# UV scattering studies of Interstellar grains towards Ophiuchus & Coalsack

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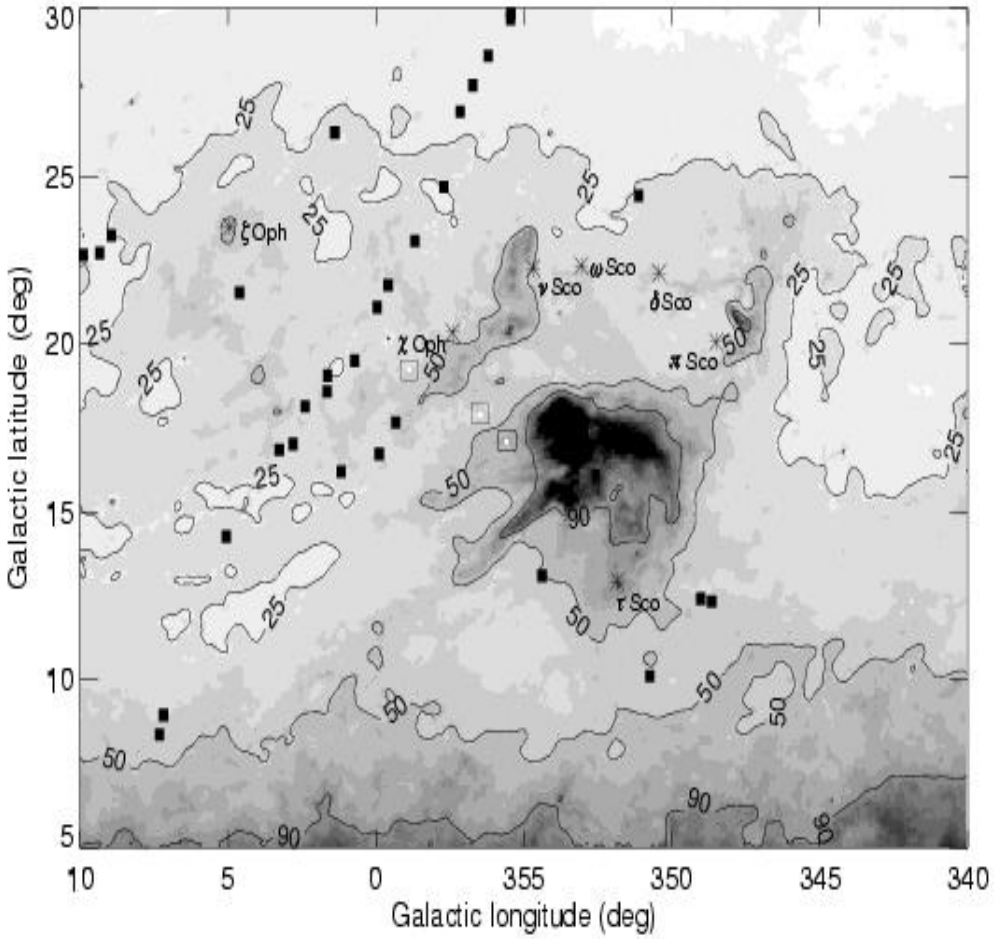
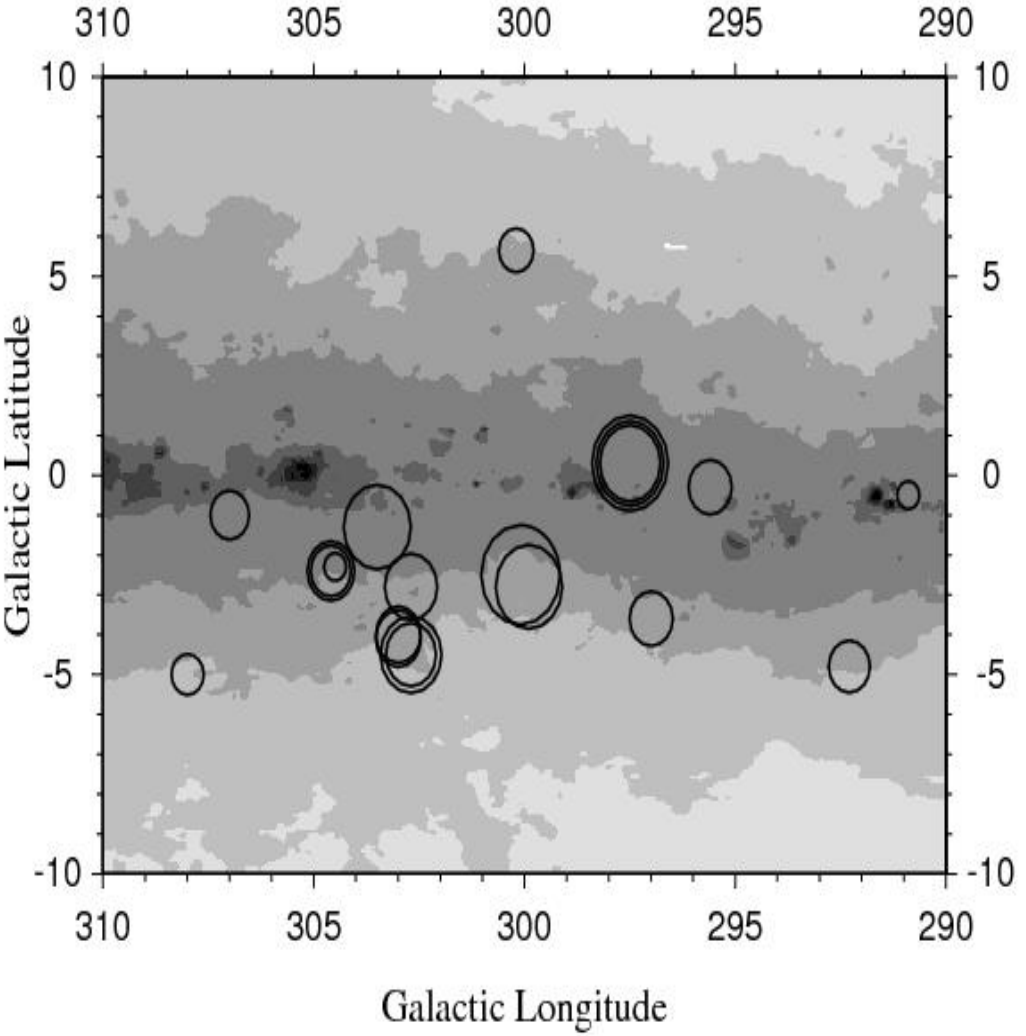
**Abstract:-** We have used ***FUSE*** and ***Voyager*** observations of diffuse emission in the neighborhood of the Coalsack Nebula and Ophiuchus region to derive the optical constants of the dust grains in the corresponding regions. We found that the grains are highly forward scattering in these regions with phase function asymmetry factor, *g* around 0.6 and albedo, *a* around 0.3.

Even though most of the gas in these directions is in the molecular cloud, the diffuse FUV emission is almost entirely due to scattering in a relatively thin foreground cloud. We have also found that there is a high dependence of diffuse background on the local effects like, the amount of dust near the dominating star in the region and the distance between dust & the dominating star etc.

Observed Locations are overplotted on the IRAS (100 μm) map of Ophiuchus & Coalsack regions.

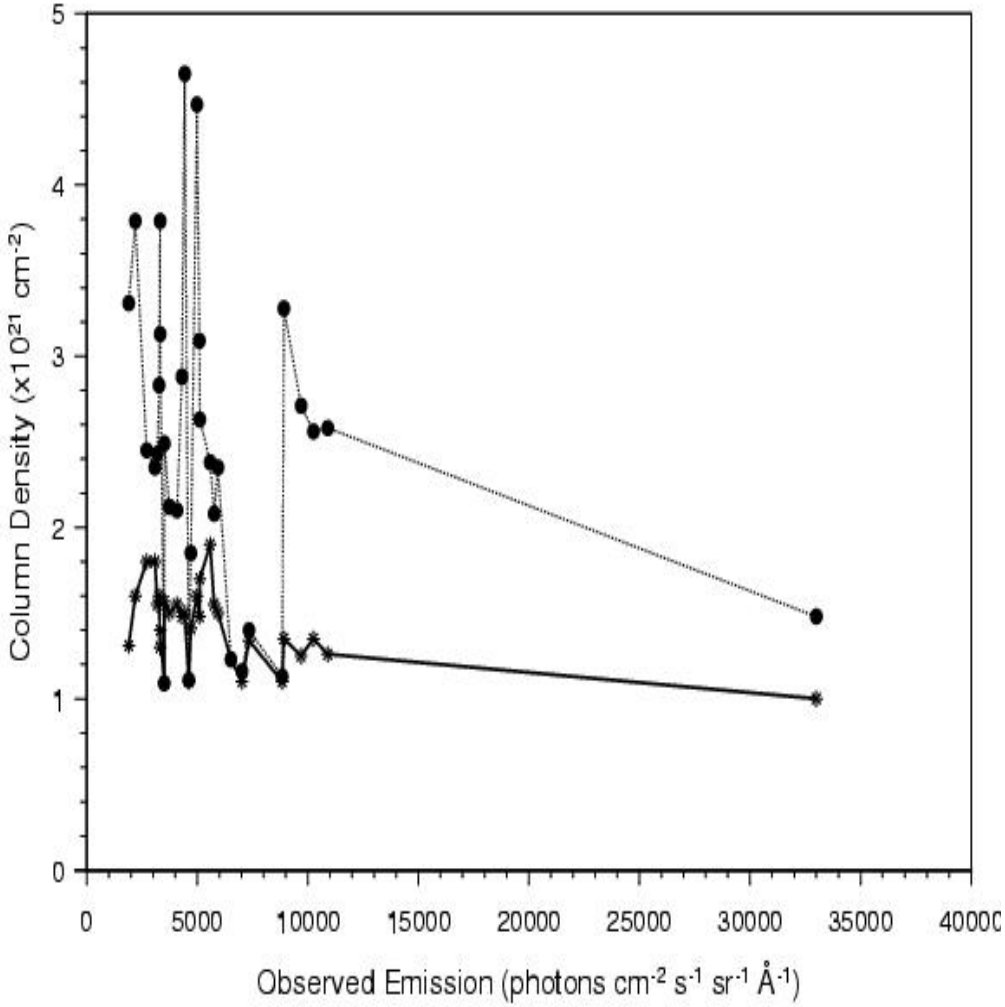


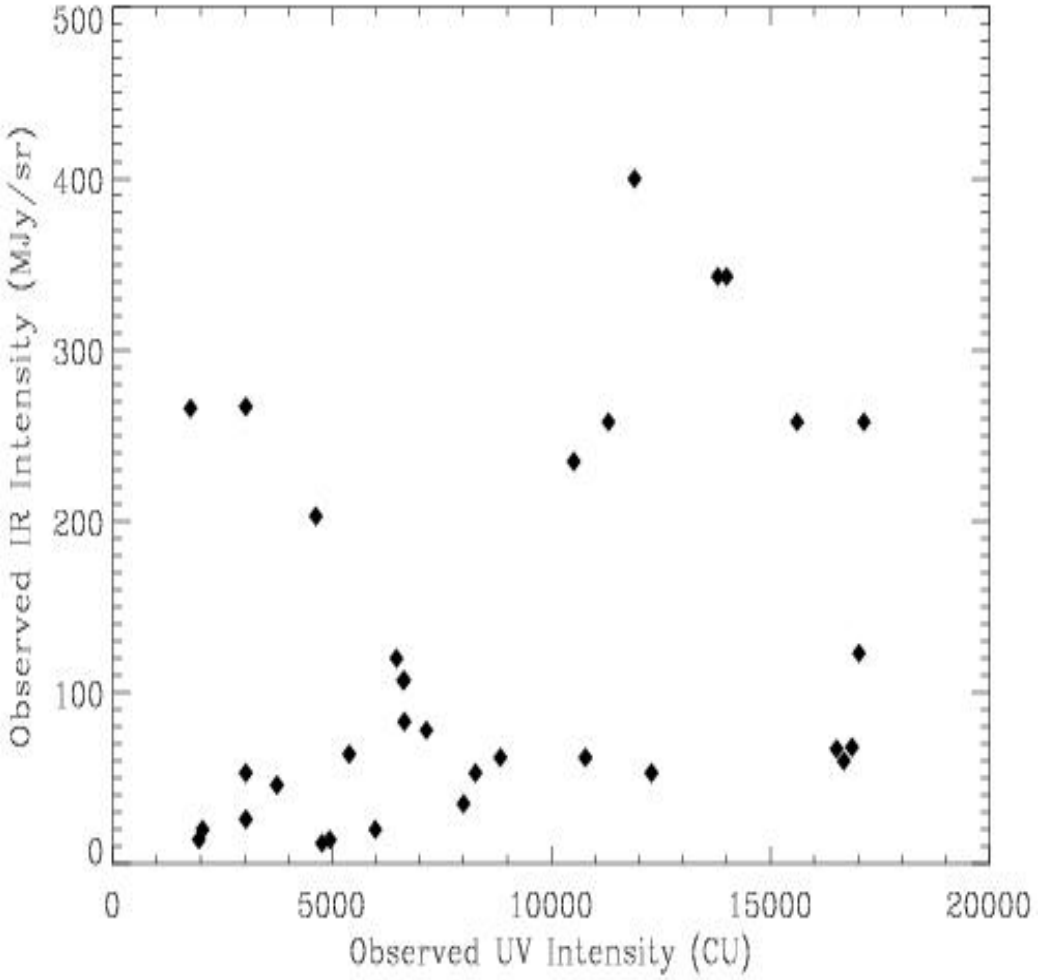




Ophiuchus (d ~ 160 pc)

Coalsack (d ~ 180 pc)

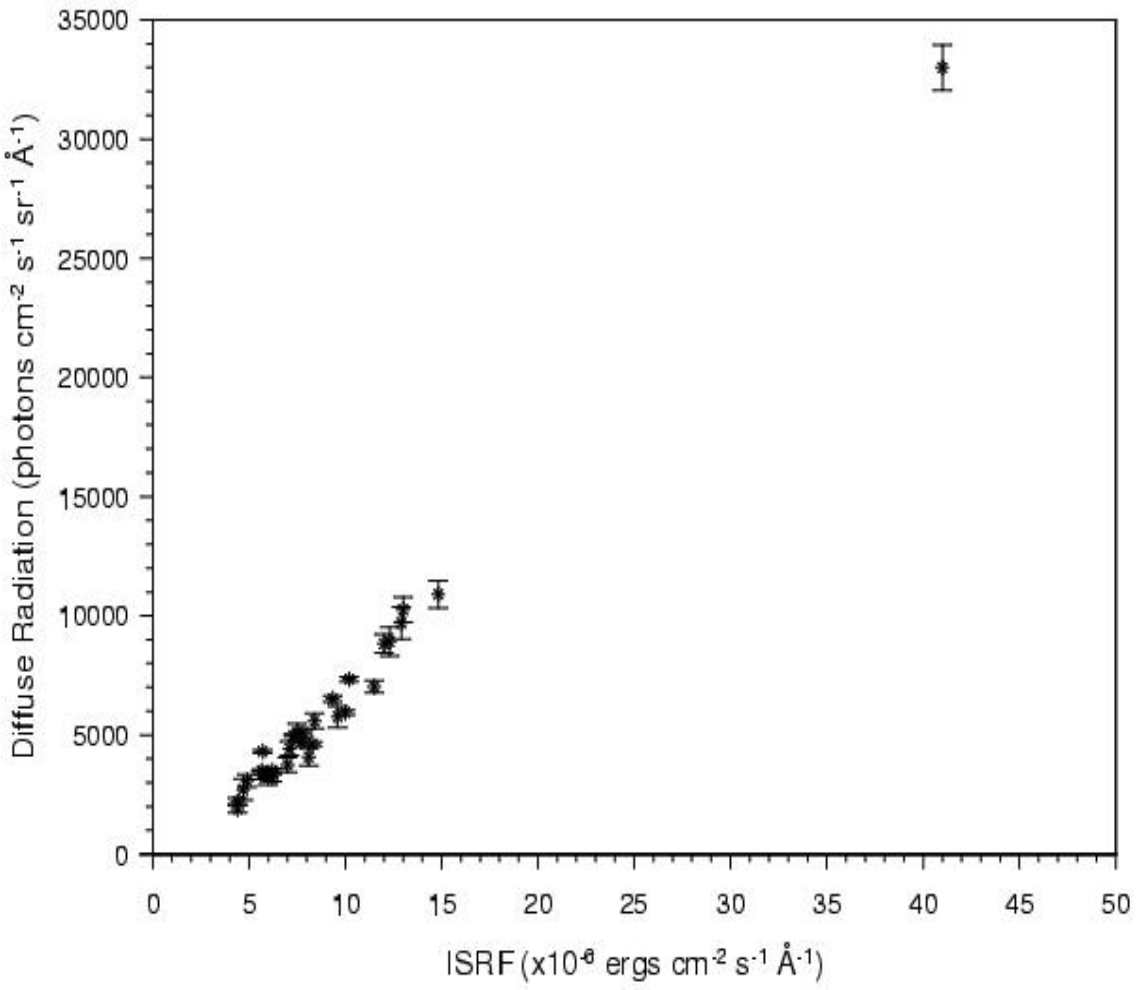
# N(H)/IR – UV Correlation



# Correlation between ISRF & UV in the Ophiuchus region

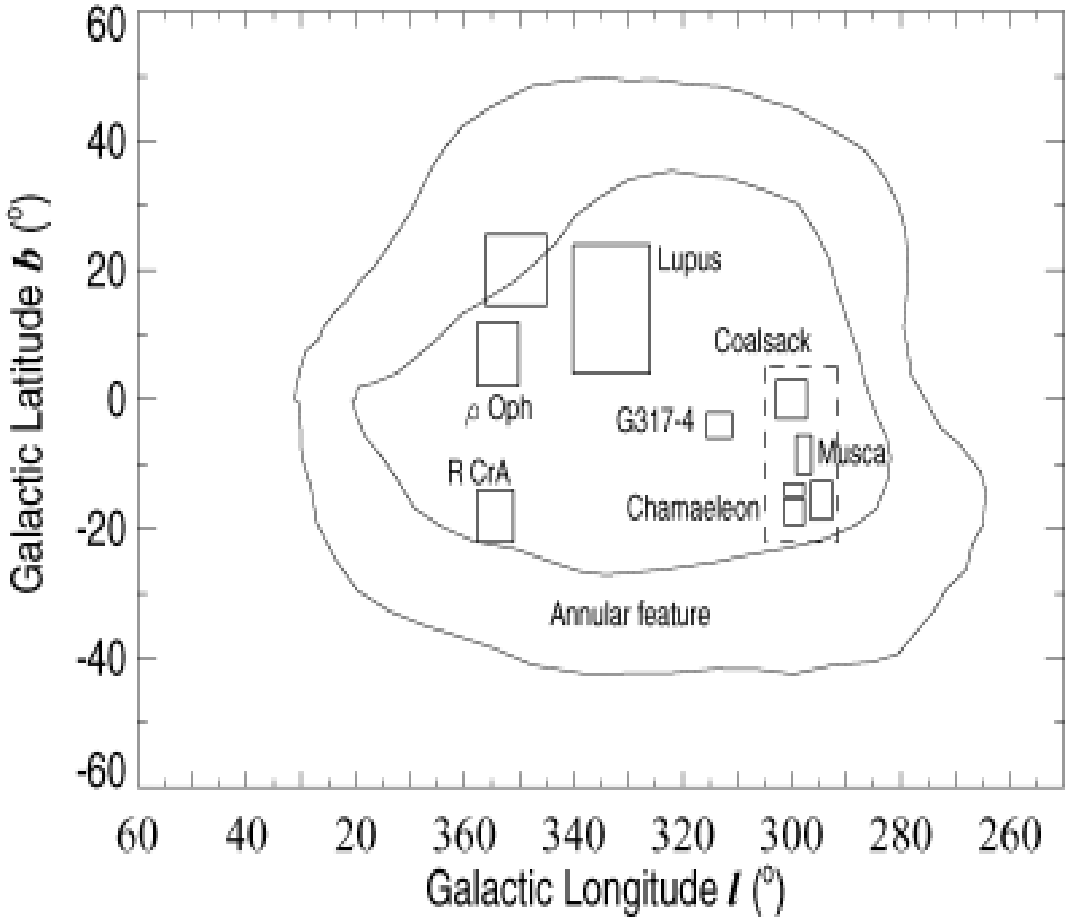
- Good correlation. The non-zero intercept is due to the absorption of diffuse radiation in the intervening ISM
- **Result** - High dependence of Diffuse Background on the Local Effects like,
  - Amount of dust near the dominating star in ISRF
  - Distance between dust & the dominating star in ISRF etc.



# Dust Distribution towards Ophiuchus & Coalsack

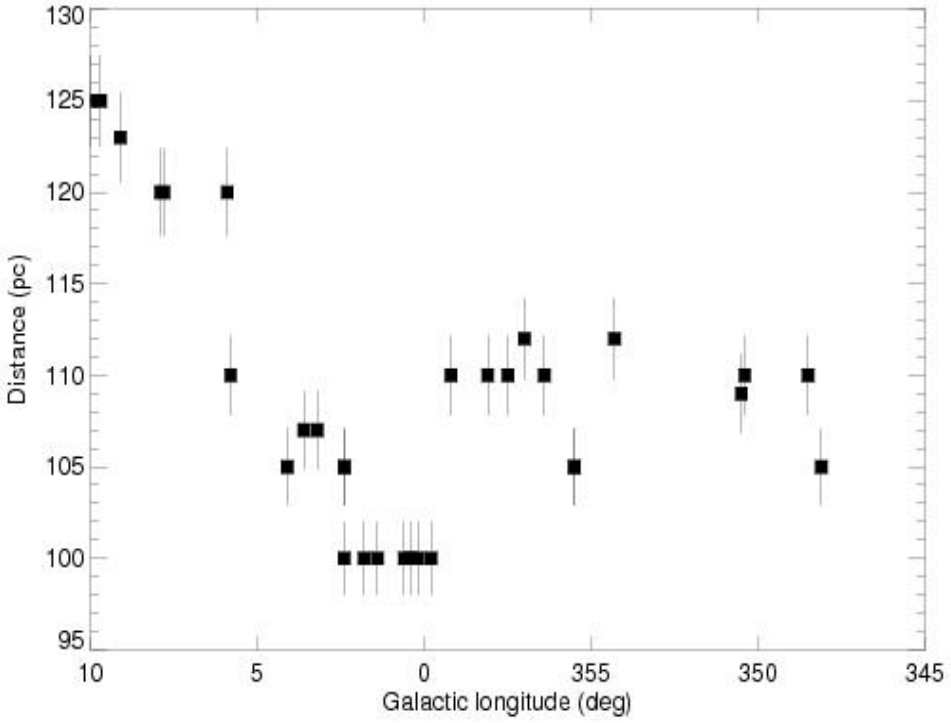
- Total Hydrogen Column Density, N(H) – Schlegel et. al. (1998)
- Total Neutral Hydrogen Column Density, $N(H_I)$ – Dickey & Lockman (1990)
- 2 extended sheet like structures covering the region gl (290° - 10°) & gb (-25° - +25°) at distances ~60 pc & 100 - 150 pc from the Sun - Corradi et. al. (2004)
- Column Density of the sheets – $3.2 \times 10^{19}$ $cm^{-2}$ & $3.7\text{-}27 \times 10^{20}$ $cm^{-2}$

# Schematic representation of the interaction zone between the Local and Loop I Bubbles with the dark clouds towards the Sco-Cen association

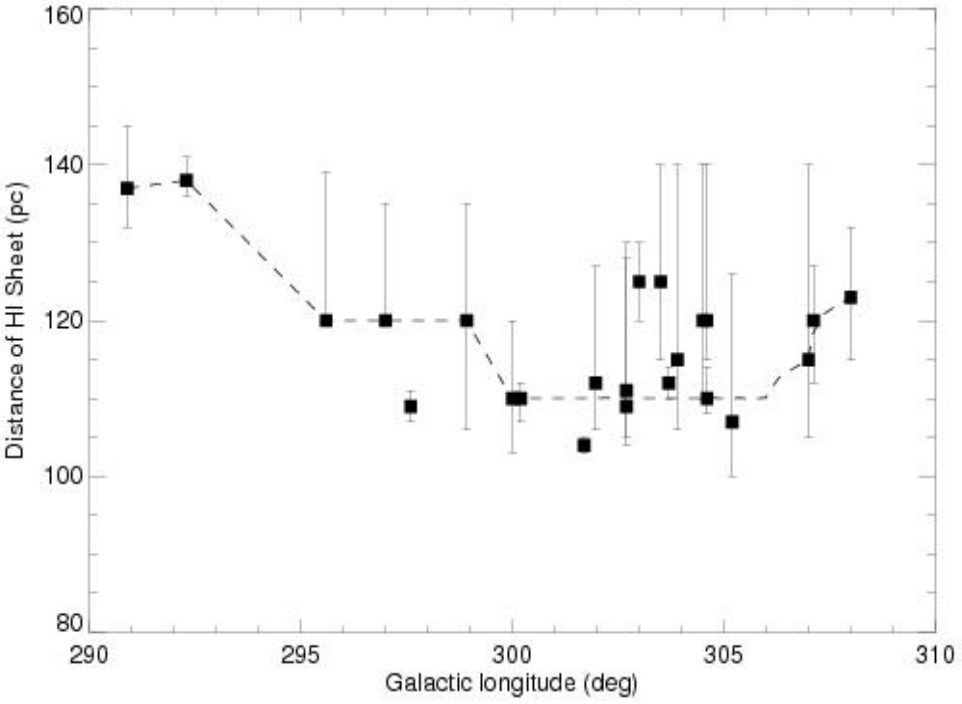



- The position and sizes of the dark clouds were obtained from the survey by **Dame et al. (1987)**.
- The ring-like contours, taken from the ROSAT All-Sky Survey data by **Egger & Aschenbach (1995)**, represent the annular volume of dense neutral matter supposedly formed during the collision of the two bubbles.

Because of the uncertainty in the distance of the second sheet (100-150 pc), we have used a three parameter model (d, a, g) to fix the distance.




Ophiuchus




Coalsack

# Modeling of Diffuse Emission

- Single Scattering Model for the Ophiuchus Region

  $\Rightarrow$ since optical depths of neutral hydrogen in the observed locations are $< 1$.

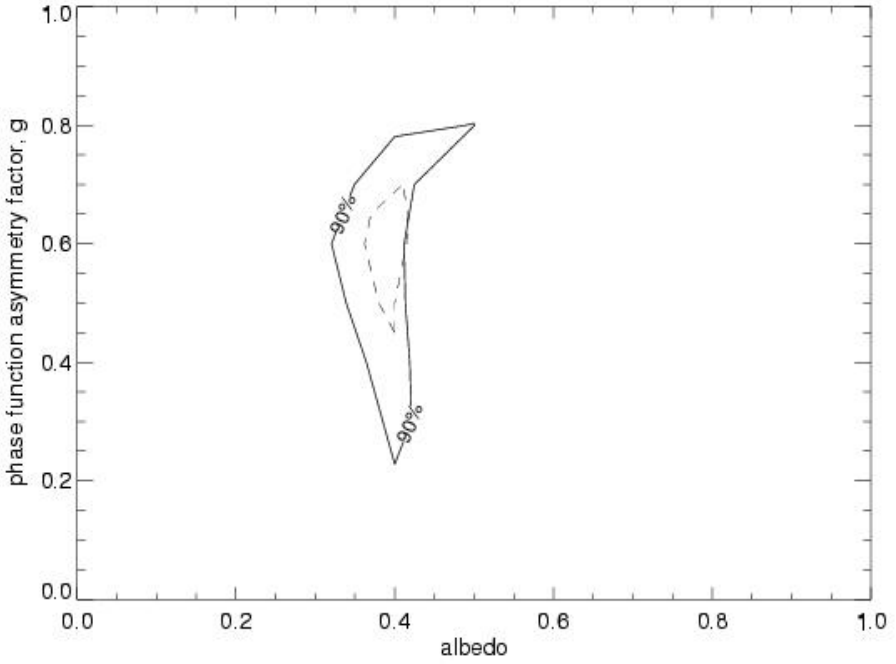
  Ref:- Sujatha et al. 2005, ApJ, 633, 257

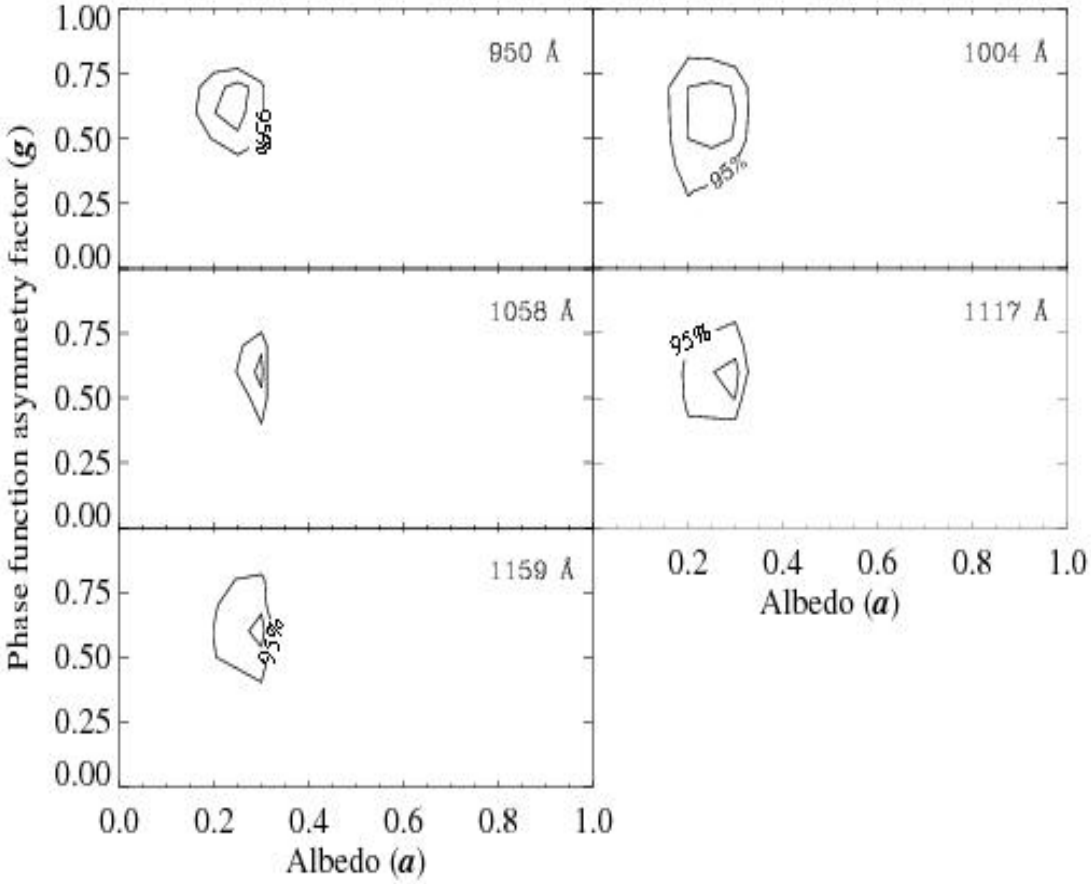
- Multiple Scattering Model for the Coalsack Region

  $\Rightarrow$ since optical depths of neutral hydrogen in the observed locations are $> 1$.

  Ref:- Sujatha et al. 2006, submitted to ApJ

# 95% and 68% confidence contours ($a$, $g$)

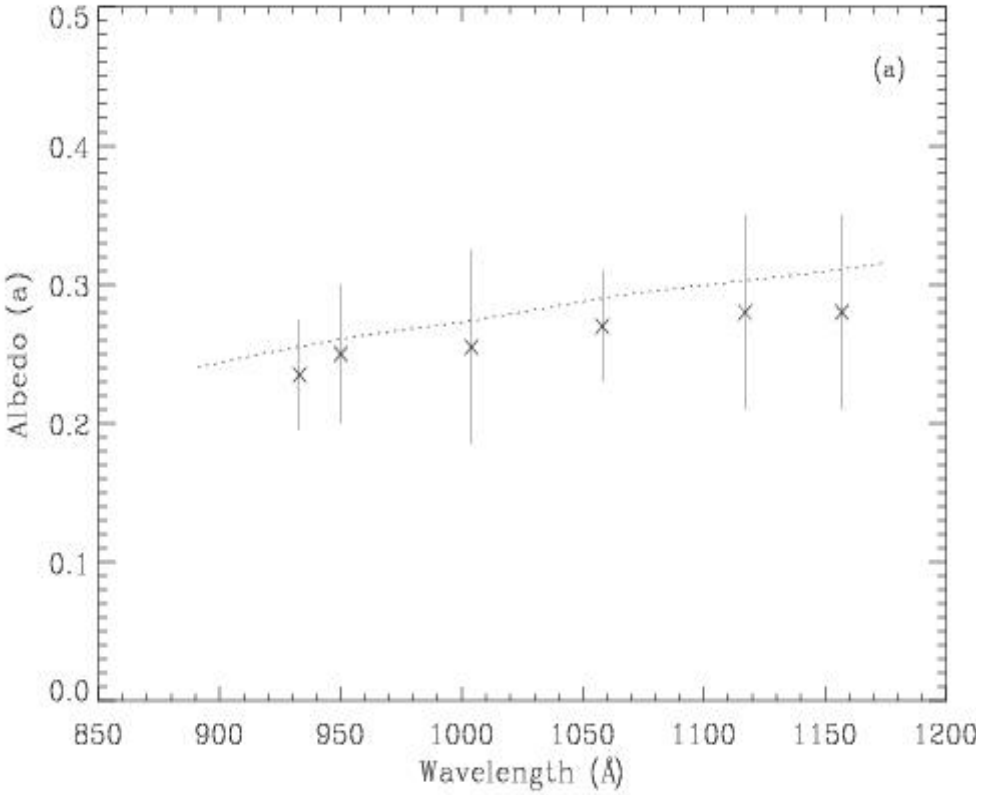


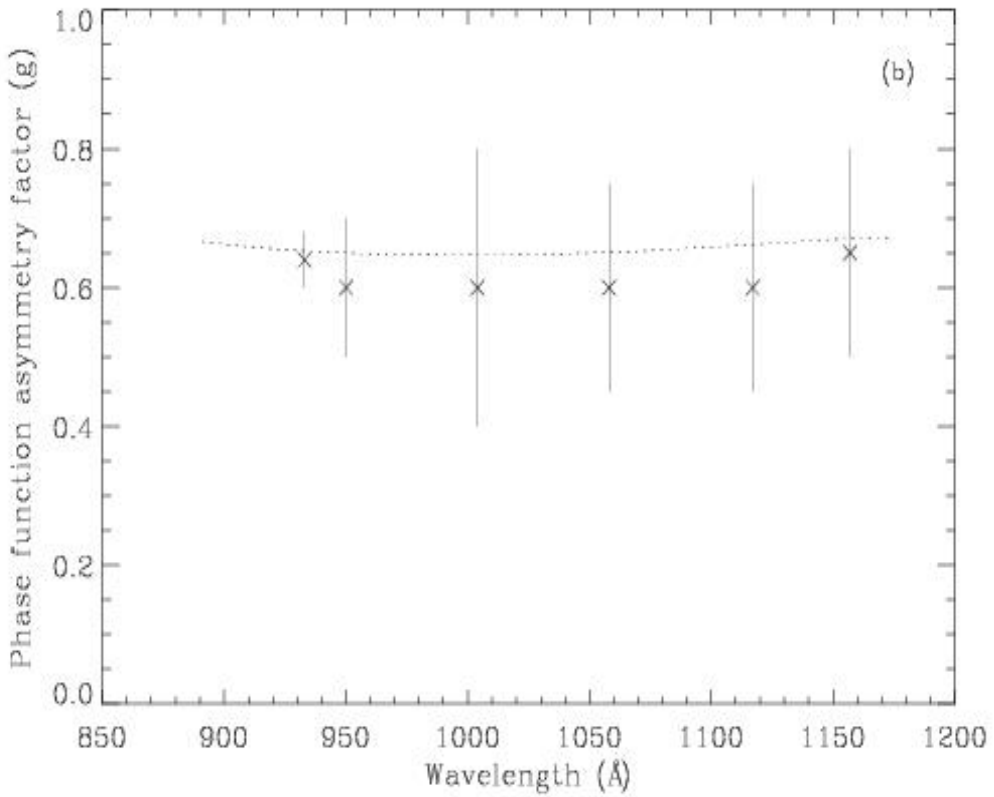




Ophiuchus

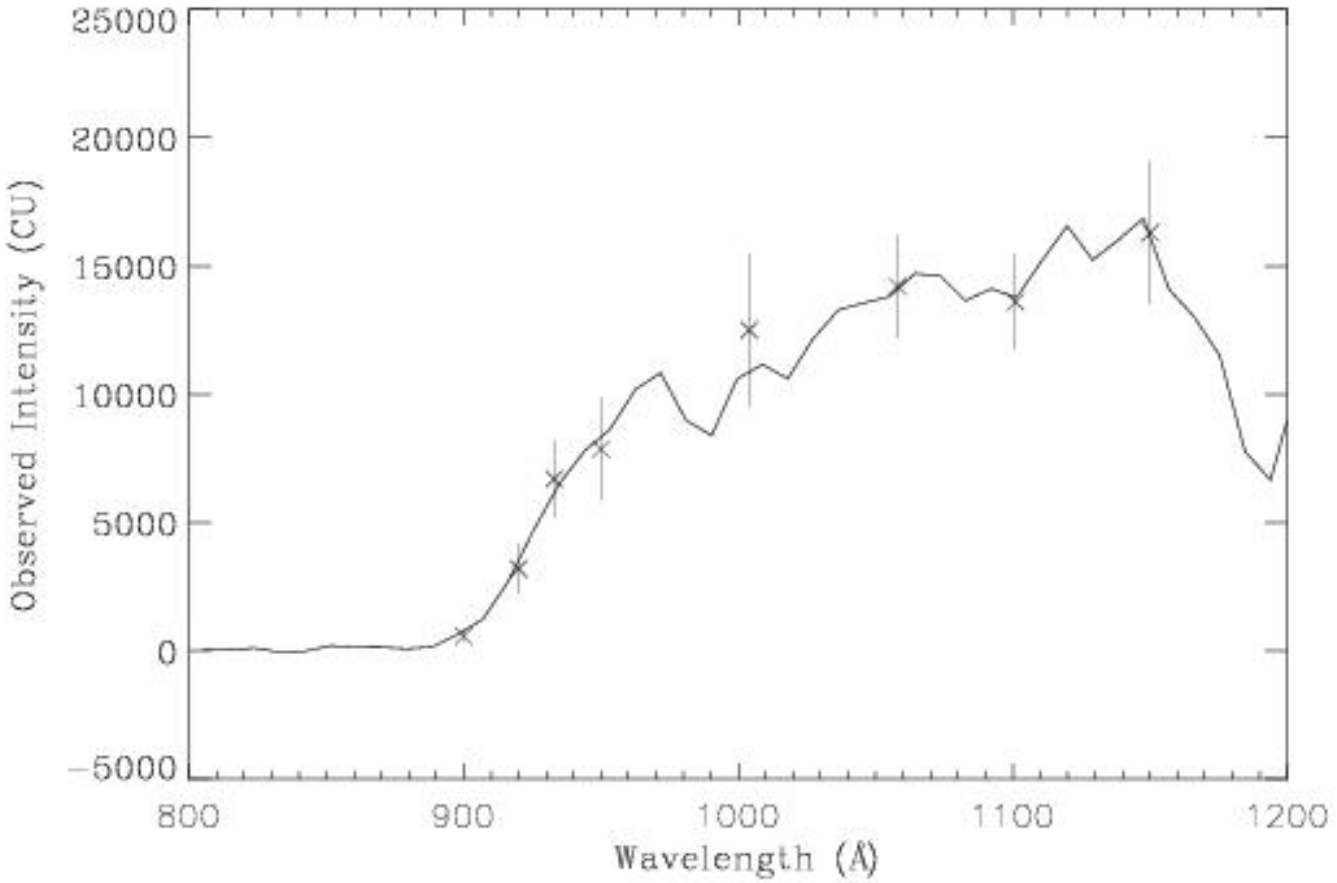
Coalsack

# Variation of *a* & *g* with Wavelength



*Voyager* spectrum for one of the Coalsack location is shown in the figure. The modeled intensities corresponding to the best-fit parameters are overplotted at different wavelengths.



# Results

We have used *FUSE* & *Voyager* observations of scattering by interstellar dust in the neighborhood of the Coalsack Nebula and Ophiuchus region to derive the optical constants of the dust grains in the corresponding regions. Our results are as follows:

- Coalsack Region $\Rightarrow$ albedo, $a$ is 0.28 ± 0.07 & phase function asymmetry factor, $g$ is 0.60 ± 0.15 throughout the spectral range from 900 -- 1200 Å
- Ophiuchus region $\Rightarrow$ $a$ = 0.40 ± 0.10 and $g$ = 0.55± 0.25 at 1100 Å

Which values are in agreement with previous determinations as well as Draine's theoretical predictions.

- We found that the intense diffuse background radiation in these regions is due to light from nearby hot stars scattered by a relatively thin foreground cloud with little contribution from the background molecular cloud. This suggests that one cannot assume that the UV background is directly correlated with the total amount of gas in any direction.