Title
EQUILIBRIUM CHARGE STATES OF URANIUM AT RELATIVISTIC ENERGIES

Permalink
https://escholarship.org/uc/item/6z6059pq

Author
Crawford, H.

Publication Date
1983-06-01
EQUILIBRIUM CHARGE STATES OF URANIUM AT RELATIVISTIC ENERGIES

H. Crawford, H. Gould, D. Greiner, P. Lindstrom, and J. Symons

June 1983

This is a Library Circulating Copy which may be borrowed for two weeks. For a personal retention copy, call Tech. Info. Division, Ext. 6782.
DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.
Equilibrium charge states of uranium at relativistic energies

Henry Crawford, Harvey Gould, Douglas Greiner, Peter Lindstrom, and James Symons

Lawrence Berkeley Laboratory, Berkeley, California 94720

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 ≈ 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 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. 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/cm² of mylar.

We thank Dr. Jose Alonso, Mr. Ismael Flores and Mr. Douglas MacDonald for their assistance in analyzing the data and in setting up the experiment. We are especially grateful to the operators and staff of the Bevalac and the Super-HILAC whose skill and dedication made this experiment possible. This work was supported by the Director, Office of Energy Research: Office of Basic Energy Sciences, Chemical Sciences Division, and Office of High Energy and Nuclear Physics, Nuclear Science Division, of U.S. Department of Energy, under Contract No. DE-AC-03-76SF00098.

Figure 3. - Equilibrium charge state distributions of uranium at 430 MeV/amu and 962 MeV/amu in mylar (Z = 6.6) Cu (Z = 29) and Ta (Z = 73)

References

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


This report was done with support from the Department of Energy. Any conclusions or opinions expressed in this report represent solely those of the author(s) and not necessarily those of The Regents of the University of California, the Lawrence Berkeley Laboratory or the Department of Energy.

Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U.S. Department of Energy to the exclusion of others that may be suitable.