

1. Science Justification

Goals. We propose to complete the coverage of the inner $\pm 10^\circ$ of Galactic longitude that were not imaged by the GLIMPSE survey, and *make the results available as soon as possible to the general astronomical community*. We seek to: 1) determine the stellar population, stellar mass, and extent of the in-plane central bar of our Galaxy; 2) determine the distribution of AGB stars, carbon stars, red giants, and other stellar bulge tracers that can be identified in IR color-magnitude or color-color plots or in multi-color images; 3) determine the rate at which the stellar surface density continues to increase with decreasing longitude and investigate a possible asymmetry in the gradient inferred from GLIMPSE; 4) determine the stellar scale length within longitudes $l=0^\circ-65^\circ$ (GLIMPSE covered $l=10^\circ-65^\circ$, $|b|=1^\circ$); 5) identify variable stars in the GC region; 6) explore the large-scale, bipolar, mid-infrared bubble at the Galactic center (Bland-Hawthorn & Cohen 2003) both to better understand its energetics and the nuclear winds of other galaxies; 7) search for new, as yet, undetected clusters and massive star formation regions within $\pm 10^\circ$ of the Galactic center (GC), including those associated with the central bar; 8) image diffuse ISM structures such as star-forming regions, planetary nebulae, and supernova remnants, some of which may be new discoveries; 9) study infrared dark clouds; and 10) determine the NIR-MIR interstellar extinction law toward the inner galaxy. In the following justification, we describe the motivation and background for each goal and demonstrate how we will use the proposed Spitzer/IRAC observations to achieve each goal.

Stellar Content and Structure of the Inner Galaxy

No systematic large scale determinations of the stellar population at high spatial resolution ($\sim 2''$) of inner Galaxy exist at longitudes $> 1^\circ$ from the GC other than the NIR surveys of 2MASS and DENIS, which suffer considerably from extinction. Our survey will be at least as sensitive as the 2MASS survey, and the IRAC $4.5\mu\text{m}$ band has no PAH emission features (thus minimizing diffuse background brightness). We note that our GLIMPSE point source archive contains 50 times more point sources than 2MASS in the same area of sky due chiefly to extinction. The ISOGAL survey (Omont et al. 2003) covered only small portions of our proposed region at 7 and 15 microns at $6''$ resolution. We will not discuss the inner 200 pc of the Galaxy further here since Dr. Susan Stolovy (also a member of this team) has an approved program to image an area of $l=\pm 1^\circ$ and $b=\pm 0.75^\circ$, which we plan to avoid. Here we concentrate on extending the GLIMPSE survey into the GC to address large-scale structure traced by the stellar distribution beyond the inner 200 pc.

The Bulge and Bar. Within our Galaxy, the central region is unique. It is enclosed within a large nuclear bulge defined by the distributions of RR Lyrae stars, OH/IR stars, planetary nebulae, red clump giants (RCGs), and carbon stars (Skrutskie et al. 2001; and others). The GC region is also home to an in-plane, triaxial, central bar with a length of 3-5 kpc (e.g. Blitz & Spergel 1991, Babusiaux 2003) and is inclined to the line between the Sun and Galactic center by 20-30 deg as seen in projection from above the Galaxy. As seen from the Sun, the bar extends to $l\sim 20$ deg and to $\sim -13^\circ$ ($l=347^\circ$). A central bar was first hypothesized by de Vaucouleurs (1964) based on noncircular motions of gas in the GC. A good summary of the size, orientation, axial ratios, and corotation radius of the bar is given by Gerhard (2002) and references therein. Cole and Weinberg (2002) have determined that the bar has an age < 6 Gyr and that it is likely to be ≤ 3 Gyr. The exact orientation, length, and axial ratios, however, are still controversial (Gerhard 2001). Its interface with the disk, stellar population content, formation and evolutionary history remain obscure (Wyse et al. 1997). Based on the slope of stellar surface

density with longitude and latitude in the inner galaxy using H and K band data from 2MASS, Alard (2001) has suggested that in addition to the main bar, a smaller bar with full width of about 2° in longitude centered on the dynamical center of the Galaxy with a different orientation than the main bar may exist. There is no doubt that the central bar has a dominant impact on the gas and stellar dynamics, stellar distribution, and star formation within the central region of the Galaxy. The bar may drive evolution of the Galaxy by redistributing angular momentum and increasing the rate of gas transport to the center, thereby impacting the star formation history and nuclear activity. Our understanding of these processes, however, is still in its infancy. Such an unclear view of a fundamental component of our Galaxy is a strong argument for a comprehensive study of the inner Galaxy that can only be done at infrared, radio, and hard X-ray wavelengths due to high visual and UV interstellar extinction.

We will use GLIMPSE II, which will fill in the crucial inner $\pm 10^\circ$ of the Galaxy, to map the extent of the in-plane central bar as traced by stars, and determine if it is different from that implied by HI and CO dynamics. We will investigate whether the nuclear bulge triaxial ellipsoid (Lopez-Corredoira, Cohen, and Hammersley 2001; Alard 2001) adequately represent the distribution of stars in the region surrounding the GC and if we see evidence for the inner bar.

Determination of the extent of the central bar can be achieved with IRAC/2MASS data using carbon stars and AGB stars, both luminous bar/bulge tracers, similar to the way Cole and Weinberg (2002), Skrutskie et al. (2001) and others have done, but with a much improved statistical sample. Cole & Weinberg (2002) have argued that carbon stars can be used as approximate standard candles. Determination of the stellar populations in the bar will require analysis of color-color and color-magnitude plots in conjunction with the interstellar extinction law to localize stars in the bar. This analysis will be aided by a current Spitzer project to obtain IRS spectra of AGB stars in the Bulge (PI Blommaert). The distribution of bulge tracers such as red giants, PNs, AGB stars, carbon stars, and RCG stars will depend on how well these classes of objects can be separated in IR color-color and/or in color-magnitude plots. Unpublished GLIMPSE analyses show that carbon stars and OH/IR stars are easily distinguished from field stars in IR color-color plots. PNs can often be recognized by color and spatial extent in IRAC images. RCG stars can be identified at NIR bands (Indebetouw et al. 2005) and detected in the planned deep NIR survey of Omont and coworkers, which should easily detect RCG stars even with $A_K \sim 4m$, corresponding to $A_V \sim 36m$.

The GLIMPSE II survey will provide the ideal data set for studying the inner bulge and bar (stellar content, mass, morphology, and extent) by tracking the average stellar surface density with longitude and latitude for sources brighter than the confusion limit of $12^{\text{th}} - 13^{\text{th}}$ magnitude.

Surface density asymmetry and scale length. Our GLIMPSE data seems to indicate that for $l > 10^\circ$ the average gradient in the stellar surface density (in stars per square degree per degree longitude) is steeper in the northern plane (i.e. the plane visible from northern latitudes) than in the southern plane (see Fig. 2) based on a small fraction of the data at $b=0^\circ$. This asymmetry is not well understood, and we seek to understand the nature of this gradient by probing the the $l < 10^\circ$ region, which may provide clues to its origin. We will measure the stellar gradient and scale-length by counting stars as a function of their (l, b) position.

We will formalize the scale-length analysis using the SKY model (Cohen 1994) of the Galaxy. This will give an estimate of the disk component of baryonic mass. Since Galactic rotation provides an estimate of the total mass, the stellar scale length has implications for the mass of dark matter in the Galaxy. We will also measure the scale height in latitude to understand the mass distribution perpendicular to the galactic plane.

Variable Stars. Identification of variable stars at NIR/MIR wavelengths will be an important addition to the study of Cepheids, RR Lyrae, LPVs, and other classes of variable stars. Although variability is often seen in YSO's at shorter wavelengths (due to accretion, star spots, etc.), it is not well known whether they exhibit variability at IRAC wavelengths; we will look for this and will interpret it in the context of photospheric and disk components of the emission. Variable stars will be possible to identify because we will be obtaining observations at two epochs separated by about 6 months. 2MASS and DENIS will provide several additional epochs and the new deep NIR survey of Omont will provide yet another epoch.

The Nuclear Wind

Many galaxies are known to have nuclear winds, but their origin is mostly conjecture and their energetics are not well determined. The recent detection at mid-infrared wavelengths of an apparent wind from the nucleus of our Galaxy provides an opportunity to study this phenomenon up close and to identify the driving source(s). A spectacular limb-brightened, bipolar structure that extends more than a degree perpendicular to the disk at the GC has been identified at $8.3\ \mu\text{m}$ from MSX observations (Bland-Hawthorn & Cohen 2003). Filamentary emission is confined to a dome-shaped shell, elongated perpendicular to the plane, which is tightly correlated with radio continuum emission over the same scales. The "caps" of this outflow extend $>1^\circ$ ($>170\ \text{pc}$) above and below the mid-plane, but they are too faint to be well defined beyond this by MSX. These authors interpret the extraplanar $8.3\ \mu\text{m}$ emission as dust entrained in a large-scale, bipolar wind powered by a central starburst. This bubble may alternatively be related to the 511 KeV positron-electron line emission from the GC which Cassé et al. (2004) propose may be produced by a GRB event caused by a bipolar WR explosion. Such bubbles may also represent a fossil record of ejection events from an earlier epoch when the accretion rate at the GC black hole was much higher than it is today.

GLIMPSE II has both the sensitivity and spatial resolution to trace the wind-blown structure in detail, providing both a clearer sense of the physical emission mechanism in the mid-infrared and the detailed interactions between the wind and the ambient ISM. Lobes and spurs of correlated radio and X-ray emission are also observed up to a few kpc above the GC and are thought to be related to the same nuclear star-forming activity that drives the smaller-scale MSX bipolar wind (Sofue & Handa 1984; Sofue 2000, 2003; Yusef-Zadeh, Hewett, & Cotton 2004; Wang, Gotthelf, & Lang 2002). Multi-wavelength observations of the GC are extremely important for understanding the ubiquitous phenomena of nuclear winds and providing a high-resolution paradigm for external galaxies. Understanding the physics and emission mechanism of the nuclear wind bubble and its interactions with the ambient ISM will be achieved by analysis of the IRAC images in conjunction with multi-wavelength data of the central few 100 pc in the GC, such as recent VLA+GBT radio images (Yusef-Zadeh, Hewitt, Cotton 2004) and Chandra and XMM X-ray surveys (Wang, Gotthelf & Lang 2002). Identification of objects that may be driving the nuclear wind will be an important contribution of these data and those of Dr. Stolovy.

Star Formation in the Inner Galaxy

The unbiased, fully sampled GLIMPSE II survey, will enable a host of possible new science, especially related to star formation, unique to the GC. We will address questions such as: Is there a change in the IMF of young stellar clusters with distance from the nucleus, and if so, can this be related to differences in local conditions? Can the innermost extent of spiral arms be detected and localized? How do the inner spiral arms relate to the central bar and what is the impact of the bar on the distribution and formation of stars in the inner galaxy?

GLIMPSE has revealed many more HII regions than listed in any catalog. IRAC is more sensitive than radio surveys (e.g. Wood and Churchwell (1989); Kurtz, Churchwell, and Wood 1994) because HII regions emit more of their luminosity at MIR than at radio wavelengths. An unbiased survey at high spatial resolution ($<2''$) has never been done in the radio. High resolution will be important to distinguish diffuse from point like emission from ultracompact and compact HII regions. In principle, both stellar and ISM emission should be detected from the far side of the galaxy (>8 kpc) for HII regions which will not be confused due to their brightness.

The search for new young massive star forming regions will be straightforward because they can be easily recognized by the brightness and spatial extent of bright dust emission (PAH features) in IRAC bands 1, 3, and 4 as demonstrated by the GLIMPSE survey. They can also be recognized by an increase of stellar density, which the GLIMPSE pipeline automatically tracks. Cross-correlation with longer-wavelength observations (e.g., MSX) will further aid in separating Young Stellar Objects (YSOs) from other objects with similar near-IR colors. New clusters of YSOs will be detected, even through regions of very high extinction. In addition, we will image diffuse emission associated with the end states of stellar evolution, including possible discoveries of new planetary nebulae and supernova remnants (SNRs). GLIMPSE showed that the most likely SNR's to be detected are those interacting with molecular clouds, which should increase in occurrence closer to the GC. We acknowledge that determining the distance to these objects will not be trivial, and we will attempt to use a combination of techniques taking into account their size, extinction, line absorption and emission properties, and bolometric luminosity.

Extinction in the Galaxy

Infrared Dark Clouds. MSX (Egan et al. 1998) discovered many cold, dense, dark clouds (DCs) in silhouette against the background diffuse IR emission of the Galactic plane. GLIMPSE has also detected many 100's of DCs with ~ 10 times the spatial resolution and ~ 100 times the sensitivity of MSX. DCs are important because they provide the natal material and initial conditions for star birth. As noted above the conditions for star formation in the GC must be quite different than in the disk. For the DCs detected in the GC region, we will attempt to answer questions such as: Are DCs fractal or do they have a preferred size? Which DCs have embedded protostars and what are the DC and YSO properties? Do DCs vary in opacity, based on star counts in and out of the clouds?

Extinction Law. Determination of the NIR-MIR extinction law will be determined using RCG stars located in the nuclear bulge using the technique demonstrated by Indebetouw et al. (2005). We will rely on the new deep JHK survey planned in conjunction with GLIMPSE II by Omont and coworkers since RCG stars in the GC are likely below our detection limit.

Larger Astronomical Impact

This GLIMPSE II survey will be released to the public with no proprietary period, leading to early data mining and unanticipated discoveries. It will provide a more complete picture of the content and distribution of stars and dust in the nuclear region of our Galaxy, which can be used as a template to understand and constrain theoretical models of barred galaxies. The 2MASS catalog (and eventually the DENIS catalog) will be bandmerged with GLIMPSE II sources as part of our public release, thereby providing SEDs from ~ 1 to $8 \mu\text{m}$. A new deep (~ 2 magnitudes fainter than 2MASS) survey of the inner Galaxy is being planned by Omont and colleagues in using SIRIUS/SAAO ($l < 2^\circ$) and UKIDSS ($l > 2^\circ$), which will significantly improve the NIR source correlations with GLIMPSE II. The GLIMPSE II survey will provide a rich public database for stellar population studies and future sensitive, high-resolution facilities such as ALMA, SOFIA, Herschel, and JWST.

2. Technical Plan

Observing Strategy and Time Requirements

We plan to make three IRAC passes of the survey area with 2 sec (1.2 sec on object) exposures per pass. Initially, we will make two passes using one-half frame overlaps precisely as the GLIMPSE survey used. The whole area will be imaged again 6 months later with single frame spacing (12 pixels overlap in cardinal directions) when the telescope roll angle is different. This will provide the necessary better sampling of the point spread function compared with GLIMPSE. The GLIMPSE survey was quite adequate for accurate photometry at $l \geq 10^\circ$ where stellar densities are lower, but with the higher stellar surface densities at $l < 10^\circ$ a better sampled point spread function is desirable to improve photometry in the more crowded inner Galaxy. Sampling at two epochs will make it easier to identify asteroids (in conjunction with bright asteroid ephemerides), variable sources, and cosmic ray hits. The ecliptic plane intersects the galactic plane at $l = 6.4^\circ$, so we expect to encounter more asteroids than in the GLIMPSE survey. Column pull-down and banding will be rotated relative to the first passes, providing independent checks of our correction algorithms for these effects. To fully image the survey area (excluding the Stolovy area, see below) with half-frame overlaps once and once with full frame steps will require 138.8 hours (see AORs with this proposal).

To sample the inner part of the nuclear bulge and include a significant number of nuclear bulge/bar RGB stars and carbon stars (which can be used as approximate standard candles), we plan to increase the latitude coverage in steps of half a degree beginning at $l = 5^\circ$. At $l = 5^\circ$, b will be increased to $\pm 1.5^\circ$, and at $l \leq 2^\circ$, b will be increased to $\pm 2^\circ$ (See Fig. 1). The longitude range $l = 5^\circ - 10^\circ$ will connect smoothly with the GLIMPSE survey in latitude coverage. We increase the latitude coverage over that of GLIMPSE inside $l = 5^\circ$ because we want to include enough of the inner bulge and bipolar bubble to accomplish our science goals.

Confusion and Background Brightness

The inner $\pm 10^\circ$ of the Galaxy was not proposed in the initial GLIMPSE survey because it was believed that crowding and background brightness would be so severe that it would be impossible to obtain reliable photometry for point sources. Although both stellar density and background levels do increase in the inner Galaxy, the GLIMPSE survey has shown that it is straightforward to extract stars and obtain accurate photometry down to $l = 10^\circ$ by modifying the magnitude limits such that confusion and bright background are not serious problems. The average background brightness is about a factor of 5-6 higher at $l = 13^\circ$ than at $l = 55^\circ$ and the stellar surface density is significantly higher, as shown in Fig. 3. IRAC will be mostly confusion limited at $l < 10^\circ$ at $14^{\text{th}} - 13^{\text{th}}$ mag in IRAC bands 1 & 2 but probably not at $< 13^{\text{th}} - 12^{\text{th}}$ mag (see Fig. 2). Thus, at $\leq 13^{\text{th}} - 12^{\text{th}}$ mag, a wide range of unique science particular to the GC will be enabled.

Saturation

Bulge/bar OH/IR stars, LPVs, carbon stars, and foreground AGB stars are likely to be saturated in the IRAC bands (Ortiz et al. 2002; Wood, Habing, and McGregor 1998). In order to recover photometry of the most luminous of these sources as probes of the central bar, we plan to obtain very short (0.02-0.1 sec) exposures of these stars using the subarray mode. This will be done after the full survey is completed with knowledge of where the saturated stars are and how bright they are, which will guide us in determining the exposure time toward each saturated star. We estimate that 10 hours will be needed for this ($< 8\%$ of the full survey time).

Sensitivity

The 5 σ detection limits for bright background, see SENS-PET (SSC website), using 3 passes each of 2 sec exposures are: IRAC [1]~98 μ Jy; IRAC [2]~119 μ Jy; IRAC [3]~520 μ Jy; and IRAC [4]~451 μ Jy. In the crowded fields in the inner Galaxy, our experience with the GLIMPSE survey at higher longitudes, indicates that the realistic 5 σ lower limits we are likely to achieve are ~0.5 mJy, ~0.5 mJy, ~1 mJy, and ~3 mJy for IRAC bands 1-4, respectively. The limits for the high reliability point source catalog will be ~1 mJy, ~1 mJy, 2 mJy, and 10 mJy for IRAC 1-4, respectively.

Data Products

We plan to release the same data products that we are releasing for the GLIMPSE project. These are:

- A high reliability **Point Source Catalog** (reliability $\geq 99.5\%$)
- A **Point Source Archive** (all sources with $S/N \geq 5\sigma$)
- A **Mosaicked Image Archive** in tiles of $1.1^\circ \times 0.8^\circ$ regridded to $0.6''$ pixels

Infrastructure and Data Release

The GLIMPSE team has developed a proven, extensively tested, automated pipeline that can process large IRAC data sets on short time-scales. It corrects for instrumental artifacts such as banding, column pull-down, scattered light, and cosmic ray hits, extracts point sources and bandmerges them into catalogs, and produces mosaicked images. These products represent an improvement over the current SSC pipeline products. The GLIMPSE pipeline is the result of extensive efforts by 6 gifted individuals and significant NASA funding investment. **We will make the data available to the community on the same schedule that we have done for the GLIMPSE survey.** Enhanced GLIMPSE II images and the point source catalog and archive will be released every 6 months or sooner after the BCD data have been released to us. We consider this an extension of the GLIMPSE survey including all the responsibilities to deliver high quality data products to the community with no proprietary period.

Other Galactic Center Programs

Dr. Susan Stolovy and collaborators have an approved program to image the region $l = \pm 1^\circ$, $b = \pm 0.75^\circ$. Dr. Stolovy is also a collaborator on this proposal. We plan to avoid the Stolovy area, but will incorporate this data into our GLIMPSE II survey when it becomes public (expected to be March 2006) so that the entire GC region will be seamlessly covered.

3. References & Figures

References

Alard, C. 2001, A&A, 379, L44 330, 591; Babusiaux, C. 2003, Ph. D. Thesis, Cambridge Univ.; Bland-Hawthorn, J., Cohen, M. 2003, ApJ, 582, 246; Blitz, L., Spergel, D. N. 1991, ApJ, 379, 631; Cassé, M., Cordier, B., Paul, J., Schanne, S. 2004, ApJ, 602, L17; Cohen, M. 1994, AJ, 107, 582; Cole, A. & Weinberg, M. D. 2002, ApJL, 574, L43; De Vaucouleurs, G. 1964, in IAU Symp. 20, The Galaxy and the Magellanic Clouds, ed. F. J. Kerr, (Canberra: Australian Acad. Sci.), 195; Egan, M.P. et al. 1998 ApJ, 494, 199; Gerhard, O. 2002, in "The Dynamics, Structure & History of Galaxies", ASP Conf. Ser. 273, 73, eds. G. S. Da Costa & E. M. Sadler; Gerhard, O. 2001, ASP Conf. Ser., 230, ed. J. G. Funes and E. M. Maria, (San Francisco: ASP), p. 21; Indebetouw, R. et al. 2005, ApJ, 615, 931; Kurtz, S., Churchwell, E., Wood, D. O. S. 1994, ApJS, 91, 659; Lopez-Corredoira, M., Cohen, M., Hammersley, P. L. 2001, A&A, 367, 106; Nakada, Y. et al. 1991, Nature, 353, 140; Omont, A. et al. 2003 A&A 403, 9750; Ortiz, R. et al. 2002, A&A 388, 279; Skrutskie, M. F. et al. 2001, AAS Meeting, 199, paper 91.04; Sofue, Y. Handa, T. 1984, Nature, 310, 568; Sofue, Y. 2000, ApJ, 540, 224; Sofue, Y. 2003, PASJ, 55, 445; Wang, Q. D., Gotthelf, E. V., Lang, C. C. 2002, Nature, 415, 148; Wood, D. O. S., & Churchwell, E. 1989, ApJS,

69, 831; **Wood**, P.R., Habing, H.J., McGregor, P.J. 1998 A&A 336, 925; **Wyse**, R. F. G., Gilmore, G., Franx, M. 1997, ARA&A, 35, 637; **Yusef-Zadeh**, F., Hewett, J. W., Cotton, W. 2004, ApJS, 155, 421

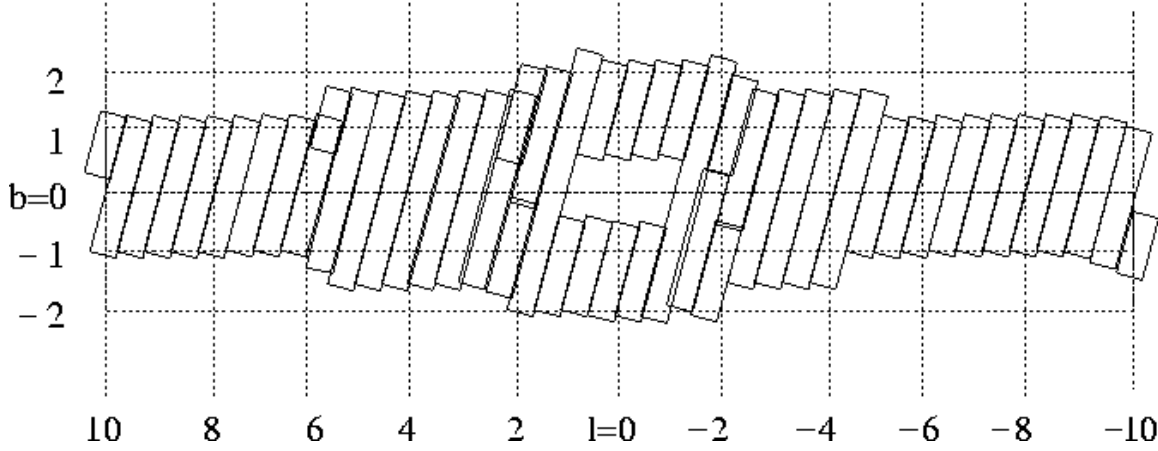


Figure 1. Schematic representation of the borders of proposed AOR's superposed on a grid labeled in degrees in Galactic coordinates.

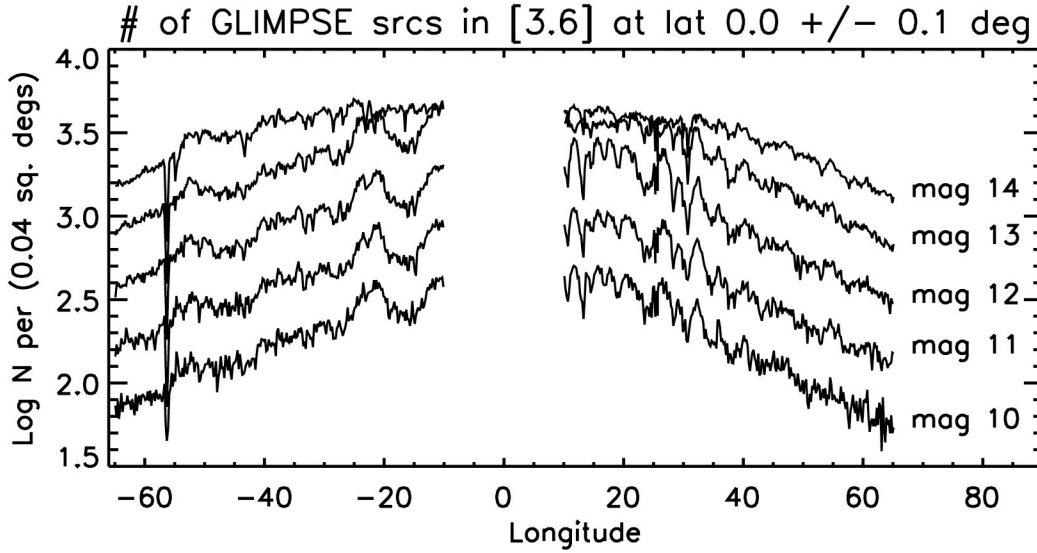


Figure 2. The number of $3.6 \mu\text{m}$ point sources per 0.04 square degrees centered at $b=0^\circ$ vs longitude. Note that the Galactic coordinates are reversed from those in Fig. 1. The deficit at $l \sim -56^\circ$ is due to missing data. At 14^{th} mag., the data are confusion limited at $l < \pm 30^\circ$ as indicated by the flattening of the 14^{th} mag curve. At all other longitudes down to $l=10^\circ$ and mags brighter than 14^{th} , the data are not confusion limited. The Scutum-Crux spiral arm is apparent at $l \sim -52^\circ$ and at $\sim +32^\circ$. An obvious excess at $l \sim -22^\circ$ does not correspond to any of the arms suggested by Taylor and Cordes (1993). The Sagittarius and Norma arms may be barely apparent at $l \sim +47^\circ$ and $l \sim -32^\circ$, respectively. The slope appears to be steeper in the northern than in the southern Galactic plane, but we caution that this is only a small fraction of the data.

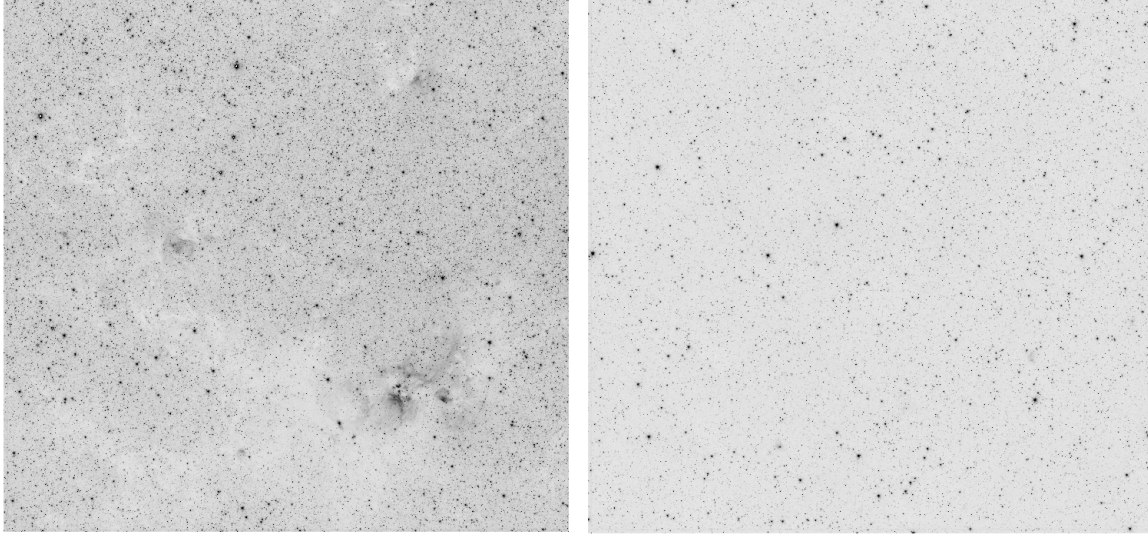


Figure 3. One square degree patches of GLIMPSE 3.6 μ m data centered at (l,b)=(13 $^{\circ}$, 0 $^{\circ}$) on the left and at (55 $^{\circ}$, 0 $^{\circ}$) on the right. Both images have the same brightness scale (reverse grayscale). The GLIMPSE survey has shown that it is possible to obtain reliable photometry at $l \leq 10^{\circ}$ even though the average background and stellar density are greater than at higher longitudes.

4. Brief Resume/Bibliography

PI: Ed Churchwell, Albert Whitford Prof. Astronomy, Univ. Wisconsin

Education: 1970 PhD in Astronomy Univ. Indiana

Professional Experience:

Post doc: NRAO 1970

Heinrich-Hertz Post Doc Fellow., Max Planck Inst. Radioastronomy (Bonn)-1970-72

Fulbright Fellow-1988-89

Univ. Wisconsin: Asist. Prof. 1977-79; Assoc. Prof. 1979-83; Prof. 1983-present

Research Experience

PI: GLIMPSE Spitzer Legacy Science Program

Co-PI: WIYN High Resolution Infrared Camera (WHIRC)

Published more than 140 refereed journal articles and more than 30 invited review articles

Recent Relevant Publications

Churchwell, E. 2002, Annual Rev. Ast. and Astrophys., Vol. 40, 27

“Ultra-Compact HII Regions and Massive Star Formation”

The NOVA Lectures at the Universities of Groningen, Amsterdam, and Leiden, Dec. 2002

“Hypercompact HII Regions: A New Evolutionary Stage of O-Star Evolution?”

Plus the list given in section 6 under GLIMPSE publications

5. Observation Summary Table

Mapping the Inner $\pm 10^\circ$ of the Galaxy

Gal. Long Range	Gal. Lat. Range	Pt. Source Flux Density Range	AOT Bands	Integ. Time/pix	AOR Duration	# AORs
Half-Step						
$\pm 10^\circ - 5^\circ$	$\pm 1^\circ$	$\sim 60\mu\text{Jy} - 200\text{mJy}$	IRAC/[1]	2.4 sec	30.4 hr	38
$\pm 10^\circ - 5^\circ$	$\pm 1^\circ$	$\sim 0.3\text{mJy} - 0.75\text{Jy}$	IRAC/[4]	2.4 sec		
$\pm 5^\circ - 2^\circ$	$\pm 1.5^\circ$	$\sim 60\mu\text{Jy} - 200\text{mJy}$	IRAC/[1]	2.4 sec	29.2 hr	32
$\pm 5^\circ - 2^\circ$	$\pm 1.5^\circ$	$\sim 0.3\text{mJy} - 0.75\text{Jy}$	IRAC/[4]	2.4 sec		
$\pm 2^\circ - 0^\circ$	$\pm 2^\circ$	$\sim 60\mu\text{Jy} - 200\text{mJy}$	IRAC/[1]	2.4 sec	25.0 hr	46
$\pm 2^\circ - 0^\circ$	$\pm 2^\circ$	$\sim 0.3\text{mJy} - 0.75\text{Jy}$	IRAC/[4]	2.4 sec		
Full-Step						
$\pm 10^\circ - 5^\circ$	$\pm 1^\circ$	$\sim 60\mu\text{Jy} - 200\text{mJy}$	IRAC/[1]	1.2 sec	19.0 hr	36
$\pm 10^\circ - 5^\circ$	$\pm 1^\circ$	$\sim 0.3\text{mJy} - 0.75\text{Jy}$	IRAC/[4]	1.2 sec		
$\pm 5^\circ - 2^\circ$	$\pm 1.5^\circ$	$\sim 60\mu\text{Jy} - 200\text{mJy}$	IRAC/[1]	1.2 sec	18.4 hr	30
$\pm 5^\circ - 2^\circ$	$\pm 1.5^\circ$	$\sim 0.3\text{mJy} - 0.75\text{Jy}$	IRAC/[4]	1.2 sec		
$\pm 2^\circ - 0^\circ$	$\pm 2^\circ$	$\sim 60\mu\text{Jy} - 200\text{mJy}$	IRAC/[1]	1.2 sec	16.8 hr	48
$\pm 2^\circ - 0^\circ$	$\pm 2^\circ$	$\sim 0.3\text{mJy} - 0.75\text{Jy}$	IRAC/[4]	1.2 sec		
Subarray	Obsrvs.	Saturated stars			10.0 hr	
Total	Time				148.8 hr	

6. Status of Existing Observatory Programs

Churchwell is the PI of the GLIMPSE Legacy Science Program. The data collection for this program was completed beginning in Nov. 2004. The complete GLIMPSE Point Source Catalog (~ 30 million sources) and Point Source Archive (~ 48 million sources) will be delivered to SSC in March 2005. The enhanced GLIMPSE mosaicked images should be $>10\%$ complete by 30 Mar. 2005, and 100% complete by the end of 2005.

Publications from the GLIMPSE program as of 12/29/04

Benjamin, R. A., Churchwell, E., et al. 2003, PASP, 115, 953, "GLIMPSE: I. A SIRTf Legacy Project to Map the Inner Galaxy"

Churchwell, E. et al. 2004, ApJS, 154, 322, "RCW49 at Mid-Infrared Wavelengths: A GLIMPSE from the Spitzer Space Telescope"

Whitney et al. 2004, ApJS, 154, 315, "A GLIMPSE of Star Formation in the Giant HII Region RCW49"

Mercer et al. 2004, ApJS, 154, 328, "Discovery of a Distant Star Formation Region Using GLIMPSE"

Kobulnicky et al. 2005, AJ, 129, 239, "Discovery of a New Low-Latitude Milky Way Globular Cluster using GLIMPSE"

Indebetouw et al. 2005, ApJ, 619, 931, "The Wavelength Dependence of Interstellar Extinction from 1.25 to $8.0\mu\text{m}$ using GLIMPSE Data"

Cohen, M. et al. 2005, MNRAS, in press, "PN G313.3+00.3: A New Planetary Nebula Discovered by the Australia Telescope Compact Array and the Spitzer Space Telescope"

7. Proprietary Period Modification

The SSC mosaics will be made available immediately. Enhanced images and point source catalogs will be made available at 6 month intervals after we receive the BCD data adopting the same schedule for which we have released GLIMPSE enhanced data to the SSC archive.

8. Justification of Duplicate Observations

We have constructed our map to avoid duplicating the region covered by the Stolovy survey, though there will be slight overlap at the edges to insure full coverage. There are scattered duplications for other small programs in the ROC which would be too costly in time for GLIMPSE II to avoid. We understand that our duplicate observations will be embargoed until the proprietary periods are over for the original GO and GTO observers.

9. Justification of Scheduling Constraints

The constraints on GLIMPSE II will be similar to those on GLIMPSE. That is, GLIMPSE II will be a flexible survey which can be rescheduled, if necessary, on a short timescale. The AORs as written are scheduled in two groups set six months apart. The earlier scheduled and larger set is constrained to start during a 7-day window. Each AOR of the first set is constrained to be observed within about 10 hours of the preceding AOR. The second set of AORs, scheduled six months after the first set, has similar constraints.

10. Data Analysis Funding Distribution

Univ. Wisconsin--52% ; Space Science Institute--19%; Boston Univ.--12%;
UC Berkeley--9%; Univ. Virginia--8%

11. Financial Contact Information

Univ. Wisconsin-Madison:

Phyllis Fass
475 N. Charter St
Madison, WI 53706.
Tel: 608-262-3072
E-mail: fass@astro.wisc.edu

Space Science Institute:

Jennifer Gartner
4750 Walnut St., Suite 20
Boulder, CO 80301
Tel: 720-974-584
E-mail: gartner@spacescience.org

Univ. California Berkeley:

Kathy Wang
601 Campbell Hall
Berkeley, CA 94720-3411
Tel: 510-643-5077
E-mail: kwang@astro.berkeley.edu

Univ. Virginia:

Gerald J. Kane
P. O. Box 400195
Charlottesville, VA 22904-4195
Tel: 434-924-4270
E-mail: gik5y@virginia.edu

Boston University:

Mureen Rodgers
25 Buick St., 2nd Floor
Boston, MA 022165
Tel: 617-353-4365
E-mail: mroddgers@bu.edu