Spitzer Observations of Young Stars in the Witch Head Nebula (IC 2118)

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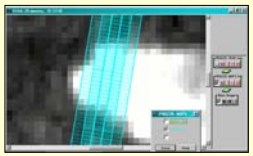
Abstract: Two high-Galactic latitude molecular clouds (HLC) in the region of IC 2118, the Witch Head Nebula, appear to be forming stars (Kun et al. 2004). Star formation in HLCs, while rare, may be the origin of some of the apparently isolated T Tauri stars revealed by ROSAT. At only ~210 pc away, the clouds in IC 2118 are thought to be excited by Rigel. Kun et al. (2004) reported the discovery of several T Tauri stars in this region and estimated their ages to be 2.5 Myr. We observed a ~15'x15' region centered on the head of the northernmost cloud with Spitzer, using IRAC (3.6, 4.5, 5.8, and 8 microns) and MIPS (24, 70, and 160 microns). We have approximately quadrupled the number of known or suspected young objects in this region. In this poster, we will present color-color plots and SEDs of these stars, and we will compare the properties of these stars to those of other star-forming regions. These observations are part of the Spitzer Space Telescope Research Program for Teachers and Students. Our companion poster on the educational aspects of this program, [109.02] Young Stars in IC2118 by Weehler et al., was presented Wednesday, January 11, 2006.

METHODS

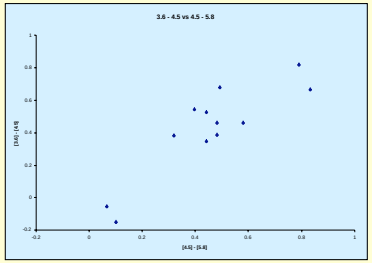


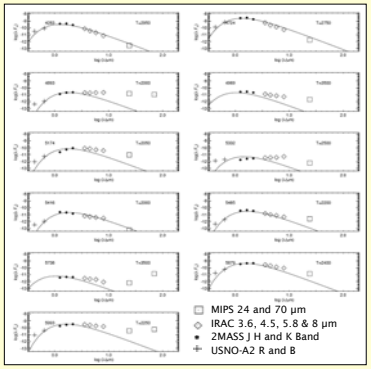
IRAC **MIPS**

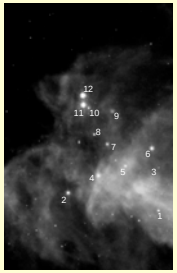
- Met with Spitzer scientist Dr. Luisa Rebull to discuss studying star formation in a region of IC 2118.
- Identified several potential target areas in the cloud and selected an area of the cloud containing a known IRAS source and three new classical T Tauri sources identified in Kun et al (2004).
- Developed an astronomical observation request (AOR) for the proposed region using Spot.
- The target center coordinates are RA 05h 07m 21s, DEC -6d 18m 04.5s (J2000).
- Used two instruments, IRAC and MIPS.
- Used IRAC to make a 4 X 5 frame map at 3.6, 4.5, 5.8, and 8.0 microns with 3 dithers (cycling dither pattern) in the high dynamic range mode, each exposure 12s. This covered a 20 x 20 arcmin area. Total duration for IRAC was 1819s.
- With MIPS we did a fast scan at 24, 70, 160 microns, four legs, stepping by half an array each time. This covered a 20 arcmin strip through the center of the target, including most of the IRAC map. The total duration for MIPS was 1902 seconds, bringing the total project time to 3721 sec (62 min).

- The data were collected in March 2005.
- We visited the Spitzer Science Center (SSC) in two groups, in August and September 2005, to work with Dr. Rebull in the reduction of the data.
- The team used MOPEX to create a mosaic and a list of band-merged sources.
- The source list data table includes 2MASS (J, H, and K bands), IRAC (3.6, 4.5, 5.8, 8 μm), and MIPS 24 and MIPS 70 μm fluxes in both magnitudes and Janskys.
- The data tables were imported into Excel. These data were used to generate color-color plots to classify young stars based on degree of infrared emission.
- Spectral Energy Distributions (SEDs) were constructed using IRAC+MIPS (combined with 2MASS) to discriminate between cluster members and background extragalactic objects.
- Maxim DL was used for generating tri-color images of the target area. It is currently not possible to extract accurate flux values using Maxim DL; however these images were used for visual observation and spatial analysis.

RESULTS





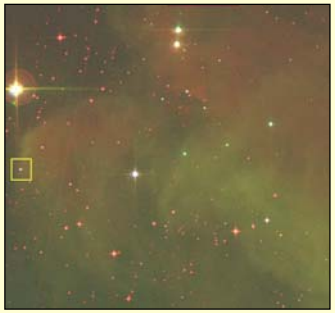


Using the 2-8 micron slope (following Wilking et al. 2001), we find :

2 Class I Objects (#7 & 10 in figure at left)
1 Flat-Spectrum Object (#4)
7 Class II Objects (just three of which -- #6,11,12 -- were previously found by Kun et al.; the new ones are #3,5,8,9)
2 Class III Objects (#1 & 2)

ABOVE: A four-color composite image of the region observed by Spitzer. Adobe PhotoShop and FITS Liberator were used to generate the composite image using IRAC 3.6 (blue), 4.5 (green), 5.8 (yellow), and 8 (red) micron data.

BELOW: Using MaxIm DL to combine IRAC 3.6 (blue), IRAC 5.8 (green) from our current observation, and POSS2 (red) data from January 20, 1985, we serendipitously may have captured the proper motion of one star. Preliminary estimates place the proper motion around 0.2 arc seconds/yr or 184 km/s.



Further Study

- Monitoring T-Tauri finds for fluctuations and additional optical data using the Faulkes 2-Meter Telescope in Hawaii, Perth Observatory in Australia, New Mexico Skies Observatory, and Pomona College Observatory.
- Submit Spitzer proposal to observe the entire IC 2118 Cloud.

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