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(Received August 23, 1955)

Recently Lawson[1] has shown that nuclear electric quadrupole moments of any I-state arising out of any equivalent proton configuration $(lj)^n$ can be calculated without explicitly setting up the wave functions in question. His method can, however, be easily extended to equivalent configurations containing both neutrons and protons.

Magnetic and electric moments for a configuration $(lj)^n$, where n includes both neutrons and protons, can be written in the form

$$\begin{aligned}\mu &= \tfrac{1}{2}(g_N+g_P)I_z+(g_N-g_P)\textstyle\sum_i j_{iz}\tau_{i3},\\ Q &= \tfrac{1}{2}\textstyle\sum_i(3z_i^2-r_i^2)-\sum_i(3z_i^2-r_i^2)\tau_{i3},\end{aligned} \quad (1)$$

where g_N and g_P are the Landé factors for the single neutron and proton in the lj-state; j_{iz}, τ_{i3} refer to the total angular momentum and isotopic spin of the ith