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Theory of Mesoscopic Threshold Detectors of non-Gaussian Noise

ANDREW JORDAN, University of Rochester

Recently, measurements of current fluctuations arising from the charge discreteness (shot noise) have become an invaluable tool in mesoscopic physics, the most noticeable achievement being the measurement of quasi-particle charge in the fractional quantum Hall state. Typically, shot noise experiments report measurements of the zero-frequency noise power, which is a characteristic of the Gaussian component of current fluctuations. A natural generalization of the noise power, the counting statistics of charge transmitted through a system, is interesting in itself, because it contains complete information about the electron transport on a long time scale. However, the measurement of non-Gaussian noise effects presents an experimental challenge because of the limitations imposed by the central limit theorem. This difficulty can be partly overcome by placing an auxiliary mesoscopic system (detector) very close to the noise source and arranging strong coupling to the noise. This leads to the idea of a threshold detector, which is able to measure rare current fluctuations. Its basic principle is analogous to a pole vault: A detection event occurs when the measured system variable exceeds a given threshold value. A natural candidate for such a threshold detector is a metastable system operating on an activation principle. By measuring the rate of switching out of the metastable state, information about the statistical properties of the noise driving the system may be extracted. This requires solving the Kramers' problem of noise-activated escape from a metastable state beyond the Gaussian noise approximation and investigating how the measurement circuit affects threshold detection.