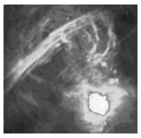
GCNEWS

The Newsletter of Galactic Center Research

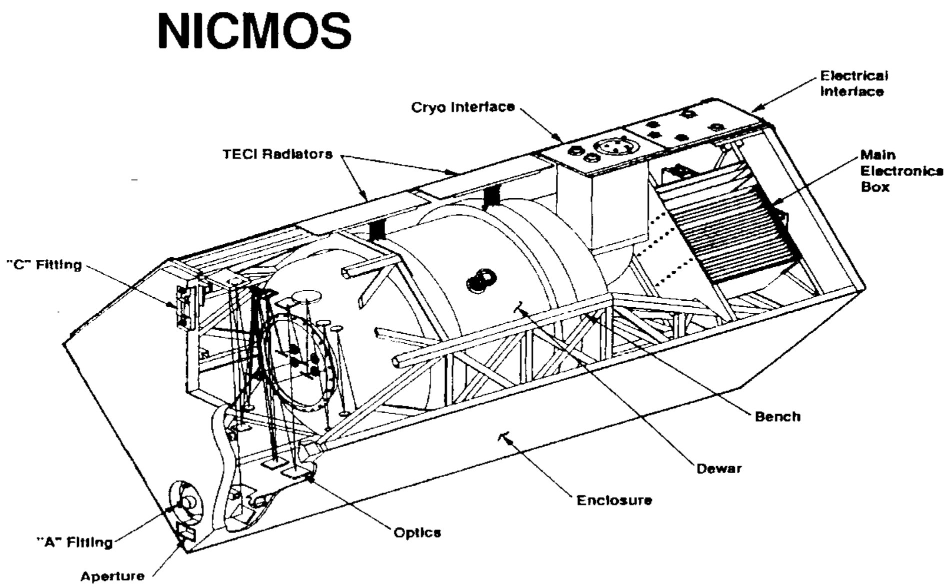
Vol.1 **May 1996**



email: gcnews@astro.umd.edu **http://www.astro.umd.edu/~gcnews/**

Exploring the Galactic Center with the Hubble Space Telescope

(see inside for a quick overview of planned guaranteed time observations)



Schematic of the NICMOS instrument to be installed during the next HST servicing mission scheduled for February 1997. NICMOS will make the heavily obscured Galactic Center accessible from the HST.

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Editorial

Angela Cotera & Heino Falcke

GCNEWS

GCNEWS was begun on March 15, 1996 during lunch at the recent ESO/CTIO Galactic Center workshop. The amount of new information presented at the conference made us realize that we needed a better way to keep up with the numerous relavent papers produced each year. Therefore we decided to take on the task of gathering together the requisite information and producing a bimonthly newsletter, the first of which you are now reading. The newsletter contains abstracts from recently submitted or accepted papers, announcements and one short invited article. This time Marcia Rieke gives a quick overview on the planned observations of the GC with HST/NICMOS, and for the next issue Miller Goss has agreed to write an updated summary of the history of Sgr A and its discovery. Suggestions for further issues are of course welcome.

Our first call for subscribers and abstracts was sent out last month to the approximately 100 participants of the Galactic Center workshop and has lead to over 80 subscriptions of GC researchers from a vast variety of subdisciplines (and as you can see from the table of contents, those 80 people have a lot to tell). We believe that the GC community is unique and fascinating because it combines nearly every discipline in astronomy — with the possible exception of traditional optical astronomy.

We hope that with the distribution of this first issue we will begin to enhance cross discipline communication and we encourage everyone interested in the GC to subscribe and submit abstracts (see below). We especially hope that our suscribers will print out an extra copy for placement in the libraries at their institutions thereby making it available to a larger readership. The electronic PostScript version of the Newsletter is free of charge; hardcopies are also available, but require a small fee for postage and copying.

WEB Access

From the outset we realized that, in addition to the newsletter, we should use the new opportunities available through the worldwide web. We therefore haved created a single web site which links many of abstracts contained in this newsletter to the full paper; many of you have already visited that web site. The web site is updated frequently, and therefore provides an even shorter time lag between completion of a paper and general circulation than the newsletter! Although we do not have room at the web site to store papers, if you are unfamiliar with services such as the E-Print Server, we will be happy to help you make your paper available over the net. The web site also provides an easy way for new suscribers to be added to the list of suscribers and for you to submit abstracts of recent work. A list of current subscribers and their email addresses is also available and of course you can download the recent and previous Newsletters. An HTML version of the Newsletter is also available for easy browsing (the pages look best if you use Netscape).

Finally, recognizing that not everyone wants to periodically check a web page, or wait for two months for the next newsletter, we also provide a weekly "Newsflash" service. Once or twice a week, all abstracts received that week are gathered and sent out as an email message to all suscribers who request the service.

Subscription and Submission

There are several ways to subscribe which are presented at the web site. For those without access to the web, simply send us an empty email message with the Subject keyword "subscribe", e.g.

mail gcnews@astro.umd.edu
Subject: subscribe
.

A subscription form will be sent to you automatically. Fill out the form and return it to become a part of our service.

To submit an abstract, the easiest way for you is to simply mail us the text of your paper (TeX/Latex, any style). We would actually prefer to receive the whole paper rather than only the abstract — we are using a script that extracts the abstract almost automatically. You can help us a little bit by mailing us your abstract with the following Subject line:

Subject: submit filename *reference*
for example
Subject: submit sgrapaper.tex *ApJ, in press*

If you have an E-Print server number for your paper (astro-ph/#######) or a web-link, please include this information in the first lines of your submission. For more information about submitting a paper, please visit the web site.

We are very pleased at the response to the start of this newsletter service, and would like to thank the people who helped us test our procedures and offered encouragement during this initial stage. Special thanks to Marcia Rieke, Farhad Yusef-Zadeh (and his secretary), Miller Goss, Mike Werner, and Leo Blitz and Marvin Leventhal from the Astronomy Department of the University of Maryland. Full steam ahead!

NICMOS Views the Galactic Center

Marcia Rieke

The NICMOS (Near-Infrared Camera and Multi-Object Spectrometer) instrument (see coverpage) will be inserted into the Hubble Space Telescope next February. It has three cameras with plate scales of 0.045″/pixel, 0.75″/pixel, and 0.2″/pixel. The cameras may be operated simultaneously, and are equipped with a selection of filters, polarizers, and 3 slitless grisms for low resolution spectroscopy. Especially in the 1.0–2.0 μm region where HST's background is extremely low, NICMOS will have superb sensitivity with 3σ detections at H=24.8 in 1000 seconds using the medium plate scale camera.

With these capabilities, the NICMOS instrument team has slated an exciting program of Galactic Center observations. Four programs will be executed: 1) Measurement of proper motions near SgrA*; 2) Search for variability of sources in the central parsec; 3) Search for the tip of the main sequence associated with star formation in the central parsec; and 4) Search for ionized tails from cool giant stars.

The proper motion program will extend over the 5 year lifetime of NICMOS with the first data being acquired as soon as possible after the on-orbit operation of NICMOS is verified. The last data will be taken at a judiciously chosen time shortly before the solid nitrogen cryogen runs out. The variability search will be conducted on times scales of 10's of seconds to several orbits (roughly 90 minutes each). The main sequence search will take multi-color images looking for a blue stellar population indicative of the tip of a young main sequence. The color-magnitude diagram for these stars will indicate the epoch of last star formation at the Galactic Center. The ionized tail project will use NICMOS' Paα filter to look for more instances, similar to IRS7's tail, of ionization of a mass-loss wind.

The first call for proposals to use NICMOS will come as part of HST's Cycle 7. This call should be released soon with proposals likely to be due in August.

Abstracts

The Galactic Center Environment

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The central half kiloparsec region of our Galaxy harbors a variety of phenomena unique to the central environment. This review discusses the observed structure and activity of the interstellar medium in this region in terms of its inevitable inflow toward the center of the Galactic gravitational potential well. A number of dissipative processes lead to a strong concentration of gas into a "Central Molecular Zone" of about 200-pc radius, in which the molecular medium is characterized by large densities, large velocity dispersions, high temperatures, and apparently strong magnetic fields. The physical state of the gas and the resultant star formation processes occuring in this environment are therefore quite unlike those occuring in the large-scale disk. Gas not consumed by star formation either enters a hot x-ray emitting halo and is lost as a thermally-driven galactic wind, or continues moving inward, probably discontinuously, through the domain of the few parsec-sized circumnuclear disk, and eventually into the central parsec. There, the central radio source SgrA* currently accepts only a tiny fraction of the inflowing material, likely as a result of a limit cycle wherein the continual inflow of matter provokes star formation, which in turn can temporarily halt the inflow via mass-outflow winds.

to appear in Annual Review of Astronomy & Astrophysics
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The Nuclear Jet in M81

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In this paper we apply the jet-disk symbiosis model developed for Sgr A* to M81* – the nucleus of the nearby galaxy M81. The model accurately predicts radio flux and size of M81* for the observed bolometric luminosity of the nuclear source with no major free parameter except for the inclination angle. We point out that the usually applied free, conical jet emission model implies a longitudinal pressure gradient that must lead to a moderate acceleration of the jet along its flow direction. This, usually neglected, gradual acceleration naturally accounts for the inverted spectrum and the size/frequency relation of M81* and may be a general feature of radio cores. M81* is so far the best case for a radio-loud jet nature of the compact radio core in the nucleus of a spiral galaxy. The fact that one can account for Sgr A* and M81* with the same model by simply changing the accretion rate, strongly supports the jet-disk symbiosis model as an explanation for the compact radio cores of galaxies in general.

to appear in ApJ Letters, Vol 464, June 10
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Faraday Rotation Toward the Galactic Center Nonthermal Filament 359.54+0.18

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Multifrequency VLA observations of the thin filamentary structure, G359.54+0.18 reveal the magnetic field geometry and detailed rotation measure and spatial distributions of this system of nonthermal filaments. The intrinsic magnetic field lines run primarily along the filaments. The rotation measure (RM) varies between -4200 and -370 rad m^{-2} along the extent of the filaments, implying that the ionized, magnetized medium responsible for the Faraday rotation is less than 0.1 pc thick. In turn, this implies that the magnetic field in the Faraday screen is large, suggesting that it is located close to the Galactic center. Further evidence is provided by the anisotropy of the RM fluctuations, which are stronger in the direction running along

the filament. The structure of the eastern portion of G359.54+0.18 suggests that the magnetic field in the filaments is highly distorted as a result of an interaction with an adjacent Galactic center molecular cloud.

submitted to ApJ
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The Discovery of Hot Stars near the Galactic Center Thermal Radio Filaments

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We report the discovery of a highly unusual cluster of stars at G0.121+0.017 near the Arched (thermal) Filaments, $\sim 10'$ northeast of the Galactic Center. H (1.65 μm) and K$'$(2.1 μm) images are used to estimate a distance to the cluster consistent with a Galactic Center location. K$'$ band spectroscopy reveals that the cluster contains 13 stars with Brγ (2.166 μm) emission, 12 of these stars also have HeI (2.112/3 μm) emission, and 2 show fainter HeII (2.189 μm) emission. Based on a spectral comparison with optically classified stars, we suggest the new emission stars are late WN stars. If the classification is correct, the cluster contains $\sim$14% of all known galactic WN stars. Observations of emission line stars near G0.15–0.05, the 'Pistol ', are also presented. There are four stars near the Pistol which contain emission lines. Three of these stars differ spectroscopically from the stars in the new cluster; one has a spectrum similar to the new cluster stars. Together with the cluster stars, these newly discovered hot young stars provide evidence for recent star formation and the stellar ionization of the thermal radio emission regions in the vicinity of the Galactic Center.

ApJ, 461, 750 (1996 April 20)
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A Hydrodynamic Model for the Formation of the Galatic Center "Mini-Cavity"

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The mini-cavity in the streamer to the southwest of the dynamical center of the Galaxy, and the unique, nonthermal radio source Sgr A* appear to be physically connected by a chain of plasma "blobs" which may be in transit from the latter to the former. Recent observations at radio and infrared wavelengths have provided clear evidence that the cavity has an opening radius of $\sim 1'' \approx 0.04$ pc and radiates with a power $L_{cav} \approx 6 \times 10^{37}$ ergs s^{-1}. Here, we model the formation of the cavity as the result of an impact between the streamer gas and the post-bow shock gas collimated by a massive ($\sim 10^6\ M_\odot$) black hole coincident with Sgr A*. Multi-wavelength observations, including those of He I, Brα and Brγ line emission in the inner ~ 0.3 pc region of the Galaxy provide strong evidence for the presence of an ambient Galactic center wind with velocity $v_w \approx 500 - 700$ km s^{-1} and mass loss rate $\sim 3 - 4 \times 10^{-3}\ M_\odot$ yr^{-1}. We show that the Bondi-Hoyle process responsible for the accretion of $\sim 10^{22}$ g s^{-1} by Sgr A* also produces a downstream, focused flow with a radius very similar to that of the mini-cavity and a mechanical luminosity about 2.5 larger than L_{cav}. In addition, the size and density of the blobs appear to be consistent with the gas characteristics in this flow.

ApJ Letters, in press
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OH counterparts for H_2O masers in the Galactic Center: evolved stars instead of signs of recent star formation

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We present the detection of OH maser emission associated with the H_2O masers recently found in the Galactic center by Levine et al. (1995) and by Yusef-Zadeh & Mehringer (1995). The 1612 MHz OH masers were found in high-sensitivity maps created by combining 17 VLA observations taken by Van Langevelde et al. (1993) as well as in new observations with the ATCA. Both Levine et al. (1995) and Yusef-Zadeh & Mehringer (1995) consider the H_2O emission to be clues for recent massive star formation, by associating it with a supergiant and an HII region. The newly found OH masers show the typical double peaked spectra for evolved oxygen-rich stars and do not stand out amongst other OH/IR stars in this region, neither in H_2O nor OH maser characteristics. We conclude that the H_2O maser detections are associated with evolved, low to intermediate mass stars and that these H_2O masers thus cannot be regarded as signposts for massive young stars or star forming regions.

ApJ, 461, L41 (1996 April 10)
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Dynamics of the Bar at the Galactic Centre

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There is now substantial evidence for a rotating bar in the inner Galaxy. This is an important change in our perception of the Galaxy because it changes the ways in which we have to think about its evolutionary history. The idea of a Galactic bar is not new; that motion on elliptic orbits in a barred potential might explain various aspects of the atomic and molecular gas observations near the Galactic Centre has been suggested a number of times (e.g., Peters 1975, Cohen & Few 1976, Liszt & Burton 1980, Gerhard & Vietri 1986, Mulder & Liem 1986, Sanders 1989). What has changed in the past few years is (i) that the evidence now comes from several fronts, including the NIR light distribution as measured by COBE, IRAS source counts, atomic and molecular gas kinematics, the first indications for triaxiality in the stellar kinematics of the bulge, and perhaps the large optical depth to microlensing in the OGLE experiment; and (ii) that there is a dynamical model which provides a physical basis for explaining a number of independent features in the observed gas kinematics, is consistent to zeroth order with the other pieces of evidence for a bar that we now have, and promises to be extendable towards including these into one coherent picture. In this review I give a brief summary of the current evidence for the bar in the inner Galaxy. Then I discuss in more detail the subject of gas flows in bars and in the Galactic Centre. The integrated NIR photometry is described in the paper by Dwek. Finally, several evolutionary processes are briefly discussed which become relevant for Galactic evolution because of the presence of the bar, such as gas infall, angular momentum transfer, subsequent central star formation, and the formation of peanut-bulge-like stellar systems from bars through a bending instability.

to appear in the Proceedings of IAU Symp. 167 Unsolved Problems of the Milky Way, ed. L. Blitz & P. Teuben, (Kluwer)
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Variable Stars Close to the Galactic Centre

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A large-format infrared camera has been used for repeated observations of a 24 $\times$ 24 arcmin^2 region around the Galactic Centre. The survey is carried out at K (2.2μm), with single-epoch coverage at H (1.65μm) and J (1.25μm). So far, the observations have extended over two seasons and it is intended that they will continue for one more. The brightest $\sim$200 objects within each 5 $\times$ 5 arcmin^2 sub-field have been examined for variability. Preliminary processing of the data has revealed about 280 likely variables in the overall field. Their positions have been determined relative to stars in the STScI Guide Star Catalog. They include several previously known OH/IR stars.

to appear in the proceedings of the 4th ESO/CTIO workskop: "The Galactic Center", R. Gredel (ed.), ASP Conf. Ser.

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Non-linear generation of warps by spiral waves in galactic disks

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We present a new mechanism to explain the frequently observed and thus certainly permanent warping of spiral galaxies. We consider the possibility of non-linear coupling between the spiral wave of the galaxy and two warp waves, such that the former, which is linearly unstable and extracts energy and angular momentum from the inner regions of the galactic disk, can continuously feed the latter. We derive an expression for the coupling coefficient in the WKB approximation. We show that the coupling is too weak in the stellar disk, except at the Outer Lindblad Resonance where the spiral slows down and is efficiently coupled to warp waves. There, the spiral can be almost completely converted into "transmitted" warps, which we can observe in HI, and a "reflected" one, which we can observe as a corrugation. Our mechanism reproduces the observed amplitudes of the warp and of the corrugation, and might explain related phenomena such as the behavior of the line of nodes of the warp. Furthermore we show that the energy and momentum fluxes of observed spirals and warps are of the same order of magnitude, adding a strong point in favor of this model.

A&A in press
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Millimetre Spectral Line Observations of the Galactic Centre

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We have surveyed the Sgr A region (roughly $-12'$ to $+18'$ in l and $-12'$ to $+3'$ in b), including the Radio Arc, in the 110-GHz lines of $C^{18}O$ ($J = 1-0$) and HNCO ($J_{kk'} = 5_{05} - 4_{04}$) using the SEST. We have observed 554 positions with a grid spacing of $45''$. The observational data are presented in form of $l-b$, $l-v$ and $b-v$ maps, recently published in A&AS 113, 257. Observations of selected regions in the Galactic Centre in the 220-GHz $C^{18}O$ ($J = 2{-}1$) line have also begun and the Circumnuclear Disk has been mapped with the SEST in the 268-GHz HCO^+ ($J = 3-2$) line with a grid spacing of $10''$. Future mapping programs are being planned in the 119-GHz O_2 line, as well as in submillimetre lines of O_2 (487-GHz) and H_2O (557-GHz), using the 1.1-m Odin satellite telescope, which has a launch date in the fall of 1997. The Odin satellite is a Swedish project in collaboration with Canada, Finland and France.

to appear in the proceedings of the 4th ESO/CTIO workskop: "The Galactic Center", R. Gredel (ed.), ASP Conf. Ser.
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JHKL Photometry and the *K*–band Luminosity Function at the Galactic Center

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J, H, K, and L photometry for the stars in the central $\sim 2'$ ($\sim$ 5 pc) of the Galaxy are presented. Using the observed $J-H$, $H-K$, and $K-L$ colors and assumed intrinsic colors, we determine the interstellar extinction at 2.2 μm (A_K) for approximately 1100 individual stars. The mean A_K (= 3.3 mag) is similar to previous results, but we find that the reddening is highly variable and some stars are likely to be seen through $A_K > 6$ mag. The de–reddened K–band luminosity function points to a significantly brighter component to the stellar population (> 1.5 mag at K) than found in the stellar population in Baade's window, confirming previous work done at lower spatial resolution. The *observed* flux of all Galactic center stars with estimated $K_\circ$ (de–reddened magnitude) ≤ 7.0 mag is $\sim$ 25 % of the total in the $2' \times 2'$ field. Our observations confirm the recent finding that several bright M stars in the Galactic center are variable. Our photometry also establishes the near–infrared variability of the M1–2 supergiant, IRS 7.

accepted by ApJ

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ASCA View of Our Galactic Center: Remains of Past Activities in X-Rays?

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Detailed X-ray images and spectra of the Galactic-center region up to 10 keV were obtained with ASCA. Diffuse thermal-emission with distinct Kα lines from highly ionized ions of various elements has confirmed the presence of an extended high-temperature plasma. The fluorescent X-ray emission from cold iron atoms in molecular clouds was also found, possibly due to irradiation by X-rays from the center, which was bright in the past, but is presently dim. The results suggest that the Galactic center exhibited intermittent activities with a time-averaged energy generation rate comparable to Seyfert nuclei, a class of active galactic nuclei.

to appear in PASJ, Vol. 48 (1996)
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Excitation of the "Arched" Filaments near the Galactic Center

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We present measurements of the far-infrared (FIR) fine structure lines [S III] (33 μm), [Si II] (35 μm), [O III] (52, 88 μm), [O I] (63 μm), and [C II] (158 μm) and the adjacent continua at these wavelengths in a strip crossing the E2 and W1 thermal radio filaments in the Galactic Center "Arc". The properties of the two filaments are similar: the line and continuum fluxes peak in the vicinity of the radio ridges, and the contrast of the ridge fluxes relative to the off-ridge fluxes is greatest for the FIR continuum and doubly ionized lines, lower for the single-dish radio measurements (Sofue et al. 1986) and smallest for the low excitation lines. The near spatial coincidence of the line and continuum emission maxima with the radio filaments demonstrates that the same excitation source must be responsible for both the line and the continuum emission. The peak FIR luminosity of $\sim 2.5 \times 10^5$ $L_\odot$ per $30''$ beam and the association of [O III] intensity with the filaments pose difficulties for shock and MHD models. Excitation by a string of stars is also unlikely, but photoionization of molecular cloud edges by a quasi-uniform distribution of stars is the most plausible excitation source proposed. The peak ionized line intensity is shifted slightly eastward relative to the FIR continuum emission. The deduced excitation, as measured by the [O III] to [S III] line flux ratios, also peaks slightly east of the radio ridges. Together, these two measurements suggest a substantial contribution from an ionizing source to the east. The strengths of the [O I] and [C II] lines are consistent with their production in photodissociated molecular material adjacent to the photoionized gas, but the FIR luminosity and the [Si II] emission appear to originate predominantly in or very near to the ionized gas.

accepted by ApJ
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The interaction of the G359.54+0.18 Nonthermal Filaments with the Ambient Medium

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We present a study of the Galactic Center nonthermal filament system G359.54+0.18 located to the north of the Sgr C region. We find evidence in support of the suggestion by Serabyn & Morris that the nonthermal filaments are the manifestations of large-scale vertical magnetic field lines illuminated by collisions with molecular clouds. Included in the study are observations of, (1) the 3 mm emission lines of CS, HCO^+ and other molecular species

with the SEST, (2) several lines of ^{12}CO and ^{13}CO with the 3-m KOSMA antenna, (3) 5 GHz radio continuum emission with the VLA, and (4) H79α recombination line emission with the 100-m antenna at Effelsberg.

to appear in the proceedings of the 4th ESO/CTIO workskop: "The Galactic Center", R. Gredel (ed.), ASP Conf. Ser.

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A Varying Mass-To-Light Ratio in the Galactic Center Cluster

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We reanalyze published kinematic and photometric data for the cool star population in the central 10 pc (240″) of the Galaxy, while (a) isolating the photometric data appropriate to this population, and (b) properly allowing for projection effects. Under the assumptions that the system is spherical and isotropic, we find that M/L_K varies from ≤ 1 outside a radius of 0.8 pc to > 2 at 0.35 pc. This behavior cannot be due to the presence of a central massive black hole. We suggest that such a varying M/L_K may be due to an increasing concentration of stellar remnants towards the Galactic center. Our derived mass-radius curve confirms the existence of $\sim 3 \times 10^6$ M$_\odot$ within 0.35 pc of the Galactic center, and $\sim 1.5 \times 10^6$ M$_\odot$ within 0.2 pc. However, the latter estimate is subject to the uncertain distribution of cool stars in this region. We also consider the dynamics of the hot star population close to the Galactic center and show that the velocity dispersion of the He I stars and the surface brightness distribution of the hot stars are consistent with the mass distribution inferred from the cool stars.

ApJ, in press

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http://xxx.lanl.gov/abs/astro-ph/9604153

Radio Continuum and Molecular Gas in the Galactic Center

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Nonthermal radio emission in the galactic center reveals a number of vertical structures across the galactic plane, which are attributed to poloidal magnetic field and/or energetic outflow. Thermal radio emission comprises star forming regions distributed in a thin, dense thermal gas disk. The thermal region is associated with dense molecular gas disk, in which the majority of gas is concentrated in a rotating molecular ring. Outflow structures like the radio lobe is associated with rotating molecular gas at high speed, consistent with a twisted magnetic cylinder driven by accretion of a rotating gas disk.

To appear in the proceedings of Nobel Symposium 98 "Barred galaxies and circumnuclear activity"(Nov 30-Dec 3, Stockholm, ed. Aa Sandqvist, Springer Verlag)

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http://xxx.lanl.gov/abs/astro-ph/9604062

A New Eclipsing X-Ray Burster near the Galactic Center: A Quiescent State of the Old Transient A1742-289

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With ASCA, we found highly absorbed X-rays from the position of the bright transient source A1742-289, with variable flux ranging from 8×10^{-12} to 4×10^{-11} erg s^{-1}cm^{-2} in the 3-10 keV band. We discovered an X-ray burst and eclipses from A1742-289, establishing that A1742-289 is an eclipsing low mass X-ray binary. Using the black body radius during the X-ray burst, we estimated the distance of A1742-289 to be about 10 kpc, or near the Galactic Center. Then the burst peak flux was found below the Eddington limit of a neutron star. Excess soft X-rays during the eclipse were detected, which are

interpreted to be a scattering by interstellar dust-grains. Since A1742-289 was found to be an X-ray emitter even in the quiescent state with a moderate but variable flux, and since A1742-289 is lying only 1.3' from the Galactic center, previously reported X-ray fluxes of the Galactic center (Sgr A*) with non-imaging instruments might have been suffered by possible contamination of A1742-289.

PASJ 48 (1996), in press
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A new sample of OH/IR stars in the Galactic Center

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We report on the preliminary results of an extensive search for OH/IR stars in the Galactic center region. The main goal is to use the larger sample of OH/IR stars to probe the gravitational potential in the Galactic center (see Lindqvist, Habing & Winnberg 1992b). The search in the 1612 MHz line of OH was performed by observations taken with the Australia Telescope Compact Array and by means of concatenating Very Large Array data sets used for a monitoring program (Van Langevelde et al. 1993). The volume surveyed is over 80 pc in diameter centered on Sgr A* and has a velocity coverage of -550 to $+600$ km s^{-1}. The 1σ noise is about 5 mJy, at least four times as deep as earlier surveys. So far we have found about 50 new OH/IR stars, almost as many as we expected. The newly found OH/IR stars seem to be similar in their observable properties to the OH/IR stars already known in the Galactic center. In our data we have found OH counterparts for two H_2O masers detected by Levine et al. (1995) and by Yusef-Zadeh & Mehringer (1995). These H_2O masers are not the argued clues for recent star formation: the objects are old OH/IR stars (Sjouwerman & Van Langevelde 1996).

to appear in the proceedings of the 4th ESO/CTIO workskop: "The Galactic Center", R. Gredel (ed.), ASP Conf. Ser.
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Hot Stars in the Quintuplet

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We present K-band spectra of newly identified hot stars in the Quintuplet cluster, as well as template spectra for 34 Galactic Wolf-Rayet stars. Five of the new stars are WR types (3 WC and 2 WN), while 14 others are OB supergiants; three of the WR stars are probably the hottest identified stars within 50 pc of the Galactic Center. The newly identified stars increase the estimated ionizing flux from this cluster by about an order of magnitude with respect to earlier estimates, to 8.2(10^{49}) photons s^{-1}, or about one third of what is required to ionize the "Sickle" (G0.18-0.04). In addition, we propose that the 5 original enigmatic members of the Quintuplet-proper are dusty WCL stars, similar to the dozen or so known examples in the Galaxy.

to appear in the proceedings of the 4th ESO/CTIO workskop: "The Galactic Center", R. Gredel (ed.), ASP Conf. Ser.
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The Molecular Gas in the Galactic Center Region based on $C^{18}O$ Measurements, Presentation of a Large Scale $J = 1 - 0$ Survey obtained with the 1.2m Southern Millimeter-Wave Telescope at CTIO

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A large scale $C^{18}O(J = 1 - 0)$ survey of the central few hundred pc ($-1.05° \leq l \leq +3.6°$, $-0.9° \leq$

$b \leq +0.75°$) of the Galaxy is presented. These 9′ resolution data were obtained with the 1.2 m Southern Millimeter-Wave Telescope (SMWT) at CTIO and compared to $^{12}CO(1–0)$ data also obtained with this telescope. In addition, $HNCO(5_{0,5}–4_{0,4})$ line data included in the spectrometer passband are also presented. Although both ^{12}CO and $C^{18}O$ are thought to be tracers of the molecular mass, their distribution and line shapes differ significantly. The $C^{18}O(1–0)$ line is mucher weaker than expected from the "Standard $I_{^{12}CO(1-0)}/\mathcal{N}_{H_2}$ Conversion Formula" obtained by Strong et al. (1988). LVG calculations suggest that on large scales the $^{12}CO(1–0)$ emission is only of intermediate ($\tau = 1 - 5$) or low optical depth ($\tau < 1$). In this case, the "Standard Conversion Formula" overestimates $\mathcal{N}_{H_2}$. Our $C^{18}O(1–0)$ data combined with other H_2 tracers indicate a total molecular mass of $(3^{+2}_{-1}) \cdot 10^7\ M_\odot$. The existence of a widespread component of molecular gas with low density (thin gas) is found to be very likely.

to appear in the proceedings of the 4th ESO/CTIO workskop: "The Galactic Center", R. Gredel (ed.), ASP Conf. Ser.

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H_2 Emission from the Inner 400 Parsecs of the Galaxy

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We have observed near–IR H_2 line emission on large scales in the Galactic center. Paper I discussed our 400 pc long strip map and 50 pc map of the H_2 $v = 1 \to 0$ $S(1)$ line. In this paper, we present observations of the higher vibrational lines (H_2 $v = 2 \to 1$ $S(1)$ and $v = 3 \to 2$ $S(3)$) at selected positions and conclude that strong far–UV radiations excites the H_2. We compare the H_2 $v = 1 \to 0$ $S(1)$ emission to far–IR continuum emission and show that the ratio of these two quantities in the Galactic center equals the ratio seen in the starburst galaxies, M82 and NGC 253, and in ultraluminous infrared bright galaxies.

to appear in the proceedings of the 4th ESO/CTIO workskop: "The Galactic Center", R. Gredel (ed.), ASP Conf. Ser.
see also ApJ 457, L43 (1996)

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Sgr A* and its siblings in nearby galaxies

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We have proposed previously that Sgr A* is simply a scaled down AGN with a black hole, an accretion disk and a radio jet operating at a very low power. It appears as if M81* – the nuclear source in the nearby galaxy M81 – is an ideal laboratory to study a Sgr A*-like source at a higher power level. The jet/disk model can explain M81* in great detail with no basic changes in the model parameters other than the accretion rate. Radio cores in other LINERs may be explained by the same model and they appear to be low-power counterparts to radio-loud quasar cores. For Sgr A*, models without a supermassive black hole are facing difficulties – some of which are discussed here, but a persistent puzzle in any scenario are the non-detections and low flux limits for Sgr A* from IR to x-rays. Especially the IR limits are a threat to accretion models. I discuss whether a thin molecular disk (as seen in NGC 4258) around Sgr A* could intercept infalling material before it reaches the black hole.

to appear in the proceedings of the 4th ESO/CTIO workskop: "The Galactic Center", R. Gredel (ed.), ASP Conf. Ser.

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Kinematics of the Ionized Gas in Sgr A West: the Minicavity and the Western Arc

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The "western arc" and "minicavity"(approximately 3″ southwest of Sgr A*) of the Galactic center H II region Sgr A West have been imaged in the H 92α line at 8.3 GHz with the VLA. The kinematics of the ionized gas in the inner 1.5 parsecs of the Galactic center have been determined. The western arc, with an inner radius of 1 pc, appears to be in circular rotation about a point near Sgr A*, with an enclosed mass of $\sim 3.5 \times 10^6\ M_\odot$. Toward the minicavity, a large velocity gradient (> 600 km s^{-1} pc^{-1}) is observed along the eastern rim and uniformly large velocities are observed along the western rim. The velocity field of the minicavity is interpreted as gas in a hyperbolic orbit about Sgr A*. Based on this model, the gas is orbiting a point at the position of Sgr A* with a mass of $\sim 3.0 \times 10^6\ M_\odot$.

to appear in the proceedings of the 4th ESO/CTIO workskop: "The Galactic Center", R. Gredel (ed.), ASP Conf. Ser.
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Interstellar extinction in the vicinity of Galactic Center thermal radio emission regions

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Broad band J, H and K′ and spectral Brγ 2.166 μm images have been obtained in four areas surrounding regions of thermal radio emission. Localized variations in the extinction are examined by means of color and comparison of the observed Brγ flux with the Brγ emission predicted from radio continuum data. Results show few spatial variations and little correlation with the position of the radio emission features.

to appear in the proceedings of the 4th ESO/CTIO workskop: "The Galactic Center", R. Gredel (ed.), ASP Conf. Ser.
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The Discovery of the Radio Source Sagittarius A (Sgr A)

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The discovery of Sagittarius A, a discrete radio source associated with the nucleus of the Milky Way, was made by Piddington and Minnett (1951) at 1210 MHz. McGee and Bolton (1954), however, brought to the attention of the astronomical world the association of Sgr A with the Galactic Nucleus. The paper was published in *Nature* and many well known astronomers (Baade, Oort, van de Hulst, Pawsey, Mills, Kerr, and Shain) were involved in the events leading to publication. We summarize the preparation of this paper, re-examining some details published by Morton (1985). In addition we summarize the significance of five publications from CSIRO, Sydney, Australia, in the period 1951 to 1954.

to appear in the proceedings of the 4th ESO/CTIO workskop: "The Galactic Center", R. Gredel (ed.), ASP Conf. Ser.
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Neutral Carbon and the Dense Interstellar Medium in the Inner 300 pc of the Galaxy

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We present observations of the 492 GHz transition of C I over the inner 400 pc of the Galactic center. Emission in the ground state fine-structure lines of C I traces UV-illuminated material at the surfaces of molecular clouds. We can therefore use C I and molecular line observations to learn about the structure of neutral clouds in the Galactic center and the influence of UV radiation upon them. We compare the C I emission to ^{13}CO and CS emission and discuss the implications of the results for the nature of interstellar clouds in the inner Galaxy.

to appear in the proceedings of the 4th ESO/CTIO workskop: "The Galactic Center", R. Gredel (ed.), ASP Conf. Ser.
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Quantitative Spectroscopy of the He I Cluster

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We present first 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 some 5×10^6 years ago. Statistical evidence for a concentration of dark mass ($\sim3\times10^6 M_\odot$) in the Galactic center is derived from the stellar velocity dispersion.

to appear in the proceedings of the 4th ESO/CTIO workskop: "The Galactic Center", R. Gredel (ed.), ASP Conf. Ser.
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Announcements

- Remember to mail in your "Publication Agreement and Copyright Assignment"for the ESO/CTIO conference proceedings...due May 15th.
- The next GCNEWS letter abstract deadline is June 30. However, you can submit an abstract at any time and it will be sent out later that week as an email message: our 'Newsflash' service.
- Good luck with your May and June GC observations!
- There will be coordinated observations of Sgr A* this fall and possibly next year at cm/mm/submm wavelengths. Interested parties should contact hfalcke@astro.umd.edu. First coordinated observations between BIMA and Nobeyama will already be done on May 24-27, 1996.
- The proceedings of the IAU Symp. 169 "Unsolved Problems of the Milky Way" are in print now, and will appear very soon.
- Be sure to check the GCNEWS web site for the papers you are interested in, many of them are linked. If you'd like information about how to make your paper available over the web, let us know. The more papers that we can make electronically available the more useful this newsletter service will be to everyone involved.
- In the future we would like to use this space in the newsletter to list job opportunities, especially in Galactic center research. So, if you have a job please let us know so we can include it in the next edition of GCNEWS!

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Comments and suggestions are welcome.

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