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Plasma instability and wave propagation in gate-controlled semiconductor conduction channels SERGEY RUDIN, GREG RUPPER, U.S. Army Research Laboratory — The plasma wave in the conduction channel of a semiconductor heterostructure high electron mobility transistor is an electron density excitation, possible at frequencies significantly higher than the cut-off frequency in a short channel device. When the electron-electron collision limited mean free path is much smaller than the wavelength of the density variations, the electron gas in the channel can be treated as a two-dimensional fluid. The flow is described by the Navier-Stokes equation and the heat conduction equation. The quality of the plasma resonance is limited by the electron mobility and the viscosity of the electron fluid. We use the hydrodynamic model derived as the balance equations from the quasi-classical Boltzmann equation, starting with a drifted Fermi-Dirac distribution as a zero order term in the expansion of the distribution function in orders of the Knudsen number. The charge flow can become unstable because of plasma wave amplification at the boundaries. The device then can be used as a tunable source of terahertz range radiation. We show that in such configuration the charge flow also develops shock waves due to hydrodynamic nonlinearities.

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