Preface

Cosmic Rays are the relativistic particles hitting our earth atmosphere continuously from outer space. Their observed energy spectrum spans over a wide range of energies i.e, from a few hundred MeV to more than 10^{20} *eV, and the spectrum follows a broken power law with negative slope. At an energy about 3 PeV, a change in slope occurs where the spectral index changes from* -2.7 *to* -3.1*, called knee and another change in slope occurs at around 3 EeV where spectral index again changes to 3.1 to pre-knee slope which is called ankle of the energy spectrum.*
In-spite of several studies over many decades, the origin of cosmic rays is still not known convincingly. Supernova remnants (SNR) are believed to be only a viable class of galactic sources which can accelerate cosmic rays up to knee or even up to ankle of the cosmic ray energy spectrum. But maximum energy achievable by a cosmic ray particle in SNR is a key unresolved issue concerning the SNR model of Cosmic ray origin. It is proposed that the mass composition of cosmic rays will be heavier beyond the knee if the knee is a proton knee under the SNR origin of cosmic rays frame-work but mass composition of cosmic rays as measured by different extensive air shower experiments above few hundreds of TeV energy is conclusively not known. So an alternate method to determine mass composition of cosmic rays is required.
The SNR origin model of cosmic rays has received some supports from the TeV gamma ray observations. If the cosmic rays are accelerated in SNRs, hadronic interactions of cosmic ray nuclei with the ambient matter/radiation will ultimately produce gamma rays and neutrinos. But the evidence is only supportive but not conclusive as leptonic mechanisms such as inverse Compton scattering of thermal/ambient photons with energetic electrons also may lead to the TeV gamma-ray emission from the SNRs. Detection of high energy neutrinos is believed to lead the unambiguous identification of the acceleration sites of hadronic cosmic rays.

Under such scenario the present works of the thesis are organized as the following:

In ***Chapter 1*** *of this present work, a general introduction to the cosmic rays and both theoretical and experimental current status of gamma ray and neutrino astronomy regarding cosmic ray origin are summarized.*

In ***Chapter 2*** *of this work, we investigated the consequences of the maximum attainable energy of cosmic rays in SNR as Z (the atomic number) times the* *knee energy, as may be achievable under amplified magnetic field scenarios, on the secondary gamma-ray spectrum of young supernova remnants. The material presented in this chapter has been published in Physical Review D (Prabir Banik and Arunava Bhadra, "Implications of supernova remnant origin model of galactic cosmic rays on gamma rays from young supernova remnants", Physical Review D 95, 123014 (2017), DOI: 10.1103/PhysRevD.95.123014) which is attached at the end of the thesis.*

*In **Chapter 3** of this work, the implication of maximum attainable energy of cosmic rays to PeV energies in SNRs on high energy gamma rays and neutrinos from molecular clouds proximity to the SNR is investigated and detection capability of ongoing/near future experiments of gamma rays/neutrinos to resolve the maximum energy issue is also discussed. The material presented in this chapter has been communicated (Prabir Banik and Arunava Bhadra, "Probing maximum energy of cosmic rays in SNR through TeV gamma rays and neutrinos from the molecular clouds around SNR W28") which is attached at the end of the thesis.*

*In **Chapter 4**, we explored the possibility of estimating the mass composition of primary cosmic rays above the knee through the study of high-energy gamma rays and neutrinos produced in the interactions of cosmic rays with solar ambient matter and radiation. The material presented in this chapter has been published in Physical Review D (Prabir Banik, Biplab Bijay, Samir K. Sarkar, and Arunava Bhadra, "Probing the cosmic ray mass composition in the knee region through TeV secondary particle fluxes from solar surroundings", Physical Review D 95, 063014 (2017), DOI: 10.1103/PhysRevD.95.063014) which is attached at the end of the thesis.*

*In **Chapter 5**, We propose a model of leptonic originated high energy neutrinos from astrophysical objects and examine critically their flux dominance with hadronic originated high energy neutrinos which is current conventional idea to be produced in a viable cosmic ray source. The material presented in this chapter has been communicated (Arunava Bhadra and Prabir Banik, "High energy leptonic originated neutrinos from astrophysical objects") which is attached at the end of the thesis.*

*In **Chapter 6**, the summary with a brief discussion of this present work is presented.*