Debanjan Bose

Ramanujan Fellow
Astrophysics & Cosmology
debanjan.tifr@gmail.com

Guidance of Students/Post-Docs/Scientists

a) Ph.D. Students

1. Tanima Mondal; Neutrino Oscillation Measurements with HyperK; Ongoing; Sanjoy Majumdar (Co-supervisor)

Talks / Seminars Delivered in reputed conference / institutions during the Period

1. **Invited talk** in a workshop named "Science with CTA" during the 39th meeting of the Astronomical Society of India held online, Title : "Atmospheric Cherenkov technique"; 19th February, 2021; Online; 30 minutes

Areas of Research

Gamma-ray Astronomy, Neutrino Astronomy, Neutrino Physics, Cosmic Ray Physics

Blazars are a class of Active Galactic Nuclei (AGN) with their jets pointed towards us. It is believed that particles are accelerated to extremely high energies in these jets. These jets provide us a glimpse to the relativistic Universe. The broadband spectral energy distributions (SEDs) of blazars show characteristic two broad humps extended from radio to gamma-rays.

The low-frequency hump is attributed to synchrotron emission from relativistic electrons, gyrating in the magnetic field of the jet. The origin of the higher frequency hump in SEDs is possibly inverse Compton (IC) scattering of relativistic electrons by the synchrotron photons (Synchrotron Self Compton, SSC) or the photons external to the jet (External Compton, EC). Alternatively, it is also possible to produce the higher energy photons in proton-photon interactions followed by the decay of neutral pions or proton synchrotron process in the hadronic scenario. Neutrinos will be produced from decay of charged pions.

It is therefore crucial to study blazars with multi-wavelengths to understand emissions at high energies. Some of my master students are involved in this project. We have already published two articles on this and currently we are working on four different blazars.

Gamma Ray Bursts (GRBs) are the most powerful explosions in our Universe. They release huge energy in energy range keV - MeV within few seconds that outshine everything else, known as "prompt emission". Later it was discovered that prompt emission is followed by afterglow emission, that lasts long, in almost every wavelength across electromagnetic spectrum. Even though very high energy (VHE) (GeV - TeV) gamma-ray emission was predicted earlier but only recently they were detected by ground based atmospheric telescopes. We are developing a model to explain VHE emission from GRBs.

I am co-ordinating to submit a joint expression of interests (EOI) on behalf of Indian community to Hyper-Kamiokande collaboration. We intend to contribute in hardware, software and in physics analysis. Earlier this year, I have represented Indian consortium in the Hyper-Kamiokande Financial Forum (HKFF) Meeting. One of my Ph.D. Student (based in IIT-Kharagpur, who is a recepient of Prime Minister Research Fellowship) is actively

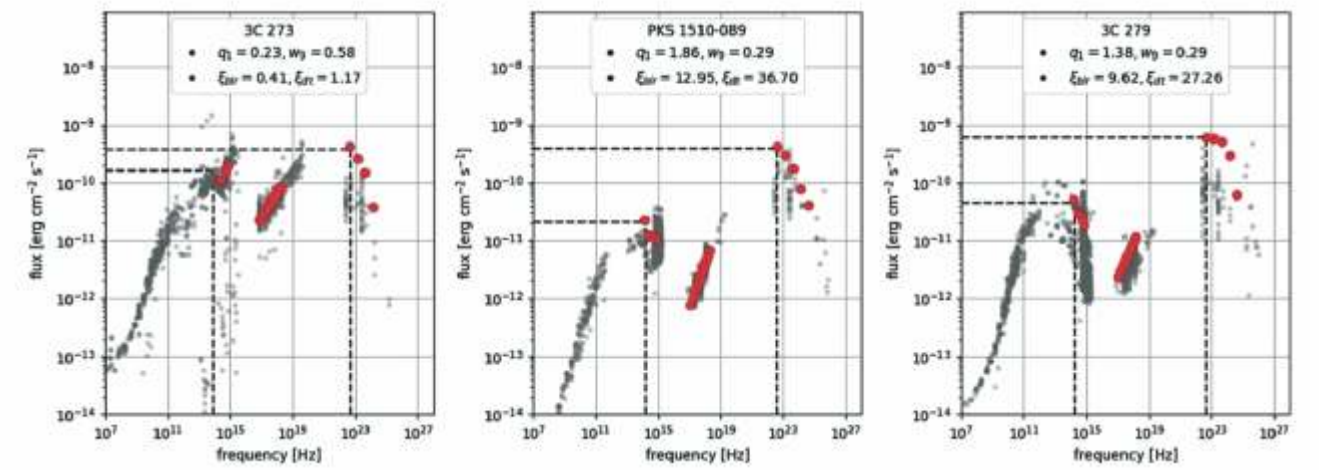

Figure 1. Spectral Energy Distrbutions for blazars 3C 273, PKS 1510-089 & 3C 279. Orphan flares are detected for them in gamma-rays. They are modelled with leptonic emissions.

working with oscillation working group to develop software for HyperK to study neutrino oscillation properties.

We are preparing a mega-science proposal to CTA. In that we propose to build few medium size telescopes (10-12m diameter). At present one of my master student is doing a sensitivity study for star bursts galaxies using Gamma-py, for CTA. Starburst galaxies are characterized by a boosted formation rate of massive stars and an increased rate of supernovae in localized regions, which also exhibit very high densities of gas and of radiation fields. Starburst regions represent a favorable environment for the acceleration of cosmic rays. Cosmic-ray protons can produce gamma-rays by inelastic collisions with ambient gas particles and subsequent neutral pion-decay.

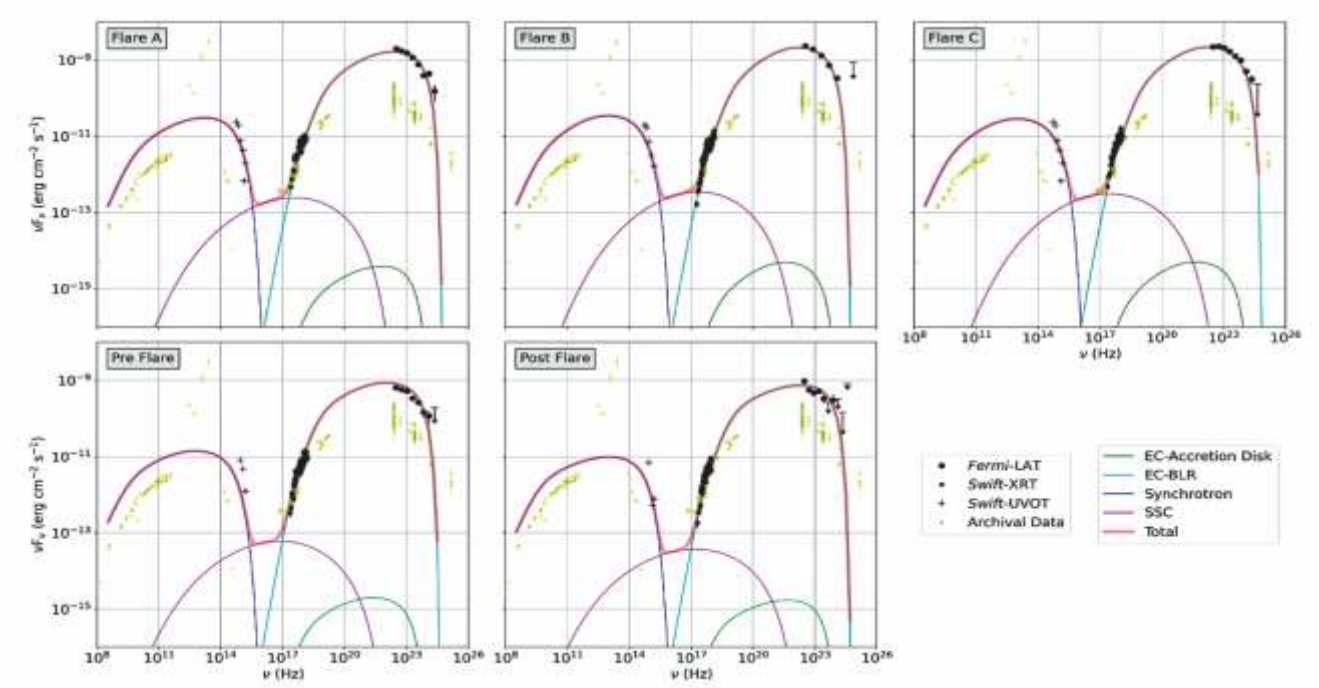

Figure 2. The multi frequency SED data fit with a leptonic External-Compton model for PKS 1830-211

Plan of Future Work Including Project

I am a member of Cherenkov Telescope Array (CTA), next generation ground based atmospheric Cherenkov Telescopes. I will pursue our proposal for CTA on behalf of Indian consortium as explained before. I will be also working particularly for the Large Size Telescope, installed at the La Palma, Spain. I will take part in developing software for data analysis.

For Hyper-Kamiokande, we are planning to submit a pilot proposal. We are interested in contributing in for DAQ, and tank structure for IWCD (Intermediate Water Cherenkov Detector). Indian consortium also intend to contribute for software development for the detector and physics analysis for HyperK. Multi-Messenger &

Multi-Wavelength study for AGNs and GRBs will also continue.

Muon Tomography of Volcanoes and Cosmic-ray Tomography of the Moon. Using muons we will study volcanoes located in Andaman Island. We are also doing some GEANT4 based simulations to measure the density structure of the shallow surface of the Moon using cosmic-rays. Our aim is to build a satellite based detector for this.