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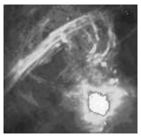

The Newsletter of Galactic Center Research

Edited by Angela Cotera, Heino Falcke & Sera Markoff

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Chandra ACIS Image of Sagittarius A West

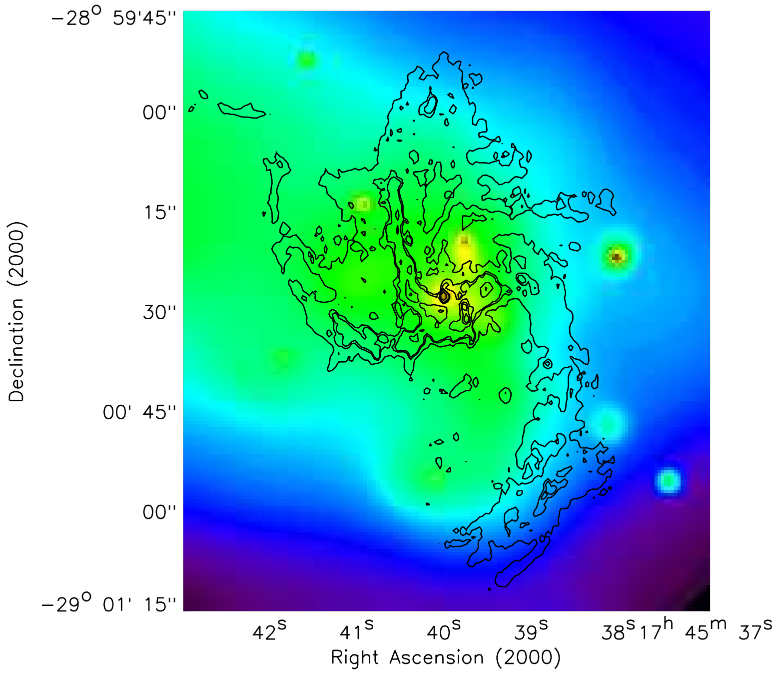

Figure 1: False-color, 0.5–7 keV image of the Sgr A West region at the Galactic Center made with the ACIS-I instrument on the *Chandra X-ray Observatory*. The X-ray image has been adaptively smoothed to display the structure of the diffuse emission (green and blue). The image is overlaid with VLA 6-cm contours showing the nuclear radio source Sgr A* and the H II region Sgr A West (F. Yusef-Zadeh, private communication). The red dot at $17^{\rm h}45^{\rm m}40\overset{\rm s}{.}0$, $-29°00'28''$ (J2000) is the faint X-ray source discovered by *Chandra* ACIS coincident within $0\overset{''}{.}35$ of the radio position of Sgr A*. X-ray emission coincident with IRS 13 (yellow) is evident just southwest of Sgr A*.

Table of Contents

Editorial:

Angela Cotera, Heino Falcke & Sera Markoff

The GC at the AAS Pasadena Meeting

A small but notable number of Galactic Center science results were presented at the AAS in Pasadena June 4-7. Mark Morris et al. presented deconvolved mid-infrared images, obtained at Keck; although Sgr A* is not obvious as a point source in these images, upper limits were given. The upper limits are still above the theoretically predicted values, but stay tuned. Doug Roberts et al. have derived new proper motion for the ionized gas in the central parsecs, and found accelerations in a few of the higher density gas blobs for the first time. Using VLBA observations of the astrometric reference sources used to establish the position and motion of Sgr A*, Geoffrey Bower et al. have concluded the reference sources are AGNs and, as a consequence, the proper motion of these source may introduce a 0.1 mas/year error to the positional determination of Sgr A*. There was also a poster by D. Halfen et al. on the first detection of NO and N_2O in Sgr B2, which suggests a mean temperature of 100K in this region.

Don Figer et al. gave a talk on the results of a study of the radial velocities for stars in the central parsec based on high resolution NIR Keck spectroscopy. They did not find a correspondence between LSR velocity with position, and found no evidence for galactocentric radial motion. Susan Stolovy discussed HST NICMOS data, and was able to establish an upper limit on the NIR flux from a possible source located at the position of Sgr A*. Fred Banagoff et al. presented evidence for a flare in Sgr A* in the X-ray from Chandra observations (see article this issue). Finally, Farhad Yusef-Zadeh et al. gave a talk on Chandra observations of the Arches cluster which indicates that in addition to peaked X-ray emission coincident with specific massive star candidates in the cluster, there is diffuse X-ray emission extending well beyond the cluster, indicating outflow of hot gas from the combined stellar winds of cluster stars. Yusef-Zadeh also participated in a press conference on this research.

Galactic Center Workshop 2002

At long last we are able to give you definitive information on the next Galactic Center conference, tentatively titled *GC02: The Central Kiloparsec.* The science scope of the conference will include objects on the kiloparsec scale and the milliparsec scale, and everything in between. The workshop will be held on November 4-8, 2002, at the Hilton Waikoloa Village on the Big Island of Hawaii. More information is given on the last page of this newsletter. We are sure this will be a very exciting workshop with many interesting discussions and are looking forward to see you in Hawaii next year.

Figure 2: The tempting location of the next Galactic Center workshop.

Chandra ACIS Imaging of the Galactic Center

Frederick K. Baganoff (MIT)

The launch of the *Chandra X-ray Observatory* in July 1999 has opened a new era in the study of X-ray emission from the Galactic Center. The unprecedented spatial resolution of the High Resolution Mirror Assembly (HRMA) combined with the high efficiency and moderate spectral resolution of the Advanced CCD Imaging Spectrometer (ACIS) on-board *Chandra* provide, for the first time, the capability of performing sub-arcsecond spectroscopic imaging of X-rays from the Galactic Center in the 0.5–10 keV band. The spatial resolution and accurate astrometry are essential to discriminate emission from Sgr A*, the compact nuclear radio source associated with the supermassive black hole (MBH) at the dynamical center of the Milky Way Galaxy, from X-rays produced in the surrounding compact cluster of massive stars and other hot plasma in the region. Additionally, the sensitivity at medium X-ray energies is essential to penetrate the high interstellar column density along the line-of-sight to the Galactic Center. The ACIS Science Team[1] observed the Galactic Center with *Chandra* ACIS for 40.3 ks on 21 September 1999. A summary of the major results are provided here (see Baganoff et al. 2001 for more details).

Figure 3 shows an exploded image of the Galactic Center made from the data. Panel (a) is a false-color image of the full $17' \times 17'$ ACIS-I field of view, covering the central 40 pc of the Galaxy. This image and the images in panels (b) and (c) have been adaptively smoothed and flat-fielded to remove mirror vignetting and chip-gap effects and to bring out the structure of the diffuse emission. The Galactic Plane is marked by a white line. The diffuse X-ray emission is strongest in the region filling Sgr A East (red), a shell-like nonthermal radio source thought to be a supernova remnant (Yusef-Zadeh & Morris 1987; Mezger et al. 1989; Maeda et al. 2001). The X-ray continuum and fluorescent-line emission from Sgr A East comes from a hot optically thin thermal plasma ($kT \approx 2$ keV) that is concentrated in the central ≈ 2–3 pc within the 6×9 pc radio shell; no significant X-ray emission is seen from the shell itself. See Maeda et al. (2001) for more details on our *Chandra* observation of Sgr A East. A curious linear feature $\sim 0\overset{\prime}{.}5$ long (yellow) extends (in projection) from the northeast toward the center of Sgr A East. This feature is superposed within the Sgr A East radio shell. It is clearly present in raw narrow-band images in the 1.5–3 and 3–6 keV bands, but it is not visible in the 6–7 keV band. This is in contrast to the core X-ray emission from Sgr A East, which dominates the 6–7 keV band due to strong Fe-Kα line emission. Sgr A East sits on a ridge of emission (green & blue) extending north and east parallel to the Galactic Plane that was first seen by *Einstein* (Watson et al. 1981). This ridge is most sharply defined in the 3–6 keV band, with clumps of bright emission in the 6–7 keV band. Emission extending perpendicular to the Galactic Plane in both directions through the position of Sgr A* is clearly visible (green & blue), as are many of the over 150 point sources detected in the field. This extended X-ray emission corresponds spatially with the so-called Sgr A East "halo" in the radio band, but is absent at 6–7 keV and therefore may be unrelated to Sgr A East. Our survey of X-ray sources is complete down to a limiting 2–10 keV absorbed flux of $F_X \approx 1.7 \times 10^{-14}$ ergs cm^{-2} s^{-1}. For sources at the distance of the Galactic Center, the corresponding absorption-corrected luminosity is $L_X \approx 2.5 \times 10^{32}$ ergs s^{-1}. The complete flux-limited sample contains 85 sources.

Panel (b) is a false-color, expanded view centered on Sgr A* of the inner $8\overset{\prime}{.}4 \times 8\overset{\prime}{.}4$ of the field. Complex structures can be seen in the X-ray emission from the vicinity of Sgr A East (yellow & green). The linear feature discussed above in panel (a) is aligned with a string of clumps or knots

[1]The members of the ACIS Science Team for the first-epoch *Chandra* ACIS observation of Sgr A* and the Galactic Center are F. K. Baganoff, M. W. Bautz, J. P. Doty, and G. R. Ricker (MIT), W. N. Brandt, E. D. Feigelson, G. P. Garmire, Y. Maeda, and L. K. Townsley (PSU), M. Morris (UCLA), W. Cui (Purdue), and S. H. Pravdo (JPL).

(yellow) within Sgr A East, implying that this feature may in fact be physically related to Sgr A East rather than simply a chance superposition on the sky. X-ray emission that we associate with the compact, nonthermal radio source Sgr A* is just discernable in this panel as the southeastern component of the red structure at the center of the image. In addition, there is a clump of bright emission (yellow) centered ≈ 0.3 pc east of Sgr A*.

Panel (c) is a false-color, $1.'3 \times 1.'5$ close-up around Sgr A* (red dot at $17^{\rm h}45^{\rm m}40.^{\rm s}0$, $-29°00'28''$) overlaid with VLA 6-cm contours showing Sgr A* and Sgr A West (F. Yusef-Zadeh, private communication). X-ray emission coincident with IRS 13 (yellow) is evident just southwest of Sgr A*. The western boundary of the brightest diffuse X-ray emission (green) coincides precisely with the shape of the Western Arc of the thermal radio source Sgr A West. On the eastern side, the emission continues smoothly into the heart of Sgr A East [see red region in panel (a)]. In addition, the indentation seen in the X-ray intensity $\approx 25''$ southeast of Sgr A* coincides with an HCN emission feature from molecular gas in the circumnuclear disk (CND; see Fig. 3a in Yusef-Zadeh, Melia, & Wardle 2000; and references therein). Since the Western Arc is believed to be the inner edge of the CND, the morpholgical similarities between the X-ray and radio structures strongly suggest that the brightest X-ray emitting plasma is being confined by the western side of the CND. This may be evidence that Sgr A West and Sgr A* physically lie within the hot cavity of the Sgr A East SNR, as has been argued previously based on radio observations.

Figure 4 shows a false-color, $1' \times 1'$ field around the position of Sgr A* made from counts in the 0.5–7 keV passband. This image has not been smoothed or flat-fielded. Clearly visible at the center of the image is the source that we associate with Sgr A* based on the extremely close positional coincidence. A black cross marks the radio position of Sgr A* as determined by Yusef-Zadeh, Choate, & Cotton (1999). Sgr A* appears to be sitting on an extended background which peaks locally. Several other X-ray sources lie within 10″ of Sgr A*, and the diffuse emission is also quite prominent $(F_x[2\text{–}10 \text{ keV}] \approx 2 \times 10^{-15} \text{ ergs cm}^{-2} \text{ s}^{-1} \text{ arcsec}^{-2})$. The source to the southwest of Sgr A* matches the radio position of IRS 13 to within $\approx 1''$. This source coincides with a strong shock at the edge of the "mini-cavity" seen in radio and mid-IR images. There is also a hint of excess counts from the vicinity of IRS 16SW, although no source was found there by the *Chandra X-ray Center's* wavelet source detection algorithm. This is interesting because we have not resolved X-ray emission from the other members of the IRS 16 cluster, which is known to contain a few dozen massive, He I/H I emission-line stars (Najarro et al. 1997). IRS 16SW has been shown to be a He-star binary, suggesting the possibility that we may be seeing X-rays from their colliding stellar winds (Ott, Eckart, & Genzel 1999). Additional observations in the coming years should clarify the situation. The other IRS sources match to within 1–2″.

The X-ray source we have discovered, CXOGC J174540.0–290027, is coincident within $0.''35 \pm 0.''26$ (1σ) of the radio source, corresponding to a maximum projected distance of 16 light-days for an assumed distance to the center of the Galaxy of 8.0 kpc. The emission was very weak, $L_{\rm X} = (2.4^{+3.0}_{-0.6}) \times 10^{33}$ ergs s^{-1} (90% confidence limits) in the 2–10 keV band, after correction for the inferred neutral hydrogen absorption column of $N_{\rm H} = (9.8^{+4.4}_{-3.0}) \times 10^{22}$ cm^{-2}, far below the luminosity limits of previous observatories (see review in Baganoff et al. 2001). The spectrum was relatively soft, with power-law photon index $\Gamma = 2.7^{+1.3}_{-0.9}$ $(N(E) \propto E^{-\Gamma})$ or electron thermal energy $kT_e = 1.9^{+0.9}_{-0.5}$ keV, and there was an inconclusive 2.5–3σ hint of variability on timescales of an hour. Only a weak $(\lesssim 2\sigma)$ upper limit of 1.8 keV could be placed on the existence of an iron Kα emission line. The mean count rate in the 2–8 keV band was $(5.4 \pm 0.4) \times 10^{-3}$ counts s^{-1} (1σ). The source appears to be slightly resolved, with an apparent diameter of $\approx 1''$.

Based on the fluxes and spatial distribution of the X-ray sources in the field, we estimate that the probability of detecting an absorbed source by random chance that is as bright or brighter than the Sgr A* candidate and that lies within $0.''35$ of the radio position is $\lesssim 5.6 \times 10^{-3}$. The nearest windy He I/H I emission-line stars are too far away $(\gtrsim 1'')$ to account for the X-ray source, and other classes of normal stars are too soft to penetrate the high absorbing column. The remaining possible alternatives to the X-ray emission coming from a MBH are quiescent low-mass X-ray binaries (LMXBs), cataclysmic variables (CVs), and isolated neutron stars or stellar-mass black holes. However, the velocity dispersion of stars in the central parsec cluster (~ 100 km s^{-1}) is an order of magnitude larger than in globular clusters. Consequently, binaries in the Galactic Center must have separations that are 100 times smaller. This may make it extremely difficult to create and retain binaries in the inner parsec of the Galaxy. In addition, isolated neutron stars are not particularly massive, so mass segregation may work to exclude them from the core. This still leaves isolated stellar-mass black holes as a possibility; but it is not obvious why one might expect one or more stellar-mass black holes in the vicinity of Sgr A* to radiate X-rays more efficiently than the central $2.6 \times 10^6\ M_\odot$ black hole.

The inferred mass accretion rate onto the supermassive black hole from the hot ambient medium is $\dot{M} \approx 1 \times 10^{-6}\ M_\odot$ yr^{-1}. Due to the limited Poisson statistics, the observed spectrum cannot discriminate definitively between thermal and nonthermal emission models (e.g., Narayan et al. 1998; Falcke & Markoff 2000; Melia, Liu, & Coker 2001). However, the strongest results (i.e., the low luminosity, soft spectrum, and low accretion rate) appear to favor the synchrotron self-Compton (SSC) models. The SSC models predict the X-ray emission should vary on short timescales and correlate with the submillimeter variability. This prediction will be tested with future, simultaneous *Chandra* and ground-based radio/submillimeter band observations of Sgr A*.

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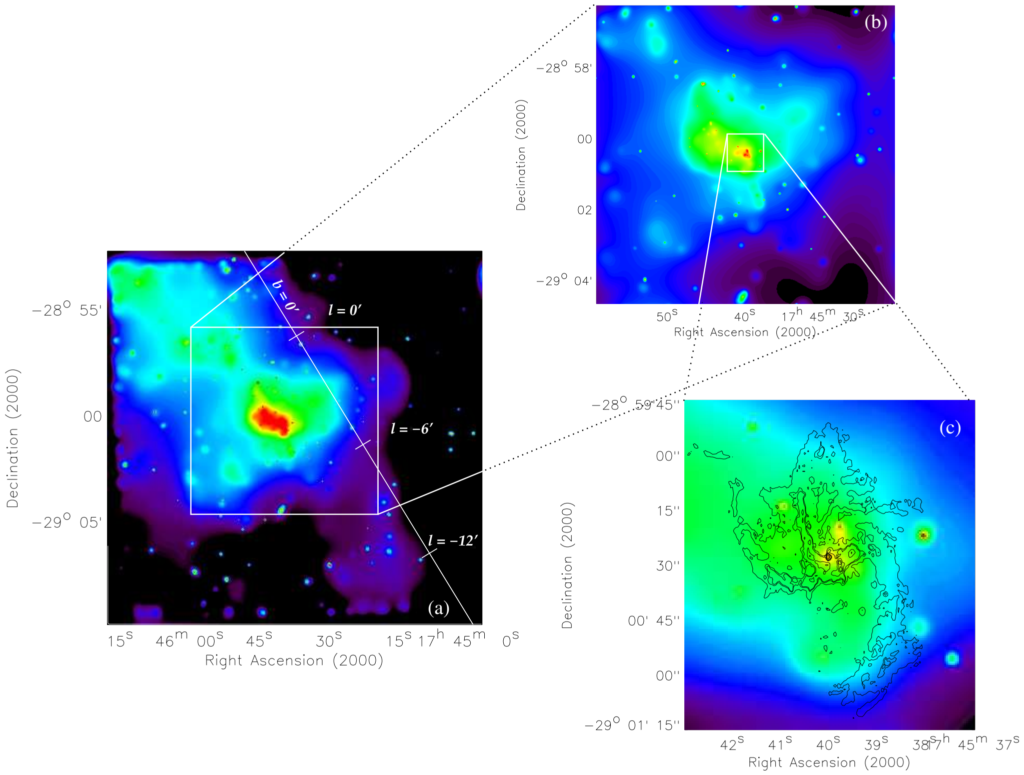

Figure 3: False-color, 0.5–7 keV exploded view of the Galactic Center made with *Chandra* ACIS-I. Panel (c) is overlaid with VLA 6-cm contours showing Sgr A* and Sgr A West (F. Yusef-Zadeh, private communication).

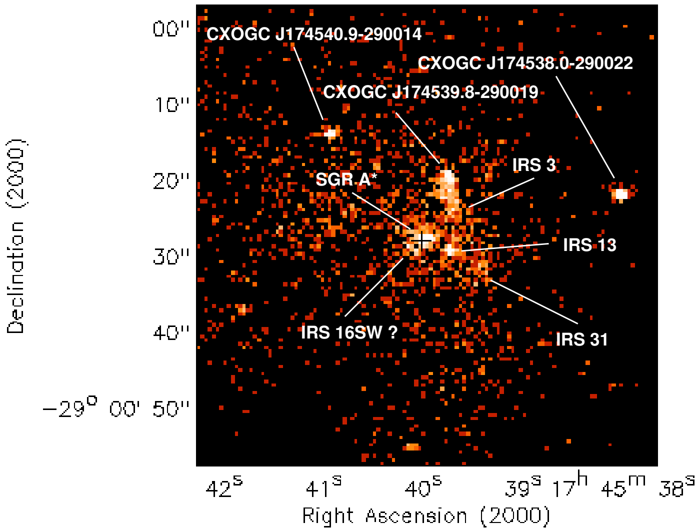

Figure 4: False-color, 0.5–7 keV raw image of the central 1′ × 1′ of the Galaxy.

Abstracts

A catalogue of soft X–ray sources in the galactic center region

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We present a catalogue of 107 point-like X–ray sources derived from a systematic analysis of all the ROSAT PSPC observations of the galactic center region performed in 1992–1993. Besides SgrA*, the massive black hole at the galactic center, 41 X–ray sources have been positionally associated with already classified objects. Twenty are identified with foreground stars and five with known Low Mass X–ray Binaries. The majority of the sources in our catalogue still remains unidentified. They are hard and/or severely absorbed and probably represent a large population of X-ray binaries located in the galactic center region, accreting at low accretion rates, and still largely unknown.

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Eprint: astro-ph/0101156

Pinpointing the massive black hole in the Galactic Center with gravitationally lensed stars

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A new statistical method for pinpointing the massive black hole (BH) in the Galactic Center on the IR grid is presented and applied to astrometric IR observations of stars close to the BH. This is of interest for measuring the IR emission from the BH, in order to constrain accretion models; for solving the orbits of stars near the BH, in order to measure the BH mass and to search for general relativistic effects; and for detecting the fluctuations of the BH away from the dynamical center of the stellar cluster, in order to study the stellar potential. The BH lies on the line connecting the two images of any background source it gravitationally lenses, and so the intersection of these lines fixes its position. A combined search for a lensing signal and for the BH shows that the most likely point of intersection coincides with the center of acceleration of stars orbiting the BH. This statistical detection of lensing by the BH has a random probability of 0.01. It can be verified by deep IR stellar spectroscopy, which will determine whether the most likely lensed image pair candidates (listed here) have identical spectra.

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The Galactic Center Interstellar Medium: from ISO to FIRST

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The Infrared Space Observatory (ISO) has shown the complexity of the Galactic center (GC) Interstellar medium (ISM) detecting, not only large column densities of warm molecular gas (H_2), but the emission of neutral atoms and ions of low ionization potential (CII, OI, SiII,...) that should arise in shocked or photon-dominated regions (PDRs). In addition, ISO has also detected emission from ions like SIII, NeII, ArII, or NII (in some clouds we have even detected NeIII and OIII) that should arise from HII regions that were previously unsuspected due to the non-detection of Hydrogen recombination lines. Here we review some ISO results on the large scale study of the GC ISM and in particular, on the heating mechanisms of the clouds. Although, shocks should play an important role on the physics and chemistry of the GC ISM, ISO shows that the effect of radiation on the heating of the gas cannot be ruled out with the simple argument that the dust temperature is lower than that of the gas.

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Email: nemesio@oan.es
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Astrophysical Limits on Massive Dark Matter

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Annihilations of weakly interacting dark matter particles provide an important signature for the possibility of indirect detection of dark matter in galaxy halos. These self-annihilations can be greatly enhanced in the vicinity of a massive black hole. We show that the massive black hole present at the centre of our galaxy accretes dark matter particles, creating a region of very high particle density. Consequently the annihilation rate is considerably increased, with a large number of e^+e^- pairs being produced either directly or by successive decays of mesons. We evaluate the synchrotron emission (and self-absorption) associated with the propagation of these particles through the galactic magnetic field, and are able to constrain the allowed values of masses and cross sections of dark matter particles.

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A CHANDRA STUDY OF SGR A EAST: A SUPERNOVA REMNANT REGULATING THE ACTIVITY OF OUR GALACTIC CENTER?

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We report on the X-ray emission from the shell-like, non-thermal radio source Sgr A East (SNR 000.0+00.0) located in the inner few parsecs of the Galaxy based on observations made with the ACIS detector on board the *Chandra X-ray Observatory*. This is the first time Sgr A East has been clearly resolved from other complex structures in the region. The X-ray emitting region is concentrated within the central $\simeq 2$ pc of the larger radio shell. The spectrum shows strong Kα lines from highly ionized ions of S, Ar, Ca, and Fe. A simple isothermal plasma model gives electron temperature ~ 2 keV, absorption column $\sim 1 \times 10^{23}$ H cm^{-2}, luminosity $\sim 8 \times 10^{34}$ ergs s^{-1} in the 2–10 keV band, and gas mass $\sim 2\eta^{\frac{1}{2}}$ M$_\odot$ with a filling factor η. The plasma appears to be rich in heavy elements, overabundant by roughly a factor of four with respect to solar abundances, and shows a spatial gradient of elemental abundance: the spatial distribution of iron is more compact than that of the lighter elements. The gas mass and elemental abundance of the X-ray emission support the long-standing hypothesis that Sgr A East is a supernova remnant (SNR), maybe produced by the Type II supernova explosion of a massive star with a main-sequence mass of 13–20 M$_\odot$. The combination of the radio and X-ray morphologies classifies Sgr A East as a new metal-rich "mixed morphology" (MM) SNR. The size of the Sgr A East radio shell is the smallest of the known MM SNRs, which strongly suggests that the ejecta have expanded into a very dense interstellar medium. The ejecta-dominated chemical compositions of the plasma indicate that the ambient materials should be highly homogeneous. We thus evaluate a simplified dynamical evolution model where a SNR was formed about 10,000 years ago and expanded into an ambient medium with a homogeneous density of 10^3 cm^{-3}. The model roughly reproduces most of the observed properties in the X-ray and radio wavelengths. A comparison with the radio observations requires the dense ambient medium to be ionized, but a luminous X-ray irradiator with an expected X-ray luminosity of $\sim 10^{40}$ ergs s^{-1} is not currently present. The presence of the ionized gas may be explained if the massive black hole (MBH) associated with the compact, non-thermal radio source Sgr A* was bright in X-rays about three hundred years ago, but is presently dim. It is possible that the dust/molecular ridge compressed by the forward shock of Sgr A East hit Sgr A* in the past, and the passage of the ridge may have supplied material to accrete onto the black hole in the past, and may have removed material from the black hole vicinity, leading to its present quiescent state. This may be a specific example of the intimate relationship between a SNR and massive black hole accretion activity in galactic nuclei.

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The jet model for Sgr A*: radio and X-ray spectrum

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The preliminary detection of the Galactic Center black hole Sgr A* in X-rays by the Chandra mission, as well as recent mm-VLBI measurements, impose strict constraints on this source. Using a relativistic jet model for Sgr A*, we calculate the synchrotron and synchrotron self-Compton emission. The predicted spectrum provides an excellent fit to the radio spectrum and the the X-ray observations. Limits on the infrared flux and the low X-ray flux require a high-energy cut-off in the electron spectrum at $\gamma_e \lesssim 100$. The implied lack of a significant power-law tail of high-energy electrons also suppresses the appearance of the extended, optically thin radio emission usually seen in astrophysical jets. The jet therefore appears rather compact and naturally satisfies current VLBI limits. The initial parameters of the model are tightly constrained by the radio spectrum and the "submm-bump" in particular. While the jet most likely is coupled to some kind of accretion flow, we suggest that the most visible signatures can be produced by this outflow. If SSC emission from the jet contributes to the Sgr A* spectrum, significant variability in X-rays would be expected. The model could be generic for other low-luminosity AGN or even X-ray binaries.

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Chandra X-ray Spectroscopic Imaging of Sgr A* and the Central Parsec of the Galaxy

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We present results of our Chandra observation with ACIS-I centered on the position of Sagittarius A* (Sgr A*), the compact nonthermal radio source associated with the massive black hole (MBH) at the dynamical center of the Milky Way Galaxy. We have obtained the first high spatial resolution ($\approx 1''$), hard X-ray (0.5–7 keV) image of the central 40 pc ($17'$) of the Galaxy. We have discovered an X-ray source, CXOGC J174540.0-290027, coincident with the radio position of Sgr A* to within $0\farcs35$, corresponding to a maximum projected distance of 16 light-days for an assumed distance to the center of the Galaxy of 8.0 kpc. We received 222 ± 17 (1σ) net counts from the source in 40.3 ks. The source is detected with high significance, $S/N \simeq 37\sigma$, despite the highly elevated diffuse X-ray background in the central parsec of the Galaxy. Due to the low number of counts, the spectrum is well fit either by an absorbed power-law model with photon index $\Gamma = 2.7^{+1.3}_{-0.9}$ ($N(E) \propto E^{-\Gamma}$ photons cm^{-2} s^{-1} keV^{-1}) and column density $N_{\rm H} = (9.8^{+4.4}_{-3.0}) \times 10^{22}$ cm^{-2} (90% confidence interval) or by an absorbed optically thin thermal plasma model with $kT = 1.9^{+0.9}_{-0.5}$ keV and $N_{\rm H} = (11.5^{+4.4}_{-3.1}) \times 10^{22}$ cm^{-2}. Using the power-law model, the measured (absorbed) flux in the 2–10 keV band is $(1.3^{+0.4}_{-0.2}) \times 10^{-13}$ ergs cm^{-2} s^{-1}, and the absorption-corrected luminosity is $(2.4^{+3.0}_{-0.6}) \times 10^{33}$ ergs s^{-1}. The X-ray source coincident with Sgr A* is resolved, with an apparent diameter of $\approx 1''$. We report the possible detection, at the 2.7σ significance level, of rapid continuum variability on a timescale of several hours. We also report the possible detection of an Fe Kα line at the $\simeq 2\sigma$ level. The long-term variability of Sgr A* is constrained via comparison with the Rosat/PSPC observation in 1992. The origin of the X-ray emission (MBH vs. stellar) and the implications of our observation for the various proposed MBH emission mechanisms are discussed. The current observations, while of limited signal-to-noise, are consistent with the presence of both thermal and nonthermal emission components in the Sgr A* spectrum. We also briefly discuss the complex structure of the X-ray emission from the Sgr A radio complex and along the Galactic plane and present morphological evidence that Sgr A* and Sgr A West lie within the hot plasma in the central cavity of Sgr A East. Over 150 point sources are detected in the $17' \times 17'$ field of view. Our survey of X-ray sources is complete down to a limiting 2–10 keV absorbed flux of $F_{\rm X} \approx 1.7 \times 10^{-14}$ ergs cm^{-2} s^{-1}. For sources at the distance of the Galactic Center, the corresponding absorption-corrected luminosity is $L_{\rm X} \approx 2.5 \times 10^{32}$ ergs s^{-1}. The complete flux-limited sample contains 85 sources. Finally, we present an analysis of the integrated emission from the detected point sources and the diffuse emission within the central 0.4pc ($10''$) of the Galaxy.

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Structure of Sagittarius A* at 86 GHz using VLBI Closure Amplitudes

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At radio wavelengths, images of the compact radio source Sagittarius A* (Sgr A*) in the Galactic Center are scatter broadened with a λ^2 dependence due to an intervening ionized medium. We present VLBI observations of Sgr A* at 86 GHz using a six station array including the VLBA antennas at Pie Town, Fort Davis and Los Alamos, the 12 m antenna at Kitt Peak and the millimeter arrays at Hat Creek and Owens Valley. To avoid systematic errors due to imperfect antenna calibration, the data were modeled using interferometric closure information. The data are best modeled by a circular Gaussian brightness distribution of FWHM 0.18 ± 0.02 mas. The data are also shown to be consistent with an elliptical model corresponding to the scattering of a point source. The source structure in the N-S direction, which is less well determined than in the E-W direction due to the limited N-S (u, v) coverage of the array, is constrained to be less than 0.27 mas by these measurements. These results are consistent with extrapolations of intrinsic structure estimates obtained with VLBI at 7 mm wavelength assuming the intrinsic size of Sgr A* has a greater dependence than $\lambda^{0.9}$ with wavelength.

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A VLA H92α Recombination Line Study of the Arched Filament H II Complex Near the Galactic Center

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The Very Large Array has been used at 8.3 GHz in the DnC and CnB array configurations to carry out an H92α recombination line study (at 8.3 GHz) of the ionized gas in the Arched Filaments H II complex, which defines the western edge of the Galactic center Radio Arc. The Arched Filaments consist of a series of curved filamentary ridges which extend over 9′*6′ (22 * 16 pc) and are intersected in two places by linear, nonthermal, magnetic filaments. The H92α observations cover the entire Arched Filaments region using a four-field mosaic, with an angular resolution of 12.″8 * 8.″10; an additional higher resolution (3.″6 * 2.″7) field was imaged in the SW portion of the H II complex. High resolution continuum images are also presented. The H92α line properties of the ionized gas (line-to-continuum ratio, FWHM line width, T) are consistent with photoionization from hot stars, and consistent with the physical properties of other Galactic center H II regions. The LTE electron temperatures vary only slightly across the entire extent of the source, and have an average value of 6200 K. The velocity field is very complex, with velocities ranging from +15 km/s to −70 km/s and the majority of velocities having negative values. Large velocity gradients (2−7 km/s pc , with gradients in some regions > 10 km/s pc) occur along each of the filaments, with the velocities becoming increasingly negative with decreasing distance from the Galactic center. The negative velocities and the sense of the velocity gradients can be understood in terms of the orbital path of the underlying molecular cloud about the Galactic center. The magnitudes of the velocity gradient are consistent with the cloud residing on an inner, elongated orbit which is due to the Galaxy's stellar bar, or with a radially infalling cloud. The ionization of the Arched Filaments can be accounted for completely by the massive Arches stellar cluster, which consists of > 150 O-stars and produces a few * 10^{51} photons s^{-1}. This cluster is likely to be located 10−20 pc from the Arched Filaments, which can explain the uniformity of ionization conditions in the ionized gas.

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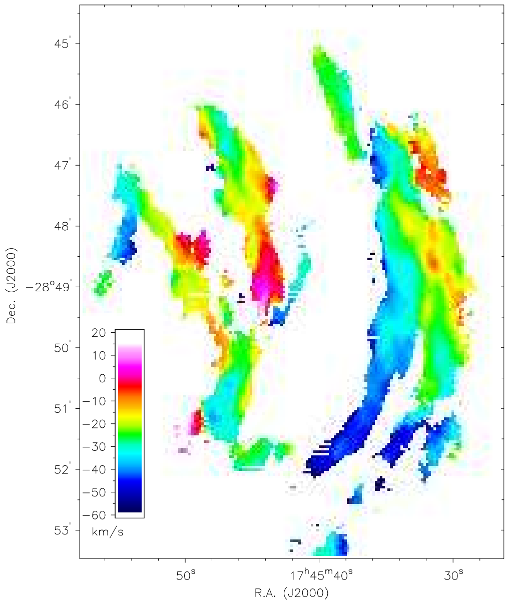

Figure 5: H92a velocity field of the ionized gas in the Arched Filaments H II complex (Lang et al.).

SPATIAL DIFFUSION OF STARS IN THE INNER GALACTIC BULGE

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Star formation in the inner few hundred pc of the Galactic bulge occurs in a flattened molecular layer called the central molecular zone (CMZ). Serabyn & Morris (1996) suggest that the star formation in the CMZ has been sustained for the lifetime of the Galaxy, and that the resulting agglomeration of stars formed in the CMZ has resulted in the prominent r^{-2} stellar density cusp at the Galactic center having about the same physical extent as the CMZ. This "central cusp" is somewhat less flat than the CMZ; thus the population of stars formed in the CMZ appears to have diffused out to larger latitudes. We hypothesize that such vertical diffusion is driven by the scattering of stars off the giant molecular clouds (GMC) in the CMZ, and perform numerical simulations of the scattering between stars and GMCs in the presence of the non-axisymmetric background potential. The simulation results show that the time scale for an initially flattened stellar population to achieve an aspect ratio of the observed OH/IR stars in the inner bulge, 1 to 2 Gyr, agrees well with the estimated age of those OH/IR stars.

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The Center of Our Galaxy: Activity and High-Energy Emission of the Closest Massive Black Hole

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The Center of our Galaxy is a peculiar region where a number of crucial astrophysical phenomena take place, from star formation to SN explosions and accretion onto a massive black hole. The quest for a massive black hole in the Galactic Nucleus is of course of particular relevance because, it would be the closest of such extreme objects, which are now believed to reside in most of the galactic nuclei of the universe. I will review here the main observational characteristics of the Galactic Center with particular attention to the the problem of existence, physical condition and activity of the 3 10^6 $M_\odot$ black hole coincident with the compact radio source Sgr A*. I will report historical and recent results of high energy observations of the central degree of our Galaxy, along with the specific accretion models proposed to account for the apparent lack of high energy activity from Sgr A*. The scientific perspectives of the next X and γ-ray missions in the domain of the Galactic Center physics are also mentioned.

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Microlensing by the Cluster of Black Holes Around Sgr A*

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We show that at any given time, the Galactocentric black hole Sgr A* is expected to be microlensing about 0.7 bulge stars if the threshold of detectability of the *fainter* image is $K_{thr} = 21$, and about 4.6 sources if $K_{thr} = 23$. The lensed images then provide a unique probe of the 20,000 stellar-mass black holes that are predicted to cluster within 0.7 pc of Sgr A*: if one of these black holes passes close to a microlensed image, it will give rise to a short (weeks long) microlensing event. We show that the mass and projected velocity of the black hole can both be measured unambiguously from such an event, if the lightcurve and the mean astrometric displacement can be measured. For $K_{thr} = 23$ and moderate magnifications by Sgr A*, these events are expected only at a rate of $0.05\,\mathrm{yr}^{-1}$, so deeper observations would be required to see an event within the next decade. However, if highly magnified images of a star were found, the rate of events by the stellar black holes would be much higher.

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Galactic Center: Implications of Recent *Chandra* Observations for Spherical Accretion Models of Sgr A*

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At the center of the Milky Way lurks a unique compact nonthermal radio source, Sgr A*. It is thought to be powered by a 2.6×10^6 solar mass black hole that is accreting the stellar winds from the numerous early-type stars that exist in the central parsec. However, until recent high resolution *Chandra* observations, Sgr A* had never been unequivocably detected at wavelengths shorter than the submillimeter. We present a spherical accretion model which is consistent with both the flux and steep spectral shape of the X-ray emission from Sgr A*.

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VLA Detection of the Ionized Stellar Winds Arising from Massive Stars in the Galactic Center Arches Cluster

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The Galactic center Arches stellar cluster, detected and studied until now only in the near-infrared, is comprised of at least one hundred massive ($M_\star \geq 20$ $M_\odot$) stars. Here we report the detection at centimeter wavelengths of radio continuum emission from eight radio sources associated with the cluster. Seven of these radio sources have rising spectral indices between 4.9 and 8.5 GHz and coincide spatially with the brightest stars in the cluster, as determined from JHK photometry and Brα and Brγ spectroscopy. Our results confirm the presence of powerful ionized winds in these stars. The eighth radio source has a nonthermal spectrum and its nature is yet unclear, but it could be associated with a lower mass young star in the cluster.

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The motion of stars near the Galactic center: A comparison of the black hole and fermion ball scenarios

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After a discussion of the properties of degenerate fermion balls, we analyze the orbits of the stars S0-1 and S0-2, which have the smallest projected distances to Sgr A*, in the supermassive black hole as well as in the fermion ball scenarios of the Galactic center. It is shown that both scenarios are consistent with the data, as measured during the last six years by Genzel et al. and Ghez et al. The free parameters of the projected orbit of a star are the unknown components of its velocity v_z and distance z to Sgr A* in 1995.4, with the z-axis being in the line of sight. We show, in the case of S0-1 and S0-2, that the $z - v_z$ phase- space, which fits the data, is much larger for the fermion ball than for the black hole scenario. Future measurements of the positions or radial velocities of S0-1 and S0-2 could reduce this allowed phase-space and eventually rule out one of the currently acceptable scenarios. This may shed some light into the nature of the supermassive compact dark object, or dark matter in general at the center of our Galaxy.

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X-ray emission from the giant molecular clouds in the Galactic Center region and the discovery of new X-ray sources

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We report the results of X–ray (2–10 keV) observations of the giant molecular clouds Sgr B, Sgr C and Sgr D in the Galactic Center region, together with the discovery of the point-like source SAX J1748.2–2808. The data have been obtained with the MECS instrument on the BeppoSAX satellite. The core of Sgr B2 has an X–ray luminosity of $\sim 6\times10^{34}$ erg s^{-1} and its spectrum is characterized by a strong Fe emission line at ∼6.5 keV with an equivalent width of 2 keV. Faint diffuse X–ray emission is detected from Sgr C and from the SNR G1.05–0.15 (Sgr D). A new, unresolved source with a strong Fe line has been discovered in the Sgr D region. This source, SAX J1748.2–2808, is probably associated with a SiO and OH maser source at the Galactic Center distance. If so, its luminosity is 10^{34} erg s^{-1}. We propose that the X–ray emission from SAX J1748.2–2808 is produced either by protostars or by a giant molecular cloud core. Emission from sources similar to SAX J1748.2–2808 could have an impact on the expected contribution on the observed Fe line emission from the Galactic ridge.

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A Non-Parametric Estimate of the Mass of the Central Black Hole in the Galaxy

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We estimate the mass of the central black hole in our Galaxy from stellar kinematical data published by Ghez et al. (1998) and Genzel et al. (2001). For this we develop a method, related to Merritt (1993), for non-parametrically reconstructing the mass profile and the stellar distribution function in the central region of the Galaxy from discrete kinematic data, including velocity errors. Models are searched using the Metropolis algorithm. We assume that the mass distribution is spherical and the stellar velocity distribution is isotropic, and devise a test of this assumption. From proper motions we obtain an enclosed mass of $2.0 \pm 0.7 \times 10^6 \mathrm{M}_\odot$ within the inner 0.0044pc, from radial velocities we obtain a mass of $2.2^{+1.6}_{-1.0} \times 10^6 \mathrm{M}_\odot$ within 0.046pc and from three-dimensional velocities we obtain $1.8^{+0.4}_{-0.3} \times 10^6 \mathrm{M}_\odot$ within 0.046pc.

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VLBA Observations of Astrometric Reference Sources in the Galactic Center

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We report here on multi-frequency VLBA observations of three extragalactic sources within 1 degree of the Galactic Center. These sources have been used as astrometric reference sources for VLA and VLBA determinations of the proper motion of Sagittarius A*, the compact nonthermal radio source in the Galactic Center. Each source has a main component with a brightness temperature in excess of $10^{7.5}$K, confirming that the sources are active galactic nuclei. The sources have simple structure that can be characterized by one or two Gaussian components. The frequency dependence of the structure indicates that the positions of Sgr A* determined by the VLA astrometry of Backer & Sramek (1999) at 4.8 and 8.4 GHz should have an offset of $\sim$ 2 mas. This offset is in the same direction as the 5 mas shift measured by Backer & Sramek (1999). The structure is unlikely to bias the 43 GHz VLBA results of Reid et al. 1999. Motions of components in the calibrator sources could lead to errors in the proper motion of Sgr A* on the order of a few km s^{-1}. All three sources show frequency dependent structure consistent with scattering which is significantly stronger than that of the Galactic scattering model of Taylor & Cordes (1993) but significantly weaker than that of the hyperstrong Galactic Center scattering. Combined with other observations, this suggests the existence of a new component of Galactic scattering located several kpc from the Galactic Center.

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NH_3 in the Central 10 pc of the Galaxy I: General Morphology and Kinematic Connections Between the CND and GMCs

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New VLA images of NH_3 (1,1), (2,2), and (3,3) emission in the central 10 parsecs of the Galaxy trace filamentary streams of gas, several of which appear to feed the circumnuclear disk (CND). The NH_3 images have a spatial resolution of $16.5'' \times 14.5''$ and have better spatial sampling than previous NH_33 observations. The images show the "southern streamer," "50 km s^{-1} cloud," and new features including a "western streamer", 6 parsecs in length, and a "northern ridge" which connects to the CND. NH_3(3,3) emission is very similar to 1.2 mm dust emission indicating that NH_3 traces column density well. Ratios of the NH_3(2,2) to (1,1) line intensities give an estimate of the temperature of the gas and indicate high temperatures close to the nucleus and CND. The new data cover a velocity range of 270 km s^{-1}, including all velocities observed in the CND, with a resolution of 9.8 km s^{-1}. Previous NH_3 observations with higher resolution did not cover the entire range of velocities seen in the CND. The large-scale kinematics of the CND do not resemble a coherent ring or disk. We see evidence for a high velocity cloud within a projected distance of $50''$ (2 pc) which is only seen in NH_3(3,3) and is likely to be hot. Comparison to 6 cm continuum emission reveals that much of the NH_3 emission traces the outer edges of Sgr A East and was probably pushed outward by this expanding shell. The connection between the northern ridge (which appears to be swept up by Sgr A East) and the CND indicates that Sgr A East and the CND are in close proximity to each other. Kinematic evidence for these connections is presented in this paper, while the full kinematic analysis of the central 10 pc will be presented in Paper II.

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Chandra Observations of Diffuse X-Rays from the Sagittarius B2 Cloud

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We present the first *Chandra* results of the giant molecular cloud Sagittarius B2 (Sgr B2), located about 100 pc away from the Galactic center. Diffuse X-rays are clearly separated from one-and-a-half dozen resolved point sources. The X-ray spectrum exhibits pronounced iron K-shell transition lines at 6.40 keV ($K\alpha$) and 7.06 keV ($K\beta$), deep iron K-edge at 7.11 keV and large photo-electric absorption at low energy. The absorption-corrected X-ray luminosity is $\sim 1 \times 10^{35}$ erg s^{-1}, two orders of magnitude larger than the integrated luminosity of all the resolved point sources. The diffuse X-rays come mainly from the south-west half of the cloud with a concave-shape pointing to the Galactic center direction. These results strongly support the *ASCA* model that Sgr B2 is irradiated by an X-ray source at the Galactic center side.

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ASCA Discovery of Diffuse 6.4 keV Emission Near the Sgr C Complex: A New X-ray Reflection Nebula

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We present an ASCA discovery of diffuse hard X-ray emission from the Sgr C complex with its peak in the vicinity of the molecular cloud core. The X-ray spectrum is characterized by a strong 6.4-keV line and large absorption. These properties suggest that Sgr C is a new *X-ray reflection nebula* which emits fluorescent and scattered X-rays via irradiation from an external X-ray source. We found no adequately bright source in the immediate Sgr C vicinity to fully account for the fluorescence. The irradiating source may be the Galactic nucleus Sgr A*, which was brighter in the past than it is now as is suggested from observations of the first *X-ray reflection nebula* Sgr B2.

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BIMA Observations of Linear Polarization in Sagittarius A* at 112 GHz

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We report here BIMA array observations of linear polarization in Sagittarius A*, the compact radio source in the Galactic Center. These observations had a resolution of $20'' \times 5''$ oriented North-South. We do not detect linear or circular polarization at a level of 1.8% (1-σ) at 112 GHz. This puts a new constraint on models that show a sharp change in linear polarization fraction at 100 GHz.

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The Supermassive Black Hole at the Galactic Center

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The inner few parsecs at the Galactic Center have come under intense scrutiny in recent years, in part due to the exciting broad-band observations of this region, but also because of the growing interest from theorists motivated to study the physics of black hole accretion, magnetized gas dynamics and unusual star formation. The Galactic Center is now known to contain arguably the most compelling supermassive black hole candidate, weighing in at a little over 2.6 million suns. Its interaction with the nearby environment, comprised of clusters of evolved and young stars, a molecular dusty ring, ionized gas streamers, diffuse hot gas, and a hypernova remnant, is providing a wealth of accretion phenomenology and high-energy processes for detailed modeling. In this review, we summarize the latest observational results, and focus on the physical interpretation of the most intriguing object in this region - the compact radio source Sgr A*, thought to be the radiative manifestation of the supermassive black hole.

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Email: hfalcke@sun184.mpifr-bonn.mpg.de
Eprint: astro-ph/0106162
http://www.mpifr-bonn.mpg.de/staff/hfalcke/publications.html#gcreview

The lives and deaths of star clusters near the Galactic center

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We study the evolution and observability of young, compact star clusters near the Galactic center, such as the Arches and Quintuplet systems. The clusters are modeled by integrating the equations of motion of all stars while accounting for the internal evolution of the stars and binaries and the effect of the tidal field of the Galaxy. We find that clusters within 150 pc of the Galactic center dissolve within $\sim$ 55 Myr, but their projected densities drop below the background density in the direction of the Galactic center within only a few Myr, effectively making these clusters undetectable after that time. Detailed observations of the Arches cluster, when taken at face value, suggest that its mass function is unusually flat and that the cluster contains an overabundance of stars more massive than $20 M_\odot$. Our dynamical analysis, however, shows that the observed characteristics of the Arches cluster are consistent with a perfectly normal initial mass function. The observed anomalies are caused by a combination of observational selection effects and the dynamical evolution of the cluster. We calibrate the current parameters of the Arches cluster using a normal initial mass function and conclude that the cluster is more massive than 40000 $_\odot$ has a half mass radius of about 0.35 pc, and is located between 50 and 90 pc from the Galactic center.

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Email: spz@space.mit.edu
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http://xxx.lanl.gov/abs/astro-ph/0102259

High Spectral and Spatial Resolution Observations of Shocked Molecular Hydrogen at the Galactic Center

F. Yusef-Zadeh, S. R. Stolovy, M. Burton, M. Wardle, and M.C.B. Ashley

The presence of OH (1720 MHz) masers, and the absence of counterparts at 1665/1667 MHz has proved to be a clear diagnostic of shocked molecular gas associated with Galactic supernova remnants. This suggests that shocked molecular gas should be associated with the OH (1720 MHz) masers that have been detected in the circumnuclear disk (CND) and Sgr A East at the Galactic center. In order to test this hypothesis, we observed the H_2 1–0 S(1) and Br γ lines using NICMOS on the HST and UNSWIRF on the AAT, near the regions where OH (1720 MHz) masers are detected in the CND and Sgr A East. We present the distribution of H_2 in the North and South lobes of the CND and in Sgr A East. H_2 emission accompanies almost all of the maser spots detected at the Galactic center. In particular, we find a striking filamentary structure near the Northwest of the CND and evidence that shocked molecular gas is associated with the 70 km s^{-1} molecular cloud at the Galactic center. We argue that the emission from the CND could arise in gas heated by the dissipation of the random motion of clumps by collisions or the dissipation of turbulence in a more homogeneous medium. In addition, highly red-shifted gas of up to 140 km s^{-1} close to the eastern edge of the Sgr A East shell is detected. These observations combined with OH (1720 MHz) results suggest that the H_2 gas is shocked and accelerated by the expansion of Sgr A East into the 50 and the 70 km s^{-1} cloud and into the lobes of the CND.

Ref.: ApJ, in press
Email: zadeh@oort.astro.nwu.edu
Eprint: astro-ph/0106190

The Stellar Winds of Galactic Centre and the Low Accretion Rate of Sgr A*

R.F. Coker

An attempt is made to reconcile the large wind-loss rates of stars in the Galactic Centre (GC) with the predicted low accretion rate for Sgr A*, the putative blackhole at the heart of the Milky Way. It is found that, independent of the details of the accretion, the bound but unaccreted gas has been accumulating in the potential well of Sgr A* for less than 1000 yrs and thus is not in equilibrium. Otherwise, the gas flows of the region would be visible in both the IR and X-ray. It appears that the blackhole was more active in the recent past due to the passing of a supernova blast shock but is presently in a short-lived dormant phase. The extended low frequency radio emission from the central parsec should visibily increase over the next few decades, as the shock passes completely in front of the absorbing gas and dust near Sgr A*. The GC may become more active in less than 10,000 yrs due to either another supernova or sufficient accumulation of stellar winds in the central arcsecond.

Ref.: A&A Letters, in press
Email: robc@ast.leeds.ac.uk
Eprint: astro-ph/0106333

2 micron Narrow-band Adaptive Optics Imaging in the Arches Cluster

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Canada–France–Hawaii-Telescope adaptive optics bonnette images through narrow–band filters in the $K-$band are presented for the Arches cluster. Continuum fluxes, line fluxes, and equivalent widths are derived from high angular resolution images, some near diffraction limited, for the well known massive stars in the Arches cluster. Images were obtained in the lines of HeI 2.06 micron , HI Brγ (2.17 micron), and HeII 2.19 micron as well as continuum positions at 2.03 micron , 2.14 micron , and 2.26 micron . In addition, fluxes are presented for HI Pα (1.87 micron) and a nearby continuum position (1.90 micron) from Hubble Space Telescope archival data. The 2 micron and Pα data reveal two new emission–line stars and three fainter candidate emission–line objects. Indications for a spectral change of one object between earlier observations in 1992/1993 and our data from 1999 are found. The ratio of HeII 2.19 micron to Brγ emission exhibits a narrow distribution among the stars, suggesting a narrow evolutionary spread centered predominantly on spectral types O4 If or Wolf-Rayet stars of the WN7 sub–type. From the approximate spectral types of the identified emission–line stars and comparisons with evolutionary models we infer a cluster age between $\sim$ 2 and 4.5 Myr.

Ref.: AJ, accepted
Email: rblum@noao.edu
Eprint: astro-ph/0106496
ftp://ftp.ctio.noao.edu/pub/blum/arches.ps.gz

X-ray Bursts from the Source A1742-294 in the Galactic-Center Region

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We present results of observations of the X-ray burster A1742-294 near the Galactic center with the ART-P telescope onboard the Granat observatory. The shape of its persistent spectra was well described by the model of bremsstrahlung from optically thin plasma, and it had remained essentially unchanged over $\sim$ 2.5 years of observations. We show that the mean interval between X-ray bursts from the source is several times shorter than assumed previously, and that the burst profile itself depends on the flux during the burst. We analyze in detail the strong X-ray burst detected from this source on October 18, 1990, and trace the evolution of its luminosity and radiation temperature.

Ref.: Astronomy Letters, 2001, v.27, N8
Email: aal@hea.iki.rssi.ru
Eprint: astro-ph/0107014

Large scale ionization of the Radio Arc region by the Quintuplet and the Arches clusters

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We present an analysis of selected fine structure lines (NeII 12.8 mm, NeIII 15.6 mum, SIII 18.7 and 33.5 mum, OIII 52 and 88 mum, NII 122 mum and NIII 57 mum) observed with the *Infrared Space Observatory* (ISO) toward the Radio Arc in the Galactic center region (GCR). Most of the data were retrieved from the ISO Data Archive. We study the density of the ionized gas and the large scale ionization structure in a region of $\sim 30 \times 30$ pc^2 by means of the OIII 52 mum/88 mum, SIII 18.7 mum/33.5 mum, NeIII 15.6 mum/NeII 12.8 mum and NIII 57 mum/NII 122 mum line ratios. The electron densities (n_e) derived from the OIII lines ratio indicate the presence of diffuse ionized material with n_e of $\sim$ $10^{1.8-2.6}$ cm^{-3}. The NeIII 15.6 mum/NeII 12.8 mum and NIII 57 mum/NII 122 mum line ratios vary from source to source from 0.05 to 0.30 and from 0.3 to 2.5, respectively. The NIII 57/NII 122 mum ratio

show two clear gradients, one pointing toward the Quintuplet cluster and the other pointing toward the Arches cluster. We have used a simple model to explain the ionization structure observed in the NIII/NII and NeIII/NeII lines ratios. The model shows that the large scale ionization of the whole region can be accounted for by the UV radiation produced by the Quintuplet and the Arches cluster. Any other ionization mechanism should play a minor role. We also investigate the influence of the clusters on the bubble of warm dust (hereafter Radio Arc Bubble, RAB) seen in the *Midcourse Space Experiment* (MSX) infrared images. We find that the warm dust is well correlated with the ionized gas indicating that the dust is also heated by the radiation from both clusters. Furthermore, the elliptical rather than circular symmetry of some structures like the Thermal Filaments can also be explained when one considers the combined effects of both the Arches and the Quintuplet clusters. We have also found that the RAB is filled with continuum emission of hard X rays and with emission from the 6.4 keV line of neutral or low ionized Fe. We briefly discuss the implications of these findings on the structure and morphology of the GCR interstellar medium and the possible origin of the RAB.

Ref.: A&A, in press
Email: nemesio@oan.es
Eprint: astro-ph/0107156

On the Formation of Degenerate Heavy Neutrino Stars

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The dynamics of a self-gravitating cold Fermi gas is described using the analogy with an interacting self-gravitating Bose condensate having the same Thomas-Fermi limit. The dissipationless formation of a heavy neutrino star through gravitational collapse and ejection of matter is demonstrated numerically. Such neutrino stars offer an alternative to black holes for the supermassive compact dark objects at the centers of galaxies.

Ref.: Phys. Lett. B, in press
Email: lindebaumr@nu.ac.za
Eprint: astro-ph/0106209

Supernova OH (1720 MHz) Masers in Sgr A East, W28 and G359.1-0.5

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A new class of OH (1720 MHz) masers unaccompanied by main-line transitions have recently been discovered (Frail, Goss and Slysh 1994). These masers lie at the interface between supernova remnants (SNRs) interacting with molecular clouds. We discuss three new aspects of SN masers found in the direction toward the Galactic center: (i) the detection of a new - 130 km/s OH (1720 MHz) maser in the southern lobe of the molecular ring at the Galactic center, (ii) the detection of extended OH (1720 MHz) maser emission from W28 accompanying the compact maser sources and (iii) the detection of linear polarization of the brightest OH (1720 MHz) maser in SNR G359.1–0.5.

Ref.: IAU Symp. 206: Cosmic Masers, in press
Email: zadeh@oort.astro.nwu.edu
Eprint: astro-ph/0107109

X-Ray Observations on the Galactic Center Region

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This paper reports on the early Chandra view of the Galactic center (GC) activities. The massive black hole Sgr A* is extremely faint, while more bright diffuse X-ray emission is prevailing in the circumnuclear disk. Another high temperature plasma is found in the Sgr A East shell. This may indicate that Sgr A East is a supernova remnant, although no clear X-ray shell is found. A hint of non-thermal X-ray filaments is found, suggesting the presence of an acceleration site of extremely high-energy cosmic rays. The giant molecular cloud Sgr B2 is established to be an X-ray reflection nebula, possibly arising from the past Sgr A activities. Chandra further discovered high temperature shells, suggesting multiple supernova explosions near the GC region.

Ref.: proc. of New Century of X-ray Astronomy, ASP Conf.
Email: hiro@cr.scphys.kyoto-u.ac.jp
Eprint: astro-ph/0108109

X-ray source population of the Galactic center region obtained with ASCA

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From the *ASCA* X-ray point-source list in the Galactic center 5×5 degree^2 region, we found the clear correlation between the position of the sources and the absorption. This fact implies that the major part of the absorption is due to the cold interstellar matter (ISM) in the line of sight. Using the correlation, we estimate the distribution of the cold ISM. We also found that the ratio of high mass binaries to low mass binaries is significantly smaller than that in the whole Galaxy or SMC, which implies that the past starburst activity in the Galactic center region was rather quiet.

Ref.: proc of "New Century of X-ray Astronomy", 6-8 March 2001, Yokohama, Japan
Email: mas@star.le.ac.uk
Eprint: astro-ph/0107444

http://www-maxi.tksc.nasda.go.jp/

Monte Carlo cluster simulations to determine the rate of compact star inspiraling to a central galactic black hole

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The capture and gradual inspiral of stellar mass objects by a massive black hole at the centre of a galaxy has been proposed as one of the most promising source of gravitational radiation to be detected by LISA. Unfortunately rate estimates for this process suffer from many uncertainties. Here we report on the use of our newly developed Monte Carlo stellar dynamics code to tackle this problem. We present results from simple galactic nuclei models that demonstrate the high potential of our approach and point out the aspects of the problem where an improved treatment seems desirable.

Ref.: 3rd LISA conference, Symposium paper appears in "Classical and Quantum Gravity"
Email: marc.freitag@obs.unige.ch
Eprint: astro-ph/0107193

Announcements

GC02 - GC workshop: The next Galactic Center conference, tentatively titled **GC02: The Central Kiloparsec, is now firmly scheduled for November 4-8, 2002**. The workshop will be held at the Hilton Waikoloa Village on the Big Island of Hawaii.

The science scope of the conference will include objects on the kiloparsec scale and the milliparsec scale, and everything in between. The format will be similar to GC98, with large blocks of time reserved for discussion. Motivated by the intention of creating an environment conducive to the interesting and useful discussions we enjoyed in Tucson, we hope to limit the number of participants to around 80, although the number will not be as strictly adhered to as at the last meeting. We will be providing a sufficient number reminders of all deadlines, however, to insure you have ample opportunity to participate. The mailing list will consist of all subscribers to GCNEWS and the conference is, of course, intended for professional astronomers.

The scientific organinzing committee will be assembled in the coming month, and we will provide you with more detailed program information in the next issue of GCNEWS. We are also in the process of setting up webpages for the workshop, and will let you know via our "Newsflash" service as soon as those are available. There is such an abundance of new and exciting GC results since the last workshop, and indeed in within the last year, that we know the workshop will be very interesting.

The Hilton Waikoloa Village (for details see http://www.hiltonwaikoloavillage.com/) is located approximately seventeen miles north of the Kona airport and is one of the premiere resorts on the island, but we have negotiated a $130 per night room rate. Although the meeting facilities are excellent, the resort is strongly geared towards family vacations. In addition, we anticipate planning several spouse/partner activities during the week, so spouses/partners are encouraged to attend (thereby getting the rest of us out of hot water for spending a week in Hawaii). The resort also caters to children, with several day long activities available (at an extra cost of course).

So, mark your calendars for the next Galactic Center Workshop, November 4-8, 2002 in Hawaii!

And finally ... We keep getting questions which are difficult to answer for the experience GCNEWS team. We, of course, know about a mouse and a pelican in the Galactic Center. There are pistols and even bullets flying around, but does anyone know anything about fish (dead or alive)? Apparently there is some money in this business. Delivery times might be a bit of a problem though ...

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Date: XYZ, 25 XYZ 2001 05:12:30
To: gcnews@mpifr-bonn.mpg.de
Subject: ENQUIRY FOR FISH PRODUCTS

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 FAX NO 002478652
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