Relativistic disk line: a tool to probe the neutron stars

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Study of neutron stars can be useful to probe some aspects of fundamental physics, which cannot be done in terrestrial laboratories. I will discuss the relativistic spectral emission line originated from the inner part of the accretion disk, and how it can be used to probe the extreme environments of a neutron star in a low-mass X-ray binary system.

MHD of accretion columns on Neutron star poles and Cyclotron spectra

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We have numerically solved the Grad-Shafranov equation for axisymmetric static MHD equilibria of matter confined at the polar cap of neutron stars. From our solutions we model the cyclotron spec- tra that will be emitted from the region by integrating the emission from all parts of the mound to get the resultant spectra. We perform a phase dependent analysis of the spectra to study the effect of the viewing geometry on the resultant emission from the local mound with distorted magnetic field. We have also explored the stability of the accretion mounds using the MHD simulation code PLUTO. We find that pressure and gravity driven modes disrupt the equilibria of the confined accretion mound for heights larger than a threshold. This will result in formation of dynamical structures as matter spreads over the neutron star surface. Such effects will influence the shape and nature of the cyclotron spectra from such high mass X-ray binaries, which are expected to be observed in great detail by upcoming missions such as ASTROSAT.

Instability of neutron star matter in high magnetic field

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The magnetars are believed to be neutron stars with surface magnetic field 10^{14}-10^{15} G. However, the central magnetic field may be higher than that at the surface. We study the effect of strong magnetic field on neutron star matter. We model the neutron star matter with non-linear Walecka model including hyperons. We find that the effect of magnetic field on the matter is significant when central magnetic field $< 10^{17}$ G. Moreover, if the central field is of the order of 10^{19} G, then the magnetized matter becomes unstable which limits the maximum central magnetic field of magnetars. We also study the effect of high magnetic field on the phase transition from neutron star to quark star. Magnetic field helps in initiation of the conversion process. The velocity of the conversion front, however, decreases due to the presence of magnetic field.

The Periodic Bursts From The 11 Hz Pulsar IGR 17498-2446 And Their Variation With Spectral States

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The 2010 outburst of the transient low-mass X-ray binary IGR J17480–2446 has exhibited a series of unique X-ray bursts as well as millihertz (mHz) quasi-periodic oscillations (QPOs) related to these bursts. These bursts were highly periodic and the burst properties were correlated with the outburst intensities. The atypical nature of these bursts as regard to the standard thermonuclear bursts suggested them to be the "type-II" bursts originating from accretion disc instability. We analyzed the Rossi X-Ray Timing Explorer (RXTE) data of IGR J17480–2446 to show that the burst that the bursts and the mHz QPOs from IGR J17480–2446 are powered indeed by the nuclear energy and hence can be used to constrain the neutron star equation of state. While in the outburst, the source showed hysteresis effect in the hardness-intensity (HID) track and also showed atoll to "Z" state transition (the only 2nd source to do so). The evolution of the burst properties over various spectral states in the HID shows a very consistent behavior and thus such smoothly varying clock-like bursts will be a very useful tool to understand the thermonuclear burst physics and the flame spreading mechanism.

kHzQPO as a tool to probe physics under extreme conditions

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Neutron stars are the most dense objects in the observable universe. Till date, after several decades of its discovery the correct equation of state is yet to be known. I shall describe a plausible way to constrain the theoretically proposed equation of state using the timing analysis (particularly kHzQPOs) of neutron star low mass X-ray binaries (LMXBs). Moreover, they are also very good candidates to probe gravity in the very strong field regime. These LMXBs are one of the few objects around which we expect some unique signatures of strong field gravity and its significant deviation from Newtonian gravity. The existence of inner-most stable circular orbit (ISCO) is one such candidate signature. I shall discuss some of the recent interesting results regarding the first observable evidence of ISCO in the LMXBs, the role of kHzQPOs in this context and some of the difficulties it faces.

Pulse Arrival Time Analysis for determination of orbital paramter of the HMXB 2S1553-542

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For the 2008 flare of the HMXB Pulsar 2S1553-542, we present two methods of determining orbital parameters and allied information such as Mass function, Pdot and an estimate of B. The first method involves the conventional phase connection method as described in Schreier et al. (1972) and Deeter et al. (1981). The second method involves the usage of wavelets for the same purpose. We compare both methods in terms of significance and error estimates of the obtained parameters.

QPO detection and Timing Studies for the fast spinning transient pulsar 4U 0115+634 outburst of 1999 by RXTE Satellite

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High Mass X-Ray Binary (HMXRB) transient pulsar 4U 0115+634 during its declining phase of the major X-Ray outburst of March 1999 showed a low powered QPO centered at 40.8 m Hertz in the observation of RXTE. QPO features become significant in the state of fast spinning of 4U 0115+634 when the pulse period was minimum but faded with the fading of X-ray burst and spin. It pointed out towards a unique feature of QPO as the non periodic outburst due to the mass ejection from the Be- star during the passage of the neutron star through the circumsteller disk close to the periastron position in the eccentric orbit.

Modeling LMXB X-ray Luminosity Function

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Theoretical modeling of the X-ray luminosity function (XLF) of LMXBs is very challenging due to the extreme processes involved in the formation and evolution of these systems. We in this work show that the "giant fraction", i.e., the fraction of LMXBs with giant companions is one of the major factors deciding the shape of the XLF. Evolutionary changes in a typical LMXB system are calculated according to the standard prescription available in the literature and the XLF calculation scheme is presented. Dependence of the XLF on parameters affecting LMXB evolution is studied. Finally, we argue that the giant fraction is not an arbitrary parameter; possible factors deciding this fraction are discussed.

Effect of Variability of X ray binaries on X ray Luminosity Functions of our Galaxy

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X ray telescopes like Chandra, XMM-Newton have enabled the construction and study of the X ray luminosity functions of nearby galaxies based on luminosities of X ray binaries. These luminosity functions are reliable indicators of galaxy parameters like star formation rate and stellar mass of galaxy. However, X ray binaries are highly variable in nature and Chandra observations are essentially snapshot observations of the galaxies. The availability of long term light-curves of X ray binaries in our Galaxy opens up the possibility of constructing X ray luminosity functions by taking variability into account. We have studied the effect of variability of X ray binaries on the snapshot measurements of the X ray luminosity functions of our Galaxy using the long term light-curves of sources obtained in the in 2-12 KeV band of RXTE All Sky Monitor. X ray luminosity functions are constructed separately for High Mass X ray Binaries (HMXB) and Low Mass X ray Binaries (LMXB) whose distances are found in literature. The variability of luminosity functions constructed for galactic X ray binaries are used to compare and test the robustness of snapshot Chandra and XMM-Newton measurements of X-ray luminosity function in nearby galaxies.

Flaring and quiescent coronae of RS CVn binaries

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In this talk, I will present the quiescent and flaring coronal parameters of the magnetically active RS CVn binaries that are observed from XMM/Chandra. The great sensitivity of the XMM-EPIC instruments allowed us to perform time resolved spectral analysis during the flares and also in the subsequent quiescent phases. Most of the RS CVns were found to have three temperatures coronal plasma during the quiescent state. During the quiescent state, the median value of hottest coronal temperature of RS CVns was found to be 2.92 keV. However, the coolest temperatures were near the 0.38 keV and 0.99 keV, respectively. The global abundances during the flaring states were always found to be more to that of the quiescent states. In most of the flares, the peak temperature was found to be more than 100 MK, whereas emission measure increased by factors of 1.5–5.5. We also found significant sustained heating during the decay of in the majority of flares.The loop lengths (L) derived for flaring structure were found to be in the order of $10^{(10-11)}$ cm and are smaller than the stellar radii (R), i.e. $L/R < 1$.

Strongly Magnetized Super-Chandrasekhar White Dwarf as Progenitor of Type Ia Supernovae

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Recent observations of peculiar Type Ia supernovae - SN 2006gz, SN 2007if, SN 2009dc, SN 2003fg - seem to suggest super-Chandrasekhar-mass white dwarfs as their most likely progenitors. These white dwarfs are believed to have masses up to 2.4-2.8 M_{sun}. We would like to investigate the possible existence of such supermassive white dwarfs by proposing a model which would explain how the Chandrasekhar mass limit can be significantly exceeded. Here we consider a relativistic, degenerate, electron gas under the influence of a strong magnetic field, which describes magnetized white dwarfs. Landau quantization changes the density of states available to the electrons, thus modifying the underlying equation of state. In the presence of very strong magnetic fields a maximum of either one, two or three Landau level(s) is/are occupied. We obtain the mass-radius relations for such white dwarfs and after their detailed investigation we arrive at the conclusion that it is possible to have white dwarfs with masses ~ 2.3-2.6 M_{sun}. Interestingly our results lie within the observational limits.

Stochastically Driven Instability in Accretion Flows

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Origin of hydrodynamic turbulence in accretion flows is investigated. Such flows are Rayleigh stable, particularly in absence of magnetic coupling. Such flows in three-dimension, which is the realistic situation, even were found to exhibit insignificant transient growth under linear perturbation, while transient growth could explain plausible turbulence in two dimensions. The present work explores the effect of stochastic noise on such hydrodynamic flows. We essentially concentrate on a small section of such a flow which is nothing but a plane shear flow supplemented by the Coriolis effect. It is found that such stochastically driven flows exhibit large temporal and spatial correlations, and hence large energy dissipations, indicating instability. A range of angular velocity (Ω) profiles, starting from that of constant specific angular momentum ($\lambda = \Omega r^2$; r being the radial coordinate) to that of constant angular velocity ($v_\varphi = \Omega r$), is explored. In general $\Omega \propto$ ^r-q, when q=1 – 2. However, all the angular velocities exhibit identical growth and roughness exponents, revealing a unique universality class for the stochastically forced hydrodynamics of accretion flows. This work, to the best of our knowledge, is the first attempt to understand origin of instability and turbulence in the three-dimensional Rayleigh stable accretion flows based on a modern statistical physics tool.

Physics of multi-species relativistic fluid

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The thermal state of the fluid is governed by the ratio of the thermal and the rest energy. This brings the composition of the fluid into the picture. Although, fluid composed of lighter particles (e.g: electron-positron pair plasma) at same temperature, is more relativistic compared to fluids with finite baryon loading, but this is not necessarily true when baryon poor transonic fluid are compared with each other. It can be shown that the transonic pair-fluid is the least relativistic. This has far reaching consequences on accreting flows around compact objects and are expected to have similar effect on relativistic outflows and explosive events as well.

Structure and Stability of X-ray Irradiated Accretion Disk

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We present here the mathematical approach in calculating the structural changes which take place in the outer regions of the accretion disk due to X-ray irradiation. It is shown here that an X-ray source powered by accretion, modifies the outer disc structure. Our calculations for the transition radius and Circularization Radius in case of various low mass X-ray binaries show that the X-ray irradiation becomes dominant after transition radius only in some binary systems.

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Outflows in Viscous Accretion Disks with Shocks

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We study the acceleration of relativistic particles in a viscous, advection dominated accretion disk containing a centrifugally supported standing shock waves in the context of energetic outflows observed around radio-loud black holes. The dynamical structure of the accreting gas is described using a new model for viscous, shocked disks recently reported by the authors, and a rigorous mathematical method is employed to solve the transport equation for the relativistic particle distribution. We observe that particle acceleration around the standing shock converts a significant fraction of the gravitational potential energy of the accretion flow into a population of relativistic particles. These particles diffuse from the disk vertically outwards, carrying away both energy and entropy and the remaining gas accrets into the black hole. We confirm that the above formalism successfully demonstrate the bulk properties of the jet outflows observed in M87 and Sgr A*. Accordingly, we argue that a standing shock may be an essential ingredient in accretion onto underfed black holes.

Comparative Study of Spectral and Timing Properties of Long X-ray Dips Observed Uniquely in GRS 1915+105 and IGR J17091-3624

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During the RXTE/PCA data analysis of the recent flaring activity in the black hole X-ray binary IGR J17091-3624, we found long dips (15 - 40 seconds) in the X-ray lightcurve when the X-ray intensity drops to 1/3 of the average intensity. Similar X-ray dips were also observed in different X-ray intensity profiles, namely, κ class, λ class, β class and θ class of another unique black hole X-ray binary GRS 1915+105. In this work, we compare the timing and spectral behavior of X-ray dips observed in different classes of GRS 1915+105 with that observed in IGR J17091-3624. We found that X-ray dips in IGR J17091-3624 has similar timing and spectral evolution as the dips observed during κ class or λ class which occurred at moderate mass accretion rate in GRS 1915+105. However, X-ray dips during β class and θ class of GRS 1915+105 which occurred at very high accretion rate showed very different timing and spectral evolution.

Phase resolved spectroscopy of IGR J17091-3624 'heartbeats' with RXTE and XMM-Newton

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IGR J17091-3624 is a transient source and is believed to be a galactic black hole candidate. It received lot of attention recently due to peculiar 'heart-beat' type variability patterns exhibited by the source, in which the quasi-periodic mini-outbursts are repeated over time scale as short as 5 seconds. So far such variability pattern is observed only in GRS1915+105 which is classified in ρ and ν variability classes. We present here the results of phase-resolved spectroscopy of IGR J17091-3624 using simultaneous observation by RXTE and XMM-Newton for a ν-class observation. It is found that the 0.7 - 35 keV spectra can be fitted 'canonical' model for black hole spectra consisting of only two components - accretion disk and power law (or its equivalent). Any other components, like Fe-K line or reflection from disk are not required for the fits. We observed a strong correlation between source flux and disk temperature over the time scale of few tens of seconds during individual burst profile. However, the inner disk radius was not found to vary significantly with phase of bursts unlike GRS1915+105 where the inner disk radius is found to vary significantly during burst profile. We also attempt to constrain system parameter of the source by simultaneously fitting the spectra during different phases of the burst profile. The results indicates that the source is a high inclination binary but no significant constrains for black hole mass and distances are possible, particularly for a spinning black hole.

LS 5039: Multi-wavelength perspective of an outflowing source!

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LS 5039 is a unique Galactic micro-quasar persistent in the radio, x-ray and gamma-ray band of the electromagnetic spectrum without showing any signature of accretion disc while the nature of the stellar wind from the companion is also poorly understood. This provides an unprecedented opportunity to understand the likely process of outflow coupled to wind accretion in a compact binary system whose central object is of unknown nature. Here we report the binary phase resolved (period 3.9 days) long term multi-wavelength monitoring of the source in tandem with various pointed multi-wavelength (radio, x-ray and gamma-rays) observations of the source.

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Systematic study of X-ray cavities in the brightest galaxy in the Draco constellation NGC 6338

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We present results based on the systematic analysis of currently available Chandra archive data on the brightest galaxy in the Draco constellation, NGC 6338, in order to investigate the properties of the X-ray cavities. In the central ~ 6 kpc, at least two, possibly three, X-ray cavities are evident. All these cavities are roughly of ellipsoidal shape and show a decrement in surface brightness of several tens of per cent. In addition to these cavities, a set of X-ray bright filaments are also noticed which are spatially coincident with the Hα filaments over an extent of 15 kpc. The Hα mission-line filaments are perpendicular to the X-ray cavities. Spectroscopic analysis of the hot gas in the filaments and cavities reveals that the X-ray filaments are cooler than the gas contained in the cavities. The emission-line ratios and the extended, asymmetric nature of the Hα emission-line filaments seen in this system require a harder ionizing source than that produced by star formation and/or young, massive stars. Radio emission maps derived from the analysis of 1.4-GHz Very Large Array Faint Images of the Radio Sky at Twenty-Centimeters survey data failed to show any association of these X-ray cavities with radio jets; however, the cavities are filled by radio emission. The total power of the cavities is 17×10^{42} erg/s and the ratio of radio luminosity to cavity power is $\sim 10^{-4}$, implying that most of the jet power is mechanical.

Temporal and spectral study of Fermi GRBs using different models and their interpretations

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We choose three sets of GRBs detected by the Fermi satellite: (1) 11 bright, long, single/separable pulsed GRBs, detected by Fermi/GBM (2) 4 GRBs detected by both GBM and LAT, and (3) 9 GBM GRBs with known redshifts. We fit the time-resolved spectra of the first set by Band and BBPL (blackbody+powerlaw) models and find that the peak energy of Band model as well as the temperature (kT) of the BBPL model decrease exponentially with the running fluence in the later part of all GRB pulses. For the second set of GRBs, we find an evidence of two BBs, whose variation of temperature are similar to each other. We use this information to identify multiple spectral components in the starting of some GRBs of the first set, which show break in the temperature evolution. We find that inclusion of a second BB makes the temperature variation smooth throughout. For the analysis of the third set of GRBs, we develop a new technique to describe the individual pulses simultaneously in the time and energy domain. We find a strong correlation between a model parameter with the energy of each pulse. A comprehensive description of redshift measured GRB pulses, using the findings of the time-resolved analysis of the first set of GRBs, can lead to an even better correlation and gives an enormous hope for using GRB pulses as standard candles.

Nucleosynthesis in the Gamma-ray Burst Accretion Disks

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Most popular models of long duration gamma-ray bursts invoke the core collapse of rapidly rotating stars. The mass of the stars undergoing core collapse is usually greater than 20M□ in the main sequence. This core collapse could result in the formation of black holes of 2-3 M□ if it is of Schwarzschild type and 6-7 M_{sun} if it is of maximally spinning Kerr type with an accretion disk around them. Such black holes are expected to accrete at the rate of 0.01-10.0 M□s-1. We investigate nucleosynthesis inside such gamma-ray burst accretion disks. We show that varying accretion rate changes the nucleosynthesis products. We also report how nucleosynthesis is sensitive to the variation of the initial abundance of elements in the accretion disk, namely whether it is Si rich, He rich or O rich. Interestingly the nucleosynthesis products appear quite different for a Schwarzschild black hole compared to that of a maximally spinning Kerr black hole. In addition to the formation of various isotopes of Fe, Co and Ni we report the synthesis of new elements like Ar35, F21 and Ca39. Many of them have already been observed in the X-ray afterglows of gamma-ray bursts.

Understanding Blazar flares

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Dedicated multiwavelength observations of blazars are required to understand the physics of these sources. Reproducing the time averaged spectral energy distribution of blazars during a flare can provide the knowledge of emission processes and energetics. However blazar jet dynamics and role of different acceleration processes are better understood by modeling their light curves. We model the flare of PKS 1222+216 in 2010 using an accelerating jet scenario. Here the flare is assumed to be a result of varying Doppler factor of the emission region. This model can successfully reproduce the observed gamma-ray light curve. Future simultaneous observations in X-rays and other wavebands will be helpful in understanding the role of other parameters during flare and in refining the present model. We also interpret the difference in the X-ray and gamma-ray spectral indices of the Bl Lac object, OJ 287 observed during a flare in 2009, as a result of different acceleration processes. This difference cannot be explained by simple radiative cooling effects. Here we propose a model where a moving turbulent plasma blob is re-accelerated by a standing shock.

The uncorrelated long term Gamma-ray and X-ray variability of blazars and its implications on disk-jet coupling

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Active Galactic Nuclei (AGNs) are among the most luminous objects in the universe. Up to 10% of all galaxies in the observable universe harbor an active nucleus (Robson 1996), a very small region at the center of the host galaxy characterized by a very high luminosity. The luminosity of an AGN can be even a few thousand times larger than that of the host galaxy. It is commonly believed that AGNs are powered by accretion onto supermassive black holes (hereafter SMBH) with a mass of 106 -108 M . In many AGNs, particularly radio-loud AGNs, bipolar outflow of energetic particles is seen which is perpendicular to the plane of the accretion disk. The jet originates from regions very close to the SMBH. The origin and the constituent of these jets (whether electron/positron or proton) are not well understood. Blazars are the subclass of AGN whose jets make a small angle to the line-of-sight. Based on their emission properties, blazars can be divided into two classes: at spectrum radio quasars (FSRQs) and BL Lacs. Their emissions are jet dominated and highly beamed. The spectral energy distributions (SEDs) of blazars are usually dominated by non-thermal emission and often has maxima in the radio-/far-infrared waveband, in the infrared waveband, and at ultraviolet and γ-ray energies. The emission from these active galaxies are highly time variable. In order to understand the physics of active galaxies multiwaveband observations complemented with SED modeling are crucial. Hydrodynamical modeling of a disk-outflow coupled system shows that the spin of the central black hole could play a significant role in jet emission. Study of blazars in high energy got a massive boost after the launch of Fermi Gamma-ray Space Telescope (Fermi) on 11th June, 2008. Fermi provides an increase in sensitivity by more than an order of magnitude over EGRET onboard CGRO (1991-1997) and observes the whole sky in every three hours. Here, I will present our current understanding of AGN physics utilizing the multiwaveband observations from Fermi and other observatories and the hydrodynamic modeling of disk-jet coupled system.

The study of warm absorbers, a probe to the central regions of AGN

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Almost half of the Seyfert 1 galaxies studied have shown absorption features in soft X-rays which are attributed to partially ionised clouds of gas along our line of sight, known as warm absorbers, mostly outflowing at high velocities. Their studies give very important information on the circum-nuclear region of the active galaxy. We have carried out high resolution spectroscopic studies on some Seyfert 1 galaxies to ascertain the properties of these warm absorbers, using XMM-Newton RGS data. Apart from warm absorbers, the warm emitters are also interesting as they provide diagnostics for the density and temperature measurements of the gas clouds in the central region. They are presumed to originate from the same type of clouds as those give us warm absorption. The dynamics and mass outflow rates obtained from our studies of warm absorbers and warm emitters help us to better understand the circumnuclear environment of the active source.

X-ray and Optical studies of Ultra-luminous X-ray sources in nearby elliptical galaxies

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Compact, off-nuclear X-ray point sources in nearby galaxies, with luminosities ~10^{39} - 10^{41} ergs s^{-1} are referred to as Ultra-Luminous X-ray sources (ULXs). In this talk, I will present the properties of optical counterparts of these sources and the variability in X-ray and optical bands. The optical counterparts of Chandra X-ray sources searched in the archival HST ACS/WFPC2 images from thirteen elliptical galaxies. The Chandra X-ray source positions are correlated with optical sources and counterparts were searched for 84 X-ray point sources from these nearby elliptical galaxies. Fifty six of these X-ray point sources were found to have potential counterparts within an error circle of few arc seconds. The X-ray sources without optical counter parts, which were referred to as optically dark X-ray bright sources. Lack of optical detection of these sources allows us to estimate the upper limit of black hole mass using standard assumptions and we find that for ten sources in our sample, the black hole mass $M_{BH} < 10,000\ M_{sun}$. In particular, an ultra-luminous X-ray source (ULXs) in NGC 4486 has mass $M_{BH} < 1244\ M_{sun}$. This is two orders of magnitude smaller than the constraint obtained from dynamical friction. Also I studied the X-ray and optical variability of point sources in nearby galaxies using Chandra and HST archival data. I will discuss the results of these studies.

X-ray and radio study of the clusters of galaxies with different merging environments

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Clusters of galaxies, the largest gravitationally bound structures in the Universe, contain hot (kT~1-10 keV) intracluster gas that emits in X-rays. A large fraction of these show clear evidence for the presence of substructures and their mergers. We have separately examined the merging environments of the bimodal cluster A3395 and the cluster-pair A3532-A3530, using X-ray and radio observations. Both A3395 and A3532, have a Wide-Angle-Tailed (WAT) radio source at their centres. However, while A3532 shows a large number of cavities (depressions) in its X-ray surface-brightness profiles (two of which coincide with the radio-emission peaks), A3395 does not show any deficit close to the location of the WAT source. In my talk, I will mainly discuss our current understanding of the different merging environments of the clusters of galaxies in view of the results obtained so far.

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X-ray Bright Optically Dull AGN's In CFHTLS field

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I will present X-ray, optical, and infrared analysis of a sample of 32 absorption line galaxies (ALGs) discovered during our spectroscopic followup observations (using AAOmega at the Anglo Australian Telescope) of the X-ray sources detected by the XMM-Newton Legacy Survey (XMM-LSS), the optical counterparts of which are found in the Canada-France-Hawaii Telescope Legacy Survey (CFHTLS). These sources lying in the redshift range $0.04 < z < 0.34$ have X-ray luminosities $L_{0.5\text{-}2keV} = 10^{39}$ - 10^{43} erg s^{-1}. Two sources are hosted by spiral galaxies and another 8 sources are cluster members. The remaining 24 sources based on their location in the luminosity - f_X/f_O plane are classified into three categories. Eight of them are normal galaxies with $\log(f_X/f_O) < -2.0$, 12 are intermediate sources with $\log(f_X/f_O)$ between -2 and -1 and 4 sources could belong to the class of objects called X-ray bright optically normal galaxies (XBONGs). Two of these XBONGS show the presence of a central point source via ellipse fitting and/or surface brightness decomposition using GALFIT. The observed optical spectra of 3 XBONGS closely matches with that of the luminous red galaxy template, while the optical spectra of one XBONG does not match either with the red galaxy template or AGN spectra. It is thus likely that this source belongs to BL Lac type object. These XBONGs have harder X-ray spectra compared to normal absorption line galaxies.

The kilo-second variability of X-ray sources in nearby galaxies

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Chandra observations of 17 nearby galaxies were analyzed and 166 bright sources with X- ray counts > 100, were chosen for temporal analysis. Fractional root mean square variability amplitudes were estimated for lightcurves binned at ~4 ksec and of length ~40 ksec. Eight sources, of which three are ultra-luminous X-ray sources (ULX) with unabsorbed $L > 10^{39}$ ergs/sec, were found to be variable at a significance level > 2-sigma. Two of the three variable ULX exhibit secular transitions and have ultra-soft spectra with temperatures < 0.3 keV while the other is a rapidly varying unique source in NGC 0628.These results seem to indicate that these sources are typically not highly variable in ksec time-scales, except for some ultra-soft one. Among the relatively low luminosity sources ($L \sim 10^{38}$ ergs/sec), apart from an earlier known source in NGC 1569, we identify a source in NGC 2403, which exhibits persistent high amplitude fluctuations.

Broadband X-ray emission from 1H0419-577: Complex Absorption or Compton Reflection

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We present here the X-ray study of a Seyfert 1 galaxy 1H0419-577 using new 123 ks Suzaku observation taken during Jan 2010. The AGN shows complex 0.6-50 keV spectrum with excess emission above 10keV. The broadband spectrum can be described with a power law of photon index 2 modified by either complex absorption or Blurred Compton reflection. We examine the best-fit parameters of both the models and discuss more appropriate physical model. We infer that the disk reflection model describes the broad band spectrum better than absorption.

*** PRL Colloquium***

25th April 2012, 4:00 pm

Black holes in the universe: an X-ray view

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Ever since the birth of X-ray astronomy in 1962, X-ray emitting objects in the sky are thought to be related to compact objects, particularly black holes. Though, initially, several bright X-ray sources are classified as 'black hole candidates', now we have firm evidence for black holes, or massive compact objects which cannot be stellar systems, residing in Galactic X-ray binaries and the centers of Active Galactic Nuclei. Mass measurements are available for these objects through dynamic mass measurements in Galactic sources and reverberation mapping in Active Galactic Nuclei. Recent observational data suggest a multitude of myriad, sometimes puzzling, astrophysical phenomena occurring close to black holes: very fast time-scale variability including quasi-periodic oscillations, generation of a population of thermal and non-thermal electrons, and episodic ejection of materials in collimated jets, sometimes to superluminal speeds. A comprehensive paradigm to understand these, however, is lacking and I will highlight the need for wide-band X-ray spectroscopic data to make further inroads in this field. The technical efforts to make good spectroscopic instruments are described along with a brief outline of the results expected from the Astrosat satellite.

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X-ray polarisation measurement techniques and prospects in near future

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