Experiments to Study the Exotic Ions and the Effect of Light on Electron Bubbles in Superfluid Helium

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We present results of time-of-of-flight measurements of the mobility of negative ions (electron bubbles) in superfluid helium-4 at temperatures around 1 K. At saturated vapor pressure we introduce ions into the cell by means of a discharge in the vapor. For measurements at pressures up to 2 bars we produced ions by emission from sharp tips and from a Ni-63 beta source. With ions produced by a discharge we detect normal electron bubbles and the exotic ions seen previously by Ihas and Sanders, and by Eden and McClintock. We also see ions which have a continuous distribution of mobility. The continuous mobility distribution is very hard to understand based on the supposition that these ions are impurity ions or helium atom negative ions. We will discuss possible explanations of the continuous distribution.

When the ions come from the tip or the radioactive source the exotic ions and the continuous background are not seen. In previous experiments, the effect of light on the transport of negative helium ions has been reported as an increase in the current through the liquid when electron bubbles are injected and light is applied. The reason for the change in the current observed in these experiments was not established. In the present work, we are able to study this process in more detail because we can directly measure the change in the mobility of the electron bubbles after the light is applied. We will report new results obtained by this method.

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