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Imaging coherent electron flow in a two-dimensional electron gas

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Images of electron flow through a two-dimensional electron gas are obtained at liquid He temperatures using scanning probe microscopy. Near a quantum point contact (QPC), the images show angular lobe patterns characteristic of the wavefunctions in the QPC. At distances greater than one micron from the QPC, narrow branches of electron flow are observed due to the cumulative effect of small angle scattering. All of the images are decorated by interference fringes spaced by half the Fermi wavelength demonstrating that the flow is coherent. To determine the origin of the interference fringes, an imaging interferometer is created by adding a circular reflecting gate. The strength and position of the interference fringes can then be controlled by the voltage on this reflecting gate. Using the interferometer, we show that the interference fringes are due to backscattering to the QPC. Both experiments and theory demonstrate that the interference signal is robust against thermal averaging.