Negative differential conductivity induced current instability in two-dimensional electron gas system in high magnetic fields

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— High mobility two-dimensional electron gas (2DEG) formed in the interface of a GaAs/AlGaAs hetero-structure in high magnetic field (B) exhibits interring non-linear response either under microwave radiation or to a dc electric field (E). It is general believed that this kind nonlinear behavior is closely related to the occurrence of negative-differential conductance (NDC) in the presence of strong B and E. We observe a new type NDC state driven by a direct current above a threshold value (I_{th}) applied to a 2DEG as a function of B at relatively high temperatures (T). A current instability is observed in 2DEG system at high B~6-8 T and at high T~20-30 K while the applied current is over I_{th}. The longitudinal voltage V_{xx} shows sub-linear behavior with the increase of I. As the current exceed I_{th}, V_{xx} suddenly drops a \Delta V_{xx} and becomes irregular associated with the appearance of hysteresis with sweeping I. We find that I_{th} increases with the increase of B and of T; meanwhile, \Delta V_{xx} is larger at higher B but lower T. Data analysis suggest that the onset of voltage fluctuation can be described by a NDC model proposed by Kurosawa et al. in 1976. The general behaviors of T and B dependence of current instability are analog to those recently reported at lower both T and B. This consistence suggests the same genuine mechanism of NDC phenomena observed in 2DEG system.