Below are the abstracts of proposals selected for funding for the Suzaku Guest Observer - Cycle 3 program. Principal Investigator (PI) name, institution, and proposal title are also included. 120 proposals were received in response to this opportunity, and 79 were selected for funding.

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**Marshall Bautz/Massachusetts Institute of Technology**

**Understanding Group Evolution with Suzaku**

Galaxy groups are vital to our understanding of structure formation, cluster evolution, and galaxy evolution, yet they are difficult to study at even moderate redshift. We have undertaken a project to observe a flux-limited sample of intermediate-redshift groups identified by the XBootes Chandra survey, and here we propose Suzaku/XIS observations of two targets to continue this program. With the unique multiwavelength coverage of the XBootes field, we aim to understand the physical connection between the X-ray and optical properties of groups, and to probe the evolution of group X-ray emission in order to constrain the non-gravitational physics affecting the energetics of the intragroup medium.

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**Massimiliano Bonamente/University of Alabama in Huntsville**

**Soft Excess, Hard Excess and Thermal Emission in Abell 3112**

We propose to perform spatially resolved spectroscopy on the X-ray bright relaxed galaxy cluster A3112, in order to characterize its soft/hard X-ray excess component. A3112 is one of two clusters with very strong soft excess emission (the other being AS1101, observed in AO1). The indications provided by this observation will be crucial in order to assess, beyond doubt, the reality of the soft excess emission, previously observed by all soft X-ray missions since EUVE. The proposed observation will constrain the nature of the excess emitter, and address outstanding questions in observational cosmology: the ‘missing baryon’ problem, the density of matter in the universe and the non-thermal energy in galaxy clusters.

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**Joel Bregman/University of Michigan**

**The Baryons Content of the Most Massive Spiral Galaxy**

Galaxies are missing most of their baryons when compared to the cosmological baryon to dark matter ratio. The Milky Way is missing at least 70% of its baryons while lower mass galaxies retain less than 10% of their baryons. Theory suggests that these baryons were expelled by intense galactic winds during the primary star formation period. These galactic winds carry gas far beyond the virial radius of small and modest galaxies, but the
most massive galaxies should retain much of this gas. We propose to test this picture by searching for the missing baryons surrounding the very massive spiral galaxy, NGC 1961, which has 10 times the stellar content of M31 and with $v_{\text{rot}} = 450 \text{ km/sec}$. If successful, we will detect a significant fraction of the $5 \times 10^{11} \text{ Msun}$ of its missing baryons.

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**David Buote/University of California, Irvine**

**The Outskirts of NGC 1550 and MKW 4**

We propose a set of two 19 arcmin observations for each of the galaxy groups NGC 1550 and MKW 4 to measure the spatially resolved densities, temperatures, and iron abundances out to $r_{500}$. These measurements are crucial for an accurate determination of the gas mass profile and gas fraction, for probing the entropy profile near the region where the accretion shocks start to be important, and for exploring the chemical enrichment at a spatial scale which retains information of early SNe II and SNe Ia enrichment. Due to their brightness, regularity and low temperature, the two objects are ideal candidates for offset observations of their peripheral gas by Suzaku, making an excellent use of its low background and soft X-ray sensitivity. By studying with detail these nearby bright low-mass and low-temperature objects, we can reach the same degree of accuracy in the measurement of the baryonic and dark matter components as for nearby hot massive clusters.

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**George Chartas/Pennsylvania State University**

**A Survey of NAL Quasars with High Velocity Outflows**

Recent spectroscopic observations in the ultraviolet (UV) band have revealed high velocity outflows in Narrow Absorption Line (NAL) quasars. Our analysis of exploratory Suzaku and XMM-Newton observations of NAL quasars indicates that their UV and X-ray properties connect smoothly to those of Broad Absorption Line quasars. The proposed expansion of our sample will allow us to place constraints on correlations between the amount of X-ray absorption and UV properties of the wind to better understand the acceleration mechanism of quasar winds. We will test existing models of the nature of NAL quasars. The detected X-ray brightest objects from the proposed survey will be followed up with deeper observations to constrain the kinematic and ionization properties of the absorbers and ultimately constrain their mass outflow rates.

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**Wei Cui/Purdue University**

**Coordinated X-Ray/TEV Observations of TEV Blazars**

We propose to observe three bright TeV blazars with Suzaku, in coordination with VERITAS and MAGIC at TeV energies. The primary objective is to make use of the recently available observational capabilities in collecting the much needed simultaneous X-ray and TeV data on these intriguing sources. The data will be essential for addressing a number of unresolved issues in the study of TeV blazars, such as spectral variability, X-ray/TeV correlation and associated time lags, spectral hysteresis, etc. The results will likely provide insights into the properties of the emitting particles, as well as those of the
emitting regions, emission mechanism, composition of the jets, and acceleration energetics.

Richard Dubois/Stanford Linear Accelerator Center
Simultaneous Observation of the Gamma-Ray Binary LS I+61 303 with GLAST and VERITAS

The main scientific purpose of this Suzaku observation is to obtain a multi-wavelength observation of LSI +61 303 in optical, x-ray and gamma ray energy bands. This information is likely to shed light on the mechanisms of gamma ray production from this binary system, both on the acceleration mechanisms and particle content. It could be the first observation of a GeV-emitting jet in our galaxy. We intend to analyze the GLAST survey data to correlate the gamma ray activity of this source with that of Suzaku: this includes the spectral and orbital timing behaviours. LSI +61 303 is an ideal source for GLAST operation in that it can be observed in one day. The region around this source is relatively quiet, so that measurements of orbital modulation are expected to be possible.

Renato Dupke/University of Michigan
Large Scale Metal Enrichment Mechanisms in Abell 496

A496 is a "normal" nearby cluster that has been the test bed for metal enrichment models in clusters and, more recently, of different mechanisms to generate cold fronts. Suzaku’s high effective area, excellent spectral resolution combined with the moderate temperatures of this cluster allows us to probe, with three short exposures, into the large scale metal enrichment processes through determination of elemental abundance ratios out to half the virial radius for the first time. We will also test the predictions of current models for cold front generation by setting strong constraints on the X-ray emitting gas associated with the candidate dark matter sub halo that was scattered by the main body of A496.

Martin Elvis/Smithsonian Astrophysical Observatory
NGC3227 Monitoring: Key to AGN Structure and Cosmic Feedback

We propose a 2 month Suzaku monitoring program of 7 weekly 50ksec observations of the normal type 1 AGN, NGC3227. Variations of the Warm Absorber will determine its location in NGC5548, discriminating between models and determining the mass loss rate in the WA wind. This mdot will provide a calibration at low M_BH/Mdot(Edd) compared with our Cycle 2 NGC5548 measurement 'cosmological feedback' models from AGN to galaxy formation. Simultaneously, the XIS and HXD spectra will study changes, or lack thereof, in the reflection components (narrow Fe-K, Compton Hump), again delimiting their location and choosing among models. The summed spectrum will determine the high energy continuum break, and any broad Fe-K or high ionization edge.
Completing Suzaku Mapping of Vela Jr SNR

These Suzaku observations will be used to complete our mapping observations of SNR Vela Jr (RX J0852.0-4622) by covering the southern hemisphere of the remnant. This remnant is one of very few shell-type SNRs that are clearly detected and identified in VHE gamma-rays with the H.E.S.S. telescope. One aim in the investigation is therefore to understand the nature of the gamma-ray emission and to understand acceleration mechanism to these energies in SNRs. The Suzaku data will help to establish the properties of the electron population throughout the whole remnant. Suzaku XIS images obtained by our previous program have clearly demonstrated the existence of ultra-relativistic electrons in the northern part of this remnant. We are aiming at (1) detecting hard X-ray emission with the HXD PIN, (2) measuring a keV-to-TeV ratio over the face of the remnant, and (3) confirming the presence of thermal X-ray emission in Vela Jr. The methods will include morphological and spectroscopical studies of the remnant. This is inline with NASA's aim of understanding basic emission properties in the Universe.

Observation of Newly Discovered TEV Gamma-Ray Sources in the W28 Region

H.E.S.S. observations (2004--2006) have revealed extended very high-energy gamma-ray emission in the region of the Supernova remnant W28 pointing to the presence of ultra-relativistic particles. The main aim of this observation is to understand the nature and origin of this particle population by measuring the X-ray properties of the emission region. The strongest gamma-ray emission is located in a region outside of the boundary of SNR W28 towards the south of it. The Suzaku observations (90 ksec in 3x30 ksec pointings) of this southern gamma-ray source for which, at present, no dedicated coverage at X-ray energies exists will allow us to study the electron population in this region visible through synchrotron emission. A potential counterpart for this TeV gamma-ray source is the ultra-compact HII region W28A2, exhibiting a powerful bipolar molecular outflow and being a bright radio and IR source. With the X-ray data, we will be able to test this hypothesis, and also to unveil the role that the relatively old SNR W28 plays in the gamma-ray emission in this part of the W28 region. The methods will include morphological and spectroscopical studies of the remnant. This is inline with NASA's aim of understanding basic emission properties in the Universe.

Mapping Observations of HESS J1825-137

The VHE gamma-ray emission in HESS J1825-137 extends asymmetrically approximately 1 degree to the south of the energetic pulsar PSR J1826-1334, which lead to associate this VHE gamma-ray source with a pulsar wind nebula (PWN). Although the past X-ray observations revealed the existence of a PWN immediately surrounding the pulsar, the whole gamma-ray emitting region has not been covered yet with sensitive X-ray instruments. The main objective of our project is to probe radiative cooling and propagation processes of relativistic electrons accelerated in the vicinity of the pulsar, by
observing the PWN region which has not covered by other X-ray observatories. Combined X-ray and VHE gamma-ray measurements can determine the magnetic field in the system and the distribution of relativistic electrons over a wide energy range. According to our estimates, we can expect marginal detection of hard X-rays above 10 keV with the HXD-PIN although our studies described above will be done mainly based on XIS data. Detection of hard X-rays (or tight upper limits on hard X-ray flux) will allow us to study the maximum acceleration energy of electrons in this pulsar/PWN system.

Terrance Gaetz/Smithsonian Astrophysical Observatory
Searching for Ejecta in the Vela Supernova Remnant Fragments

Elements heavier than hydrogen and helium are almost entirely produced in nuclear burning in the interiors of stars. When a massive star explodes as a supernova, these processed elements from the interior ("ejecta") are released back into the interstellar medium, where they can be incorporated into succeeding generations of stars and planets. The ejecta fragments projecting from the nearby Vela supernova remnant provide a unique opportunity to examine supernova ejecta as they shock and finally merge into the interstellar medium. Fragments "A" and "D", observed with Chandra and XMM-Newton, and Fragment "B", observed with Suzaku, show strongly enhanced (but very different) abundances: "B" and "D" are strongly enhanced with oxygen, neon, and magnesium, while "A" is strongly enhanced in silicon. These fragments are indeed ejecta, but originating in different layers of the precursor star. We propose to observe two of the remaining ejecta fragments, "C" in the east, and "E" in the west. The X-ray spectra will be fitted with plasma emission models to evaluate the abundances of the elements visible in the X-ray band. In combination with the existing observations of fragments "A", "B", and "D", these data will provide a much more complete picture of the variation in ejecta fragment abundances and their interactions with the remnant shell and the surrounding interstellar medium. This work thus addresses the science question of "how did the elements of life and the universe arise?" from the NASA "Astrophysics" science area.

Massimiliano Galeazzi/University of Miami
Filamentary X-Ray Structure in the Shapley Supercluster

It is, in principle, possible to search for the signature of the Warm-Hot Intergalactic Medium (WHIM) in regions between clusters, where WHIM filaments are expected. However, the complexity of the filament network and the distance between clusters makes this approach very difficult (if not impossible), except in few cases where several clusters are sufficiently close together, such as within a supercluster. We propose an investigation using Suzaku of a region within the Shapley Supercluster where, following the cluster network, a filament is expected and a ROSAT PSPC investigation has found excess emission. Suzaku's characteristics will allow a clear detection and characterization of the filament. A second observation in an "empty" region nearby will be used as control field.
Kajal Ghosh/USRA/NSSTC/MSFC
Probing the Inner Structure of AGNs Using the Polar BALQSOs

We have discovered polar broad absorption-line quasars (BALQSOs) from their radio variabilities. We know their inclination angles. Our results derived from the archival Chandra data of one polar BALQSO (SDSS J155633.77+351757.3) indicate that the X-ray emissions are from the jet and the X-ray absorbing gas is located at tens of parsecs above the accretion disk corona (described in section 4). We want to confirm these results at high confidence level using better signal to noise ratio (S/N) data from a big observatory, like SUZAKU. In addition, we propose to observe three more polar BALQSOs, which have wide range of radio/UV/X-ray properties. Our primary science goal of this proposal is to determine the radial distribution of the X-ray absorbing gas in 4 polar BALQSOs. This can be determined from the measurements of the hydrogen column densities and the X-ray spectral shapes, which require relatively simple data analysis and easily doable, similar to that of SDSS J155633.77+351757.3. Already, we know the angular positions. Thus, for the first time, the angular and radial distribution of the X-ray absorbing gas will be determined directly from observations. This will be the first step to study the inner structure of BALQSOs. Here, we propose 90 ks observations each for 4 polar BALQSOs and we are fully confident that we will achieve our science goals using the results from the proposed observations. We will also perform temporal and spectral analysis of all the X-ray sources that will be detected in each field. Optical identifications of these sources will also be carried out.

Kenji Hamaguchi/NASA Goddard Space Flight Center
X-Ray Emission from ETA Carinae During the X-Ray Maximum and Minimum

X-ray observations of Eta Carinae near the 2003 periastron passage confirmed that the X-ray emission primarily arises from collision of winds in a binary system, but raised fundamental questions about the cause of the 3 month-long X-ray minimum and an excess above ~10 keV (possibly up to 50 keV) in addition to the thermal emission with kT ~3-5 keV. These features would originate from plasma extremely embedded in the primary winds and acceleration of high energy particles at the wind colliding region. To resolve these features clearly, broad band Suzaku observations around the periastron passage are crucial. We propose four 30 ksec Suzaku observations of Eta Carinae during AO3, which will cover the next X-ray maximum (in late 2008) and minimum (in early 2009).

Kenji Hamaguchi/NASA Goddard Space Flight Center
X-Raying the Periastron Passage of the Canonical, Long Period Colliding Wind Laboratory, WR140

WR 140 (WC7+O4I) is a long-period (P=7.94 yrs), extremely eccentric (e=0.88) massive binary. Winds from each star collide and produce strong changes in the X-ray spectrum and the production of thick dust shells. All the orbital and stellar parameters are
measured, so WR 140 is the best shock-physics laboratory known. X-ray observations are crucial to understand the hot shocked gas and the mass loss phenomena. WR140's next periastron passage is in Jan. 2009. We propose a series of Suzaku observations to precisely determine the change in the X-ray emitting plasma and in the cool absorbing wind from the WC7 star, and the amount of hard X-ray emission (E>20 keV) from particle acceleration in the shock. This may be the only opportunity to observe a periastron passage of WR 140 with Suzaku.

Thomas Harrison/New Mexico State University
Can Intermediate Polars also Explain the Galactic Hard X-Ray Background?

Intermediate Polars (IPs) have recently been receiving much attention in the high energy community as they appear to be able to explain the numerous point sources seen in deep Chandra images of the Galactic Center region. Recent INTEGRAL observations suggest an equally large population of faint, hard X-ray point sources. Can IPs also explain this population? Existing hard X-ray observations suggest this possibility, but we do not have adequate hard X-ray spectra to determine the luminosities of IPs in this energy regime. We propose a deep, 100 ksec exposure on GK Per, the IP with the highest observed hard X-ray flux. The resulting spectrum will enable us to determine if IPs have sufficient hard X-ray luminosities to explain the INTEGRAL observations.

J. Henry/University of Hawaii
Search for WHIM in the Shapley Supercluster

We aim at the first significant detection of redshifted OVII and OVIII lines from the warm-hot intergalactic medium (WHIM) in the Shapley Supercluster. The system, located at z = 0.048, shows the richest concentration of X-ray clusters in the nearby universe. Previous ROSAT observations showed enhanced soft X-ray emission along the cluster connection. We propose to observe for 80 ksec a region between A3558 (the brightest central cluster) and A3556, separated by 0.9 virial radius from both clusters and along the line of cluster connection. A 40 ksec observation is also proposed at a 2-degree offset region to measure the foreground Galactic spectrum. Based on the ROSAT flux, we expect to detect redshifted OVII and OVIII lines at more than 7 sigma confidence.

Ryan Hickox/Smithsonian Astrophysical Observatory
Exploring Supermassive Black Hole Accretion in Obscured AGN and XBONGs

This project will use Suzaku XIS to observe two interesting samples of active galactic nuclei (AGN), which are powered by the accretion of gas onto supermassive black holes (SMBHs) in the centers of galaxies. It is increasingly clear that the accretion process in AGN can follow several different modes, and the key diagnostics of these modes may be derived from their X-ray emission. This project seeks to study the X-ray emission from two sets of AGN targets selected from the 9.3 square degree Chandra XBootes survey. The targets were approved at Priority C in AO-2, and we have derived updated sensitivities based on the one existing observation from the program. The first set of
targets includes 7 distant, optically-obscured (Type 2) infrared-selected quasars, which are a new class of object that have only recently been observed in large numbers thanks to IR data from the Spitzer Space Telescope. We will use Suzaku to estimate the X-ray luminosities and neutral gas absorption for these quasars, and compare them to the observed IR luminosities and dust extinction, to help test the "unified model" of obscured AGN. We also target 7 X-ray Bright Optically Normal Galaxies (XBONGs). Recent clustering and X-ray stacking results suggest that red XBONGs may represent a radiatively inefficient, low-Eddington mode of supermassive black hole accretion. We will test this picture with Suzaku by measuring the photon index and gas absorption simultaneously for these objects. Overall, this work will help gain valuable insights into the accretion processes in AGN, which affect the growth and cosmic evolution of supermassive black holes and their host galaxies.

Amalia Hicks/Michigan State University  
Cosmology with Clusters: Constraining Physical Differences Between X-ray and Optically Selected Samples at Moderate Redshift

Comparisons between moderate-z X-ray and high-z optically selected clusters indicate that the latter have lower Lx than expected for a given Tx, however it is hard to tell if such discrepancies are due to cluster evolution or selection effects. In an attempt to isolate these two variables, we propose the first detailed comparison of X-ray and optically selected clusters that are well-matched in both velocity dispersion (a quantity independent of both methods) and redshift. Our X-ray analysis of X-ray selected CNOC clusters is complete. Here we propose to determine Lx, Tx, and morphology for an optically selected sample, most of which already have velocity dispersion data in hand, enabling rigorous quantitative comparisons between physical characteristics of the two groups.

John Hughes/Rutgers University  
Secondary FE-Peak Elements as a Probe of SN Ia Explosion Physics

This proposal requests funds to support the analysis of an approved "Long Program" Suzaku observation of the Tycho supernova remnant. The goal of the observation is to study faint lines from Cr and Mn recently detected in an earlier observation and to study the variation of line width with position across the remnant.

Kevin Hurley/University of California, Berkeley  
Maintaining Suzaku in the Third Interplanetary Network of Cosmic Gamma-Ray Burst Detectors

We propose to continue to use the data from the Suzaku Hard X-Ray Detector Wideband All-Sky Monitor (HXD WAM), in conjunction with the data from other instruments in the Interplanetary Network (IPN), to derive the positions of gamma-ray bursts by triangulation. The IPN is the only all-sky, full time GRB monitor, and its current detection rate is ~200/year. This makes it possible to study a wide variety of events which
narrow field-of-view GRB instruments like the Swift BAT and INTEGRAL-IBIS will seldom detect. The Suzaku/IPN burst rate is ~1/2.5 days. The HXD WAM data are useful to the IPN because Suzaku is often the only near-Earth vertex. The resulting IPN localizations are useful to the Suzaku team for spectral analysis.

**Richard Ignace/East Tennessee State University**  
**X-Rays from Magnetically Confined Hot Plasma in Tau Sco**

We are proposing to observe the magnetic hot star tau Sco (B0.2V) with four Suzaku pointings of 10 ksec each. This star has a highly structured surface magnetic field at around 500 G, and its unusually hard emission has been associated with wind confinement in closed magnetic loops. Our proposal is to test this claim. The surface field sports a torus-like structure of closed loops with a magnetic axis that is tilted by nearly 90 degrees from the stellar rotation axis. We selected four phases to optimize the detection of hard X-ray variability from occultation of hot plasma confined in the torus field arrangement as it rotates about the star. The Suzaku data will be important for confronting models of interactions between line-driven winds and magnetic fields in massive stars.

**Stefan Immler/NASA/USRA/GSFC**  
**Suzaku Observations of X-Ray Bright Supernovae**

Supernovae (SNe) 2005kd and 2006jd are one of the X-ray brightest SNe ever observed. We propose one SUZAKU observation each to obtain high-quality X-ray spectra that can be used to measure the temperature of the forward and reverse shock, constrain the absorbing column density at the surface of contact discontinuity, and to establish the X-ray rate of decline.

**Philip Kaaret/University of Iowa**  
**Testing the Cool Disk Emission Component in Holmberg II X-1**

Ultraluminous X-ray sources (ULXs) have generated great interest because they may be intermediate-mass black holes (IMBHs). Detection of cool disk emission in ULXs would be evidence for the presence of IMBHs, but in one case the cool disk model has been proved not true. We propose to test the validity of the cool disk interpretation for Holmberg II X-1 by determining if the luminosity varies as the fourth power of the temperature, as expected for an accretion disk. Archival data show that Holmberg II X-1 follows such a correlation but at a low confidence level. Due to a surrounding photoionized nebula, the source is known to be truly ultraluminous, so it is an important test case.
Timothy Kallman/NASA Goddard Space Flight Center

Spectroscopy of Vela X-1 (4U0900-40) and Searches for Pulse Phase Variability

We propose to observe the well-known X-ray pulsar Vela X-1 (4U0900-40) using Suzaku in order to test models for the circumstellar environment by measuring the spectrum and searching for variability in the iron line. The line is expected to exhibit changes in intensity and centroid energy as the X-ray beam sweeps around the wind and illuminates material with varying column density, ionization state, and velocity. In addition we will study the variability in the cyclotron feature. We will compare our observations with detailed hydrodynamical simulations of the stellar wind and its interaction with the compact object.

Oleg Kargaltsev/University of Florida

Studying the Long Pulsar Tail of the PSR B1929+10 with Suzaku

A bow-shock pulsar wind nebula (PWN) with an exceptionally long tail (>1.6 pc) has been detected in X-ray observations of the pulsar PSR B1929+10. Such long structures may be associated with many other pulsars. With the physical sizes of several parsecs, these tails are the longest extended structures observed around Galactic compact objects. This implies that PWNe have much larger spatial extent than it was previously thought and can contribute substantially to the production of Galactic CRs that have a major impact on the evolution of the Galaxy, its constituents, and the Universe.

The physical processes responsible for the formation of such extended tails, associated with the supersonically moving pulsars, are not well understood, and the existing numerical models may only be valid at small distances from the pulsar. The proposed Suzaku observations of PSR B1929+10 will measure the tail's full extent, map the surface brightness distribution, and perform spatially resolved spectroscopy. This will enable us to determine the major factors governing the post-shock wind flow in extended pulsar tails. We will also measure the pulsar spectrum to study and determine the properties of its hot polar caps.

Henric Krawczynski/Washington University in St. Louis

Target of Opportunity Observations of the Blazars MRK 421, MRK 501, and 1ES 1959+650

We propose one 150 ksec Suzaku ToO observations of one of the three strong GeV-TeV gamma-ray blazars Mrk 421, Mrk 501, or 1ES 1959+650 during a 10 day multiwavelength campaign with coverage from radio to gamma-rays. The proposal is submitted by the VERITAS collaboration, assuring excellent TeV gamma-ray coverage. The Suzaku observations will play a key-role in interpreting the multiwavelength data set, allowing us to measure the time lag between the X-ray and gamma-ray flux variability and to scrutinize the correlation of the X-ray and gamma-ray spectral indices. The Suzaku and gamma-ray energy spectra will allow us to constrain the intensity of the IR Diffuse Extragalactic Background Radiation which absorbs TeV gamma-rays in extragalactic pairproduction processes.
Julia Lee/Harvard University
A Direct Test of the Nuclear X-Ray Dichotomy in Radio-Loud AGN

The phenomenal X-ray emission of Active Galactic Nuclei (AGN) is believed to be powered by accretion onto a supermassive black hole, the process where material falls under the influence of gravity toward a compact central object, loses angular momentum and, through viscous forces, radiates a fraction of its energy away. By making precise measurements of the X-ray emission of AGN with Suzaku, we can determine fundamental properties of black holes and accreting matter. The Suzaku X-ray observatory provides key new insights into AGN physics, owing to its unique ability to detect, with high sensitivity, X-rays over a large energy range. Here, we will perform a 85,000-second observation with Suzaku of NGC 6251, a nearby, so-called "radio-loud" AGN, the subclass of AGN with extremely powerful twin jets of particles that propagate out to over one million light years from the black hole. Our previous studies of have indicated that the X-ray properties of this source do not fall into the canonical description of AGN (so-called unified models). Our Suzaku observation will provide new constraints on the state of accretion in the immediate vicinity of the black hole, which will be vital for comparing to the behavior of other AGN. Our Suzaku observation of NGC 6251 is relevant to NASA Strategic Sub-goal 3D ("Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets"), and in particular Science Outcome 3D.1 ("Progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity."). In addition, our work addresses multiple goals outlined in the Structure and Evolution of the Universe (SEU) Roadmap: in particular Science Objective 2 ("Observe how black holes manipulate space, time, and matter"), and Science Objective 4 ("Explore the cycles of matter and energy in the evolving Universe.")

Michael Loewenstein/NASA Goddard Space Flight Center
Uncovering the True Abundances of Elliptical Galaxies with Suzaku

We were awarded 150 ksec of A-target Suzaku observatory time on NGC 5846, and 90 ksec of B-target time on NGC 4406. Suzaku observations of these two bright galaxies are an integral part of a program to investigate star formation history and chemical evolution of elliptical galaxies via abundance studies of the hot interstellar medium using Suzaku XIS and XMM-Newton RGS spectra in conjunction with theoretical modeling. The low background and superior spectral resolution of the Suzaku XIS detectors enable one to demonstrate the necessity of including a second thermal component in global spectral fits, and confirm the result using specific spectral lines. The extended bandpass allows one, in conjunction with RGS data, to derive abundance profiles (including the first such for O) and detail a broad pattern of abundances including Ne, Mg, S, and Ar as well as O, Si, and Fe. These provide critical diagnostics for the star formation and enrichment history of elliptical galaxies.
Larry Maddox/University of Illinois at Urbana-Champaign
A Search for Nonthermal X-Ray Emission from Superbubbles

Clusters of massive stars, through their stellar winds and supernovae, form large diffuse structures known as superbubbles (SBs), which play an essential role in shaping the local interstellar medium. Most SB models indicate that these objects should be dominated by thermal plasma processes. However, observations of 3 SBs have detected significant nonthermal contributions to their X-ray emission, which raises many questions. Is it generated by synchrotron, inverse-Compton, or nonthermal Bremsstrahlung processes? Are colliding stellar winds or internal supernova remnants responsible? We therefore propose to examine the X-ray emission from 3 X-ray bright SBs, to search for nonthermal X-ray emission, and if possible place strong contraints on the source of this emission.

Grzegorz Madejski/Stanford University
Suzaku and GLAST Observations of 3C279

This budget is for analysis of the Suzaku observation of bright gamma-ray blazar PKS 3C279. This observation will be coordinated with optical and radio observations, with the goal of obtaining broadband spectra and light-curves. The X-ray and gamma-ray fluxes are known to be rapidly variable, but the information regarding the correlation between the X-ray and gamma-ray flux is limited, and the approved observations are designed to remedy this shortcoming. Such detailed spectral and variability studies are crucial to discriminate between different radiation scenarios responsible for production of X-rays and gamma-rays, and to constrain the matter content and by extension, the formation process of the jet, dissipation of the jet energy, and energization of the radiating particles.

Grzegorz Madejski/Stanford University
Suzaku and GLAST Observations of PKS 0528+134

This budget is for an analysis of the approved Suzaku observation of bright gamma-ray blazar PKS 0528+134, to be coordinated with GLAST, and optical and radio observations, with the goal of obtaining broadband spectra and light-curves. The X-ray and gamma-ray fluxes are known to be rapidly variable, but the information regarding the correlation between the X-ray and gamma-ray flux is limited, and the proposed observations are designed to remedy this shortcoming. Such detailed spectral and variability studies are crucial to discriminate between different radiation scenarios responsible for production of X-rays and gamma-rays, and to constrain the matter content and by extension, the formation process of the jet, dissipation of the jet energy, and energization of the radiating particles.
Grzegorz Madejski/Stanford University
Study of Hard X-Ray Evolution from the Brightest X-Ray Jet

This proposal requested a 150 ks Suzaku observation of the brightest X-ray emitting active galaxy jet, from active galaxy Mkn 421, and was approved as a category "B." AGN jet emission is variable, and simultaneous observation is necessary to determine the relationship between time series in as many spectral bands as possible. The Suzaku observations are coordinated with a broad range of other observational facilities, such as GLAST, TeV observatories, and optical and radio telescopes. The resulting data are likely to play an important role in determination the structure of AGN jets, and in particular, the emission processes, the jet content, and the location of the region where the kinetic energy of the jet is dissipated into radiation.

Alex Markowitz/University of California, San Diego
Ionized Disk Reflection in the Seyfert AGN NGC 7469

This project will center on analysis and interpretation of data obtained during a 100 ksec Suzaku Cycle 3 observation of the Seyfert 1 active galaxy nucleus (AGN) NGC 7469. The aims of this project include characterizing the X-ray emission and physical properties of the accretion disk surrounding the supermassive black hole in this AGN, which is a strong candidate for having ionized reflection from the accretion disk. Our observation will thus be an example of how broad bandpass X-ray observations can critically test blurred, ionized disk reflection model in Seyfert 1s. This observation program supports NASA Research Focus Area Goal II, Structure \& Evolution of the Universe, RFA 2(c).

Herman Marshall/Massachusetts Institute of Technology
SS 433 Jet Dynamics

SS 433 is still the only source that is known to have emission lines from ionized gas in a highly collimated jet. X-ray emission lines have been detected from highly ionized Fe, Ar, S, Si, Mg, and Ne, showing that the jet contains collisionally ionized plasma at its base at a wide range of temperatures up to at least 100 MK. Chandra observations have shown that the emission lines track the direction of the jet on very short time scales, inaccessible to radio and optical observations. Recent Chandra data show that the Doppler shift of the blue jet varies on a timescale of 20 ks while the red jet does not, indicating that the jet may be affected or directed by a disk wind. The proposed Suzaku observations would test models of a jet-wind interaction and the origin of the jet.

Dan McCammon/University of Wisconsin
Resolving Large-Scale Spatial Dependence of Soft X-Ray Diffuse Emission

The low background and clean gaussian spectral response at low energies of the Suzaku XIS offer a unique opportunity to address the longstanding problem of the origins of the Galactic 3/4 keV diffuse background. We propose to observe diffuse radiation from the Galactic plane in the general direction of the anticenter, and to compare it with data from
higher latitudes. This will allow a search for spectral signatures of non-thermal emission in the 3/4 keV band and the determination of abundances in any widely distributed hot gas. Absolute measurement of the O VII and O VIII line fluxes will help establish the origin of this mysterious component of the diffuse background. This question fundamentally involves the hottest phases of the interstellar medium, galactic halos, the IGM, and the connections between them. These area are all poorly understood, and all are directly accessible only through X-ray emission and absorption studies. These issues are among the most important contributors to NASA's strategic goal 3D, being central to the science questions on the evolution of the universe and the origin of stars and galaxies, and to the research objective of understanding the origin and destiny of the Universe.

Dan McCammon/University of Wisconsin
Soft X-Ray Diffuse Emission from the Galactic Disk

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Jon Miller/The University of Michigan
Uncovering Variable Quiescent Emission in the Neutron Star Cen X-4

Observations of blackbody-like thermal emission from the surface of quiescent neutron star low-mass X-ray binaries (LMXBs) can be used to measure neutron star radii. However, the quiescent spectra of these objects are rarely purely thermal - they often display a significant power-law contribution also. This complicates matters, especially given that in several objects X-ray variability is sometimes seen between different epochs during quiescence. The nearest known neutron star LMXB Cen X-4 gives us the clearest view of these objects in quiescence. A short XMM-Newton observation of Cen X-4 showed that variability can even occur on timescales down to a 100s. But, this observation lacked the sensitivity to determine the cause of the variability - whether it was the power-law component or the thermal component. Yet, the source of the variability has important ramifications for using these objects to measure neutron star radii - if it is the thermal component that is varying our picture for what is causing the thermal emission may be more complicated, or even wrong. To solve this critical
problem we will observe Cen X-4 with Suzaku for 150 ksec. This project relates directly to NASA research goal 3D.1.

Jon Miller/The University of Michigan  
Accretion Disk Evolution Throughout a Neutron Star LMXB Outburst

The true nature of X-ray emission from neutron star X-ray binaries (NSXRBs) has not been clear for sometime. The spectra may be comprised of a disk blackbody, a blackbody from the boundary layer, Comptonized emission from the accretion disk, or some combination thereof. Recent progress has been made using many observations of NSXRBs during outburst, but relies on data from RXTE which lacks the low energy sensitivity where the disk emission is most prominent. Using Suzaku we will observe the NSXRB transient 4U 1608-52 four times (30 ksec each) with Suzaku throughout an outburst. We will test how each of the spectral parameters change with luminosity, allowing us to untangle the possibilities for the spectra, providing us with essential information on the source and geometry of the accretion in NSXRBs. An essential part of this proposal is the unique ability of Suzaku to detect asymmetric broad iron emission lines in NSXRBs. We will study how the iron line varies throughout the outburst, which combined with the spectral fits will test the interaction between the accretion disk and corona. This project relates directly to NASA research goal 3D.1.

Jon Miller/The University of Michigan  
Suzaku Study of an Intermediate Mass Black Hole in a Dwarf AGN

Black holes are seen over a huge range in mass in the Universe, ranging from stellar-mass black holes in binary systems, to supermassive black holes at the centers of AGN. The recent discovery of a handful of low luminosity AGN with black hole masses lower than in typical AGN allows a unique probe of the properties of accretion onto intermediate mass black holes. With this 50 ksec Suzaku observation of the brightest X-ray source in this new sample we will investigate its X-ray spectrum in detail, search for variability and determine whether it displays the same properties, such as a soft excess, as more luminous/massive typical AGN. This project relates directly to NASA's strategic goal 3D.1.

Jon Miller/The University of Michigan  
Measuring Neutron Star Masses Using Broad Iron Lines and kHz QPOs

The behavior of ultra-dense matter in neutron stars remains enigmatic, with a wide range of possibilities. To probe this requires accurate measurements of neutron star radii and masses. We have recently shown that broad relativistic iron emission lines in neutron star low-mass X-ray binaries (LMXBs) can be used to constrain the neutron star radius. These sources also provide us with another tool, high frequency kHz quasi-periodic oscillations (QPOs). Combining a measurement of the velocity of the gas in the inner disk (from modeling the iron line) and the frequency of the kHz QPOs gives a method to measure the neutron star mass. Our 100 ksec observation of the neutron star LMXB Cyg
X-2 with Suzaku will provide a detailed iron line profile. We will also observe Cyg X-2 with RXTE to get a simultaneous measure of the kHz QPO frequency, allowing us to measure the neutron star mass in this object. Cyg X-2 provides a perfect test case given that it already has a well-determined mass from optical observations. If the masses agree then we have a powerful technique. But, even if the masses disagree this would be a very important result as it would challenge our understanding of the origin of these phenomena. This project relates directly to NASA research goal 3D.1.

Richard Mushotzky/Goddard Space Flight Center
The Origin of the Compton Thick Absorber in the Type 1 QSO PDS 456

PDS 456 is the most luminous nearby AGN. A Suzaku AO-1 observation revealed a powerful relativistic outflow, at 0.3c. Above 10 keV the HXD shows a factor of 8 rise in flux over the XIS, requiring that a high column density (>10^{24} cm^{-2}) absorber is located close to the X-ray source and partially covers its emission. Thus, PDS 456 challenges the standard paradigm of AGN, as such high columns of matter were not known to exist in type I AGN. We propose to monitor changes in the remarkable X-ray absorption in PDS 456, through 3x90 ks broad band Suzaku observations. This will test whether the spectral variability can be explained by changing absorption, while the spectral imprint of the ionized outflow in the iron K band will be measured with unprecedented accuracy.

Here we ask for funding to support the analysis of this approved Suzaku observation

Richard Mushotzky/Goddard Space Flight Center
Determination of the Number Density and Template Spectra of Compton Thick AGNs

Swift/BAT extragalactic survey above E>15 keV has provided us with the first unbiased AGN sample in the local universe. Here we propose to observe the remaining four Compton thick AGN candidates in the 2nd BAT catalog with Suzaku to make it complete. To resolve the degeneracy of spectral modeling to the XMM spectra of these sources, the simultaneous wide-band coverage with the XIS and the HXD is crucial. This will lead us to the first reliable measurement of the fraction of Compton thick AGNs and column density distribution, which are key parameters in the population synthesis of the X-ray background. We also aim to construct the template spectra of Compton thick AGNs, applicable to buried AGNs at high redshifts detected in deep surveys. The proposed funding is required to support a graduate student to perform the data analysis and present the results at an upcoming international meeting.

Richard Mushotzky/Goddard Space Flight Center
Broad Band Spectra of Swift/BAT Selected AGNs and the Origin of the X-Ray Background

The number of Compton thick AGNs is the biggest issue in the origin of the X-ray background and AGN evolution. According to the latest population synthesis
model, its estimate is strongly coupled with the broad band spectral shape of moderately absorbed AGNs, which is only poorly understood. Recently, Swift/BAT has provided the first unbiased AGN sample above 15 keV, which includes many hard X-ray bright, absorbed AGNs that can be best followed-up with Suzaku. Here we propose to observe two of them to measure the amount of reflection component with unprecedented accuracy, a key parameter to determine the total contribution of Compton thick AGNs to the X-ray background. The proposed funding is required to support a graduate student to analyze the data and present the work at a national conference.

Richard Mushotzky/Goddard Space Flight Center
Spectral Variability of Obscured Black Holes in The Early Universe

The hard X-ray excess found for the bright high-z (3.668) blazar IGR J22517+2218 with INTEGRAL/IBIS suggests it may harbor an obscured AGN behind a column density of more than 1024 similar in nature to a few heavily obscured AGN discovered recently by Suzaku in the local universe. We propose two 70 ks Suzaku observations to obtain for the first time simultaneous hard and soft X-ray spectra of this truly remarkable source with XIS and with HXD, respectively, in order to study the spectral variability of IGR J22517+2218 and determine whether it harbors an obscured AGN - the first such example at such high redshift. This observation will produce the best X-ray spectrum and at the highest-resolution of IGR J22517+2218 yet. Here, we ask for funding to support the analysis of this approved Suzaku observation.

Richard Mushotzky/Goddard Space Flight Center
The Structure of Buried Compton-Thin AGNs Discovered by Swift

The hard X-ray survey with Swift BAT have been finding various types of AGNs. Many buried AGNs with very low scattered X-rays have been discovered, for example. We propose to obtain broad band spectra of Compton-thin buried AGNs in the Swift sample. The data will be used to measure the amount of absorption in the direct and reflected emission and to constrain the structure of the obscuring matter around the AGN. The funds are to support a graduate student to participate in the data analysis and to support a trip to Japan for the collaborative effort.

Richard Mushotzky/Goddard Space Flight Center
Suzaku Observations of X-Ray Bright Type II AGN

While the classical unified model predicts that there is only one type of Seyfert II, Suzaku observations of SWIFT BAT-detected AGN make it clear that there are at least 4 classes of Seyfert II objects. These classes include (1) objects with a high line-of-sight column density and evidence for scattered soft x-rays (with a large range of reflection fractions), (2) “Compton thick objects” which are seen only by their scattered radiation, (3) objects with high line-of-sight column density but without evidence for an x-ray scattering region (Ueda et al. 2007, Winter et al. 2007) and (4) the “changing look” objects (Risaliti et al 2006) which apparently can change from Compton thick to Compton thin and vice versa.
It is not at all clear that these classes can be simply “unified” by geometry effects alone. It is only with high quality data for a large sample of Seyfert IIs that we can determine what is intrinsically different about these objects. In order to determine the fraction of objects in each class and to measure the distribution function of reflection fractions, Fe K line properties, scattered x-ray flux, and the fraction of soft emission due to photoionized gas, one needs high signal-to-noise broad band x-ray spectral observations. This is only possible with Suzaku.

Michael Nowak/Massachusetts Institute of Technology
Continuing to Enhance the Long Term Monitoring Campaign in the Suzaku Era

We request two additional 30 ksec observations of Cyg X-1, to be coordinated with our ongoing RXTE and Ryle radio telescope monitoring campaign. Suzaku will bring three unique attributes to this campaign: the ability to describe the 0.5-3 keV spectrum (crucial for describing the disk spectrum), high spectral resolution in the Fe line region (crucial for resolving narrow from relativistically broadened features), and the 200-600 keV spectrum (crucial for distinguishing among thermal corona, non-thermal corona, and jet models). By coordinating with our ongoing monitoring program, we not only obtain useful cross-calibration information, we will be able to place current and future Suzaku observations of Cyg X-1 in the context of the source’s global history.

Paul Nulsen/Smithsonian Astrophysical Observatory
The Energetics and Metal Abundance Patterns in the Outskirts of M87

We propose to take advantage of Suzaku's low background and good collecting area to observe a strong surface brightness discontinuity, most likely a cold front, in the outskirts of M87. We will make accurate temperature and pressure profiles across this cold front, determine the energy associated with it, and compare this to the energy of known AGN-ICM interaction features in M87. With Suzaku's spectral redistribution function we will for the first time measure Mg and O in the M87 outskirts and improve constraints on relative contributions by SN Ia and SN II. We will study abundance and abundance-ratio variations across the cold front and determine the role of gas sloshing in transporting metals produced by the central galaxy into the ICM.

Takashi Okajima/NASA Goddard Space Flight Center

This proposal aims to understand the structure of the Seyfert galaxies, the population synthesis of the Cosmic X-ray background (CXB), and the history of the growth of nuclear black holes, by measuring broad band X-ray spectra of two Compton-thick Seyfert 2s selected based on [OIII](lambda=5007A) and soft X-ray flux (<10 keV). Study of the CXB and the growth of nuclear black holes has made a big progress with Chandra and XMM-Newton X-ray survey observations. In this study one of the important data is distribution of the amount of absorption (NH) for Seyfert galaxies, since the NH changes
an X-ray spectral shape dramatically. However, lack of sensitive instruments in the hard X-ray energy band (>10 keV) has prevented us from precisely measuring NH especially for heavily obscured Seyferts (NH > 10^25 cm^-2), called "Compton-thick Seyferts". Thus the above study is based on "assumption" of the distribution of NH. It is crucial to get the true NH distribution including Compton-thick Seyferts, which is the first goal of this proposal. The most sensitive observation ever by the Suzaku HXD-PIN in 20-40 keV will allow us to obtain the intrinsic NH. The Seyfert galaxies sampled with [OIII] flux well indicates the intrinsic luminosity of the nuclear emission. In this proposal we selected the brightest ones in the [OIII] flux but weak at soft X-ray band and with no hard X-ray observation made so far. This suggests that the selected samples are most likely Compton-thick Seyferts. The samples result in only two; NGC 5347 and NGC 7130. By observing these two, reliable measurements of the amount of absorption for 32 [OIII] flux limited Seyferts will be completed. Systematic analysis will be done on not only Suzaku data but also historical data with other missions.

**Sangwook Park/Pennsylvania State University**

**Oxygen-Rich Supernova Remnant 0049-73.6 in the SMC**

This program is to analyze the Suzaku observation data of a supernova remnant 0049-73.6 in the Small Magellanic Cloud. 0049-73.6 is an old version of the oxygen-rich supernova remnant, which provides an important opportunity to study core-collapse supernova nucleosynthesis and its matter distribution into the interstellar space. We will utilize the high resolution spectral data of this remnant obtained by Suzaku for this study. We will also use archival Chandra data to help the Suzaku data analysis of metal-rich ejecta by discriminating the superimposed shocked ambient medium. This program will be of significance to help understand how heavy elements are created in a massive star and are distributed into the interstellar space, which eventually triggers the next generation star and planet formations.

**Rosalba Perna/Regents of the University of Colorado**

**Suzaku Prompt Study of Magnetar Outbursts**

The discovery of transient magnetars, and outbursts from known magnetars, has opened a new perspective in the field. This proposal is aimed at gathering new insights on the physics of magnetars (manely AXPs and SGRs) through the study of the multiband spectrum of the initial phase of their outbursts. We ask for one 80 ks ToO Suzaku, observation, to be triggered within 10 days following a X-ray flux increase (> than a factor of 10) from a sample of 5 magnetars (those reliably observable with the HXD-PIN). This observation is aimed at discovering (or study the variability) of the hard X-ray emission during magnetars' outburst activity.
Katja Pottschmidt/University of Maryland (Baltimore County)
The Broad Band Spectrum of Cen X-3 over Orbit and Pulse Phase

We ask for a 90 ks observation (which will be performed within typically 180 ks taking Suzaku's duty cycle into account) of the accreting HMXB Centaurus X-3 to conduct the most sensitive study to date of the wide range of changes of its broad band spectrum over one 2.1 binary orbit and with pulse phase. Especially we will determine the evolution of the hydrogen absorption column over the orbit and test whether signatures of the tidal wake observed with RXTE can be confirmed. The variable Fe line complex will be studied. The cyclotron resonance scattering feature of Cen X-3 at ~30 keV is especially well suited to test new physical models describing phase-resolved line profiles, since it is very variable over the pulse, with the line centroid spanning an energy range from 28 to 39 keV.

Katja Pottschmidt/University of Maryland (Baltimore County)
Searching for Cyclotron Resonance Scattering Features in Transient Accreting X-ray Pulsars with Suzaku

We propose to perform Target of Opportunity Observations of one accreting neutron star in outburst during Suzaku AO3. The aim of the observations is to observe the source at a level of 40 and 200mCrab, to determine the properties of the cyclotron line in this system and to determine its broad band spectrum.

Andrew Ptak/Johns Hopkins University
The Nature of the X-ray Absorber in Seyfert 2 Galaxies

This project is analyze data from approved Suzaku observations of a sample of active galactic nuclei (AGN) that are likely to be highly obscured. These AGN were selected from very hard X-ray Swift BAT survey data. This will help determine the extent to which obscured AGN are similar to unobscured AGN. This study is relevant to NASA goal of understanding the structure and evolution of the Universe.

Mallory Roberts/Eureka Scientific, Inc.
Searching for X-Ray Counterparts of Two Galactic TEV Sources

We requests funds to support the data analysis of a Suzaku observation of the neighborhood of an extended TeV source to determine if there is a X-ray source that is a potential pulsar wind nebula powering the TeV emission. The source is near the colliding wind binary RCW 49, which has been suggested as the source of TeV emitting particles, and would therefore represent a new source class if there is no other plausible accelerator in the neighborhood. While RCW 49 is a proposed X-ray counterpart, currently only part of the TeV nebula has been imaged in hard X-rays, and so it is unknown if there are other, more plausible counterparts. The observation we have requested is to image the rest of this nebula with Suzaku to search for such counterparts. As such, this proposal is directly in pursuit of the primary goal of the Suzaku mission to investigate the nature and
physics of astrophysical objects as revealed through detailed observations of their high-energy emission.

Roger Romani/Stanford University
PSR J1420-6048 and its Wind Nebula

PSR J1420-6048 is one of the more remarkable Galactic particle accelerators with a very high spin-down luminosity, an association with one of the brightest unidentified EGRET sources and a surrounding complex radio/X-ray/TeV nebula. We have been awarded 50ks of Suzaku AO3 time, in Pri C, along with Japanese co-PI T. Kishishita to obtain a deep XIS image that will allow us to measure the low surface brightness X-ray synchrotron emission and connect its structure and spectrum with the TeV ICS emission. This study will connect the two components, probe the energetics of the pulsar wind, constrain the pulsar birth site and set the stage for deep GeV imaging and spectral studies with the GLAST LAT. We will also make a careful search for pulsed emission in the HXD, with reasonable prospects for detection in the PIN data. This proposal seeks funds for partial support of the graduate student's effort to reduce the XIS data and to assist with the HXD analysis, pending scheduling of the proposed exposure.

Richard Rothschild/University of California, San Diego
Broad Band Study of GX 301-2

We propose the first observation of the bright neutron star GX 301-2 with Suzaku. The aim of the proposed 60 ks observation is a study of the broadband spectrum of the source in unprecedented detail and quality. This will allow us to analyze the structure (including density and clumpiness) of the intense wind of the optical companion and the gas stream flowing from Wray 977 to the neutron star. As the source is mostly quite bright and extremely bright during the pre-periastron flare, we will obtain spectra with exceptional statistical quality. These data will then be used to study the evolution of nH and the iron line with very high time resolution. Furthermore, we will perform phase resolved spectroscopy to study the spectral variation of the cyclotron line with pulse phas.

Richard Rothschild/University of California, San Diego
Revealing the Nature of Anomalous Bursting Episodes in GS 1826-238

This project will center on analysis and interpretation of data obtained during a Suzaku Cycle 3 observation of the bursting neutron star GS 1826-238. The primary aim of this investigation is to characterize the X-ray emission and physical properties of the accretion disk surrounding the source, which exhibits extremely regular unstable thermonuclear explosions that take place when the temperature and pressure at the base of the accreted layer increase beyond some threshold value. The interval between the bursts gives a measure of the amount of mass accreted since the previous burst, and unusually short intervals may indicate the accretion disk has moved closer to surface the star. This movement of the accretion disk can be measured by fitting the data using sophisticated spectral models containing both thermal and non-thermal emission.
processes. The dependence of the radius of the accretion disk on the accretion rate in neutron stars is not well understood, so this proposal has the potential to contribute to the NASA RFA "Structure and Evolution of the Universe."

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**Rita Sambruna/NASA Goddard Space Flight Center**  
**Suzaku Observations of the Hard Broad-Band Continuum of Swift/BAT High-Redshift Blazars**

We propose to observe with Suzaku two powerful, high-redshift FSRQs, 1656-330 and 2149-307, recently detected in the hard X-ray band by BAT onboard Swift. Both sources display a hard continuum, with photon index 1.4-1.5, assuring a good detection up to 70 keV, thus fully exploiting the capabilities of the satellite. With its high-energy coverage and good response at soft energies, Suzaku will allow to determine with precision the spectral properties in the hard, medium, and soft X-ray ranges, providing important clues on the physics of relativistic jets. A good measurement of the continuum will allow us to estimate the luminosity of the inverse Compton component, which usually dominates the radiative output, and the total kinetic power carried by the outflow.

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**Rita Sambruna/NASA Goddard Space Flight Center**  
**Suzaku Observations of 3C 111: Uncovering the Jet Within**

The origin of the high-energy emission from Broad-Line Radio Galaxies is still an open issue. A plausible scenario is reprocessed emission from a cold medium (disk) diluted by variable, non-thermal jet flux. To test this scenario we propose Suzaku observations of the BLRG 3C 111, which exhibits flux variability above 10 keV from available data, suggesting a jet contribution. Moreover, 3C 111 was previously detected with EGRET at GeV energies, and synergy with GLAST will thus be exploited in the proposed program. The coupled timing and spectral information provided by Suzaku are key to disentangle the disk and jet contributions, and determine their respective role for the source energy budget.

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**Craig Sarazin/University of Virginia**  
**Understanding the Physics at and Beyond the Cluster Virial Radius**

The physical state of the hot gas in the outskirts of clusters is poorly known. Precision cosmology studies with clusters require a full understanding of cluster physics with a few percent systematic uncertainty. We propose a 110 ks Suzaku observation of the hot relaxed cluster Abell 2390 to study the physics at and beyond the virial radius. Physical properties such as density, temperature and abundance will be studied for the very first time at these large radii. These data can place important constraints on theoretical models of clusters and their environments. We will search for an accretion shock, and test models for pre-heating, shock heating, thermal conduction, e-p equipartition, and heavy element transport. The low Suzaku background allows this measurement.
The cluster radio relic PKS B1400-33 in the poor cluster Abell S753 will be observed with the HXD/PIN to detect and characterize the nonthermal Inverse Compton emission. This is one of the brightest cluster radio relics known. Remarkably, it is associated with a relatively poor, cool cluster. Although it has many properties similar to other cluster radio relics, it is possible that it is an old radio lobe, displaced by motions or buoyancy. The HXD/PIN data will be a strong test of merger shock acceleration processes. The XIS observations will constrain the low energy nonthermal spectrum and determine the thermal gas properties near the relic, and allow a merger shock to be detected. The long exposure with the XIS will also provide accurate abundances for the gas in this cool cluster.

The radio galaxy Cygnus A lies in a cooling core cluster which is currently undergoing a cluster merger with a particularly simple geometry. We propose XIS spectra of the radio source/cooling core interaction region, merger shock region, and second subcluster. The Fe K emission line will be used to measure gas velocities in these 3 regions to determine the dynamics of the merger, and to constrain hydro/N-body simulations of the merger. Collisionless merger shocks may produce detectable non-equilibrium effects. We will also determine an upper limit for the rate of expansion of the X-ray bubble around the radio source, studying the interaction of the radio galaxy and X-ray gas in the only FR-II radio galaxy in a nearby cluster. HXD data will constrain inverse Compton from the radio source.

We will observe the Coma cluster radio relic with the HXD/PIN to detect nonthermal Inverse Compton emission. This is the second brightest cluster radio relic known. The small PIN FOV will separate the Coma radio relic and halo. The PIN data will be a strong test of merger shock acceleration processes; a nondetection would be inconsistent with current theories. The data will allow the relic magnetic field, and nonthermal energy and pressure to be derived. The XIS observation of the relic will be used to detect the merger shock. The relic is associated with the merging NGC 4839 subgroup, which will also be observed. The 2 XIS observations will determine the dynamics of the merging subgroup. We will search for redshift differences between the Coma cluster, subgroup, and merger shock.
Nikolai Shaposhnikov/USRA/GSFC
Iron K_Alpha Emission Line Diagnostics in Accreting Neutron Stars

In this observational program we propose to observe accreting neutron stars source GX 340-0. The observational goal of the program is to collect high-spectral resolution data in the region of K iron line. Our scientific motivation is to put the origin of the line emission under intensive theoretical scrutiny. This emission feature in black hole (BH) and neutron star (NS) sources is commonly attributed to fluorescence in the cold outer accretion disk, while redskewed shape of the line is explained by General Relativity (GR) effects. However, our recent analysis of K line in accretion white dwarf (WD) GK Per showed noticeable red-skewness of the feature shape. If the physics governing the line emission production is common for all three types of accreting sources, i.e. BH, NS and WD, then the GR effects would be ruled out as the origin of a redskewed profile. In this case an alternative paradigm should be invoked to explain the form of the line in accreting compact objects. Specifically, down-scattering in the diverging wind is a good candidate for such explanation, especially taken the fact that outflow is a common phenomenon for such systems. There is a developed theoretical and numerical treatment for wind processing. We wish to compare the performance of the wind-reprocessing model to relativistic red-shift model in as many sources as possible. With the proposed observations we hope to resolve the presented controversy. This proposal is a part of our broader effort to investigate the origin of iron emission line in Galactic X-ray binaries, which includes a parallel proposal to observe WD binaries.

Robin Shelton/University of Georgia
A Closer Look at Hot Halo Gas: A Suzaku Study of an X-Ray Bright Arc

Aside from the lengthy bright arcs in the northern sky, few X-ray bright, high latitude regions are understood. Yet, studying this gas is important for understanding the Galactic halo. Here, we propose to study a medium-sized (~7 degrees) bright feature in the southern sky. The feature is arc-shaped, suspiciously like the edge of a hot bubble. We propose to make Suzaku observations of the arc and nearby background. With them and an existing Suzaku observation, we will be able to determine the thermal properties of the arc plasma and if the arc is the bright limb of a hot bubble.

Randall Smith/Johns Hopkins University
Simultaneous Multiwavelength Observations of the Symbiotic Star SS73 17

SS73 17 was an innocuous Mira-type symbiotic star until INTEGRAL and Swift discovered its bright hard X-ray emission. Suzaku observations showed it emits three bright iron lines, with almost no emission in the 0.5-2 keV bandpass. The PI has an approved 100 ksec Chandra HETG observation in 2008 to determine the origin of the iron lines and measure any weak emission lines. With simultaneous Suzaku observations we will also measure the hard X-ray emission from the source, both to constrain the continuum and detect any non-thermal component. The effective areas of the XIS and HXD will constrain the broadband emission process much better than the HETG data.
Combined with simultaneous optical observations of the Mira-type star we will determine the origin of this star’s unusual emission.

**Randall Smith/Johns Hopkins University**

**Reobserving MBM12: Is the Soft X-Ray Background due to the LHB or SWCX?**

By observing MBM12, the nearest dense molecular cloud we have measured diffuse emission from local O VII and O VIII. The lines are emitted by either (1) the Local Hot Bubble (LHB; Smith et al. 2007), or (2) solar wind charge exchange (SWCX) within the heliosphere and geocorona (Kouttroumpa et al. 2007). Smith et al. showed that the Suzaku data on MBM12 could be from a LHB, though the O VII emission was quite bright. The SWCX model depends strongly on viewing geometry and solar wind flux, including flares. Conversely, the LHB model predicts constant emission. We propose to reobserve MBM12; if the original value is confirmed, it will require a reanalysis of existing LHB models, while confirming the SWCX model would be a leap forward in understanding foreground soft X-ray emission lines.

**David Strickland/Johns Hopkins University**

**NGC 3079'S 40 KPC-Scale Outflow: AGN or Starburst-Driven?**

We will determine whether AGN can drive galactic-scale winds by observing NGC 3079, the best nearby candidate for such a wind. The edge-on spiral NGC 3079 hosts a Compton-thick AGN and is surrounded by a 40 kpc-scale soft X-ray nebula, the largest manifestation of outflow activity also seen in the optical and radio. Proving the outflow is AGN-driven requires Suzaku's unique abilities. We will measure the AGN luminosity using the HXD in the 15-40 keV range and the 2-10 keV band reflection spectrum to assess whether the AGN can radiatively-or-mechanically power the observed superwind. We will determine the origin of the soft X-ray nebula using the relative elemental abundances in the plasma. We can also detect any significant starburst through the 6.7 keV line emission it would create.

**John Tomsick/University of California, Berkeley**

**Constraining Models for Black Hole Accretion in the Hard State**

Although accreting black holes exhibit a variety of spectral states, the Hard state is the one state that is associated with the presence of a steady jet. Thus, understanding the physics of this state is critical to understanding the disk/jet connection, but our picture of the Hard state is unclear. Using Suzaku along with multi-wavelength observations, we propose to extend studies to low fluxes to test theoretical models. The proposed observations can answer the following questions: Does the inner edge of the accretion disk recede in the Hard state? How is the location of the disk's inner edge related to the presence of a jet? What is the high energy emission mechanism? Answering such questions would represent a major advance in our understanding of accreting black holes and jets.
Tracey Turner/University of Maryland (Baltimore County)
Unveiling PKS 1549-79 with Suzaku

Galaxy merger models predict rapid black hole growth and strong outflows late in the merger as the accretion rate increases. PKS1549-79 is a powerful, low redshift, high accretion rate active galaxy which has undergone a recent merger. It is therefore an ideal object to test our understanding of galaxy activity and mergers and for studying feedback between AGN and their host galaxies. An 80 ks Suzaku observation will: (i) determine the amount and ionisation state of the nuclear obscuring material in PKS1549-79 and hence confirm its status as a local proto-quasar; (ii) search for the massive, probably highly ionised, outflowing wind predicted by galaxy evolution models and hence complete a census of out-flow components in this object; and (iii) quantify the high energy spectrum. This source has a high, possibly super-Eddington, accretion rate; this is unusual as high accretion rates are not normally associated with the presence of powerful relativistic radio jets which are observed in PKS1549-79. The presence of a high mass, high accretion rate nucleus in a local active galaxy reminds us of another such object, PDS456, which does display a high-mass, ionised out-flow only detected in X-rays. A recent Suzaku observation of PDS456 also revealed a previously unknown high-energy absorbed component above 10 keV in HXD, which implies that colder Compton-thick absorbing material must exist close to the nucleus and may be associated with a cooling outflow.

Tracey Turner/University of Maryland (Baltimore County)
Deconstructing Seyfert Spectra - Time for a Paradigm Shift?

The powerful combination of Principal Components Analysis with time-resolved X-ray spectroscopy of Seyfert AGN has shown strong evidence that changes in a complex absorber are the origin of much of observed AGN spectral and flux variability. Large column, high ionization layers of gas may arise in a disk wind, representing a significant new, and possibly dominant, component, responsible for shaping the X-ray spectrum of low luminosity AGN. The broad energy range of Suzaku used to observe highly-variable AGN gives us a unique opportunity to model primary and reflected continua and the effects of variable absorbing zones, and test wind and other models. Our long 340 ks exposure on the NLSy1 NGC 4051 will test models to the limit and provide a powerful dataset for testing the origin of X-ray emission in high accretion-rate AGN.

Tracey Turner/University of Maryland (Baltimore County)
MCG-02-14-009: Probing the Physical Properties of the Strongest Iron K Line

MCG-02-14-009 appears to have the strongest relativistic iron line of all the Seyfert 1s: a short 5 ks XMM-Newton observation found the line to have an EW_530-770 eV, two times larger than for MCG-6-30-15 and a spectrum that may be reflection dominated. We propose a 125 ks Suzaku observation of this AGN, which provides a unique opportunity to probe the innermost accretion disk in the region of strong gravity. The main goals are:
(a) utilize the unique broad bandpass of Suzaku to detect the expected strong reflection hump and determine the form of the X-ray continuum; (b) accurately measure the relativistic iron K line profile and thereby the geometry of the X-ray emitting region and (c) determine whether the iron line responds to the continuum down to the orbital timescales of the inner disk.

Yangsen Yao/University of Colorado
A Joint X-ray Absorption and Emission Study of the Hot Gas Toward Mrk 421

The high ionization absorption lines consistent with zero velocity shift have been discovered in the Chandra/XMM spectra of several bright AGNs, but the location of these absorptions has been debated since their discoveries. Here we request Suzaku observations of the soft X-ray background emission in the vicinity of Mrk 421, to conduct a joint analysis of the emission data with the absorption data. This analysis will naturally yield an effective length of the absorbing/emitting gas, and therefore shed light on its origin. This proposed program clearly matches the NASA Strategic Objective to "explore the universe to understand its origin, structure, and destiny".

Yangsen Yao/University of Colorado
Study of Warm-Hot Gas Toward PKS 2155-304

The highly ionized X-ray absorption lines of OVII, OVIII, and NeIX at zero velocity shift have been unambiguously detected toward the bright AGN PKS 2155-304 by the high resolution grating instruments. However the spatial extent and thus the nature of the absorbing warm-hot gas are yet unknown; it can be from a few kpc scale Galactic interstellar gas to 1 Mpc scale warm-hot intergalactic medium. We propose to observe the very vicinity of the AGN to determine the OVII, OVIII, and NeIX emission line intensities and temperature of the warm-hot gas. Joint analysis of absorption and emission lines will constrain the spatial extent of the absorbing gas. The proposed program matches the NASA Strategic Objective to "explore the universe to understand its origin, structure, and destiny".

Farhad Yusef-Zadeh/Northwestern University
A Suzaku Survey of the Galactic Center Lobe: A Nuclear Starburst?

Like a jungle where many species evolve, share the same resources and interact with each other, the center of our Galaxy is occupied by an impressive collection of components that coexist and interact with each other. On a small scale, the compact radio source at the center of our Galaxy is thought to be a 4 million solar mass black hole. On a large scale, two components that have been recognized for more than 20 years are the striking and puzzling "Galactic Center Lobe". The Galactic Center Lobe consists of two "columns" of radio and infrared emission with a degree scale (~400 light years) rising in the direction away from the Galactic plane. Within the region, there is considerable amount of thermal ionized and dust emission. Using SUZAKU observations, we plan to search for X-ray emission from the interior of the lobes and to test the idea that the lobes
are produced from a burst of star formation more than 10 million years ago. Suzaku has proven an ideal satellite to study the Galactic Center diffuse X-ray emission, due to its high sensitivity, low background, and good spectral resolution. The proposed measurements toward pointings away from the plane should also examine the inferred diffuse 5-7 keV plasma in collisional ionization equilibrium distributed in the plane of the Galactic center. The significance of the proposed study is that it allows us to examine the possibility of a starburst nucleus in our Galaxy.