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EQUILIBRIUM CHARGE STATES OF URANIUM AT RELATIVISTIC ENERGIES

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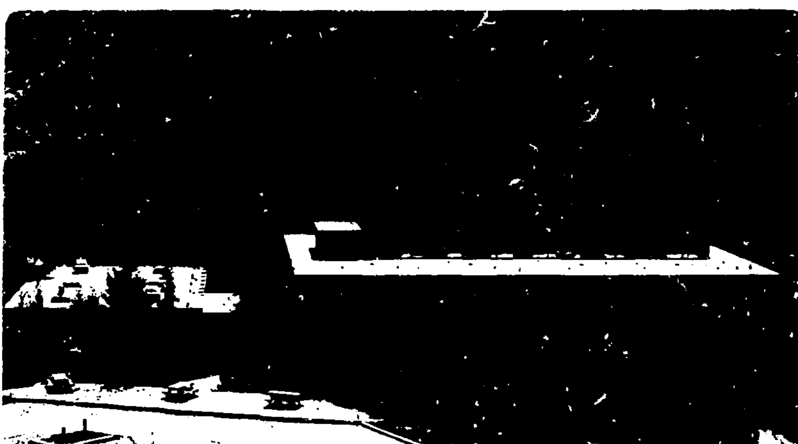

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Equilibrium charge states of uranium at relativistic energies

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We have measured the charge fractions of uranium ions at energies of 962 MeV/amu and 430 MeV/amu passing through various thickness targets of mylar ($Z \approx 6.6$), Cu ($Z=29$) and Ta ($Z=73$). From these we determine the equilibrium charge state distributions.

Uranium 68+ ions from the LBL Bevalac are transported in vacuum through a windowless beam line and pass through targets located upstream of the beam 40 magnetic spectrometer (Fig. 1). The charge states produced by collisions in the targets are spatially separated in the magnets and are detected by a position sensitive ionization chamber located approximately 10 meters downstream from the magnets. At the detector the charge states are separated by roughly 1 cm. The convolution of the instrumental resolution and the beam width is about 0.2 cm (Fig. 2).

The equilibrium charge state distributions are shown in Fig. 3. These distributions were obtained from the data as follows: Charge capture and loss cross sections were fit[1] to the curves of charge state population verses target thickness. The fitted capture and loss cross sections were then used to construct the equilibrium distributions.

Fig 3 shows that at 962 MeV/amu the average charge state of the uranium ions is monotonic with target Z. However, at 430 MeV/amu the average charge state first rises and then falls with increasing target Z. The qualitative behavior of the charge state distributions can be understood in terms of the different energy and target Z dependence of the ionization cross section and of the charge exchange, and radiative electron capture cross sections[2]. These will discussed in detail in a future paper.

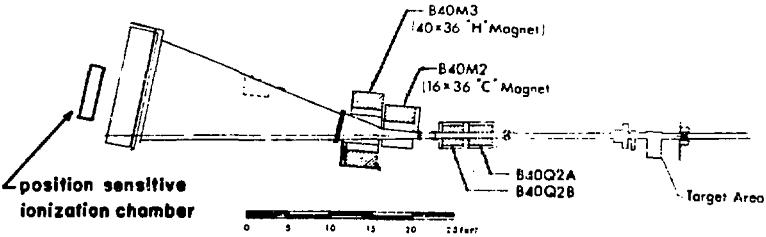

Figure 1. - Schematic diagram of the experimental apparatus

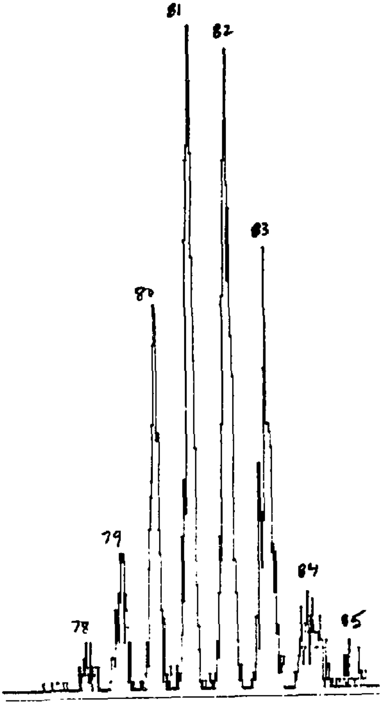

Figure 2. - Charge state fractions of 962 MeV/amu uranium (incident charge state 68+) after passing through 7.1 mg/cm^2 of mylar.

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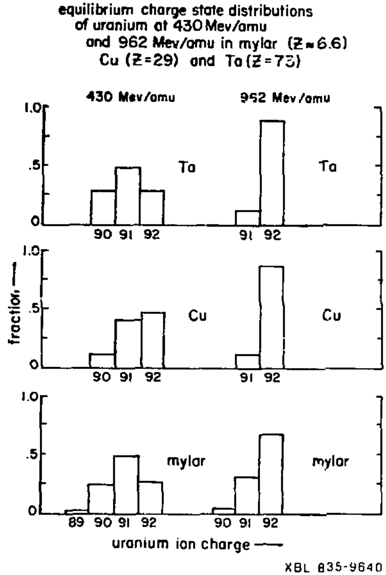

Figure 3. - Equilibrium charge state distributions

References

(a) also University of California Space Sciences Laboratory, Berkeley Ca. 94720.

(1) The method used to fit the cross sections to the data is described in S. Datz, H.O. Lutz, L.B. Bridwell, C. D. Moak, H.D. Betz, and L.D. Ellsworth, Phys. Rev. A2, 430 (1970).

(2) see for example, H. Bethe, Ann. Phys. (Leipsig) 5, 325 (1930); P.H. Fowler, V.M. Clapham, V.G. Cowen, J.M. Kidd, and R.T. Moses, Proc. Roy. Soc. (London) A318, 1 (1970); C. Raisbeck and F. Yiou, Phys. Rev. A4, 1858 (1971); C.M. Lee, Phys. Rev. A17, 566 (1978); L. Wilson, Lawrence Berkeley Laboratory report No LBL-7723; H. Crawford, Lawrence Berkeley Laboratory report No LBL-8807; R. Shakeshaft, Phys. Rev. A20, 779 (1979); B.L. Moiseiwitsch and S.G. Stockman, J. Phys. B13, 2975 (1980). D.H. Jakubaßa-Amundsen and P.A. Amundsen, Z. Physik A298, 13 (1980).

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