Search for Characteristic Timescales and Quasi-periodic Oscillations in Blazars: Disk-Jet Interactions

-Gopal Bhatta

Active galactic nuclei (AGN) are the brightest sources in the universe. They are believed to harbor super-massive black holes, as massive as billion times the sun, squeezed within a compact region comparable to the solar system. AGNs are usually surrounded by a large disk of matter, called *accretion disk*, which feeds the black holes. Consequently, the sources shine brightly across the universe. Blazars, a sub-class of AGNs, have jets that eject matter in the direction of the earth nearly with the speed of the light. In the radio images, these jets seem to extends up to a large distance from the central engine. Although, with the advancement of the telescopes and the detectors, we have a fair understanding of the source, there are many exciting questions which are not well understood. For example, "How are the jets are launched and how do they manage to travel so unimaginably far away?", is one of the challenging questions many astronomers are working hard to get answers. Nevertheless, we are sure that the heart of an AGN is the most mysterious place where the extreme conditions including strongest gravity environment prevail. Furthermore, AGNs being *visible* from the cosmological distances, they can be used to investigate the nature of the universe at large. Hence understanding of AGN processes lies at the forefront of extragalactic research as well as modern cosmology.

Curiously, blazars display variability in all timescales and frequencies, and they are highly variable in a wide range of electromagnetic frequencies. The variability timescales can range from a few hours to a few years. Astronomers study the variability properties of a variable source by graphing its brightness over time. Such a graph is commonly called *light curve*. Study of light curves, alternatively variability analysis, reveals important clues about the processes producing the light curves. Most of the blazars are so far away us that the compact active region can not be resolved by current telescopes. In such cases, the study of variability becomes one of the most important tools to investigate the processes occurring in the central region. Although, in most cases, the AGN variability appears aperiodic, having no fixed period, recently astronomers have detected *quasi-periodic oscillations* (QPO) in the multi-frequency light curves. QPOs are the kind of periodic oscillations which gradually change the modes of oscillations over the course of time: they can grow stronger/weaker in amplitude and/or move to higher/lower frequencies. In both, aperiodic and quasi-periodic, the variability timescales carries important information about the disk and jet processes. Furthermore, QPOs help probe the hidden cores of AGNs, the way earth-quakes probe the center of the earth. Although there are reports of detection of characteristic timescales and QPOs in the a few individual sources, so far there is no systematic approach to such studies. Therefore, I propose to carry out a study which will look for characteristic timescales and QPOs in the multi-frequency light curves of several blazar sources. The study will make use of both space-bound such as gamma ray, X-ray and telescopes, and ground-based optical and radio telescopes.

As we do not have a complete picture of the central engines of blazars, some astronomers believe that accretion disk is immersed in the *magnetospheres*, a region pervaded by the magnetic filed. In this scenario, the magnetic field is very much responsible for the launch of the jets, and even extracts energy from the black hole, the ultimate sucker. In that case, QPOs are predicted to originate at the interface of the magnetosphere due to various instabilities at the core. In fact, such QPOs are also seen in the simulations of the jets. The results of the study will also show us how common are the QPO in blazars, and reveal the corresponding characteristic timescales in operation. This way, The results will also indirectly test the above picture about nature of the magnetic field around the disk.

Broadly speaking, the results of the study will allow us to peer into the hearts of blazars and provide and understanding of the on-going processes. The knowledge of such processes, in tun, can shed light into the evolution of the galaxies and the universe itself.