Experimental Observation of Few Electron Bubbles in Liquid Helium

Neha Yadav[1] and Ambarish Ghosh[1,2]

1 Department of Physics, Indian Institute of Science, Bangalore, India
2 Centre for Nano Science and Engineering, Indian Institute of Science, Bangalore, India

An electron entering liquid helium experiences a repulsive potential of 1 eV. This originates in the interaction between the injected electron and electrons of the closed shells of helium atoms through Pauli exclusion principle. If the energy of the electron exceeds 1 eV, it can penetrate the liquid, form a cavity free from helium atoms and subsequently localize itself within the cavity. This is known as a single electron bubble (SEB). In another configuration, a system of electrons of energy less than 1 eV can form a floating charged layer above the surface of liquid helium: a two-dimensional system that has been studied in great detail over last few decades. If the number of electrons in this layer exceeds a critical value of $2 \times 10^{13}\ electrons/m^2$, an electro hydrodynamical instability sets in, giving rise to multielectron bubbles (MEBs), referring to micron to mm sized cavities containing a large number of electrons.

In the experiments to be discussed in my talk, the primary technique is based on cavitation of liquid helium using pulsed ultrasound. We have observed a new species of electron bubble which cavitates at a negative pressure approximately 80 percent lower magnitude than SEBs. We conclude that these are multielectron bubbles with small (<20) number of electrons; I'll be presenting various evidences supporting this claim and compare our results with related experiments previously reported.