Conclusions

Multi–wavelength variability studies play an important role in order to understand the physical mechanism that drives the emission variations of different energy bands and, thus, clarify the complex interaction between the optical/UV, soft, and hard X–ray emission. Such studies essentially requires simultaneous X–ray and UV/Optical band observations, possible with the current generation X–ray space missions such as XMM–Newton, Swift, & ASTROSAT, as co–ordinated observations through space based and ground based telescopes are not much efficient. We present the results from the spectral and temporal variability study of three narrow line seyfert 1 galaxies using the multi–wavelength observations by space borne facilities like XMM–Newton, Swift, and Suzaku. This study demonstrates the complexities that are involved in the optical/UV and X–ray emission processes and their connection.

Chapter 3 demonstrates the X–ray variability, both spectral as well as temporal, of a NLS1 galaxy Ton S180 using XMM–Newton and Suzaku broadband observations. The study confirms the presence of soft excess, hard excess and broad Fe Kα line in the source. We derived light curves in various bands and the hardness ratio to demonstrate the temporal as well as spectral variability. We also derive the fractional variability amplitude to show that the variability is energy dependent.
In this chapter, we used different models to explain the soft X-ray excess, among which the two most competing models are – intrinsic emission from an accretion disk including Compton scattering in the disk material itself and the blurred reflection from partially ionized accretion disk. The soft excess can be adequately described by the intrinsic disk emission consisting of color temperature corrected disk emission and the inverse Compton scattering of disk photons in the inner regions of disk itself. The X-ray Spectral variability of Ton S180 has revealed that the soft excess is variable. While the broadband *Suzaku* spectrum is well described by a simple reflection model, the *XMM-Newton* data requires a complex reflection. The emissivity profile exhibits a break at $\sim 8.6 \, R_g$, with the ionization parameter within this break radius much less than the outer disk ionization parameter.

In Chapter 4, we study the relationship between the UV and X–ray variability of the narrow-line Seyfert 1 galaxy 1H 0707−495. Using a year long *Swift* monitoring and four long *XMM-Newton* observations, we perform a cross-correlation analysis of the UV and X–ray light curves, on both long and short time scales. We also perform the time-resolved X–ray spectroscopy on scales of $1 – 2 \, ks$ and study the relationship between the UV emission and the X–ray spectral components – the soft excess and the primary X–ray emission (parametrized with a simple blackbody and a power-law model). We show that the UV and X–ray variations anti-correlate on long time scales. We find evidence of an anti-correlation between the UV and the hard X–ray variations on short time scales as well. This kind of behaviour has not been observed in any other AGNs so far and rules out the reprocessing as the dominant mechanism for UV variability, as well as the presence of inward propagating mass accretion rate fluctuations. Absence of a positive correlation between the power law photon index and the UV flux also rules out the hypothesis that the UV are the input soft photons to the X–ray corona. Our results support the hypothesis of the soft excess being X–ray reprocessed emission in the inner disc, as we observe a strong correlation between the continuum flux and the soft-excess temperature and flux. The soft excess flux should contribute to the soft photon input of the X–ray corona and can be assessed through the weak but significant positive correlation that has been evidenced between the spectral slope and the soft-excess flux. This study suggests that strong X–ray heating of the disc, due to gravitational light bending affects only in the inner disc, is likely an important effect in this source, giving rise to a significant fraction of the soft excess as reprocessed thermal emission. At the same time, we also find indications for a non-static, dynamic X–ray corona, where either the size or height or both are probably varying with time.
In Chapter 5, we present results from the simultaneously observed X-ray and UV emission of NLS1 galaxy IRAS 13224–3809 using four long XMM-Newton observations. Although, the light curves reveal complex variability, we find that the variability is energy dependent in the sense that the two X-ray bands – soft (0.3–1 keV) and hard (1.5–3 keV) – show highest variations while the UVM2 band show least variations. We studied the correlation between X-ray and UV emission using discrete correlation function, which revealed two positive peaks at $\sim -10$ ks and $\sim 5$ ks. We verified significance of both the peaks using two independent methods: (A) Boot strap method based on random subset selection of original data points of light curve and (B) the model dependent continuum fitting used in ‘JAVELIN’. We find that both these independent methods provide identical results. The UV lead corresponds to the light travel time between the two emission regions and the X-ray lead is attributed due to the X-ray reprocessing of the same region of accretion disk. Since, we are referring to the same emission regions, we should have observed comparable lags. We could resolve the discrepancy between the difference in the observed lags from the two emission regions by attributing the additional delay as the Comptonization lag.

In Chapter 6, we checked the reality of iron L line by using the time resolved spectroscopy of 1H 0707-495 and IRAS 13224–3809 performed in previous two chapters. Both these sources are strongly variable narrow line Seyfert 1 galaxies and show broad features around 1 keV that has been interpreted as relativistically broad Fe $L_\alpha$ lines. Such features are not clearly observed in other AGN despite sometimes having high iron abundance required by the best fitted blurred reflection models. Given the importance of these lines, we explore the possibility if rapid variability of spectral parameters may introduce broad bumps/dips artificially in the time averaged spectrum, which may then be mistaken as broadened lines. We tested this hypothesis by modeling the segmented spectra using two component phenomenological model. Using best fit model we simulated model spectra for each segment and then co-added to get a combined simulated spectrum which were later compared with the time averaged spectra. In the simulated spectra, we do not find broad features or deviations below 1 keV as is seen in the real time averaged spectra. This implies that the broad Fe $L_\alpha$ line that is seen in the spectra of these sources is not an artifact of the variation of spectral components and hence provides evidence that the line is indeed genuine.

Future prospects:
Pre-requisite of present work is the simultaneous observations in multiple wave-bands. We used data from the present generation satellites which were capable of observing in X-rays as well as in UV/Optical bands, simultaneously. Recently, India launched its first Multi-wavelength space observatory ASTROSAT which is capable of observing celestial sources in both these bands. The ASTROSAT consists of five different types of instruments that are capable of observing from UV to X-rays (up to few hundred keV), simultaneously. We were actually involved in the ground calibration of one of the instrument, CZT – Imager. We will extend our study to include the observations from the ASTROSAT, complemented by the data from the current satellites, to improve our understanding of AGN emission. But in addition to UV/Optical/X-ray bands, the significant AGN emission falls in the radio, particularly the jet emission, and IR, emission from dust/torus, and without studying them it is not possible to find complete solution of AGN phenomenon. This work is data demanding and as an observer one would like to observe a source forever in all possible wavelengths. Getting such high quality data is very essential. We will incorporate simultaneous observations of all possible bands in near future to reveal the true AGN phenomenon.