



Searching for Star Formation in Lynds Dark Nebulae near the Galactic Equator



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We used archival data from the Spitzer Space Telescope IRAC (3.6, 4.5, 5.8 and 8 μm) and MIPS (24 μm) instruments for 17 Lynds clouds within 1° of the galactic equator. We selected these objects because a preliminary literature search provided IRAS data indicating star formation may be taking place. The goal of this study was to search for signs of star formation in each of these dark dust clouds of Lynds opacity classes 5 and 6, to further explore any known young stellar objects (YSOs) in these clouds, to search for additional embedded YSOs, and to explore a possible relationship between YSOs and their proximity to the Galactic Equator.

This project was completed by nine high school students as part of the Spitzer / NITARP program.

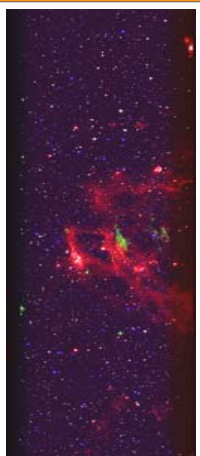
Background

Dust is pervasive in the universe. It collects in large areas all over our galaxy. In 1962, Beverly Lynds undertook a general survey of dark nebulae based on Palomar-Schmidt photographs (Lynds 1962). She determined the position of the center of each cloud and made visual estimates of the opacity of each cloud, using a scale of 1 to 6 with the higher number corresponding to greater visual opacity.

We specifically wanted to use Spitzer data to look for new YSOs in opacity class 5 or 6 LDN in the galactic plane. We selected 17 LDN; we report here on early results from 5 of the LDN in our sample.

LDN 604

Lynds 1962 reports galactic coordinates L(II) 33.03, B(II) 0.25, RA 18:49.0, Dec +00 10 [1950], RA 18:51.6, Dec +00 14 [2000]. Opacity class 5.

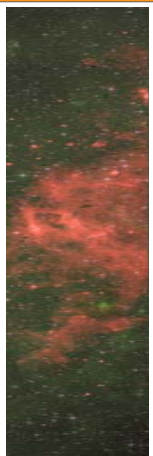


LDN 604 is much more obvious in optical than in infrared wavelengths.

No YSOs detected.

LDN 611

Lynds 1962 reports galactic coordinates L(II) 33.65, B(II) -0.53, RA 18:53.1, Dec -00 20 [1950], RA 18:55.7, Dec -00 16 [2000]. Opacity class 5.



LDN 611 is bright at infrared bands.

One possible Class II YSO detected.

LDN 1614

Lynds 1962 reports galactic coordinates L(II) 203.26, B(II) -16.69, RA 05:33.0, Dec -00 40 [1950], RA 05:35.5, Dec -00 38 [2000]. Opacity class 5.



LDN 1614 has dark regions of the cloud visible in short (3.6 μm) and long (24 μm) infrared wavelengths.

One possible Class II/III YSO detected.

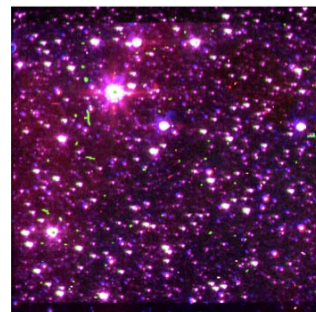
LDN 1620

Lynds 1962 reports galactic coordinates L(II) 203.84, B(II) -16.72, RA 05:43.0, Dec -00 10 [1950], RA 05:36.6, Dec -00 08 [2000]. Opacity class 5. Two possible Class II YSOs detected.



LDN 587

Lynds 1962 reports galactic coordinates L(II) 31.50, B(II) 2.88, RA 18:37.0, Dec 00 00 [1950], RA 18:39.6, Dec +00 03 [2000]. Opacity class 5.



LDN 587 has dark regions visible in the optical but little or no nebulosity in the infrared.

One possible Class II YSO detected.

Results

We found a total of 5 potential new YSOs over 5 LDN.

The other 12 LDN we examined exhibited no obvious signs of star formation:

LDN 576	LDN 582	LDN 597	LDN 605
LDN 578	LDN 583	LDN 601	LDN 613
LDN 582	LDN 588	LDN 603	LDN 1627

Our next step will be to match our YSO candidate lists to previously identified objects in the literature. We need to match our sources to IRAS, 2MASS, and other archival data source lists.

References

Dickman, R.L. 1975. *ApJ*, 202, 50.
Dieter, N.H. 1973. *ApJ*, 183, 449.
Lynds B.T. 1962. *ApJS*, 7, 1.
Stutz, M, et al. 2009. *ApJ*, 707, 137.

Color Composite Images

The authors compiled the composite images using Adobe Photoshop and FITS Liberator. IRAC-1 (3.6 μm) = violet, IRAC-2 (4.5 μm) = blue, IRAC-3 (3.6 μm) = green, IRAC-4 (3.6 μm) = red, and MIPS-1 (24 μm) = maroon. LDN 587 contains all 5 bands, while the other images show IRAC wavelengths only.

Spitzer/NITARP Research Programs

The Spitzer Space Center (SSC) and the National Optical Astronomy Observatory (NOAO) are working together to provide teachers and students with authentic science experiences using the Spitzer Space Telescope. The main goal is to inspire students to pursue STEM careers, as well as to engage the public in sharing the experience of exploration and discovery. More information available at: http://coolcosmos.ipac.caltech.edu/cosmic_classroom/teacher_research