# Characteristics of electron multipliers in the detection of alkali ions

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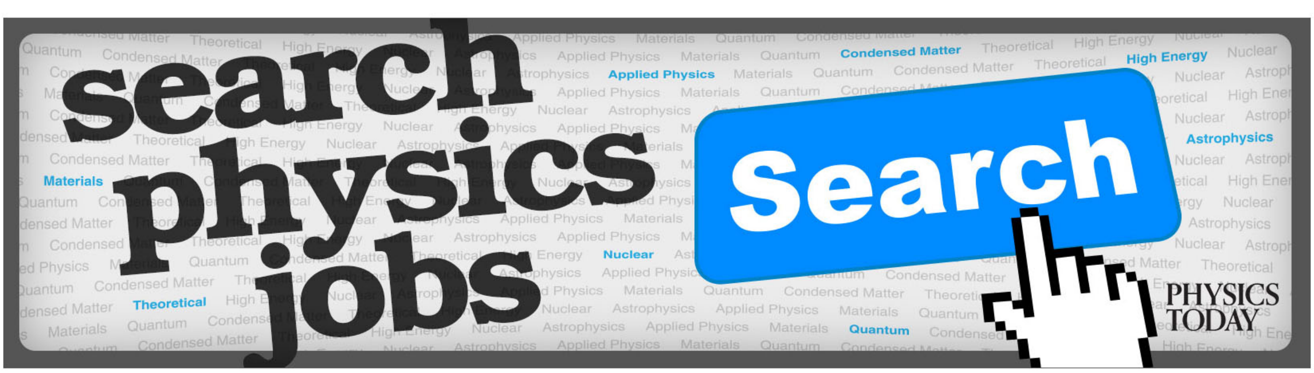

where $\alpha =$ the linear coefficient of the thermal expansion of stainless steel and $\epsilon_r =$ radial strain at the tube bore (calculable from Lamé's theorem). Displacement of the piston is measurable to $\pm 0.005$ mm using a linear variable differential transformer[4] with a suitable supply voltage and a good quality millivoltmeter. Consequently volume changes can be determined to an accuracy of better than 0.0001 $cm^3$.

By suitable choice of lengths of tubes 1, 2, and 3, a wide range of mixtures can be covered with comparable accuracy, and fluids of different compressibilities can be catered for.

The device constructed has been tested with the water–ethanol system at equimolar concentration of the two components at 25 ° and 50 °C in the pressure range of 1000–3200 psi. The excess volumes of mixing thus obtained were compared with those of Götze and Schneider,[5] and excellent agreement was found between the two sets. A graphical representation of the comparison is presented in Fig. 3.

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Results are presented showing the gain of electron multipliers EMI 9603-B and EMI 6260 as a function of their multiplying dynode voltage, ion input current, and ion accelerating voltage for $Li^+$, $Na^+$, $K^+$, $Rb^+$, and $Cs^+$ ions. The high sensitivity of the particle multipliers for very low ion currents ($\sim 10^{-14}$ and $10^{-10}$ A) and their potentialities for mass discrimination of different alkali ions have been discussed.

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Enough data and literature[1–3] exist on the use of electron multipliers for the detection of positive ions. The author in this note has studied the gain factors of an EMI 9603-B particle multiplier and EMI 6260 multiplier (converted from photomultiplier EMI 6260) under alkali ion bombardment with respect to multiplying dynode voltage, input ion current, and ion accelerating voltage.

The ion beams of $Li^+$, $Na^+$, $K^+$, $Rb^+$, and $Cs^+$ obtained by heating ultrapure alumino-silicates of alkali metals in Kunsman ion sources were collimated and accelerated through a series of stainless-steel slits followed by an efficient Faraday cup placed in front of the particle multiplier. The vacuum in the system was better than 0.1 mPa, and the applied voltages on the EMI 9603-B and EMI 6260 multipliers were 3500 and 1850 V, respectively. The particle multipliers were operated in dc mode. The gain of electron multiplier 9630-B with 15 stages having OAgMg dynodes used for standardization was $8.4 \times 10^6$ for 500-eV electrons, whereas for electron multiplier EMI 6260 with 11 stages having Cs–3Sb dynodes it was $1.6 \times 10^4$ for 500-eV electrons. The minimum ion current detected was $10^{-14}$ and $10^{-10}$ A, respectively, in the case of the OAgMg dynode particle multiplier and the Cs–3Sb dynode particle multiplier. The gain of these particle multipliers for alkali ions was calculated by taking the ratio of currents at the anode of the multiplier and an efficient Faraday cup placed in front of the multiplier.

The gain of these two electron multipliers (EMI 6260 and EMI 9603-B) for different alkali ions as regards multiplying dynode voltage, input ion current, and ion accelerating voltage is given in Figs. 1(a)–1(c) and Figs. 2(a)–2(c).

Since gain is directly proportional to the coefficient of the secondary electron emission, heavier ions on bombardment of the OAgMg and Cs–3Sb surface of these two electron multipliers give a lower secondary electron yield as compared to a lighter one. The ability of the particle multipliers for mass discrimination of different ions at very low ion current used after a mass spectrometer can be of immense value.

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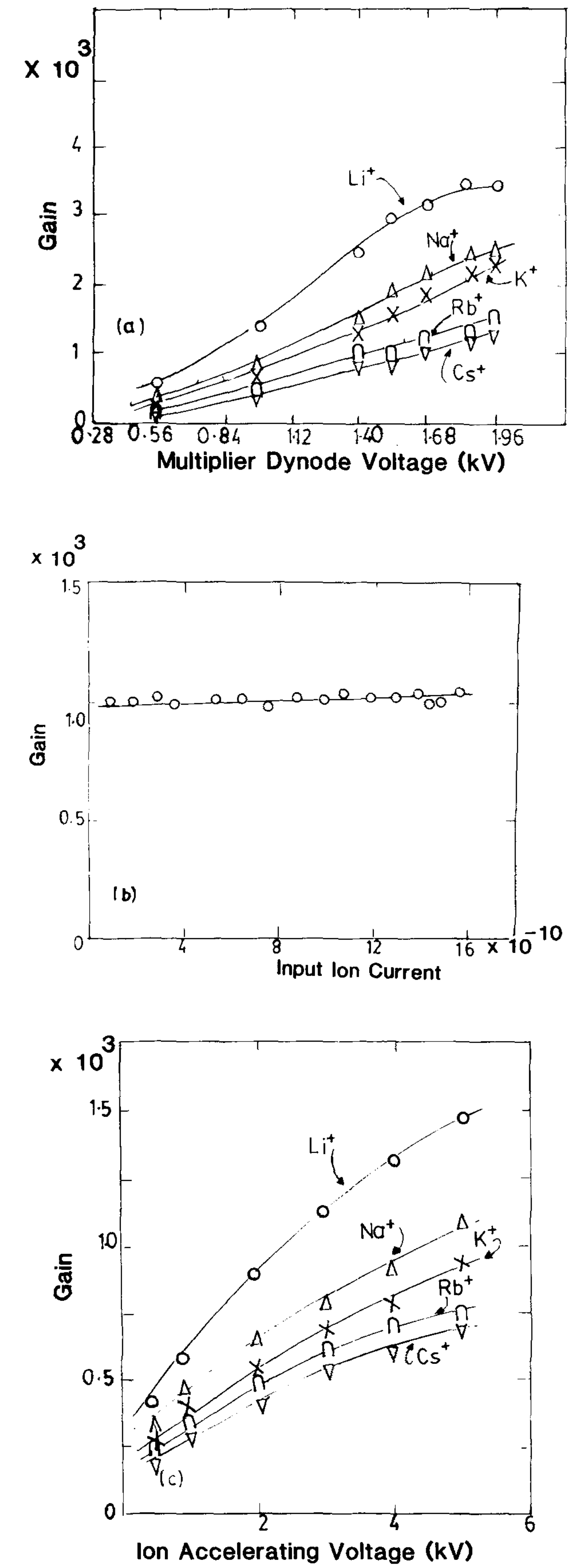


FIG. 1. Representation of the gain of the 6260 particle multiplier for $Li^+$, $Na^+$, $K^+$, $Rb^+$, and $Cs^+$ as a function of (a) different multiplying dynode voltage at constant accelerating voltage of 10 keV, (b) different ion current, and (c) different ion accelerating voltage.

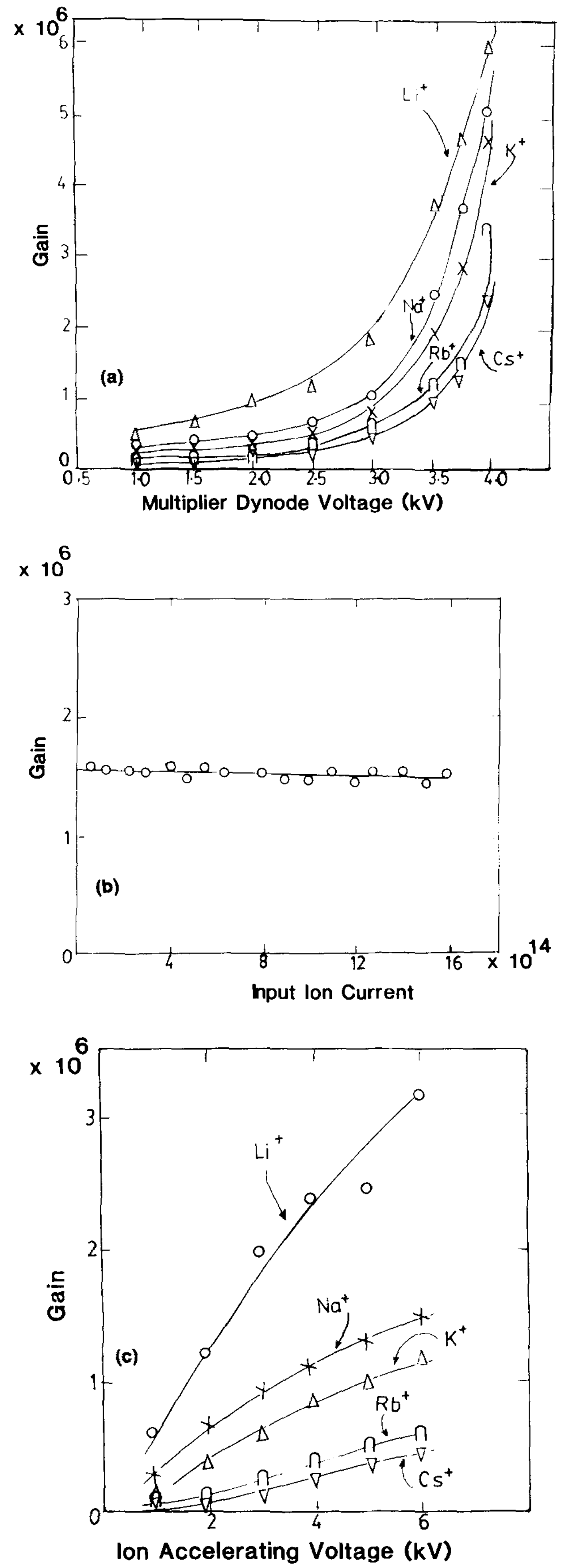


FIG. 2. Representation of the gain of the EMI 9603-B electron multiplier for $Li^+$, $Na^+$, $K^+$, $Rb^+$, and $Cs^+$ as a function of (a) different multiplying dynode voltage at constant accelerating voltage of 10 keV (b) different ion current, and (c) different ion accelerating voltage.

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