Gwendal Feve – Colloquium seminar – October 14, 2021

Ecole normale supeieure, Paris, France

Fractional statistics of anyons in a mesoscopic collider

In three-dimensional space, elementary particles are divided between fermions and bosons according to the properties of symmetry of the wave function describing the state of the system when two particles are exchanged. When exchanging two fermions, the wave function acquires a phase, $\varphi = \pi$. On the other hand, in the case of bosons, this phase is zero, $\varphi = 0$. This difference leads to deeply distinct collective behaviors between fermions, which tend to exclude themselves, and bosons which tend to bunch together. The situation is different in two-dimensional systems which can host exotic quasiparticles, called anyons, which obey intermediate quantum statistics characterized by a phase φ varying between 0 and π [1,2].

For example in the fractional quantum Hall regime, obtained by applying a strong magnetic field perpendicular to a two-dimensional electron gas, elementary excitations carry a fractional charge [3,4] and have been predicted to obey fractional statistics [1,2] with an exchange phase $\varphi = \pi/m$ (where m is an odd integer) for Laughlin states corresponding to a fractional filling $\upsilon = 1/m$ of the first Landau level. I will present how fractional statistics of anyons can be demonstrated in this system by implementing and studying anyon collisions at a beam-splitter [5]. The collisions are first studied in the low magnetic field regime, where the elementary excitations are electrons which obey the usual fermionic statistics. It leads to the observation of an antibunching effect in an electron collision: electrons systematically exit in two different arms of the beam-splitter. The observed result is completely different in the fractional quantum Hall regime at filling factor $\upsilon = 1/3$. Fractional statistics lead to a suppression of the antibunching effect and quasiparticles tend to bunch together in larger packets of charge in a single output of the splitter. This effect leads to the observation of negative correlations of the current fluctuations [5] in perfect agreement with recent theoretical predictions [6].

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