A SPITZER/GLIMPSE INVESTIGATION OF W43

Jessica Fuselier (Xavier U. of Louisiana), Heidi Gneiser, Robert A. Benjamin (U of Wisconsin-Whitewater), GLIMPSE Team

Introduction

The Galactic Legacy Infrared Mid-Plane Survey Extraordinaire (GLIMPSE) is a comprehensive effort to map the Galactic Mid-Plane (Benjamin et al. 2003). Using the Spitzer space telescope (launched August 2003 and first data received Jan 2004) the GLIMPSE team will collect a total of 400 hours of infrared data covering approximately 220 deg^2 of the Milky Way (Benjamin 2003).

This survey has two principal goals: (1) to better constrain the global stellar structure of the Galaxy, including the search for a stellar ring corresponding to the molecular ring, and (2) to study star formation with a large unbiased sample of star formation. However, as part of the Spitzer Legacy program, the GLIMPSE team is also producing a point source catalog and an atlas of mosaicked images which will allow other researchers to search for numerous classes of objects.

Observations

Interstellar dust and absorption of light in the atmosphere limit our current understanding of the galaxy. But an infrared telescope can help, allowing researchers to uncover hidden information.

Using IRAC on the Spitzer Space telescope, infrared data at 3.6, 4.5, 5.8, and 8.0 μm was collected in April 2004 of the star forming region W-43 located at a Galactic latitude l=30.8 and Galactic longitude b=-0.11. (See Figure 1 for a schematic representation of W43's location in the Galaxy). After mosaicking the data, a tricolor image can be made using any three of the four bands.

Previous infrared observations were made with the 2MASS (Two-Micron All Sky Survey) in the J, H, and K bands which can be combined with the GLIMPSE data to produce a 7 band survey of any particular sky region. Images produced with visualization program ds9 are shown in Figure 2-4.

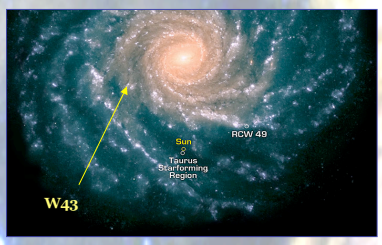

FIGURE 1
An artist depiction of our Galaxy. Through GLIMPSE, we hope to shed some light on the true nature of the shape of the Milky Way.

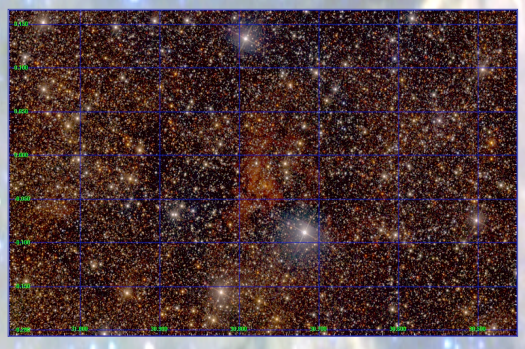

FIGURE 2: Tricolor image of the central region of W43 using 2MASS bands J,H, and K

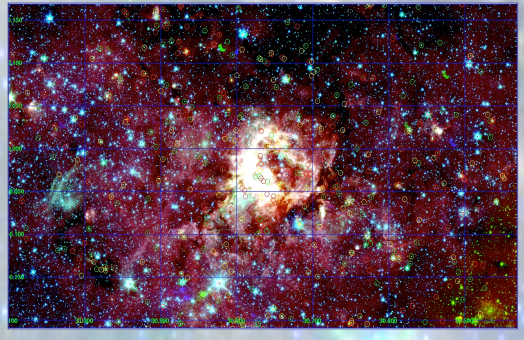

FIGURE 3: GLIMPSE bands 1, 2, 4, overlaid with the location of unusually red point sources. Sources in green have a spectral index of -0.5 to 0, sources in yellow have a spectral index of 0 to 1.0 and sources in red have a spectral index between 1 and 10.

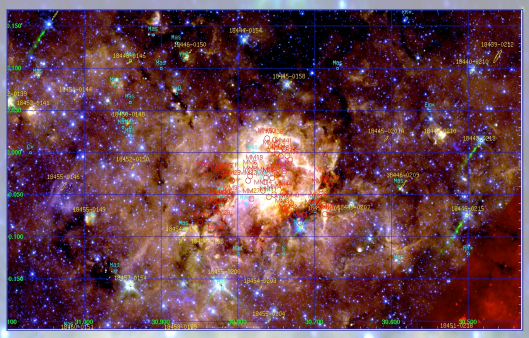

FIGURE 4: Tricolor image using GLIMPSE bands 1, 3, 4. The location of IRAS sources, masers, unusual stars, and molecular cores (MM) from Motte et al 2003 are overplotted.

Analysis

To search the W43 area for interesting objects an annulus of radius=20 arcmin centered at l=30.767 b= -0.035 was chosen covering the brightest section of W43. Color-color and color-magnitude diagrams of the point sources within the annulus were created using IDL (Figures 5 and 6).

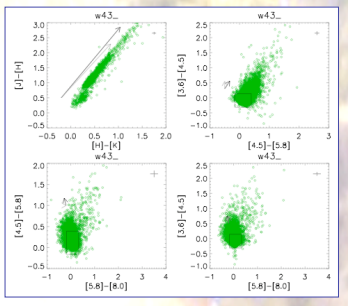

FIGURE 5: Color-color diagrams of the point sources within the central region of W43 were generated using the seven bands in the combined 2MASS and GLIMPSE point source catalog. The arrows show the direction that interstellar extinction would move stars. From these we can categorize stars and identify unusual ones to study further.

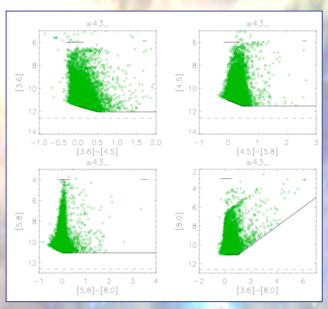

FIGURE 6: Using the seven bands in the combined 2MASS and GLIMPSE point source catalogs, the color-magnitude diagrams of the central region generated show the point source magnitudes along with our magnitude cuts.

Once the color-color diagrams were generated, we selected approximately 200 unusually red sources for further examination. The selected stars were both located on the images as well as searched for in the SIMBAD database, to determine if there has been previous identification. Several sources matched with previous IRAS sources as well as a catalog of molecular cores by Motte et al (2003), denoted by MM. The unusually red GLIMPSE sources for which we found counterparts are shown in Table 1.

GLIMPSE name	Associated Object name	J	H	K	[3.6]	[4.8]	[5.8]	[8.0]
SSTGLMC G030.6517-00.0752	IRAS 18449-0207 (Maser)	-	-	-	11.71±0.09	10.63±0.07	9.71±0.19	8.69±0.31
SSTGLMC G030.6682+00.0631	HD173743	-	-	-	10.72 ± 0.04	9.24±0.06	8.42±0.04	8.56±0.09
SSTGLMC G030.7599-00.0524	MM11/BE83/Caswell (Maser)	-	-	-	10.76 ± 0.33	8.02±0.15	6.61±0.13	5.51±0.16
SSTGLMC G030.7760-00.2384	IRAS 18457-0205	-	-	13.79±0.05	12.09±0.09	11.72±0.12	11.04 ± 0.15	10.38±0.33
SSTGLMC G030.8109-00.0501	MM9	-	-	-	11.91±0.20	8.74±0.06	7.72±0.05	7.81±0.14
SSTGLMC G030.8187-00.0233	MM16	-	-	-	12.36±0.09	10.69±0.07	9.28±0.05	8.57±0.07
SSTGLMC G030.8371-00.1113	IRAS 18454-0158 (Maser)	14.60±0.04	13.53±0.03	13.03±0.04	12.46±0.08	12.37±0.14	11.19±0.35	10.36±0.28
SSTGLMC G030.8694-00.1031	IRAS 18454-0156 (Maser)	15.93±0.10	13.18±0.04	11.14±0.02	8.26±0.04	7.41±0.06	6.75±0.04	5.41±0.04

TABLE 1: Unusually red GLIMPSE sources with their magnitudes in all seven bands.

Three of our sources lie in the direction of the molecular cores, MM9 MM11 and MM16, discussed in Motte et al. MM9 has a core dust temperature T_{dust}= 20K, dust mass M_{smm}= 290 M_o, molecular hydrogen density $<n_{H2}>$= 1.2 x 10^5 cm^{-3}, and velocity dispersion of $\Delta\upsilon$= 5.5 km s^{-1} for $H^{13}CO^+$(3-2) molecular transition. For MM11 the properties are a core temperature T_{dust}= 20K, dust mass M_{smm}= 190 M_o, molecular hydrogen density $<n_{H2}>$= 1.6 x 10^6 cm^{-3}, and velocity dispersion $\Delta\upsilon$= 3.8 km s^{-1} for $H^{13}CO^+$(3-2) molecular transition and $\Delta\upsilon$= 6.7 km s^{-1} for HCO^+(3-2) molecular transition. MM16 is found to have a core dust temperature T_{dust}= 20K, dust mass M_{smm}= 260 M_o, and molecular hydrogen density $<n_{H2}>$= 4.2 x 10^6 cm^{-3}. Although it is not yet clear if these sources are embedded protostars, the association is clearly worth further study.

Figure 7 shows the correspondence between our highly reddened GLIMPSE sources and associated objects.

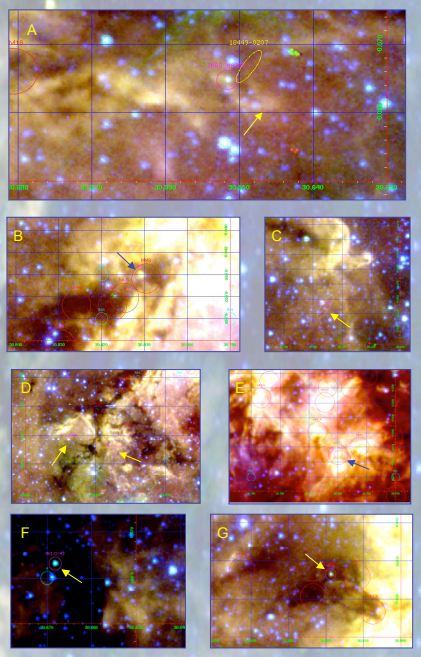

FIGURE 7: A compilation of images using GLIMPSE bands 1, 3, 4 showing the point sources reidentified by the GLIMPSE survey. (A) IRAS 18449-0207 (B) MM9 (C.) IRAS 18457-0205 (D) IRAS 18454-0156 and 18454-0158 (E) MM11 (F) HD173743 and (G) MM16.

Future Study

We have also used the S2KB detector on the WIYN 0.9m telescope in June 2004 to obtain optical UBVRI and H-alpha photometry in the direction of W43. When this data is completely analyzed, we will have a total of 12 bands with which to generate images and diagrams and further classify and characterize the stellar content within W43.

References

Benjamin et al 2003 PASP, 115, 953B
Whitney et al 2004 ApJS, 154, 315W
Motte et al 2003 ApJ, 582, 277M

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