The 3.4 μm absorption band profile : comparison of aliphatic interstellar dust observations and laboratory analogues properties

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Carbonaceous dust in the diffuse interstellar medium (ISM) is widely observed through infrared absorption bands related to C-H vibration in aliphatic groups. The main absorption signatures around 3.4 μm (-CH_3 and –CH_2- stretching modes) were detected in many lines of sight probing the diffuse ISM towards the Galactic centre [1,2,3,4], in other Milky Way sight lines probing the local diffuse ISM [1,2,5], and in other galaxies [6].

These IR interstellar signatures are well reproduced by hydrogenated amorphous carbons (a-C:H) interstellar analogues synthesized in the laboratory. a-C:Hs constitute a large family of materials spanning a range of structural and spectroscopic properties. In particular, different a-C:H materials differ from each other in terms of their 3.4 μm absorption band profile (i.e. relative absorption ratio at 3.38, 3.41, and 3.48 μm) and intrinsic strength.

We review interstellar observations of the 3.4 μm absorption signature, focusing on the band profiles, and compare them to interstellar analogues IR measurements to constrain hydrogenated amorphous carbons constitutive of diffuse interstellar dust.

Moreover, among the different galactic 3.4 μm interstellar observations, the ratio between the 3.4 μm optical depth $\tau_{3.4}$ and the visual extinction A_V of each line of sight where this aliphatic signature is detected appears higher towards the Galactic center than in local diffuse ISM [1,2].

In this work, after reevaluating the visual extinction A_V from the diffuse ISM towards different Galactic center sources from recent studies [7,8], we show that :

i) not only the $\tau_{3.4}/A_V$ ratio varies with the direction probing the Galactic diffuse ISM, but also the 3.4 μm absorption band profile,
ii) the 3.4 μm absorption band profile variation observed in the Milky Way correlates with the $\tau_{3.4}/A_V$ ratio,
iii) the variations of laboratory a-C:H properties (3.4 μm absorption band profile, and 3.4 μm to visible absorption coefficient ratio) follow the same behavior as the one of aliphatic hydrocarbon dust observed in galactic diffuse ISM.

Références

[1] Sandford S. A., Allamandola L. J., Tielens A. G. G. M. et al, ApJ, 371, 607 (1991)
[2] Pendleton Y. J., Sandford S. A., Allamandola L. J. et al, ApJ, 437, 683 (1994)
[3] Chiar J., Tielens A. G. G. M., Adamson A. J. et al, ApJ, 770, 78 (2013)
[4] Geballe T. R., Pendleton Y., Chiar J., Tielens A. G. G. M., ApJ, 912, 1 (2021)
[5] Godard M., Geballe T. R., Dartois E., Muñoz Caro G. M., A&A, 537, A27 (2012)
[6] Dartois E., Geballe T. R., Pino T. et al, A&A, 463, 2, 635 (2007)
[7] Nogueras-Lara F., Schödel R., Neumayer N., A&A, 653, A133 (2021)
[8] Wang S., Chen, X., ApJ, 877, 2 (2019)