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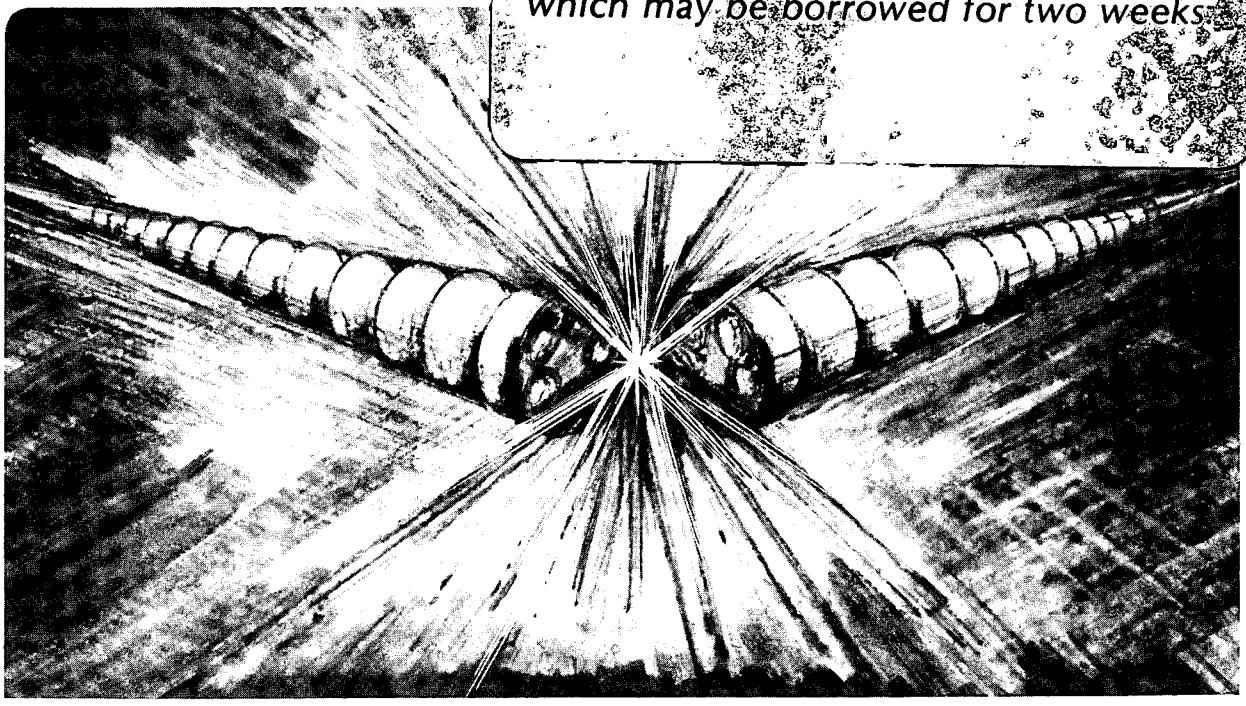

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DISCLAIMER

LBL-18016

Negative Lithium Emission from a Tungsten Surface in a Plasma*

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Negative Lithium Emission from a Tungsten Surface in a Plasma*

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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 quantative 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, Leung[2] 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 surfaces[3] 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 then 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 initated 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 ($\pm 2^o$) 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 ii, p. 767 (1984).

Fig. 1. The experimental arrangement.

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

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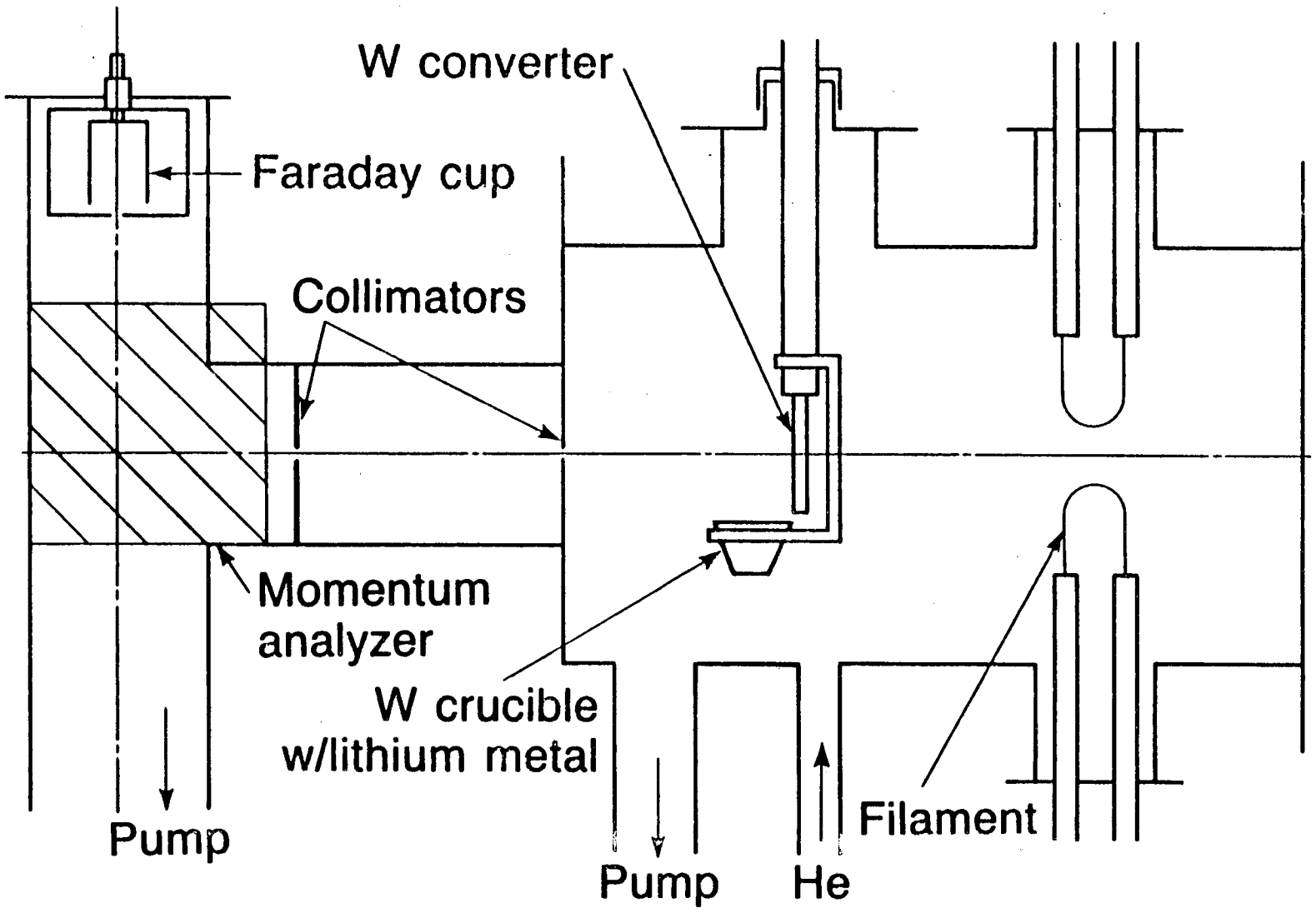
W converter
Faraday cup
Collimators
Momentum
analyzer
W crucible
w/lithium metal
Pump
Pump
He
Filament
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Fig. 1

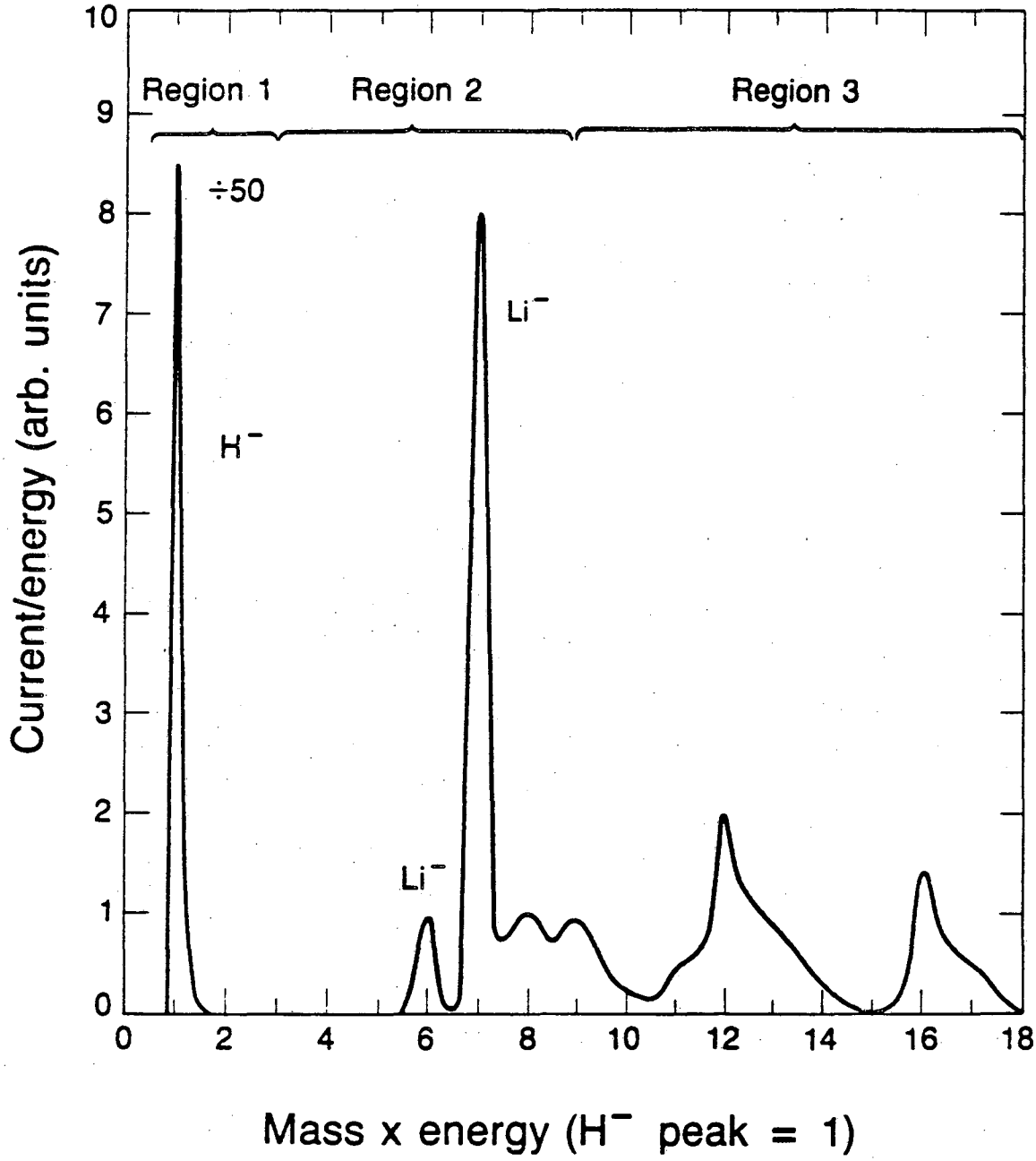

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Fig. 2

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