

A Multiwavelength Study of Barnard 1: A Young Star-forming Region

Srabani Datta*

Jodrell Bank Centre for Astrophysics, University of Manchester, Oxford Road, Manchester M13 9PL, U.K.

Email- Srabani.Datta@manchester.ac.uk

We perform a multiwavelength study of a young star-forming region in Perseus, Barnard 1, involving data in the infrared using the Infrared Array Camera (IRAC) and the Multiple Imaging Photometer (MIPS) on the Spitzer Space Telescope from the Cores 2 Disc (C2D) programme and the 2 Micron All Sky Survey (2MASS); in the sub-mm using the Submillimeter Common User Bolometer Array (SCUBA) on the James Clerk Maxwell telescope (JCMT). We detect huge plume-like outflows from very young stars around the region, probably connected to it. We also determine age, mass and extinction of these young objects and derive dust and molecular properties.

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1. Introduction

Barnard 1 is a dark cloud in the Perseus molecular cloud complex. It is located at a distance of 320 pc [1] at RA 3h 33m 14.09s; 31d 8m 59.0s [2]. It is connected to L1448, L1455, NGC 1333, B5 and IC348 in the Perseus complex through an ambient molecular gas of density about 10^2cm^{-2} . It has a dense core surrounded by a less dense envelope and a thin outer shell.

Observations reveal that B1 contains a clumpy substructure, several young stellar objects (YSOs) and Herbig Haro (HH) objects [1,2,3] around its central region. Early star formation can be traced by Herbig Haro objects, of which 26 are found in B1 [1]. We have found parsec scale outflows from MIPS images (Fig.1), which implies that star formation has been taking place for at least 10,000 years.

2. Extinction studies in B1

Our analysis of early star formation in B1 consists of constructing a K-band luminosity function and measuring the extinction in the K-band ($2.15 \mu\text{m}$). We use images from the Spitzer Infrared Array Camera (IRAC) and Multiple Imaging Photometer (MIPS) instruments. IRAC images are in the mid-infrared in $3.6 \mu\text{m}$, $4.5 \mu\text{m}$, $5.8 \mu\text{m}$ and $8.0 \mu\text{m}$, while the MIPS images are in $24 \mu\text{m}$. The processed data (post BCD) were taken from the Cores 2 Disc (C2D) Spitzer archive using Leopard (Table 1).

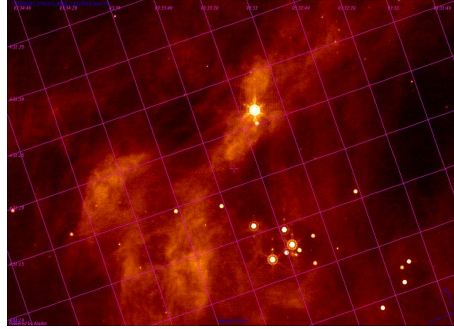


Figure 1: Spitzer MIPS image of Barnard 1 showing parsec scale outflows (AOR 5782272).

Table 1: Details of IRAC and MIPS data taken from the Spitzer archives.

AOR	RA	Dec	Instrument	PID
5782272	3h 33m 34.0s	31d 08m 57.0s	MIPS	178
5785344	3h 33m 36.0s	31d 08m 50.0s	IRAC	178
5788928	3h 33m 34.0s	31d 08m 57.0s	MIPS	178
5792512	3h 33m 17.4s	31d 09m 36.0s	<i>IRAC_{map}</i>	178

We look for embedded stellar clusters in the dusty regions of B1, which would otherwise be obscured in visible wavelengths. Our methods are statistical, based on stellar surface density

studies. We derive the A_k values using H -K colours of all stars taken from 2MASS data as the K band is most sensitive to embedded young stars. We reject stars with $H - K$ values greater than 3σ from the mean in order to avoid foreground and background stars [4]. Fig.2 shows a A_k contour map over the MIPS field of view (AOR 5782272).

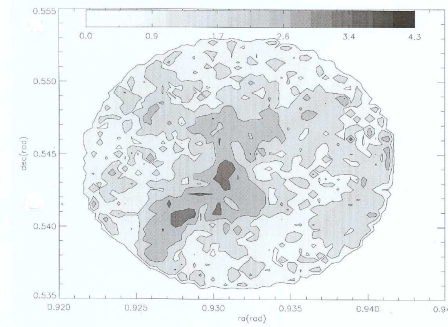


Figure 2: Map of A_k in the area given in MIPS AOR 5782272 derived from 2MASS data of all stars from H-K colors.

We also construct the K-band luminosity function (KLF), looking for significant asymmetric structure (figure 3). Our results show that the B1 region is dusty with predominantly young stars and YSOs.

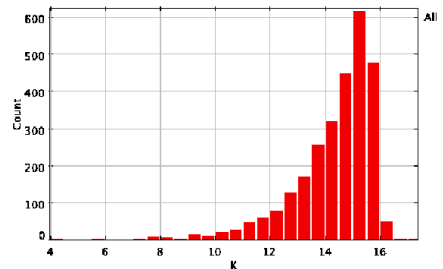


Figure 3: K-band apparent magnitude histogram for B1 for all stars in MIPS image (AOR 5782272).

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References

- [1] Walawander,J; et. al. 2005 Ap.J.; 130; 1795
- [2] Matthews,B.C. & Wilson, C.D. 2002; Ap.J.;574; 822
- [3] Walawander,J ;Bally, J. & Reipurth, B. 2005;A.J.; 129;2308
- [4] Gutermuth,R.A.; et. al. 2005; Ap.J.; 632;397