Quantum Metrology Triangle and Determination of Charge Quantum

Plática Plenaria

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ABSTRACT

Following the ac Josephson Effect (JE) and the quantum Hall effect (QHE) which is now widely used to maintain the volt and the ohm, the single electron tunneling (SET) effect could be a basis for a quantum standard of current. From theory the constant involved in SET is presumed the electron charge e. Similarly, the constants K_J and R_K provided by JE and QHE should correspond to $2e/h$ and h/e^2 respectively. Testing these theoretical presumptions presents a great interest especially at an accuracy level as high as one part in 10^8. This is the ultimate goal of the quantum metrological triangle (QMT) experiment. In addition to strengthen our confidence on the Josephson and von Klitzing relations, the QMT experiment combined with the measurements of $K_J^2 R_K$ from a watt balance and of R_K by means of a Thompson-Lampard calculable capacitor also allows a SI determination of the charge quantum Q_X to be compared to the elementary charge.

At LNE, the QMT experiment consists in the direct comparison of the voltage supplied by a Josephson junction array to the Hall voltage of a QHE device crossed by a current delivered by a SET current source. The very low value (a few pA) of the quantized current issued from the electron pump (the more promising SET device) is amplified by means of a cryogenic current comparator.

The talk will first present foundations of the QMT. Then some experimental set-up will be described along with expected uncertainties in both the short and long terms. A progress report of SET measurements carried out at LNE will be finally given.