X-ray Astronomy: From Classical Spectral-Timing Analysis to Machine Learning Frontiers

Samir Mandal

IISST

X-ray astronomy has long relied on classical tools—spectroscopy for probing emission mechanisms and timing analysis for exploring variability—to reveal the physics of compact objects, accretion flows, and high-energy transients. These methods, while powerful, are increasingly challenged by the sheer volume and complexity of data from modern observatories and upcoming all-sky missions.

This presentation reviews the evolution of X-ray data analysis, highlighting the foundational spectral and timing techniques that shaped the field and their key scientific successes. It then examines the growing role of machine learning methods in addressing next-generation challenges: automated source classification, variability characterisation, and relative importance of physical parameters through representative case studies.