Persistent currents controlled by non-classical electromagnetic fields

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Mesoscopic systems and the non-classical electromagnetic fields are of central importance for quantum information processing. Our aim is to present the significant impact of the non-classical radiation on the properties of persistent currents. We study mesoscopic rings or cylinders subject to both classical and non-classical magnetic flux. Our discussion is limited to one- and two-mode fields prepared in a given state. For the monochromatic radiation we study reduction of the current amplitude due to the quantum and classical noise in the field. We also present the change of the sign of the current from para- to diamagnetic (and vice versa) controlled by the state of radiation. The effect of temperature will by shortly reviewed.
There are two qualitatively distinct classes of two-mode fields: separable and entangled. This is reflected in the properties of the currents which become time-dependent for the fields in an entangled state. We investigate the effect of entanglement for the family of states with various amount of entanglement: from separable to Bell states quantified by the concurrence.

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