INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study : **Ph.D.**

Thesis Title: **Electrical and Thermal Transport through Spin-Orbit coupled Nano-junctions: An emphasis on Graphene based junction devices**

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Thesis Submitted to the Department/ Center : **Physics**

Date of completion of Thesis Viva-Voce Exam : **23/02/2019**

Key words for description of Thesis Work : **Quantum Transport, Junction System, Rashba Spin-Orbit Coupling, Kane-Mele Model, Thermoelectric applications.**

SHORT ABSTRACT

The thesis investigates electrical and heat transport in spin-orbit coupled normal-superconductor and normal-insulator-superconductor based junction devices via a modified version of the Blonder - Tinkham - Klapwijk (BTK) theory. The primary motivation is to study the conductance characteristics of these junction devices in presence of Rashba spin-orbit coupling. In this thesis, we explore both electrical and thermal transport and how they can be controlled via tuning the fundamental properties of these junctions. Further, the interplay between the spin-orbit coupling and the parameters that characterize the insulating region has been studied extensively in the thesis. Moreover realistic applications of these junction has remained a prime focus with a view of fabricating devices. Particularly, applicability of these junctions for tunable delivery of thermopower and as a thermoelectric cooling device are discussed in details. A special emphasis is laid towards the latter part of the thesis on the graphene-based junction devices owing to their non-trivial topological physics and possible spintronic applications, which have motivated us to study the conductance features of a spin-orbit coupled graphene based junction. The presence of the spin-orbit couplings, namely, the intrinsic and the Rashba couplings in graphene is included via the Kane-Mele Hamiltonian. The transmission properties and practical applications of the Kane-Mele normal-insulator-superconductor junctions are studied thoroughly. Finally, a comparison between a usual junction (with parabolic energy dispersion) and a graphene based junction (linear energy dispersion) with regard to their charge and heat transport is presented.