DELAYED DISINTEGRATION OF HEAVY FRAGMENTS*

By Francoise A. Brisbout† and V. D. Hopper†

Two examples of the delayed disintegration of heavy fragments somewhat similar to those observed by Danysz and Pniewski (1953), Tidman *et al.* (1953), and Crussard and Morellet (1953)‡ have been found in this laboratory. They were observed in Ilford G5 400 μ emulsions flown at 90,000 ft.

The first event is shown in Figure 1. A heavy fragment ($Z=3$ or possibly 4) is emitted by a large star containing 2 minimum tracks, 2 grey tracks (grain density between minimum and $5\times$minimum) and 15 black tracks. The heavy

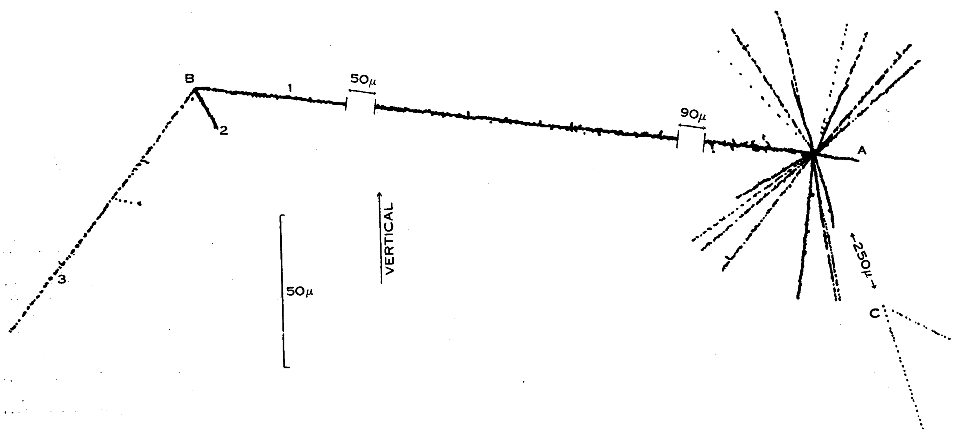

Fig. 1.—Event showing delayed disintegration of a heavy fragment ($Z=3$) emitted from star A and producing star B after traversing 370 μ in the emulsion.

fragment has a track length of 370 μ and reaches within 70 μ of the end of its range. If it has a charge of $Z=3$, its kinetic energy is less than 25 MeV when it produces the second star B which has two additional tracks. Of these, one short track is 15 μ long and the second track has a grain density $3\times$minimum. Certain identification of these tracks is not possible although scattering measurements suggest that the faster track is probably a proton of energy 90 MeV. If the other track carries the rest of the charge of the incident nucleus it will have a charge of 2 or 3.

* Manuscript received March 1, 1954.

† Physics Department, University of Melbourne.

‡ *Note added in Proof.*—Since this article was submitted, three further events of a similar type have been observed and are discussed in a recent review by Professor C. F. Powell in *Nature* **173**: 469 (1954).

The visible energy release of event B taking into account the binding energy of the emitted particles will be greater than 70 MeV. In order to conserve momentum one or more neutrons may also be emitted. If it is assumed that a single neutron balances the visible momenta and the heavy nucleus comes to rest before producing star B, the total energy will be 230 MeV. If more than one neutron is emitted, the total energy will be somewhat less but will still be greater than 100 MeV.

What appears to be a V-decay event occurs at a distance of 250 μ from star A and is shown at C. The two singly charged tracks cannot be identified but have grain densities of 43 ± 2 and 53 ± 3. The difference in grain density seems

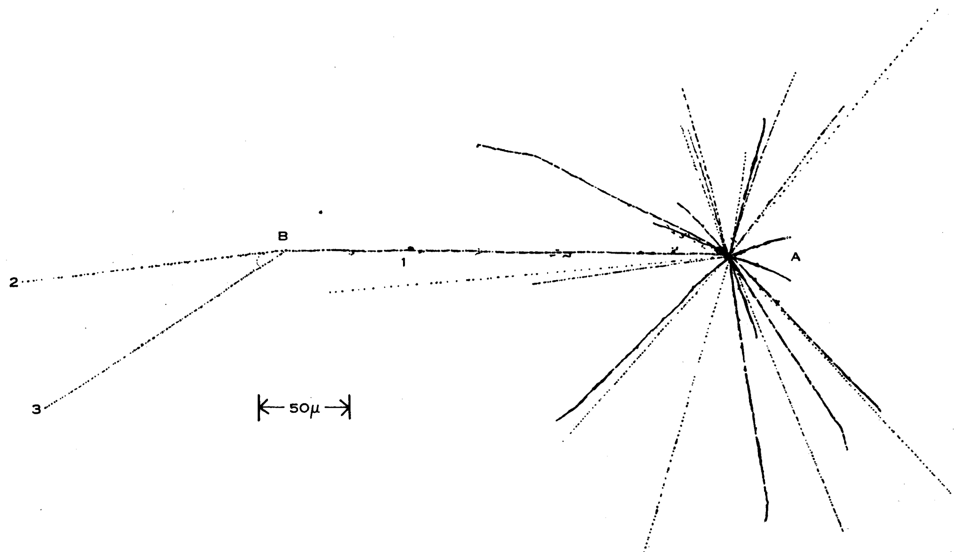

Fig. 2.—Delayed disintegration of a heavy fragment ($Z=2$) emitted from star A and producing star B before it reaches the end of its range in the emulsion.

too large to explain the event as the scattering of a single particle. The tracks are not coplanar with the origin of star A so if event C is connected with star A it cannot be completely represented by the V_2^0 or V_1^0 decay. Stars of this type are rarely observed in the nuclear emulsion but it might be merely a coincidence that it is observed close to star A. It is recorded here in case other such events are observed near stars containing heavy fragments which show delayed disintegration.

The second event is shown in Figure 2. Here the fragment ($Z=2$) is emitted from star A which has 2 minimum tracks, 3 tracks between minimum grain density and $5 \times$minimum, and 19 other tracks. The heavy fragment track has a length of 250 μ and does not reach the end of its range before producing the second star B. If the heavy fragment is an α-particle, its energy at star B is 30 MeV. The additional tracks at star B are produced by singly charged particles, one of which must be heavier than a meson.

The total energy released in star B must therefore be greater than 150 MeV since there must be an additional uncharged particle emitted to balance momenta.

A summary of the data for the two events is given in Table 1.

TABLE 1

SUMMARY OF DATA FOR THE TWO EVENTS

Event	Track	Z	Energy (MeV)	Momentum (MeV/c)	Grain Density	Angle to Track 1
First	1	3	<25	<600	Black	
		(4)	<(35)	<(900)		
	2	2	4·3	180	Black	113°
		(3)	(9)	(350)		
	3	1p	90	420	3·0 × min.	101·5°
		1π	12	56		
Second	1	2	30	500	Black	
	2	1p	90	420	3·0 × min.	8°
		1π	12	56		
	3	1p	80	400	4·1 × min.	35°

The lifetimes of the heavy fragments which disintegrate have been estimated as $\geqslant 9 \times 10^{-12}$ and 6×10^{-12} sec for the first and second event respectively. These observations are not inconsistent with the view proposed by Danysz and Pniewski (1953) that the heavy fragments observed contain V_1^0 particles among their nucleons and these have a lifetime in the nucleus greater than 3×10^{-12} sec.

References

CRUSSARD, J., and MORELLET, D. (1953).—*C.R. Acad Sci., Paris* **236** : 64.
DANYSZ, M., and PNIEWSKI, J. (1953).—*Phil. Mag.* **44** : 348.
TIDMAN, D. A., DAVIS, G., HERZ, A. J., and TENNENT, R. M. (1953).—*Phil. Mag.* **44** : 350.