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Charge-State Dependence of Electron Loss From H by Collisions with Heavy, Highly Stripped Ions

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Authors

Berkner, K H

Graham, W G

Pyle, R V

et al.

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Abstract

Lawrence Berkeley Laboratory
UNIVERSITY OF CALIFORNIA

Accelerator & Fusion Research Division

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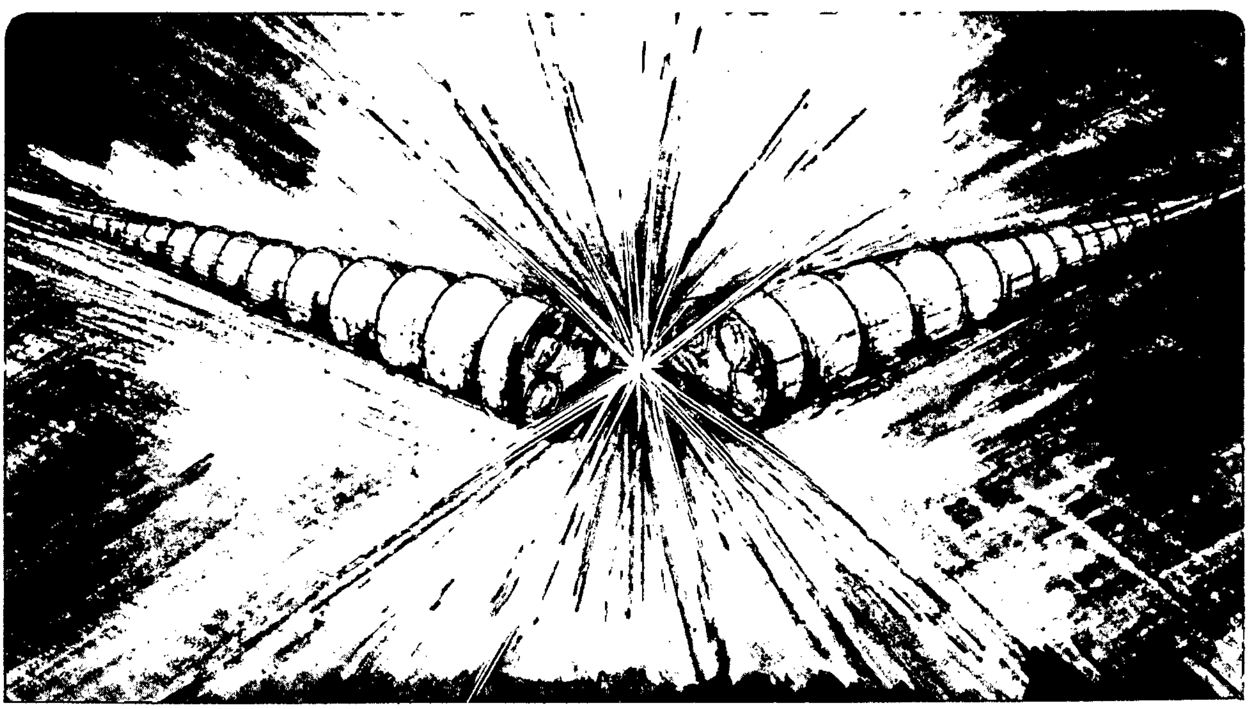
K. H. Berkner, W. G. Graham, R. V. Pyle,
A. S. Schlachter and J. W. Stearns

June 1979

For Reference

Not to be taken from this room



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CHARGE-STATE DEPENDENCE OF ELECTRON LOSS FROM H BY COLLISIONS WITH HEAVY, HIGHLY STRIPPED IONS*

K. H. Berkner, W. G. Graham**, R. V. Pyle, A. S. Schlachter and J. W. Stearns

Lawrence Berkeley Laboratory
University of California
Berkeley, California 94720

We have extended the experimental confirmation of our previously determined theoretical/experimental scaling rule[1] for electron loss from a hydrogen atom in collision with a heavy, highly stripped ion. Electron loss is the sum of charge exchange and ionization. The theoretical calculations covered the energy range E = 50 to 5000 keV/amu, and charge states q from 1 to 50. Our previous experimental cross sections for electron loss from hydrogen were for iron projectiles in charge states q = 3 to 22 (E ÷ q in the range 10 to 100 (keV/amu) ÷ q). The results we report here are for carbon ions in charge states 4 to 6 at 310 keV/amu and 1.1 MeV/amu, and for niobium ions in charge states 23 to 36 at 3.5 MeV/amu. We find that these results are all consistent with our scaling rule and that the scaled cross section is independent of the projectile species. The new experimental results cover the E/q range 50 to 280 (keV/amu) ÷ q.

Figure 1 shows the theoretical scaling rule for electron loss from H, along with our experimental results[1,2] for iron ions in H_2 (divided by a factor of the order of 2 for comparison with H calculations, see discussion in references 1 and 2), and our results for C and Nb ions in H_2 (divided by a factor of 2 for comparison with H calculations). The agreement with the theoretical calculation is good.

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**Present address: New University of Ulster, Coleraine, Northern Ireland.

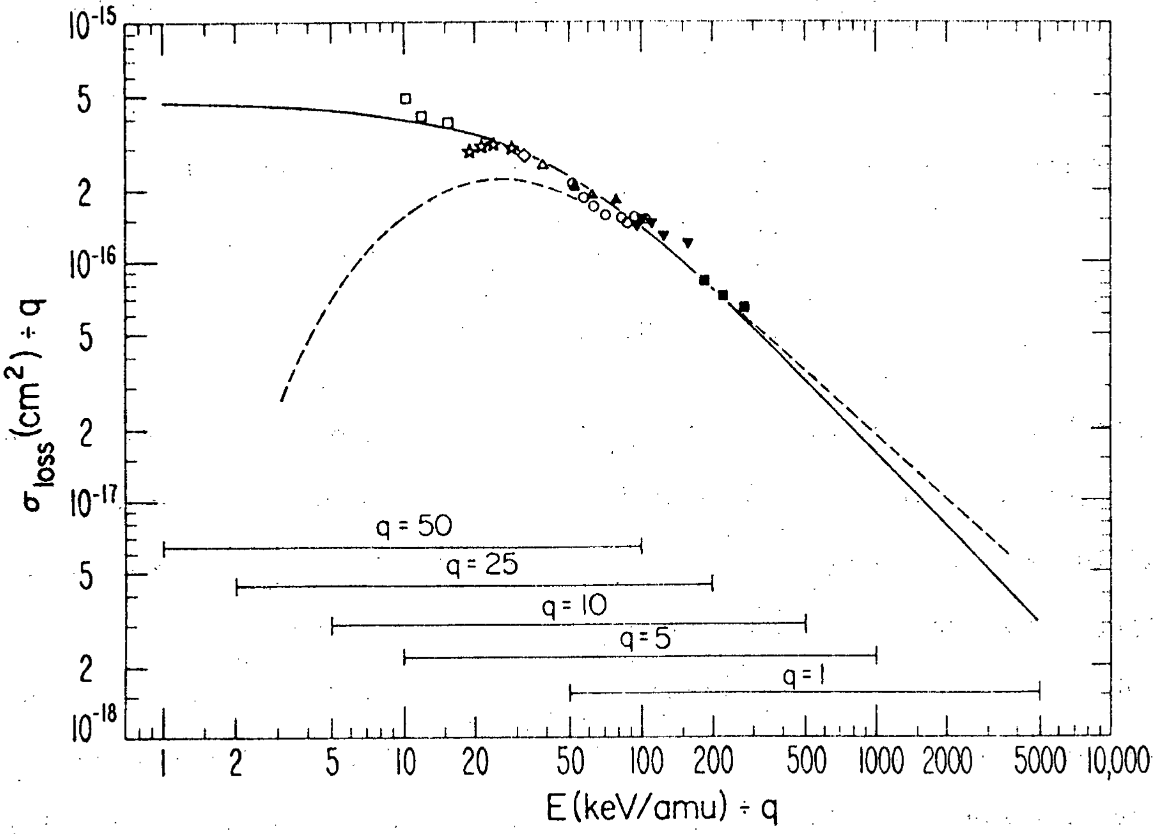

Fig. 1. Cross section σ_{loss} for electron loss by atomic hydrogen in collision with an ion in charge state q. Solid line: calculation; this curve is valid for $1 \leq q \leq 50$ and for energies in the range 50 to 5000 keV/amu. The range of E/q values for which the curve is valid is indicated by the bars drawn in the lower portion of the figure. The uncertainty in the calculated cross sections is ±25%. Dashed line: Plane-wave Born-approximation cross section for ionization only (Refs. 3, 4). Closed Symbols: Present experimental results for $C^{+q} + H_2$ and $Nb^{+q} + H_2$, divided by a factor of 2 to allow comparision with the calculations. The uncertainty is 30%. Triangles, 0.31 MeV/amu carbon ions, q = 4-6; squares, 1.1 MeV/amu carbon ions, q = 4-6; inverted triangles, 3.5 MeV/amu niobium ions, q = 23-36. Open symbols: Previous experimental results by the present authors (refs. 1 and 2) for $Fe^{+q} + H_2$ divided by a number between 1.5 and 2.0 to allow comparison with the calculations. Squares, 108 keV/amu, q = 7-11; triangle, 110 keV/amu, q = 3; diamond, 282 keV/amu, q = 9; stars, 290 keV/amu, q = 10-15; circles, 1140 keV/amu, q = 11-22.

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