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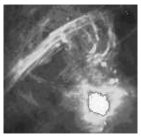

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Modelling of the gas around Sgr A*

A slice, ~0.2 pc on a side, of the gas density for a 3D hydrodynamical simulation of the Galactic Center using distributed stellar wind sources (see Coker & Melia, p.6, this issue). The accretor is marked with a filled white circle; the number density ranges from $\lesssim 50$ cm^{-3} to $\gtrsim 5 \times 10^4$ cm^{-3}.

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Editorial: Galactic Center Claims Top Spot:

Sgr A* beats out NGC 4258 as best black hole candidate (Heino Falcke & Angela Cotera)

The following summary of the exciting Sgr A* results presented at IAU Symposium 184 was the front page story of the "Sidereal Times" (No. 8, Tue., 26 August 1997)—the daily newspaper accompanying the XXIIIrd General Assembly in Kyoto, Japan. We wrote the article when we realized the primary players in this exciting game had already left the conference, and were therefore unable to use this unique forum to emphasize to the importance of Galactic Center research within the larger astronomical community. Of course, we also used it to further advertise GCNEWS! Since most of our readers had already left when the article appeared (or were unable to get to Kyoto) we are reprinting it here (a copy of the original article can be found on our web page):

Sgr A* beats out NGC 4258 as best black hole candidate

("Sidereal Times", No. 8., Tue., 26 Aug. 1997)

Among the highlights from Symposium 184, "The Center of the Galaxy and Galaxies", were the presentations of stellar proper motions within the central parsec of the Galaxy, probing the gravitational potential of the Galactic Center down to a few milliparsecs. Andreas Eckart and Reinhard Genzel from the MPE in Garching, presented the results of several years of high resolution NIR speckle imaging of the central star cluster, measuring stellar velocities of several hundred km s^{-1} up to $\sim$2000 km s^{-1}, peaking near Sgr A*. Together with radial velocity dispersions derived from NIR spectroscopy, the German team has determined that there must be a dark point mass of $2.61 \pm 0.2 \times 10^6$ $M_\odot$ at the position of Sgr A*. These results were confirmed by the UCLA group, Andrea Ghez, Mark Morris, and Eric Becklin, using the superior resolution of the Keck telescope. With 50 milli-arcsec resolution, over the past three years using slightly different techniques, they also find that a central dark mass of $2.7 \pm 0.2 \times 10^6$ $M_\odot$ is necessary. From these measurements, Eyal Maoz infers that any possible alternative to a black hole, such as a cluster of stellar remnants, gives a lifetime to core collapse which is unreasonably short. Since the estimated mass of Sgr A* is smaller than the present leading black hole candidate in NGC 4258, the inferred cluster lifetime would have to be even less than for NGC 4258, making Sgr A* now the best candidate for a supermassive black hole in the known universe.

The newly determined mass estimates suggest that with future (sub)mm-VLBI techniques, we may in principle even be able to obtain a direct picture of the black hole by imaging it against the radio background of Sgr A*. The existence of such a compact component at millimeter to submm-wavelengths was inferred by the results of a recent campaign to measure the spectrum of Sgr A* simultaneously on three continents, including (here in Japan) at the Nobeyama 45m telescope (Falcke, Matsuo, Zylka, et al.).

The quality of the data obtained at the Keck in only three years, highlights the possibilities for the advancement of science with the latest generation of large ground based telescopes, and may be one of the most significant results of the Keck telescope to date. The work of Eckart and Genzel illustrates, however, that with improved techniques, smaller telescopes can still lead the way when the determination of the scientist and the cooperation of operating institution (in this case ESO) function together. *(A short reference to, and an explanation of GCNEWS followed)*

JD12: Electronic Publishing

Besides the IAU symposium we were also concerned with a Joint Discussion on electronic publishing, where GCNEWS was presented as a poster. Peter Boyce presented the efforts of ApJ to become fully electronic. The determination he and his colleagues have shown in pushing ApJ and the AAS in this direction are quite impressive, leaving the Europeans in the audience wondering what was going to happen with A&A (especially given the fact that the only A&A representative present had never used electronic preprint servers or anything similar). During the discussion, Peter Boyce acknowledged the contributions electronic newsletters are now making to the distribution of scientific information—reviving, in an electronic form, aspects of the pre-journal era when results were sent by personal letters from scientist to scientist. On the other hand, the A&A representative argued that those newsletters could lead to an incestuous situation, where insiders only talk to insiders. However, since all the recently developed newsletters are publically available, usually over the Internet, are carried by a number of libraries, and primarily report on papers to be published in well established journals, we considered this to be unfounded criticism. Of course, this was only a minor point of the overall discussion which led to the conclusion that electronic publishing is a tidal wave, which cannot be stopped—either you are going to adapt or you will perish. At the moment, we have no intention to perish! We are in fact quite happy to report, that for the first time an ApJ Letter (Vol. 489, L47, Markoff et al., see p. 6) features GCNEWS in its reference list since the necessary information was nowhere else to be found!

GC Workshop 1998?!

One way to keep GC research hot and boiling are the meetings and conferences, which are needed to keep pace with the rapid developments within the field. After a number of bigger conferences, we think it is now time for reflection and discussion in a smaller workshop setting, which we (in conjunction with others) are in the process of organizing for next year (September 7-11, 1998) in Tucson. Funding is still very preliminary at the moment, so we only ask you to keep an eye open for further developments (e.g. by looking at the announcements in this and the future issues of GCNEWS).

This issue

This issue of GCNEWS obviously has a focus on the recent IAU Symposium, with this editorial and a summary of other results of this conference in the following summary article. In fact, some of those results which will be published in regular papers are presented in our big abstract section already, such as the theory results by the Arizona theory group (Coker & Melia) which are also shown on our cover image. We hope you enjoy this issue as much as you have previous issues, and we thank you for the positive feedback we have received.

Highlights of the IAU Symposium 184

Angela Cotera & Heino Falcke

The recently concluded IAU Symposium 184, "The Central Regions of the Galaxy and Galaxies" held in Kyoto, Japan, was as breathtaking in the the range of topics covered as it was in the location. Therefore, we will not attempt to cover, in a cursory review such as this, all the talks at the conference but will highlight those we found to be most interesting (we apologize ahead of time to any of our subscribers who may feel slighted, and wholeheartedly admit to extreme personal bias in this report). In particular, we are going to concentrate on the results for the inner ~500 pc of the Galaxy.

Sgr A*

With that said, certainly the most exciting results were those which have significantly reduced the possibilities that Sgr A* is anything but a black hole. The observational results by Eckart & Genzel, Ghez et al., and the theoretical discussion by Maoz have already been highlighted in the Editorial. There was, however, much more presented about Sgr A* than this. The theory crowd presented their—as usual—differing views. Of course, the ADAF (Advection Dominated Accretion Flow) proponent, represented by Ramesh Narayan, presented their results, once again drawing lively reactions from the few theorists present. An important advantage of the ADAF solution is that it explains what we do not see (e.g. the lack of NIR emission). However, this is also achieved by the Bondi-Hoyle accretion scenario presented by Fulvio Melia, and for which Robert Coker presented new 3D hydrodynamical calculations showing the important effect of distributed wind sources (in contrast to the earlier homogeneous models). The expected accretion rate onto Sgr A* can now be much higher than in the idealized solutions, and inhomogeneous density clumps (or pancakes) can form in the ISM. Melia (with Sera Markoff) also discussed the possibility of Gamma-emission from this accretion process and (to his honest surprise) could not rule out that Sgr A* is indeed responsible for the EGRET source at the GC (see article by Mattox, GCNEWS, Vol. 4)—this is also predicted in the ADAF model.

Wolfgang Duschl discussed the radio spectrum of Sgr A*, presenting a two-component fit of his "monoenergetic electron model" to the spectrum, and pointed out that the Narayan model falls short of the data by a factor of 10 at lower radio frequencies. Heino Falcke, however, was quick to point out that the recent, simultaneous radio spectrum taken of Sgr A* required at least a three component fit (which will vary with time). He suggested that, if you keep adding components, a stratified medium, such as in a jet, would eventually be a simpler explanation. Unfortunately, interstellar broadening hides the intrinsic structure of Sgr A* as was shown by K.Y. Lo, who presented multi-wavelength VLBA observations of Sgr A* which showed the (in)famous λ^2-law and little else. Finally, Mark Reid reported on his attempts to measure the trigonometric parallax to Sgr A* with the VLBA in order to measure the distance to the GC. While the motion of the sun around the GC is easily visible in his maps, the motion of the earth around the sun was not yet seen in the available maps (giving at least a lower limit to the distance), but with some further improvement in the observational technique a reliable distance estimate for the most important dimension of the Galaxy (from *our* point of view of course) may be within reach.

Elsewhere in the Galactic Center...

Taking the rest of the talks roughly in the order in which they were presented, we start by mentioning the ongoing research by Kris Sellgren on high resolution, R~40,000, spectra of the M giant IRS7, which seems to show that the metallicity of the star, as derived from the iron lines, is approximately solar. Solange Ramírez also presented high resolution spectra of other GC stars and found an enhancement of Mg, Si, Gs, and Ti relative to iron, but also found the iron abundance to be solar in IRS7, IRS11 and IRS12. Why the iron abundances should be solar in a region which has been suggested to have an enhanced supernova rate is quite puzzling, and we look forward to the final results from this data. That there has been a large number of supernovae in the region was suggested by both Tsuboi and Hasegawa (see below) in their presentations of molecular cloud observations made with the Nobeyama 45-m telescope. In that context the morphology of Sgr A East becomes also of interest, since it resembles a supernova-like bubble who's nature and interaction with the molecular gas in the GC was discussed by Kevin Uchida. He found that the cluster of H II regions found just east of Sgr A East was in an apparent valley of molecular gas.

The formation of stars and the stellar population were addressed by a number of speakers. Gene Serabyn suggested the apparent dichotomy of an aging stellar bulge and the known hot young stars in the central regions was not in fact contradictory. He argued that our Galaxy's center $1/r^2$ cluster is an intermediate age population resulting from long-term star formation and not simply the innermost part of the bulge. Dieter Lutz, however, presented ISO data which he suggested would look more like a starburst region if the beam where larger, such as would be the case in external galaxies. Tetsuya Nagata presented ISO results on the Quintuplet and Arches clusters which showed, in addition to [Ar II] 6.99 μm from the Pistol itself, CO (4.3 μm and 4.7 μm) absorption from the stellar clusters. Don Figer presented data on OB and WR stars in the Quintuplet Cluster, in addition to data on the LBV candidate, in a talk which wins our "most information presented in the time allotted" award. He suggested that the material which forms the Pistol is the result of a previous episode of mass loss from the LBV candidate, the Pistol Star (subject of a recent HST press release).

Studying the CS $J = 1 \rightarrow 0$ transition with the Nobeyama 45-m telescope, Masato Tsuboi identified dozens of shell-like structures which he had identified within the central molecular zone. Tetsuo Hasegawa found, with ^{12}CO and ^{13}CO images, over two hundred shell– or arc–like structures in the same region. Although the exact source of these structures was not identified, the possibility of their being formed by supernovae or being wind swept bubbles around massive stars was discussed. Yoshiaki Sofue presented observations in the continuum and CO-line emissions and derived the total central mass using a newly determine conversion factor from the CO line intensity to the H_2 molecular mass. He found the mass to be lower, by a factor of three, than previous results. He also suggested that within a well defined molecular ring at 120 pc, the star formation efficiency is low. Not always, however, do you need to justify observation of molecular clouds with your desire to understand stars and star formation, sometimes stars are just a useful foreground screen to learn more about the position and structure of molecular clouds. This was done by Robert Zylka who used star counts along various line of sights in his NIR images to place GC clouds in the third dimension.

In the MIR, Eric Becklin presented 12.5 μm Keck observations of the central parsec. Although they see the MIR source identified by Stolovy *et al.* (1996, ApJL, 470, 45), their astrometry places Sgr A* southeast of this source (this was consistent with the recent results of Cotera in 8.7 μm images taken from the Hale 200-inch telescope). Dan Gezari presented data on the central parsecs at several wavelengths and suggested that there is considerable variation in the positions of the MIR sources, which he attributed (in his characteristic tender way) to wrong scaling and rotation in other MIR observers images.

Finally, more is being carried out and has been presented on the non-thermal filaments in the GC. While Cornelia Lang & Mark Morris showed some very detailed VLA studies of isolated non-thermal filaments, Johannes Staguhn presented the results of a combined effort to study some new regions where magnetic field lines might interact with molecular clouds in a scenario very similar to the Qunituplet/Pistol/Sickle complex—a field which has developed quite rapidly in recent years.

Abstracts

Synchrotron radiation from quasi-monoenergetic electrons: Modelling the spectrum of Sgr A*

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We investigate the spectrum of a quasi-monoenergetic ensemble of relativistic electrons, especially for the mildly relativistic case, and discuss the effect of inclination of the magnetic field on the emissivity. We apply the exact theoretical description to the spectrum of the radio source Sgr A* which is located at or very close to the dynamical center of our Galaxy. We find that the radio-MIR spectrum can be reproduced well, but that the resulting self-comptonized X-ray flux is much smaller than the observed one.

A&A, in press
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Polarized Far-infrared Emission from the Core and Envelope of the Sagittarius B2 Molecular Cloud

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We have detected linear polarization in the 115 micron continuum radiation from the giant molecular cloud Sagittarius B2. We found polarization at nine positions in the dense cloud core, and at fifteen positions in the less-dense envelope. The polarization mechanism in the core is polarization due to absorption by magnetically aligned grains, and that in the envelope is polarized emission from magnetically aligned grains. The inferred magnetic field direction is roughly North-South everywhere, but with spatially smooth variations of up to 30 degrees. By considering our data together with Zeeman splitting observations we are able to set a conservative lower limit of 150 microGauss on the strength of the large-scale field in the envelope. If large-scale fields this strong are common in Galactic Center clouds, they could be detectable via large-beam Zeeman measurements. For positions in the envelope that are furthest from the core, the field is nearly parallel to the plane of the Galaxy. This is consistent with the idea of a globally azimuthal magnetic field in the Galactic Center neutral gas layer, which is expected if gravitational forces dominate magnetic forces.

ApJ, in press
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Hydrodynamical Accretion Onto Sgr A* From Distributed Point Sources

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Spectral and kinematic studies suggest that the nonthermal radio source Sgr A*, located at the center of the Milky Way, is a supermassive compact object with a mass $\sim 2-3\times10^6 M_\odot$. Winds from nearby stars, located ~ 0.06 pc to the east of Sgr A*, should, in the absence of any outflow from the putative black hole itself, be accreting onto this object. We report the results of the first 3D Bondi-Hoyle hydrodynamical numerical simulations of this process under the assumption that the Galactic center wind is generated by several different point sources (here assumed to be 10 pseudo-randomly placed stars). Our results show that the accretion rate onto the central object can be higher than in the case of a uniform flow since wind-wind shocks dissipate some of the bulk kinetic energy and lead to a higher capture rate for the gas. However, even for this highly non-uniform medium, most of the accreting gas carries with it a relatively low level of specific angular momentum, though large transient fluctuations can occur. Additionally, the post-bow-shock focusing of the gas can be substantially different than that for a uniform flow, but it depends strongly on the stellar spatial distribution. We discuss how this affects the morphology of the gas in the inner 0.15 pc of the Galaxy and the consequences for accretion disk models of Sgr A*.

ApJL, in press
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On The Nature Of The EGRET Source At The Galactic Center

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The recent detection of a γ-ray flux from the direction of the Galactic center by EGRET on the Compton GRO raises the question of whether this is a point source (possibly coincident with the massive black hole candidate Sgr A*) or a diffuse emitter. Using the latest experimental particle physics data and theoretical models, we examine in detail the γ-ray spectrum produced by synchrotron, inverse Compton scattering and mesonic decay resulting from the interaction of relativistic protons with

hydrogen accreting onto a point-like object. Such a distribution of high-energy baryons may be expected to form within an accretion shock as the inflowing gas becomes supersonic. This scenario is motivated by hydrodynamic studies of Bondi-Hoyle accretion onto Sgr A*, which indicate that many of its radiative characteristics may ultimately be associated with energy liberated as this plasma descends down into the deep potential well. Earlier attempts at analyzing this process concluded that the EGRET data are inconsistent with a massive point-like object. Here, we demonstrate that a more careful treatment of the physics of p-p scattering suggests that a $\sim 10^6\ M_\odot$ black hole may be contributing to this high-energy emission.

ApJL, in press
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The circumnuclear material in the Galactic Centre: A clue to the accretion process

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On the basis of "sticky particle" calculations, it is argued that the gas features observed within 10 pc of the Galactic Centre– the circumnuclear disk (CND) and the ionized gas filaments– as well as the newly formed stars in the inner one parsec can be understood in terms of tidal capture and disruption of gas clouds on low angular momentum orbits in a potential containing a point mass. The calculations demonstrate that a dissipative component forms a "dispersion ring", an asymmetric elliptical torus precessing counter to the direction of rotation, and that this shape can be maintained for many orbital periods. For a range of plausible initial conditions, such a sturcture can explain the morphology and kinematics of the CND and of the most conspicuous ionized filament. While forming the dispersion ring, a small cloud with low specific angular momentum is drawn into a long filament which repeatedly collides with itself at high velocity. The compression in strong shocks is likely to lead to star formation even in the near tidal field of the point mass. This process may have general relevance to accretion onto massive black holes in normal and active galactic nuclei.

MNRAS, in press
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Spectrum of Optically Thin, Advection-Dominated Accretion Flow around a Black Hole: Application to Sagittarius A*

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The global structure of optically thin advection dominated accretion flows which are composed of two-temperature plasma around black holes is calculated. We adopt the full set of basic equations including the advective energy transport in the energy equation for the electrons. The spectra emitted by the optically thin accretion flows are also investigated. The radiation mechanisms which are taken into accout are bremsstrahlung, synchrotron emission, and Comptonization. The calculation of the spectra and that of the structure of the accretion flows are made to be completely consistent by calculating the radiative cooling rate at each radius. As a result of the advection domination for the ions, the heat transport from the ions to the electrons becomes practically zero and the radiative cooling balances with the advective *heating* in the energy equation of the electrons. Following up on the successful work of Narayan et al. (1995), we applied our model to the spectrum of Sgr A*. We find that the spectrum of Sgr A* is explained by the optically thin advection dominated accretion flow around a black hole of the mass $M_{BH} = 10^6 M_\odot$. The parameter dependence of the spectrum and the structure of the accretion flows is also discussed.

ApJ, in press
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Evidence for GeV emission from the Galactic Center Fountain

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The region near the Galactic center may have experienced recurrent episodes of injection of energy in excess of $\sim 10^{55}$ ergs due to repeated starbursts involving more than $\sim 10^{4}$ supernovae. This hypothesis can be tested by measurements of γ-ray lines produced by the decay of radioactive isotopes and positron annihilation, or by searches for pulsars produced during starbursts. Recent OSSE observations of 511 keV emiss extending above the Galactic center led to the suggestion of a starburst driven fountain from the Galactic center. We present EGRET observations that might support this picture.

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Quantitative Spectroscopy of the He I Cluster in the Galactic Center

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We present results on quantitative infrared spectroscopy of the brightest He I emission line stars in the Galactic center. The observed He I and H broad emission lines are caused by extremely strong stellar winds ($M_\odot \sim 5$ to 80×10^{-5} $M_\odot$ yr^{-1}) with relatively small outflow velocities ($v_\infty \sim 300$ to 1000 km s^{-1}). The effective temperatures of the objects range from 17,000 K to 30,000 K with corresponding stellar luminosities of 1 to $30\times10^{5} L_\odot$. Strongly enhanced helium abundances ($N_{He}/N_H > 0.5$) are found. These results indicate that the He I emission line stars are evolved blue supergiants close to the evolutionary stage of Wolf-Rayet stars. They power the central parsec and belong to a young stellar cluster of massive stars which formed a few million years ago.

A&A, in press
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The IBIS view of the galactic centre: INTEGRAL's imager observations simulations

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The Imager on Board Integral Satellite (IBIS) is the imaging instrument of the INTEGRAL satellite, the hard-X/soft-gamma ray ESA mission to be launched in 2001. It provides diagnostic capabilities of fine imaging (12' FWHM), source identification and spectral sensitivity to both continuum and broad lines over a broad (15 keV–10 MeV) energy range. It has a continuum sensitivity of $2\ 10^{-7}$ ph cm^{-2} s^{-1} at 1 MeV for a 10^{6} seconds observation and a spectral resolution better than 7 % at 100 keV and of 6 % at 1 MeV. The imaging capabilities of the IBIS are characterized by the coupling of the above quoted source discrimination capability with a very wide field of view (FOV), namely $9^\circ \times 9^\circ$ fully coded, $29^\circ \times 29^\circ$ partially coded FOV. We present simulations of IBIS observations of the Galactic Center based on the results of the SIGMA Galactic Center survey. They show the capabilities of this instrument in discriminating between different sources while at the same time monitoring a huge FOV. It will be possible to simultaneously take spectra of all of these sources over the FOV even if the sensitivity decreases out of the fully coded area. It is envisaged that a proper exploitation of both the FOV dimension and the source localization capability of the IBIS will be a key factor in maximizing its scientific output.

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Nuclear Rotation Curves of Galaxies in the CO Line Emission

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We have obtained high-resolution position-velocity (PV) diagrams along the major axes of the central regions of nearby galaxies in the CO-line emission using the Nobeyama 45-m telescope and the Millimeter Array. Nuclear rotation curves for 14 galaxies have been derived based on the PV diagrams using the envelope-tracing method. The nuclear rotation curves for most of the galaxies show a steep rise within a few hundred pc, which indicates a high-density concentration of mass.

AJ, in press
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Interpreting the HCN/CO Intensity Ratio in the Galactic Center

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We studied the dense molecular gas in the Galactic center using maps of HCN and CO $J=1\to 0$ emission from the central 630 pc of the Milky Way, and images of HCN $J=3\to 2$ emission, which requires high densities for excitation ($n_{H_2} \gtrsim 10^6$ cm^{-3}), from Sgr A and Sgr B. The ratio of integrated HCN and CO $J=1\to 0$ intensities is a sensitive measure of molecular gas pressure, and the ratio of integrated HCN $J=3\to 2$ and J$=1\to 0$ intensities uncovers density enhancements in the maps. However, the HCN/CO ratio is difficult to model without knowing the relative HCN and CO abundances. Further, because of the different filling factors of HCN and CO emission, models that use homogeneous clouds may not be accurate for analyzing the HCN/CO ratio. Most of the mass traced by HCN and CO in the Galactic center is at high densities ($n_{H_2} \sim 10^4$ cm^{-3}), roughly an order of magnitude higher than cloud densities in the Galactic disk. Most of the dense gas traced by HCN $J=3\to 2$ emission is coincident with star forming regions and cloud interaction zones, and not necessarily emission peaks. We smoothed the HCN and CO maps to the typical spatial resolution of extragalactic observations, and repeated the analysis. The single large-scale measurement was sensitive to the mass-weighted average properties of the map. Therefore, if we can extrapolate this result to other spirals, studies such as this are sensitive to the *average* gas properties in galactic nuclei, despite poor spatial resolution.

ApJ, in press
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Infrared Identification of SiO Maser Sources toward the Sgr B2 Molecular Cloud

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J, H, and K imaging observations have been made in order to identify infrared counterparts for 6 new SiO maser sources toward the Sgr B2 molecular cloud. Only two of these 6 new sources were previously identified with known objects in other catalogues: one with an OH/IR object, another with an IRAS point source. With the imaging observations, we find infrared counterparts for four of the objects: #1, #2, #4, and #7. These are late-type stars either nearby or near to the galactic center. The remaining two sources of which we could not find counterparts can be candidates of young stellar objects with SiO masers. However, it is highly possible that these two are late-type stars

located behind the galactic-center molecular cloud, suffering from very high dust extinction.

PASJ, in press
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VLA Observations of the Sagittarius D Star-Forming Region

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We have carried out a program of VLA observations of the Sgr D (G1.13–0.10) star-forming region in order to gain a better understanding of this source. Continuum observations at 6 and 18 cm show a region which is dominated by a single compact source. This source is embedded in a halo of ionized gas and there are several compact continuum sources scattered about the field. The supernova remnant G1.05–0.15 is located $5'$ south of the main H II region. From the continuum observations we determined the physical conditions of the thermal sources in Sgr D. Observations of the 6 cm transition of H_2CO which appears in absorption were also carried out to study the distribution and kinematics of molecular material in this region. These data indicate that the distribution of molecular material is clumpy, with apparent optical depths varying by about one order of magnitude within single clouds. In addition, the line widths of the molecular clouds associated with the Sgr D H II region (G1.13–0.10) are $\sim$3 km s^{-1}, which is more typical of Galactic disk than Galactic center sources. The narrow molecular lines and the presence of higher velocity, broader H_2CO absorption lines in the Sgr D spectrum indicate that this region is probably located on the far side of the Galactic center region. OH and H_2O maser observations indicate that there may be at least three sites of very recent star formation in this region.

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Anomalous Motion of Ionized Gas in the Sickle (G0.18–0.04) Near the Galactic Center

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We present VLA measurements of H92α radio recombination line emission from an unusual HII region G0.18–0.04, the "Sickle", with spatial and spectral resolutions of 27.8 arcsec $\times$ 24.9 arcsec and 14 km/s, respectively. These observations detected two new kinematic components of ionized gas whose velocities differ greatly from the +25 km/s molecular cloud surrounding the Sickle. One component is highly red-shifted with peak velocity of about +150 km/s and the other is a blue-shifted velocity feature peaking near −35 km/s. Neither of these high-velocity features have molecular counterparts. The blue-shifted feature is forbidden in the sense of Galactic rotation and coincides with the prominent nonthermal filaments crossing the Sickle, thus suggesting that they are physically associated with each other. The results presented here are interpreted in terms of ionized gas being accelerated away from the surface of the cloud associated with the Sickle region, either by the magnetic field associated with the nonthermal filaments or by the stellar winds from the hot helium stars near G0.18–0.04.

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The hard X-ray source GRS 1734–292: a Seyfert 1 galaxy behind the Galactic Center

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The radio, infrared and optical counterparts of the hard X-ray source GRS 1734−292 (l^{II}=358.9°, b^{II}=+1.4°) are reported. The optical spectrum exhibits broad (> 1000 km s^{-1}) Hα emission at a redshift of 0.0214 ± 0.0005. The radio counterpart is a double-sided synchrotron jet of 5 arcsec, which at a distance of 87 Mpc corresponds to a size of 2 kpc. The multiwavelength observations of GRS 1734−292 indicate that this X-ray source is a Seyfert 1 galaxy behind 6 ± 1 magnitudes of visual absorption.

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The Stellar Content Near the Galactic Center

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High angular resolution J, H, K, and L' images are used to investigate the stellar content within 6 arcsec of SgrA*. The data, which are complete to $K \sim 16$, are the deepest multicolor observations of this region published to date. The mean locus of the $(K, H-K)$ CMD varies across the field, a result that is attributed to differential reddening with amplitude $\Delta A_V \sim 15$ mag. The reddening variations within 3 arcsec of SgrA* are significantly smaller than this, and the resolved members of the compact star cluster immediately surrounding SgrA* have photometric properties that are not significantly different from objects at larger radii. We find that sources in our field with published 2μm spectra showing either line emission or CO absorption occupy different sequences on the $(K, J-K)$ CMD. The emission line stars, which fall along the most richly populated sequence, have redder $J-K$ colors than stars in the Magellanic Clouds with similar spectroscopic characteristics, and evidence is presented that this is due to excess infrared emission in the spectrum of the GC sources. The photometric properties of the giant branch, which is defined by stars showing CO absorption, are similar to those of the giant branch in Baade's Window (BW). The mean $J-K$ color and peak K brightness of the red giant branch are both consistent with a metal-rich population having an age ~ 10 Gyr, while the width of the giant branch on the $(K, J-K)$ CMD is indicative of an age spread $\Delta log(t) \leq 1$ dex. Therefore, if the inner bulge contains an underlying population of stars with ages in excess of ~ 10 Gyr, as is the case in BW, then the region within a few arcsec of SgrA* cannot contain a large population of giant branch stars younger than 1 Gyr. We also report the detection of a modest population of faint, blue sources with $K \geq 14$. We speculate that these are bright main sequence stars at the distance of the GC, although spectra will be required to confirm this interpretation. Nevertheless, the photometric properties of the largely unresolved compact knot of stars immediately surrounding SgrA* provide indirect evidence to support the presence of a large population of faint blue stars. In particular, we confirm previous studies that measure a relatively blue color for this cluster.

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High Frequency Measurements of the Spectrum of Sgr A*

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We report near-simultaneous interferometric measurements of the spectrum of Sgr A* over the 5 to 354 GHz range, and single-dish observations which have yielded the first detection of Sgr A* at 850 GHz. We confirm that Sgr A*'s spectrum rises more steeply at short mm wavelengths than at cm wavelengths, leading to a near-millimeter/submillimeter excess which dominates

its luminosity. Below 900 GHz, Sgr A*'s observed luminosity is 70 +/- 30 $L_\odot$. A new upper limit to Sgr A*'s 24.3 μm flux, together with a compilation of other extant IR data, imply a FIR spectral turnover, which can result either from an intrinsic synchrotron cutoff, or excess extinction near Sgr A*. If the former applies, Sgr A*'s total synchrotron luminosity is $< 10^3$ $L_\odot$, while in the latter case it is $< 3 \times 10^4$ $L_\odot$ if spherical symmetry also applies.

AJ, in press

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http://www.journals.uchicago.edu/ApJ/journal/articles/ApJL/v490n1/975502/sc0.html

Announcements

- A **conference on Galactic Center research** is currently in the planning stages. The workshop will be held in Tucson, September 7-11, 1998, at the Sheraton El Conquistador Resort. The tentative title will be "The Central X Parsecs of the Galaxy", where X will be determined such that N, the number of participants, is smaller than 60.
- If you would like to **volunteer** to write an article for any of the upcoming GCNEWS newsletter, please let us know. We are always on the look out for interesting, timely research being done in the Galactic Center.
- We have not, to date, received **abstracts for Ph.D. Theses**. We hope recent graduates will utilize this forum to share their Ph.D. work. Up to one page per abstract and a small figure can be accommodated.
- When sending out our Newsflashes, we often encounter **email answering machines**, providing us with a detailed insight of our readers travel plans and other events and we just assume, since submitted to GCNEWS, they might be of interest to a wider audience. Here are two examples:

1) *Because of the birth of "Toine van Langevelde" on 16/9 I won't be reading/answering e-mail for a while. I am happy to inform you that "GCFLASH - Vol. 6, No. 7 (Sep 17, 1997)" has been moved to a lower priority! (Huib Jan van Langevelde)*

Well, we will accept this move to a lower priority as an exception from the rule in this case – congratulations, anyway!

2) *Your mail regarding "GCFLASH - Vol. 6, No. 9 (Oct 8, 1997)" will be read when I return. ... If you really need to speak with me (for example, to offer me a tenure-track position), you can call me in Cambridge at The Inn at Harvard Square, ...*

Unfortunately we cannot make any such offer, but we will follow carefully whether this unconventional solicitation of job offers is effective, and if so report immediately to our non-tenured readers.

GCNEWS is brought to you by

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