Finding the Fundamental Charge with the Millikan Oil Drop Experiment PHYS 451

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Abstract

Across most scales of structure in the universe, many interactions of matter are dictated by electrical forces. Charge, like matter, can only be broken down so far until it is made solely of fundamental particles. The most common charge we associate with charge is the electron. All electrons are identical- they carry the same charge, have the same inertial and gravitational masses, etc. It is important then to characterize electrons, and measure the value of their charges- which in turn suggests we have the proton charge as well. To do this, I sprayed microcopic bits of oil, which had become electrically charged by jostling over one another, in between the plates of a parallel plate capacitor and imaged the drops with a microscope. Using the method described by the 'Balance Method' section of the fundamental electron charge to be *electroncharge* $\pm$ *uncertainty* C. Other parameters of the experiment had to be assumed, including the viscocity of air, η, which I took to be $1.846 \times 10^{-5}\ kg\ m^{-1}\ s^{-1}$. I assumed the atmospheric pressure was 75.99 $cmHg$. Calibration showed a 0.266 mm wire was $15 \pm 0.5\ mm$ on the screen, and a voltmeter showed the 'zero' on the apperatus was approximately 2 V. To find this value, 17 drops were characterized, and the charge on each was found using the 'Balance' method. Both differences between charges were compared, and I made a histogram of the truncated values with bins of $1 \times 10^{-20}\ C$ between the values of 1×10^{-18} to 1×10^{-20}. The reported value is the most populated bin. To improve the measurement, the terminal velocity for each drop should have been measured more times. Accurate measurements of the atmospheric pressure and temperature could small (almost negligible) effects on the reading, but would tamp down uncertainty. More drops could be measured as well. Finally, the radii are calculated, but I believe precise direct measurements of the droplet radii could improve accuracy of the measurement.