An Infrared Supernova Remnant Survey in the Galactic Plane

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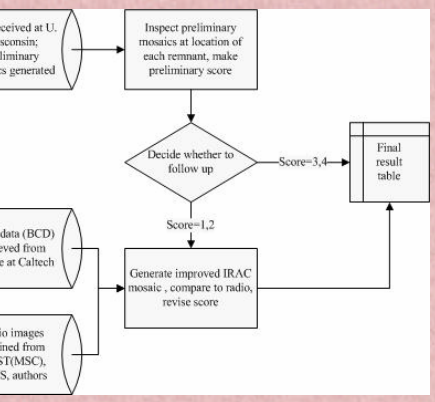
ABSTRACT

rched for infrared counterparts of known supernova remnants that fall the boundaries of the Spitzer/GLIMPSE Legacy survey (gala ctic nates |b|<1°, 65°>|l|>10°). The survey uses the Infrared Array Camera) with four bands at 3.6, 4.5, 5.8, and 8 µm. Ninety-six known supernova nts are included in the survey, which is ongoing but nearly complete. We d infrared emission from several supernova remnants, and for many of is the first detection of their infrared emission. The 4.5 µm images t least some supernova remnants distinct from the blinding ly bright on of HII regions and molecular clouds in the galactic pla ne. The 4.5 waveband in these cases is dominated by molecular line em ission (H_2 0) and possibly Brackett alpha. The infrared images reveal not only the ova remnants themselves but also nearby surrounding interstellar m such as HII regions, dark clouds and possible young stars. Some of the mpressive images include G311.5-0.3, W 44, 3C 391, and RCW 103.

INTRODUCTION

of the radiation from supernova remnants is expected to be in rared range, from heated grains and nebular emission lines. ver, supernova remnants have generally proven to be difficult in the infrared, especially in the galactic plane where HII s are far brighter than supernova remnants. Infrared supemova nt surveys have been nearly impossible in the galactic plan e. tempts using IRAS found possible emission from 12 and 14 nts, respectively, and only 7 in common, from the sample of nants in the portion of the Galactic plane covered by our . The new Spitzer/IRAC results presented here are a cant advance because of the large increase in angular ion and sensitivity.

DATA ANALYSIS



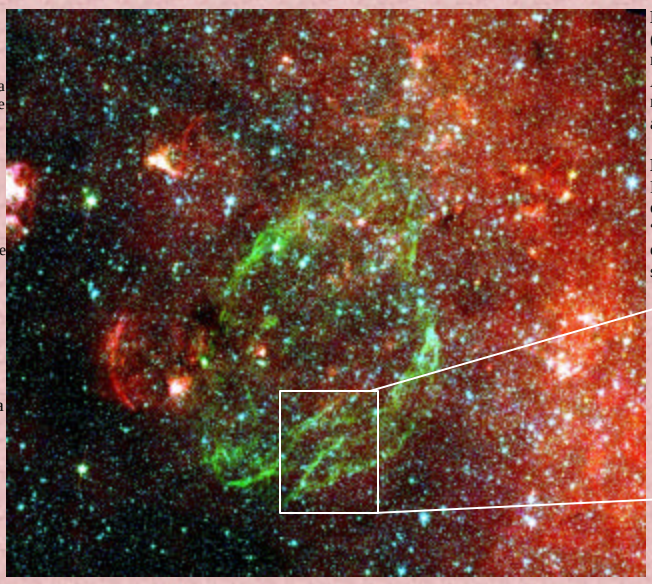
INFRARED COLORS

se the following templates, with the proportion notation annels 1:2:3:4 (wavelengths 3.6:4.5:5.8:8 µm), to y infrared emission:

SO spectra of the reflection nebula NGC 7023 yield 0.054:0.061:0.40:1, and GLIMPSE images of NRAO eld colors 0.040:0.046:0.35:1. The colors are a nation of PAH and nebular line emission

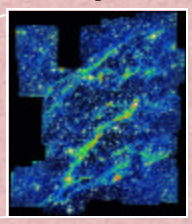
ked molecules: An H_2 excitation model for IC 443 (Rho 2001) yields colors 0.16:0.15:0.55:1. A CO fundamental falls within channel 2, comparable to H_2 in molecular s in HH objects, so a molecular clump would have 0.16:0.3:0.55:1. Such shocks are distinguished by channel 1+2 enhancement.

d gas: Pure H recombination (case B) has colors .7:0:1. Including atomic fine-structure lines (mostly Fe r), and using RCW 103 as a guide to the brightness e to H lines, the predicted colors for ionic shocks are .10:0.69:1. Such gas is distinguishable from the ISM nocked molecular gas by bright channel 3+4 and very hannel 1. If the shocks cannot destroy grains as ntly as in RCW 103, then channel 3 (dominated by Fe II) crease, while channel 4 (dominated by Ar) remains



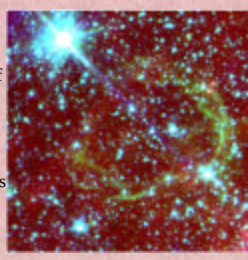
LEFT. IRAC color image of 3.6 µm (blue), 4.5 (green) and 8 µm (red) emission from W 44. The remnant is the green filamentary oval near the ce A red HII region is just west of the remnant, and red extended emission extends along the galactic along the eastern third of the image.

BELOW: Narrow-band H2 2.12 µm image (Palo Prime Focus Infrared Camera) of the portion of W enclosed by the white box in the figure at left. Th "green" IRAC emission matches this H2 image i detail, demonstrating that the former is almost en shocked molecular gas.



By the numbers: Summary of survey results

96 Remnants in the survey region
51 Remnants analyzed as of 1/3/05
10 Remnants detected
6 with colors of shocked molecules
3 with colors of ionized gas
1 with colors of interstellar dust
3 Possible detections, but too confused
18 No bright infrared emission

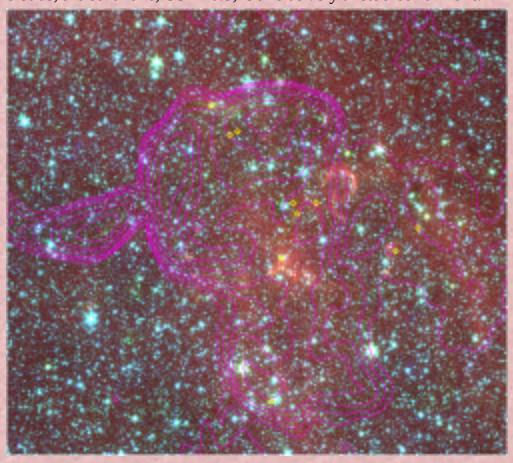


RIGHT: IRAC color image of 3.6 µm (blue), 4.5 µm (green) and 8 µm (red) emission from G311.5-0.3. This relatively unstudied remnant was prominent in the IRAC images due to its distinct colors, which are consistent with shocked molecular gas.

LEFT: IRAC color im of 3.6 µm (blue), 4.5 µ (green) and 8 µm (red) emission from W 49B. This is a combination o molecular and ionic emission (based on the bright FeII and H2 nea infrared lines we detec at Palomar).

RESULTS

We detect infrared emission from 10 remnants with the new Spitzer/GLIMPSE/IRAC data. The set of infrared detected remnants is mostly different from those reported with from the IRAS-based surveys, both because of different wavelengths and severe source confusion in the IRAS (~2′) beam compared to IRAC (~2″). Using the color templates described above, we classified the emission. Six remnants have colors characteristic of shocked molecules. Such emission stands out as "green" on the color images shown in this poster because of relatively bright H2 and CO emission in IRAC channel 2. Five of these already had good indications of interaction with molecular clouds; the other one, G311-0.5, is a relatively unstudied remnant.



LEFT . Radio continuum (magenta) contours superposed on the color image of 3.6 µm (blue), 4.5 µm (green) and 8 µm (red) emi from CTB 37A (center) and G348.5+0.1 (filament extending wes left-hand edge of image). Yellow diamonds show locations of OH MHz masers (Green et al.). Patches of "green" emission are locat the northern shell of CTB37A and along the radio ridge of G348.5 this green emission is most likely shocked molecular gas. The "re patches in the south and east portions of CTB 37A have colors mo characteristic of the ISM and could be unrelated photodissociation regions; however, some of the "red" regions have detailed relatio with the nonthermal radio continuum emission and are plausibly into lower-density gas.

CONCLUSIONS

The data for the survey have been collected and over half of the remnants have been analyzed. Many of the most-noticeable infra emitting supernova remnants in the galactic plane are those inter with molecular clouds. Results from the complete survey are bei compiled into a journal article to be submitted this Spring.