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Study of Far Infrared Nebula at Declination +53° (J2000) In Iras Map

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Abstract: *In this present work we studied the flux density variation, calculate temperature, dust mass and finally Jean's mass of structure using data reduction software ALADIN2.5. Our aim was to test whether this region is star forming or not. Sky view observatory was used for the search of isolated nebular structure in the far infrared (100 µm and 60 µm) in IRAS (Infrared Astronomical Satellite) catalogue. Stellarium software was used to find coordinate of the structure. A far infrared dust structure (about ~ 11.99 × 3.14 pc.) at Right Ascension (J2000):01^h 51^m 56.02^s Declination (J2000): +53^{deg} 27^m* 39.0^s *found at the distance of about 550 pc. The dust color temperature was found to lie in the range 18.02 K to 39.56 K. An offset of about 21 K suggests that the structure is not independently evolved, discrete source may play significant role in structure formation mechanisms. The study of flux variation along major and minor axis of structure showed that mass is concentrate at the center of structure. The total mass of the gas structure was found to be about 1.1432× 10^{31}Kg. The Jeans mass was found to be 1.17 x 10^{33}Kg, more than that of the total mass of the structure, suggest no clue of star formation.*

Keywords: Infrared, Jeans Mass, Nebula, IRAS, ALADIN 5

1 INTRODUCTION

Study of infrared light emitted from the celestials object seem to be more precise and accurate to understand the actual physics behind the structure formation. The distance interstellar (ISM) molecule, dense and cool cloud, nebula, even white dwarf emits visible wavelength but these wavelength band spectrum converted into infrared band while detecting through our telescope like IRAS. The space between the two star systems in a galaxy contains 99% gas(H, He) and only 1% mass of dust (Silicates, graphite) and it can absorbs visible light but can emits radio wave or infrared radiation are the part of interstellar medium. The collapses of interstellar cloud leads to the formation of nebula and finally star. The fundamental method of describe the formation or evolution of star particularly depend on the content and mechanisms of young stellar object (YSOs) because these are the object responsible for birth of star. But these kinds of object are hidden within the cloud such that they are invisible in optical band and can detectable in infrared wavelength spectrum. Although the IRAS (Infrared Astronomical Satellite) provide the map of sky two decades ago there are still large numbers of unknown structure. IRAS catalog provide the physical and chemical composition of any (stellar) object which might be capable of shaping interstellar structure of small or moderator mass located at or around the extended emission. All the theories based on the current observations indicate that the star is formed as a result of large scale gravational instability developed in the central region of the massive molecular clouds.The instability initiated by the this process is called Jean's instability. This instability caused the collapse of interstellar gas clouds and subsequent star formation. If the mass of the gas exceeds the jeans mass limit of the structure then the foramtion of star is likely to take palce in the region.The mass limit of star stillcontrovisral among many theories and it will be take a long time studies to ferceses. Characterstics of stellar masses as stellar parameter is quit different for lower and higher mass star.

In this present paper we describe the temperature and mass of dust along with jeans mass to feresee star formation activities. Flux density varation along different axis of structure show the concentration of mass along the structure.

2. THEORY

The constitute of ISM are the part of old star which are already burnt-out and scattered in space. These ejected materials are in low density state excited due to collision of molecules under low density conditions. Kinetic energy of interstellar cloud goes decreasing due to continuous emission of radiation from excited level molecule cause them to cool. Further these low temperature molecules of

ISM get accumulated due to the gravitational attraction and form a clump of cloud. This process will continuous till the fragments (or clumps) become so dense that they are optically thick so the radiation can no longer escape and the temperature begins to rise, stabilizing the collapse and forming a proto-star. This leads naturally to the formation of a stellar nursery and therefore the formation of star cluster with a range of the star masses.

We believe that star formation results from the collapse under gravity of large diffuse interstellar clouds. As we consider spherical cloud of radius, "*R*", mass, "*M*", isothermal temperature, "*T*", and density "*ρ*". In hydrostatic equilibrium the outward force due to the gas pressure (which tries to expand the gas) is exactly balanced by the inward gravity force (trying to collapse the gas). In stars like the Sun, these two forces are in balance and the star remains stable and has a constant radius.

The simple equation of Hydrostatic Equilibrium (HE) gives:

$$P = -\rho\, G \frac{M}{R^2}$$

Where *"P"* is pressure and "*G*" is gravitational constant.

If L.H.S. > R.H.S, the gas would expand and the radius increase and vice-versa.

3. METHODOLOGY

3.1 Region of Interest

We search the isolated structure using the IRAS catalogue at Right Ascension (J2000):$01^h\ 51^m\ 56.02^s$ Declination (J2000): $+53^{deg}\ 27^m\ 39.0^s$

3.2 Temperature Estimation

For dust color temperature estimation of structure we use the method describe by Schnee et al: (2005). We use the IRAS 100 µm and 60µm FITS image to calculate the flux density in each pixel of structure.

$$T_d = \frac{-96}{ln\left\{R \,X\, 0.6^{(3+\beta)}\right\}}$$

Where R is given by $R = \frac{F(60\mu m)}{F(100\mu m)}$

F (60 µm) and F (100 µm) are the flux densities at 60 and 100. The average value of the background flux is obtained by remarking and summing up of the minimum flux densities around the region of interest and dividing the sum by total number of pixels.

3.3 Dust mass estimation

The dust mass of structure was calculated by using following formula suggested by Young et.al.

$$M_{dust} = \frac{4}{3}\frac{a}{Q_v}\left[\frac{S_v D^2}{B(v,T)}\right]$$

Where,

a = weighted grain size

ρ = grain density

D = Distance of the Structure

= grain emissivity = f x MJy/Sr x 5.288 x 10^{-9}

$$B(v,T) = \frac{2hv^3}{c^2}\left[\frac{1}{\exp\left(\frac{hv}{kT}\right)-1}\right]$$

Where $B(v,T)$ = Plank function

c = velocity of light

ν = frequency at which the emission is observed

T = Average temperature of structure

To understand the actual mass distribution of our interested region, study of flux density across different axis is essential. Here we study Flux density along major diameter and minor diameter of the structure.

3.4 Size of Structure

To measure the size of structure (Diameter) we use the following expression for the calculation.

$$L = R \times \theta$$

Where R = 550 pc and θ = pixel size (In radian can be measured from the ALADIN2.5).

3.5 Jeans Criteria

We use the following mathematical formula for the calculation of jeans mass of structure.

$$M_J = C\left[\frac{K_B T}{m_H G}\right]^{3/2}\frac{1}{\ \ ^{1/2}}$$

Where K_B is Boltzman constant, T average temperature, is mass of H atom, G is gravitational constant and is density of structure and given by

4. RESULT AND DISCUSSION

4.1 Contour level

To separate the different flux density emission region we draw the three contour level for both 100 micron and 60 micron images show in figure (1).

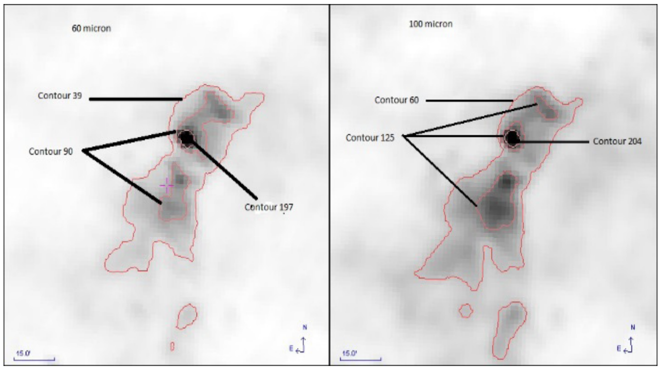

Fig 1: Contour level of 100 μm (left) and 60 μm (Right)

4.2 Temperature Estimation

Overall study of our region maximum and minimum temperature found to be 39.34 K and 18.02 K respectively. There is upset of about 21.32 K variation in our region which suggests that our region is not independently evolved. The average temperature 25.10 k suggests that our region is not cirrus cloud and the region is to cold and faint.

Table 1: Show the temperature of three different contour level profile

Region	Temp.(K)	
	Max.	Min.
Contour 204	34.1731	24.84
Contour 125	32.504	22.64
Contour 60	39.56	18.02

4.3 Mass Estimation

We use the method suggested by Young to calculate the mass of structure, where flux density of each pixel were noted by ALADIN2.5

Table 2: Following table show that the mass of each contour level.

Contour level	Dust Mass (kg)	Mass of Gas (Kg)
204	5.61×10^{26}	1.22×10^{29}
125	1.17×10^{28}	2.34×10^{30}
60	4.49×10^{28}	8.89×10^{30}

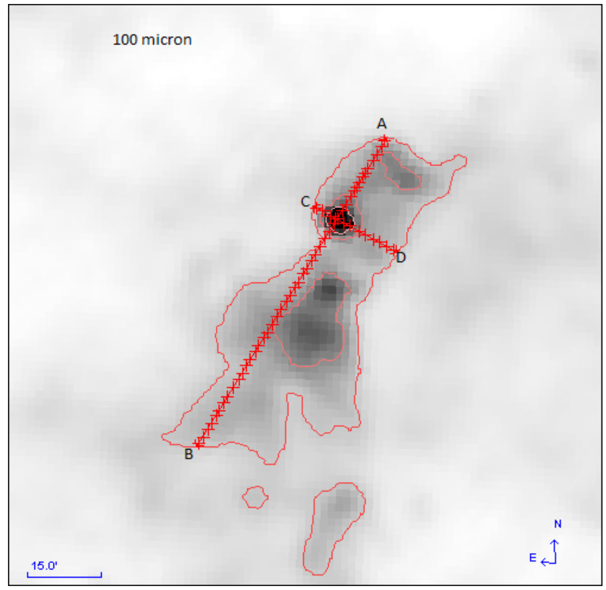

Fig 2: Major (AB) and Minor (CD) axis of structure

So the total dust mass of structure was found to be 5.7161×10^{28} kg, Considering the dust-to-mass ratio 200 (Weinberger & Armsdarfer 2004), the mass of the gas in the region of interest is 1.1432×10^{31} Kg equal to 5.75.

Here, in our case the center region (counter level 204) has low temperature and high mass relatively outer region. For the object should be collapse, gas pressure should be low as possible and thus we need the low temperature. Theoretically the gas mass should be large as possible to maximize the gravity. This concludes that in dense region there is high possibility of collapse of clouds.

With the average radius(R) of a structure about 23.35×10^{16} m and density of structure was 1.92 x, then Jean's mass of structure found 1.17 x Kg which is less than the total mass of structure. This result concludes that there is no possibility of star formation.

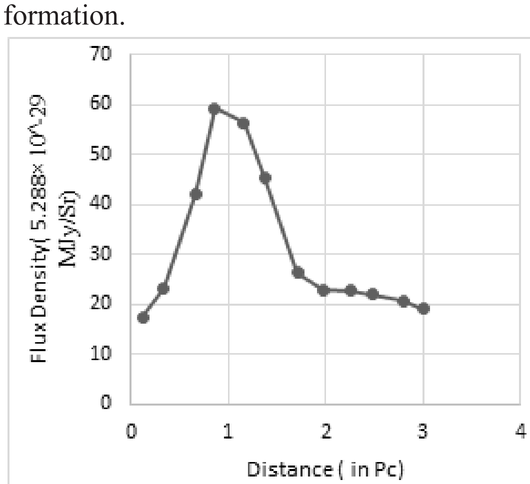

Fig 3: Flux density variation along major axis.

Flux density variation along different part i.e Major and minor axis is shown in figure 3. Here in both case the flux density is maximum at center region, which indicates that mass should be concentration on center region of the structure. As compare the mass of structure from table 2, we can make conclusion that PM1 (contour 204) have significant mass although have minimum number of Pixel number.

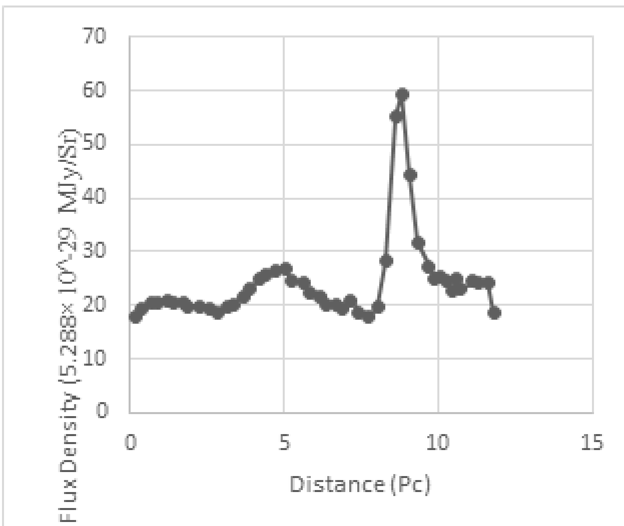

Fig 4: Flux density variation along minor axis

5. CONCLUSIONS

With the help of IRAS (Infrared Astronomical Satellite) survey using Sky View Virtual Observatory (http://skyview. gsfc. nasa.gov/) we find the far infrared isolated structure at Declination + 53.65^0 and Right Ascension 27.7^0(J2000) at distance 550 pc. The dust color temperature was found in the range of 39.56 K to 18.02 K, with an average value 25.01 K and offset of about 21 K suggests the structure is not independently evolves the discrete sources have measurable effect in the field. The Jeans mass was found 1.17 x Kg which is large than that of the total mass 1.1432×10^{31} Kg of the structure, suggest absence of star formation activity in the structures. The cloud is still cool, faint and presence of cold plasma (Aryal 2010). Although the structure has large amount of mass it should accumulate more mass for the formation of star in comparison to jean's mass of structure. If it could not able collect the mass then it will may converted into brown dwarf.

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