

Lawrence Berkeley National Laboratory

Recent Work

Title

NEGATIVE LITHIUM EMISSION FROM A TUNGSTEN SURFACE IN A PLASMA

Permalink

<https://escholarship.org/uc/item/74n453j5>

Authors

Stearns, J.W.

Pyle, R.V.

Publication Date

1984-10-01

c.2



Lawrence Berkeley Laboratory

UNIVERSITY OF CALIFORNIA

RECEIVED
LAWRENCE
BERKELEY LABORATORY

NOV 20 1984

LIBRARY AND
DOCUMENTS SECTION

Accelerator & Fusion Research Division

To be presented at the American Vacuum Society
31st National Vacuum Symposium, Reno, NV,
December 4-7, 1984

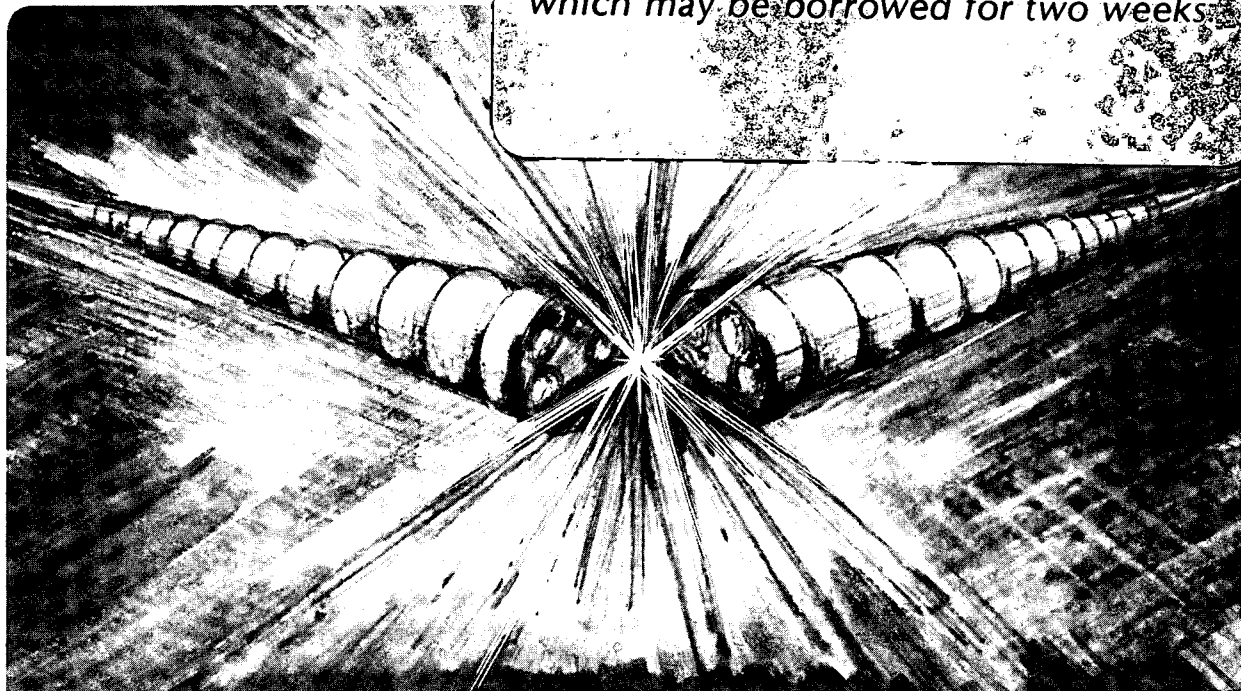
NEGATIVE LITHIUM EMISSION FROM A TUNGSTEN
SURFACE IN A PLASMA

J.W. Stearns and R.V. Pyle

October 1984

TWO-WEEK LOAN COPY

*This is a Library Circulating Copy
which may be borrowed for two weeks*



LBL-18016
c.2

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.

Negative Lithium Emission from a Tungsten Surface in a Plasma*

J. W. Stearns and R. V. Pyle

Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720

October 1984

Negative Lithium Emission from a Tungsten Surface in a Plasma*

J. W. Stearns and R. V. Pyle, Lawrence Berkeley Laboratory, Berkeley, CA 94720.

Intense (ampere) beams of high-energy lithium atoms may have applications in fusion and space programs. In principle they can be produced by accelerating Li^- ions and then detaching the electrons. This technique is used to produce H^0 beams from H^- ions.

Three possibilities for making Li^- ions have been considered: electron capture in a suitable gas or vapor, extraction from a lithium plasma, and production on a low work function surface in a plasma. The only quantitative results, so-far, have been for electron capture, with the highest yield being about 5% for Li^+ in Cs vapor at 5 keV.¹ Of the other two methods, Leung² has seen some Li^- produced in the volume of a plasma, and we now report the observation of Li^- from a surface in a He-Li plasma.

A model for negative ion production on surfaces³ predicts that Li^- yields will be lower than H^- yields. Li has an even smaller electron affinity (0.5 eV) than H (0.75 eV). If Li^- is formed on the surface, it is less likely than H^- to escape intact, because its lower velocity and affinity increase the probability that the surface will recapture the extra electron. Our observations are consistent with this prediction.

The apparatus (Fig. 1) consists of an arc-discharge chamber with a small tungsten plate opposite a collimated beam line and momentum analyzer.⁴ The plate is biased negatively with respect to the plasma to accelerate positive ions from the plasma into, and negative ions away from the surface. For this experiment, the arc was initiated with helium gas. The discharge heated a small crucible filled with lithium metal to introduce lithium vapor and form a composite plasma. The discharge was a bright rose color when the best Li^- yield was obtained.

Fig. 2 shows a composite of spectra with Li^- peaks. The angular resolution ($\pm 2^\circ$) permitted observation of only that negative ion current which was emitted normal to the surface. The plasma sheath causes all very low energy Li^- ions to be accelerated in this direction, while backscattered, higher energy ions are emitted in a larger cone. Note the presence of many peaks from contaminants on the surface or in the plasma which, while normally undesirable, can be used to confirm the analyzer calibration.

Although no hydrogen was deliberately introduced into the plasma, a very sharp mass=1 peak was observed. Clearly, for these conditions, the Li^- production efficiency is much smaller than the H^- production efficiency.

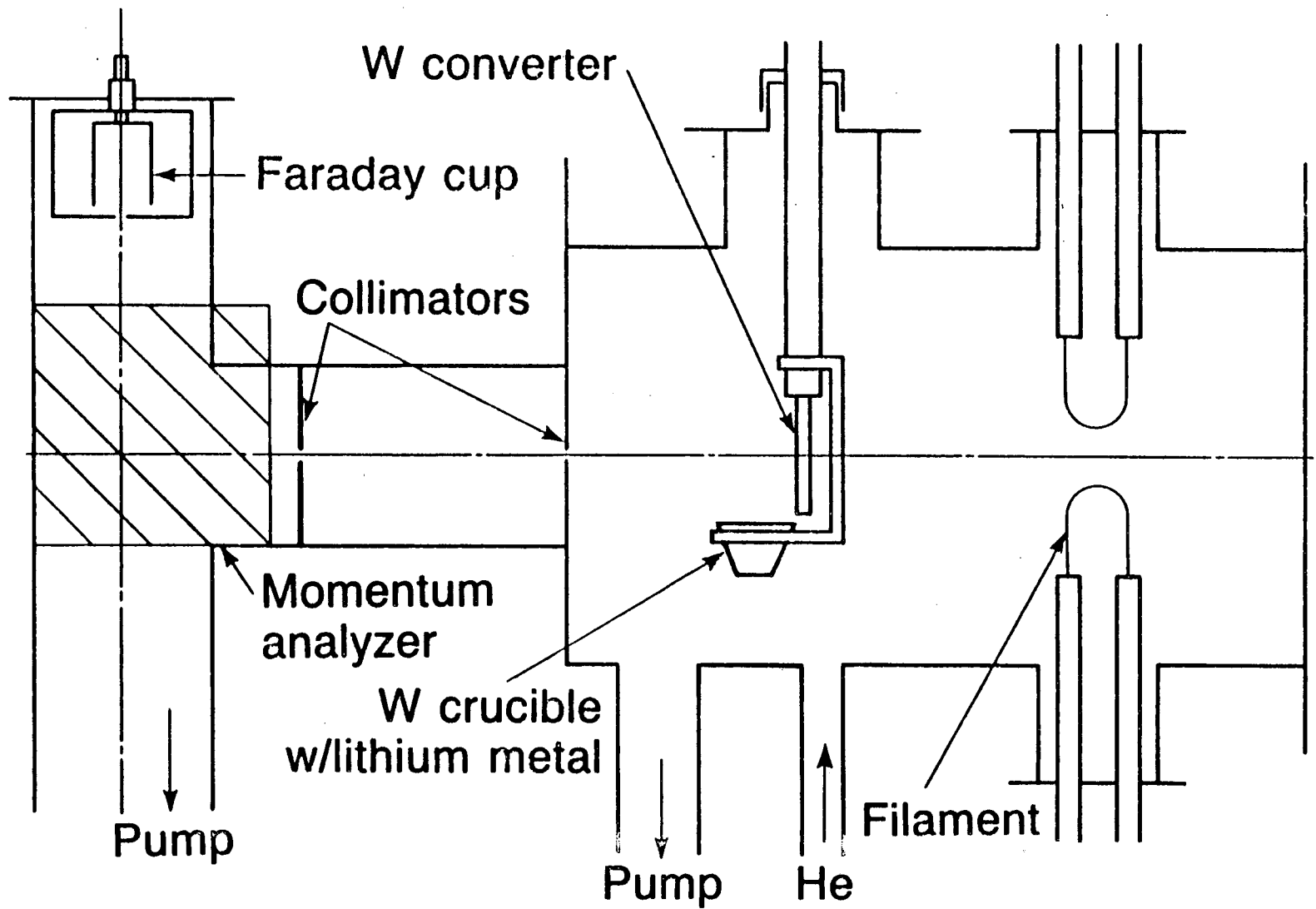
The observation of a Li^- current from the surface was sufficiently encouraging that a lithium oven is being built so that we can stabilize the plasma. To reduce the surface work function, it will be used in conjunction with the Cs oven already in place. This will allow measurements of both desorption and backscattering to be made under variable controlled conditions.

1. J. Richard Mowat, Alfred S. Schlachter, Emily Fisch, J. W. Stearns, Y. K. Bae, to be submitted to Physical Review.
2. Ka-ngo Leung, private communication.
3. J. R. Hiskes, A. M. Karo, E. Wimmer, A. J. Freeman and S. R. Chubb, J. Vac. Sci. Technol. A2, pg. 670 (1984).
4. M. Wada, R. V. Pyle and J. W. Stearns, J. of Vac. Sci. Tech. A Vol. 2, No. 2. Part 11, p. 767 (1984).

Fig. 1. The experimental arrangement.

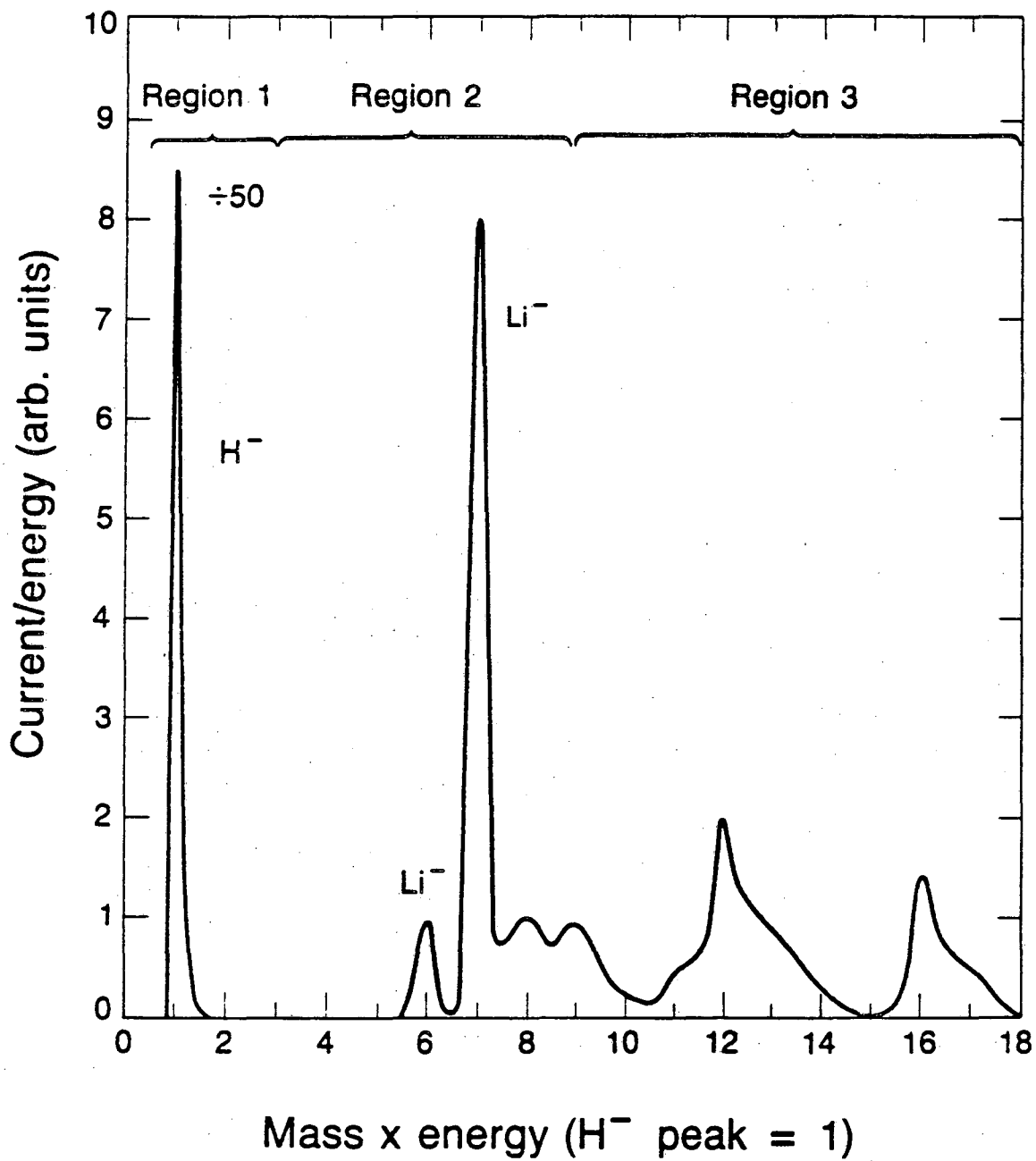
Fig. 2. Composite negative ion spectrum showing $^6\text{Li}^-$ and $^7\text{Li}^-$ peaks, plus H^- and other contamination. The three regions are comparable within a factor of 2.

*Work supported by the U.S. Department of Energy under Contract No. DE-AC03-76SF00098, and by Department of Defense order number W31RPD-43-Z840.



XBL 8410-10900

Fig. 1



XBL 8410-10899

Fig. 2

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.

TECHNICAL INFORMATION DEPARTMENT
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720