Coherence Resonance and Stochastic Resonance in an Excitable Semiconductor Superlattice

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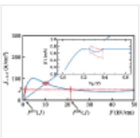
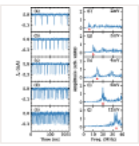
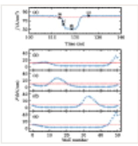
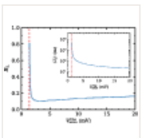
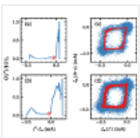
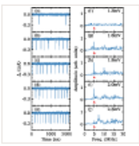
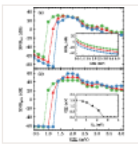
ABSTRACT

Collective electron transport causes a weakly coupled semiconductor superlattice under dc voltage bias to be an excitable system with $2N+2$ degrees of freedom: electron densities and fields at N superlattice periods plus the total current and the field at the injector. External noise of sufficient amplitude induces regular current self-oscillations (coherence resonance) in states that are stationary in the absence of noise. Numerical simulations show that these oscillations are due to the repeated nucleation and motion of charge dipole waves that form at the emitter when the current falls below a critical value. At the critical current, the well-to-well tunneling current intersects the contact load line. We have determined the device-dependent critical current for the coherence resonance from experiments and numerical simulations. We have also described through numerical simulations how a coherence resonance triggers a stochastic resonance when its oscillation mode becomes locked to a weak ac external voltage signal. Our results agree with the experimental observations.

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Physics Subject Headings (PhySH)

Research Areas

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