INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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The thesis investigates the behaviour of conductance properties of spin-orbit coupled ballistic junction devices using the Landauer-Büttiker formalism and Green's function technique. The primary motivation is to explore spin Hall effect in these devices via computing the spin Hall conductance which assesses their utilities for spintronic applications. Two terminal, three terminal (Y-shaped) and four terminal structures are discussed extensively in the thesis. The step-like features in the longitudinal conductance, emphasizing discrete modes available for transport, and an oscillatory, coupled with an antisymmetry about the zero bias for the spin Hall conductance are the highlights of the transport characteristics. The inclusion of disorder destroys the former and suppresses the latter. Further, since conductance in graphene and graphene-based devices have been under focus in recent times for their non-trivial topological physics and possible spintronic properties, we have considered adatom decorated graphene nanoribbons described via Kane-Mele model. The quantum spin Hall (QSH) phase is shown to be robust in presence of heavy adatoms that are capable of inducing strong spin-orbit coupling. On the other hand, the Rashba spin-orbit interaction is seen to have detrimental effects on the QSH phase, which however has prospects in enhancing spintronic applications. Finally, an interplay between an external magnetic field and the Rashba spin-orbit coupling is explored for a six terminal graphene nanoribbon.