lighter particle then decayed in the usual μ-meson manner.)

The following explanation seems satisfactory.[4] If the $\mu-p$ mesonic atom referred to above finds a deuteron, and the deuteron becomes bound in the mesonic equivalent of an H-D molecular ion, then the mean H-D spacing is about 1/200 as large as that in the ordinary H-D molecular ion. The meson, in effect, confines the two nuclei in a small box. Rough estimates of the barrier penetration factor (approximately 10^{-5}) and the vibration frequency (approximately 10^{17} per second) indicate that the time required for a nuclear reaction between H and D should be small compared with the life of the μ meson. In some yet unknown fraction of the cases, the reaction energy is taken up by the μ meson, which appears in the bubble chamber with a kinetic energy of 5.4 Mev, i.e., nearly the mass difference between H+D and He^3. (The recoil He^3 should not be visible in any case.)

If, as we believe, the explanation outlined above is correct, several apparent discrepancies must be resolved. For example, early suggestions that deuterium might have something to do with the observations were discarded because the ratio of 1.7-cm μ's to decay electrons is about 1/200 whereas the deuteron contamination in the bubble chamber is only about 1/5000. It seems possible to overcome this difficulty if a deuteron is able to rob the meson from a proton. The μ mesons will be bound more tightly by deuterons than by protons, because of the 5% larger reduced mass. This amounts to 135 ev for the ground state. This effect, and several others of a similar nature, are being investigated experimentally by increasing the concentration of deuterium in the bubble chamber.

It may also be that the surprisingly long gaps at the end of some of the stopping μ's can be understood by invoking the 135 ev available for recoil when the deuteron robs the μ^- from a $\mu-$H mesonic atom during a collision.

It is interesting to speculate on the practical importance of this process if a sufficiently heavy, negatively charged, weakly interacting particle more long-lived than the μ is ever found. The particle observed by Alikanian *et al.*[5] in the cosmic rays has a mass of about 500 m_e, and was observed to come to rest in a cloud chamber without interacting or ejecting a decay fragment. A bubble chamber filled with liquid deuterium should be an excellent detector for such particles. One might expect to see large "stars" at the end of the heavy meson track, due to a sequence of catalyzed reactions that would continue until the meson disappeared by decay.

We wish to express our thanks to the bubble chamber crews, under the direction of R. Watt and G. Eckman, and to our scanners. We are also indebted to the three new members of our group, M. Cresti, L. Goldzahl, and K. Gottstein; and to E. Teller for an interesting discussion.

Note added in proof.—We have obtained preliminary results on the effect of increasing the deuterium concentration. The following numbers come from spot-checking and fast scanning only:

Deuterium Concentration:	Natural	0.3%	4.3%
$\mu^-\rightarrow e^-$	2541	2959	1269
$H+D\rightarrow He^3+\mu^-$	15	57	32
$He^3+\mu^-$ per μ^- ending	0.6%	2%	2.5%

Preliminary analysis indicates that the frequency of visible gaps in $\mu-e$ decays at first increases with increasing deuterium concentration; however, at the 4.3% concentration, gaps are no longer seen. We have seen one case where the same μ^- catalyzes the $He^3+\mu^-$ reaction twice. We have seen a few events which we interpret as the reaction $D+D\rightarrow H^3+H^1$.

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1 Alvarez, Bradner, Falk-Vairant, Gow, Rosenfeld, Solmitz, and Tripp, University of California Radiation Laboratory Report UCRL-3583, 1956 (unpublished).

2 Panofsky, Aamodt, and Hadley, Phys. Rev. **81**, 565 (1951).

3 We have telephoned to inquire if other groups observe these gaps. R. H. Hildebrand has noticed occasional 1-mm gaps of $\mu-e$ decays in the Chicago hydrogen bubble chamber. Leon Lederman reports that no surprising gaps have been noticed by the Columbia diffusion chamber group [C. P. Sargent, thesis, Columbia University, 1951 (unpublished)].

4 F. C. Frank, Nature **160**, 525 (1947); Ya. B. Zel'dovitch, Doklady Akad. Nauk U.S.S.R. **95**, 493 (1954).

5 A. I. Alikanian *et al.*, 1956 Moscow Conference on High-Energy Physics (unpublished).

Nuclear Electric Quadrupole Moment of K^{39}

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THE authors of a recent communication[1] appear to have overlooked a previous determination made in this laboratory two years ago.[2] The experiments there briefly described have now been completed: a full account will shortly be published.[3] The Columbia result $Q_{K^{39}}=(0.07\pm0.02)\times10^{-24}$ cm^2 is not in disagreement with our final value, $+(0.11_3+0.02)\times10^{-24}$ cm^2, which is based on a complete analysis of the hyperfine structure of 5 $^2P_{\frac{3}{2}}$ in weak and strong magnetic fields. No assumptions are made concerning the ratio of the a factors in the $P_{\frac{1}{2}}$ and $P_{\frac{3}{2}}$ levels: these are determined independently of each other. The sign of Q is determined unambiguously in our experiments. Our final value differs from the preliminary value by an amount within the limits of error of the latter.

1 Buck, Rabi, and Senitsky, Phys. Rev. **104**, 553 (1956).

2 G. J. Ritter and G. W. Series, Proc. Phys. Soc. (London) **A68**, 450 (1955).

3 G. J. Ritter and G. W. Series, Proc. Roy. Soc. (London) (to be published).