Comment on "Nature of Exotic Negative Carriers in Superfluid ^{4}He"

In a recent paper,[1] Sanders and Ihas have suggested an explanation for the hierarchy of high-mobility exotic ions[2-5] that can be created in He II with the aid of an electrical discharge in the vapor above a free surface. They propose that these ions are multielectron bubbles. Such entities would necessarily have radii larger than that of the normal negative ion in He II so that, at first sight, one would expect them to have lower mobilities, rather than the higher mobilities actually observed. Sanders and Ihas argue persuasively that this apparent discrepancy might be accounted for if proper allowance were made for the "anomalous" kinematics of roton scattering.

While warmly welcoming a possible explanation of this long-standing mystery, and applauding the ingenuity of the Sanders and Ihas proposal, we would like to point out two additional pieces of evidence that have not been considered and which would appear to weigh against the idea of multielectron bubbles.

First, the critical drift velocities at which some of the exotic ions undergo transitions to charged vortex rings have been measured.[5] They are up to 10 m s^{-1} larger than for the normal negative ion. Most models of the ion-vortex-ring transition[6] would suggest, on this basis, that the radii of the exotic ions are *smaller* than that of the normal ion. Such a conclusion would, of course, be entirely consistent with their relatively higher mobilities, even if the anomalous roton-scattering processes were left out of the account altogether.

Secondly, a very recent observation[7] is that the relative magnitudes of the exotic and normal ion fluxes entering the liquid depend crucially, not on the current in the discharge, but on the current density and the character of the discharge. This result tends to support the idea that the exotic ions arise from precursors in the vapor above the liquid: for example, excited helium molecular ions,[8] which might be stabilized on entry to the liquid on account of the additional energy which would then be needed for their excess electrons to form independent bubbles.

It can be argued that neither of the above observations is necessarily lethal to the Sanders and Ihas proposal. Both points are highly relevant to the argument, however, and in particular to the weighing of the balance of the evidence. They deserve to be given proper consideration.

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