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Observation of neutral modes via shot noise measurements

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Current propagates in the quantum Hall regime along the edges of a two-dimensional-electron gas via chiral edge modes, with chirality dictated by the applied magnetic field. In the fractional regime, for some fractional states - the so called "holes-conjugate" states – e.g., between filling factor 1/2 and 1 - early predictions suggested the presence of counter propagating edge modes: a "downstream" mode with the expected chirality and an "upstream" mode with an opposite chirality. Since experiments in the ubiquitous 2/3 state did not find upstream propagating edge modes, it had suggested that in the presence of interactions and disorder edge reconstruction may take place with a resultant downstream charge mode accompanied by upstream neutral mode - with the latter carrying only energy - thus explaining why the upstream modes were not detected thus far. Moreover, a neutral upstream Majorana mode is also expected for selected wavefunctions proposed for the even denominator state 5/2. I will review some of our observations of neutral modes in selected quantum Hall states. Neutral mode detection was performed by allowing a chiral mode to impinge on a quantum point contact (QPC) constriction. The partitioning of the neutral mode led to current fluctuations propagating in the downstream chirality. The main following effects that were observed were: (a) Current noise, being proportional to the applied voltage on the injecting contact, without net current; (b) Similarly, partitioning charge current in a QPC led to generation of an upstream neutral mode; (c) The neutral mode decays fast with length and temperature; (d) Having a neutral mode impinge simultaneously with a charge mode affects strongly the Fano factor and the temperature of the partitioned charged quasiparticles; (e) For the 5/2 fractional state, our observation of an upstream neutral mode is likely to single out the proposed reconstructed Pfafian or anti-Pfafian wavefunctions for non-abelian quasiparticles.