Diffuse Interstellar medium toward the IRAS18511+0146 cluster

Observations of a deep 3.4 µm absorption band

Marie Godard [1,2], Emmanuel Dartois [1], Tom Geballe [3], Guillermo Muñoz Caro [4]

marie.godard@nasa.gov

[1] Institut d'Astrophysique Spatiale (IAS, Orsay, France)
[2] NASA Goddard Space Flight Center (GSFC, Greenbelt MD)
[3] Gemini Observatory (Hawaï)
[4] Centro de Astrobiología (CAB, Madrid, Spain)

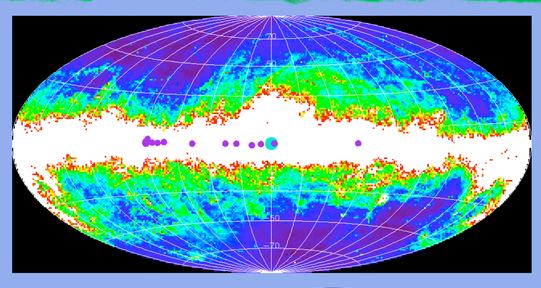
Hydrogenated amorphous carbon dust and its 3.4 µm absorption band in the Milky Way diffuse ISM

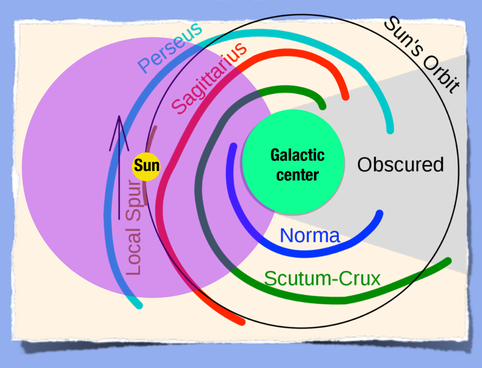
A **3.4 µm absorption band** is ubiquitously observed **in the diffuse interstellar medium** of the Milky Way and other galaxies. This band corresponds to the aliphatic C-H stretching modes of hydrogenated amorphous carbons (**a-C:H** or **HAC**), an important component of **carbonaceous dust**. In the lines of sight probing the local diffuse ISM of the Milky Way, there is in general a **linear correlation between the 3.4 µm optical depth and the visual extinction A_V**.

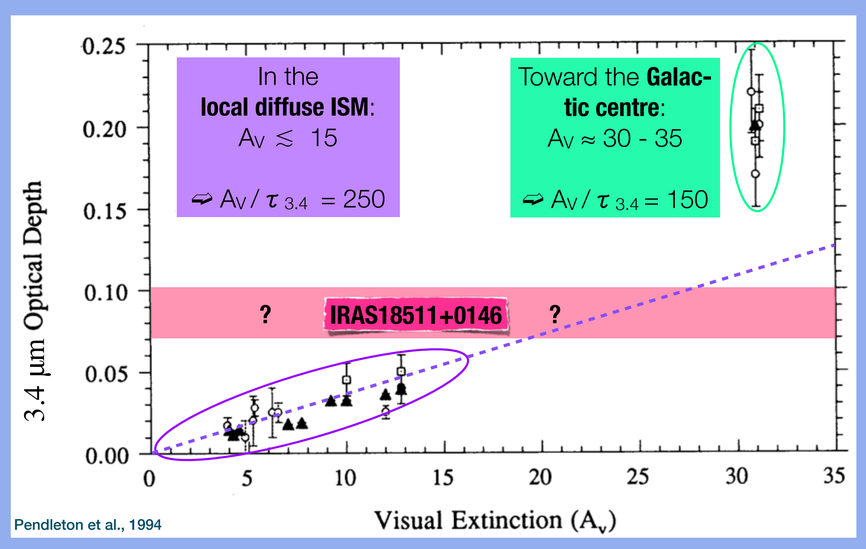
A **deep 3.4 µm band** has been detected toward the young stellar object **IRAS 18511+0146** by Ishii et al (1998, 2002). This 3.4 µm optical depth seems three times higher than predicted from the most likely value for the distance of the object (3.9 kpc), the extinction-distance relation for the Galactic diffuse ISM (1.8 mag/kpc), and the value of $A_V/\tau_{3.4}$ in the local diffuse ISM.

➪ *Aims:*

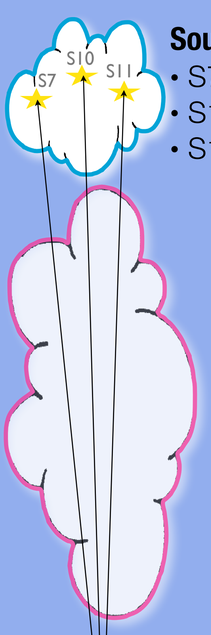
- Verify the unusually high 3.4 µm optical depth toward IRAS 18511+0146
- Use different bright sources of the cluster to test for eventual patchiness in the foreground diffuse ISM







Observations of 3 lines of sight toward bright sources in the IRAS18511+0146 cluster



Sources:

- S7 (IRAS18511+0146)
- S10
- S11

➪ Cluster of young stellar objects embedded **in a molecular cloud**

Dense cloud: 3.1 µm band (H_2O ice), 3.47 µm band

+

Diffuse ISM: 3.4 µm band (a-C:H)

=

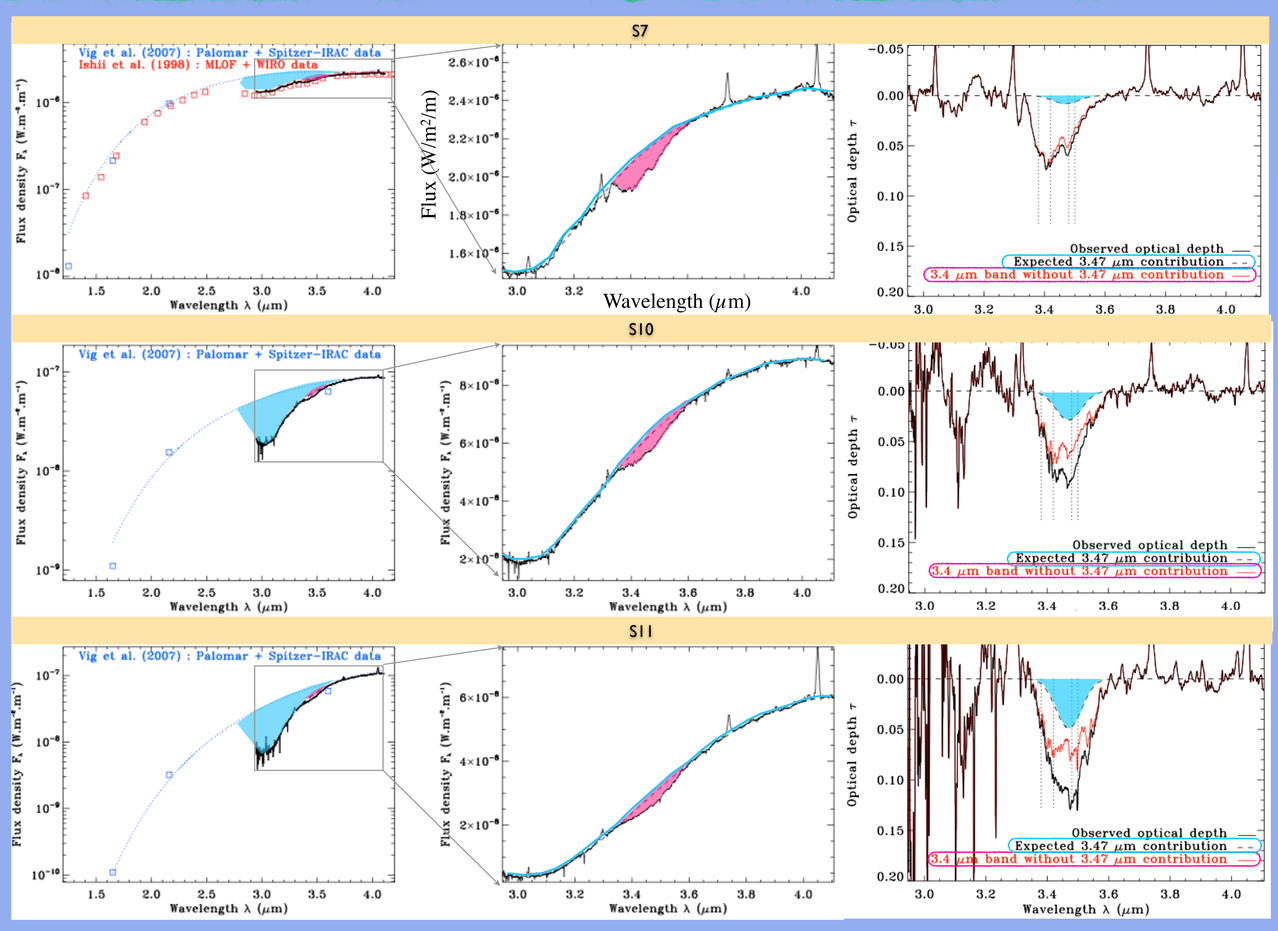
Observed Spectrum

Instrument:

- Gemini North telescope (Mauna Kea, Hawaii)
- Near-InfraRed Imager/ spectrograph (NIRI)

➪ **IR Spectra:**

- 2.95 - 4.15 µm
- $R = \lambda/\Delta\lambda \sim 690$



$\tau_{3.4} = \tau_{obs} - \tau_{3.47}$

$\tau_{3.47}$ is estimated from $\tau_{3.1}$ (Brooke et al., 1999)

Table 3. Optical depths of the different absorption bands for each line of sight.

Source	$\tau_{3.1}$	$\tau_{3.47}$	τ_{obs}	$\tau_{3.4}$
S7	0.36 ± 0.08	0.008 ± 0.007	0.073 ± 0.005	0.065 ± 0.012
S10	1.00 ± 0.08	0.029 ± 0.009	0.093 ± 0.008	0.064 ± 0.017
S11	1.60 ± 0.02	0.049 ± 0.010	0.119 ± 0.012	0.070 ± 0.020

Conclusions (1/2):

Importance of the **3.47 µm removal**

$\tau_{3.4} = 0.07$ similar in the 3 directions
➪ **Homogeneity** of diffuse ISM

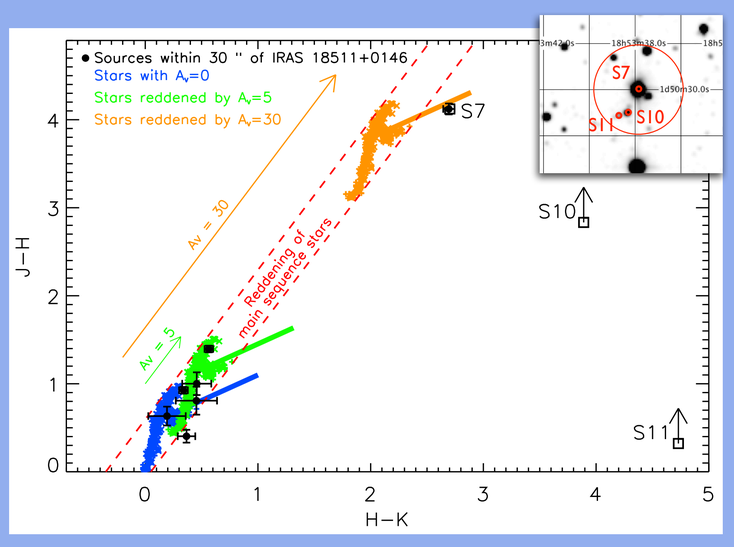
➪ **Deepest 3.4 µm band** observed in the Milky Way outside the Galactic center

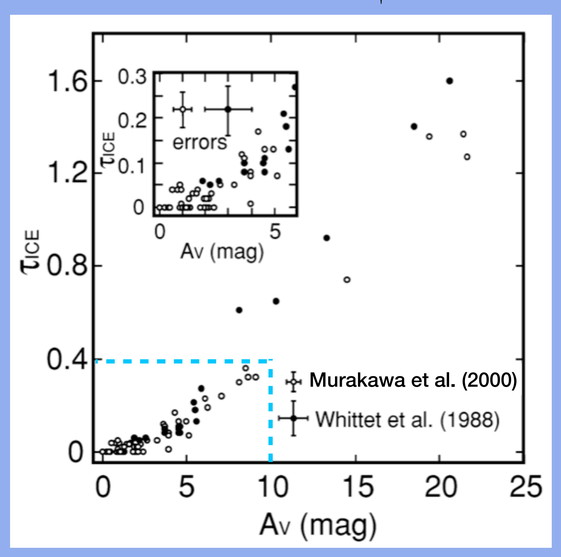
➪ S/N allowing to clearly observe the **substructure of the 3.4 µm band**

Extinction to IRAS 18511+0146

S7 in a color-color diagram
Locus of stars with no extinction
Extinction law
→ Total extinction A_V toward S7

S7 water ice optical depth τ_{ice}
τ_{ice} - A_V correlation
→ $A_{V,\ Dense\ ISM}$ toward S7





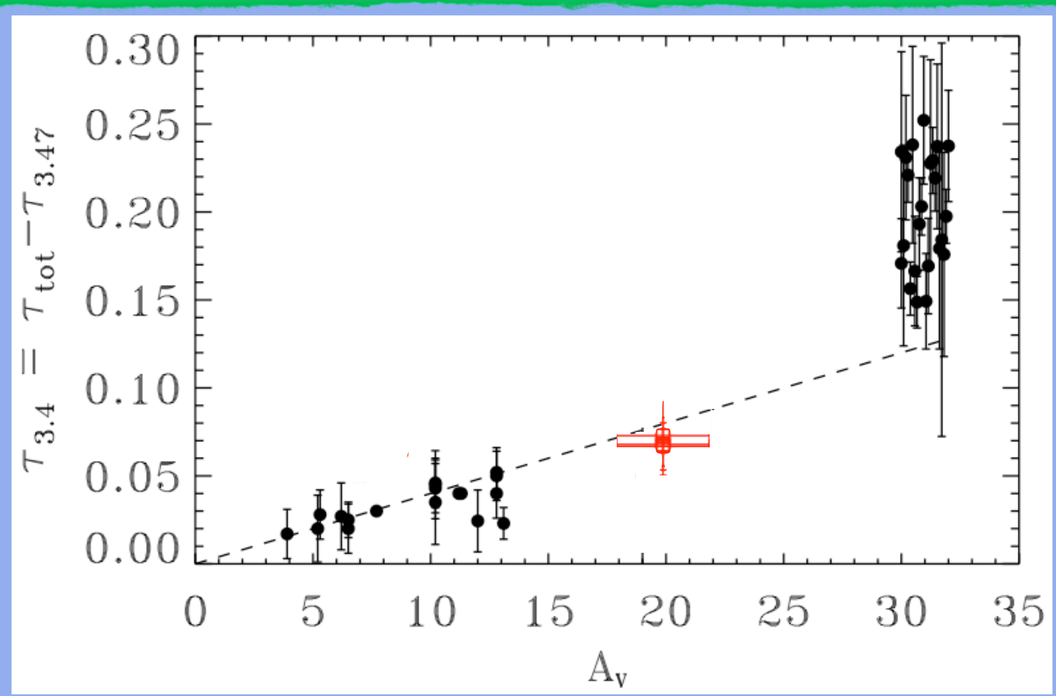
➪ A_V (S7) ≈ 30

τ_{ice}(S7) = 0.4
➪ $A_{V,\ Dense\ ISM}$ (S7) ≈ 10

$A_V = A_{V,\ Diffuse\ ISM} + A_{V,\ Dense\ ISM}$

$A_{V,\ Diffuse\ ISM}$ (S7) ≈ 20

An interesting direction to study the diffuse ISM dust



Conclusions (2/2):

➪ Most probable **distance** to IRAS18511 (from ≠ independent constraints): ~ **3.9 kpc**
➪ Most probable **extinction** to IRAS18511 due to diffuse ISM: $A_V \sim 20$
➪ Most probable interpretation: a **diffuse ISM cloud is associated to this cluster**

➪ ***the IRAS18511 cluster provide an interesting direction to study the diffuse ISM dust***

Godard et al., A&A, 2012