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Shot Noise

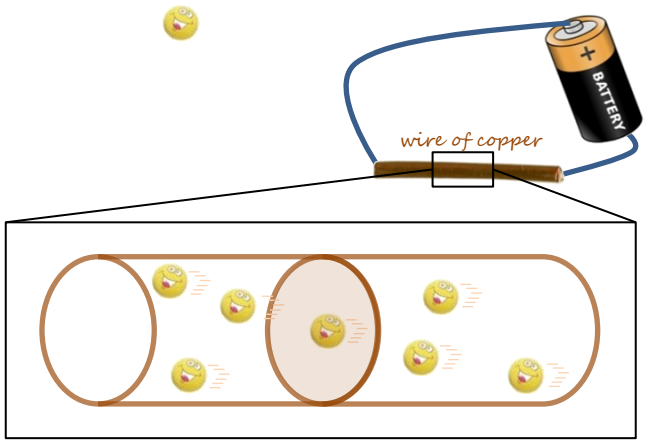
Why is noise interesting?

In a conductivity measurement, noise can give a lot of precious information about:

- the charge of (quasi-)particles that contribute to the current (e.g. charge e/3 in the fractional quantum Hall regime),
- the statistics obeyed by these particles (fermions, bosons),
- interactions causing correlations between them (e.g. Cooper pairs).

What is shot noise?

Shot noise arises because electronic charge is transported in quantized portions.
Example: electrons with a net charge -e

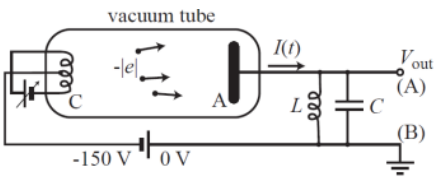


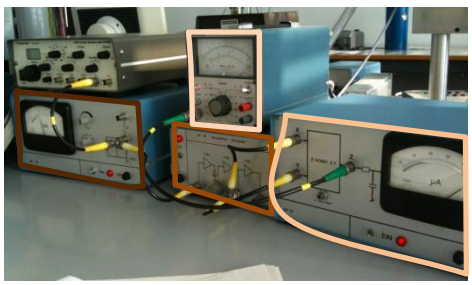
The experiment

In this basic experiment, we propose you to determine the value of the elementary charge $|e|$.

How can we measure it?

As in real lab work, you will be in charge of finding good experimental conditions.





Vacuum tube = noise generator = damped harmonic oscillator (RLC) → Voltage amplifier → amplify U_{out}^{noise} → Rectifier → Rectify U_{out}^{noise} into a DC voltage U_{amp} → Voltmeter → measure U_{amp}

- Look for the f_{res} of this circuit!
  ➡ You will obtain C_{tot}...
- Determine R with the help of the RLC bridge!
- You can read P...
- And determine the amplification factor GA^2 thanks to the HF oscillator and thus $\langle U^2_{amp}(t) \rangle$!

$$|e| = \frac{PC_{tot}}{GA^2R|\langle I \rangle|}$$ +/- some experimental error...

elementary charge = 1.602176565(35) × 10^{-19} C

Clément Barraud, 30/04/2012