DISTRIBUTION OF DUST COLOR TEMPERATURE, DUST MASS AND EXTINCTION AROUND PSR J1240-4124

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Objective

- To calculate and study the physical properties such as dust color temperature, Planck's function, dust mass. size of the structure, inclination angle, and visual extinction around the cavity near PSR J1240-4124.
- To analyze the distribution of the different physical parameters along the extension and contraction.
- To study the distribution of dust color temperature along visual extinction.

Introduction

The interstellar medium (ISM) is low-density matter which consists of gas in molecular as well as the radiations and dust particles. The cold interstellar medium contains far infrared (FIR) structures, cavities, and loops. The process of the formation of these FIR structures indicates the interaction of pulsar wind with the ISM. The physics and chemistry of these structures will enhance a broader knowledge in further research works like polyaromatic hydrocarbon etc.

Infrared Astronomical Satellite (IRAS)

- Launched on 25 January 1983
- Joint project of the US (NASA), the Netherland (NIVR), and the UK (SERC)
- Performed all-sky survey at 12, 25, 60, and 100 μm

AKARI

- AKARI (formerly known as ASTRO-F).
- launched on 21 February 2006 by an M-V rocket, Japan.
- Mapping the entire sky aim six infrared bands from 9 to 180 μm.

Methodology

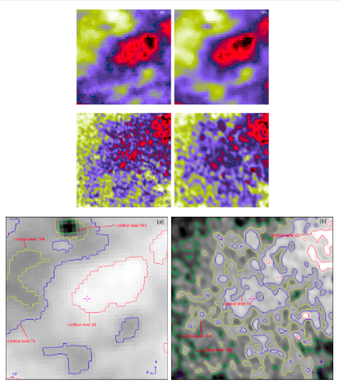
- Database Catalog: The ATNF pulsar database
- SIMBAD
- SkyView Virtual Observatory

Workflow

Data Reduction	Aladin2.5
Calculation	Excel and Python
Graph and Plottings	Python

Region of Interest

We intended to study isolated cavity region at 60 μm and 100 μm in IRIS survey where as 90 μm and 140 μm in AKARI survey.



Working Formula

Dust Color Temperature:

For IRIS:

$$T_{\mathrm{d}} = \frac{-96}{\ln[R \times 0.6^{(3+\beta)}]} \quad (1)$$

For AKARI:

$$T_{\mathrm{d}} = \frac{-57}{\ln[R \times 0.6^{(3+\beta)}]} \quad (2)$$

Planck's Function:

$$B(\nu, T) = \frac{2h\nu^3}{c^2}\left[\frac{1}{e^{\frac{h\nu}{KT}} - 1}\right] \quad (3)$$

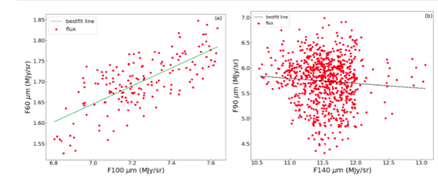
where K is Boltzmann's constant.

Dust Mass:

$$M_{\mathrm{dust}} = \frac{4\alpha\rho}{3Q_\nu}\left[\frac{S_\nu D^2}{B(\nu, T)}\right] \quad (4)$$

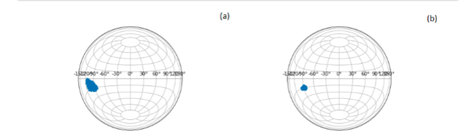
Graph and plots

Linear Plot

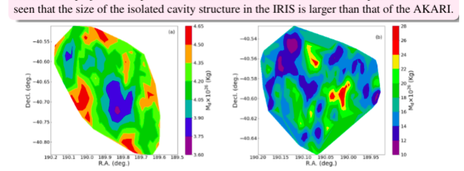


For IRIS, we found the slope = 0.218, the correlation coefficient (r)= 0.714, the intercept = 0.110. For the AKARI, we found the slope = -0.098, intercept = 6.868, the correlation coefficient (r)= -0.074.

Map Projection



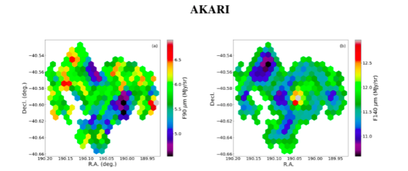
Here, in this projection map, the candidate is located at the southern hemisphere. It can be seen that the size of the isolated cavity structure in the IRIS is larger than that of the AKARI.



In both cases, the maximum mass is observed at the outer region, and minimum mass is observed at the inner region which is indicated by the red and the violet color respectively. From the hexbin and the contour plot, it can be observed that the value of dust mass is higher in AKARI than that of IRIS.

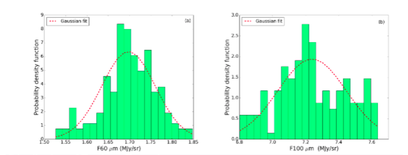
Flux Density Distribution

AKARI

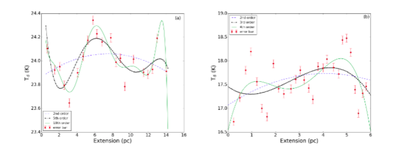


Flux Density Distribution

IRIS



Distribution of T_d along Extension



It can be seen from figure, that the higher order polynomial can best fit our data. And, the standard error in IRIS is ± 0.041 K. Likewise, in the case of AKARI, the standard error is ±

Results

Table 1:Extension and contraction in IRIS and AKARI

Data map	Extension(pc)	Contraction(pc)
IRIS	14.62	6.24
AKARI	5.80	0.17

The angle of inclination for the selected cavity region were found to be 73.33°in IRIS and that of AKARI is 69.76 ° (180°-110.26°). The average visual extinction in the IRIS and the AKARI maps are1.49×10^{-4} mag and 5.81×10^{-4} mag respectively.

Conclusion

The dust color temperature in the IRIS and AKARI survey were found to be in the range of 23.608 ± 0.012 K to 24.342 ± 0.012 K and 16.123 ± 0.017 K to 17.524 ± 0.017 K. While studying the variation of dust color temperature along with visual extinction, we got the coefficient of correlation value near -1 in both the surveys.

References

[1] A . K. Jha, and B. Aryal, A Study of a Cavity Nearby a Pulsar at-60 ∘ Latitude in the Far Infrared Map, Journal of Nepal Physical Society,4, 1, 33-41, (2017).

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