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Identification of the "unidentified IR features" of interstellar dust

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The unidentified IR (UIR) features (also known as PAH features) were discovered in 1973. In the intervening 36 years, they have become a major tool helping us understand the behavior of star-forming galaxies in the early universe (e.g. Valiante et al. 2007), as well as of our own interstellar medium and what is observed in nearby galaxies. A very important step in this process was the work of Léger & Puget (1984), who demonstrated that a good approximation to the observed spectra of these UIR features in NGC7027 and the Red Rectangle was obtained from the expected emission of aromatic species (polycyclic aromatic hydrocarbons or PAHs) similar to coronene ($C_{24}H_{12}$) heated to 600 K. Such a high "effective" temperature might be obtained subsequent to the absorption of a UV photon of around 2000 A. Léger and Puget were building on an important observational study by Sellgren (1984), who realized that the observed near-to-mid IR flux from reflection nebulae could not be interpreted as the emission of classical 0.1 micron-sized grains. She proposed instead the transient heating of "small" few-angstrom-sized grains, and it was a small step from that to large molecules. The net result of all this was that this mixture of large molecules and small grains was the intermediary breaking down the UV emission of young stars into observable IR emission. Moreover, photoelectrons from these species turn out to be an important heat source in the so-called photon-dominated regions or PDRs.

The Léger-Puget study of course built on earlier work (the study by Sellgren already cited, as well as earlier suggestions by Platt 1956 and Donn 1968). These authors realized that small (10 Å or so) particles could play an important role in interstellar extinction and that "organic" or graphitic material was likely involved. Donn pointed out that graphite can be looked on as a series of layers of polycyclic hydrocarbon stacked upon one another. A somewhat different suggestion came from Duley & Williams (1983), who concluded that aromatic hydrocarbons on grain surfaces might be responsible for the 3.3 μm emission. However, the Léger-Puget article provided a much more all-encompassing identification of the UIR features, together with an understanding of the processes that regulate their relative intensity. Moreover, it paved the way for later work (e.g. Omont 1986) that aimed at putting the physics of the PAHs on a firm footing. Very importantly also, it allowed a clearer understanding of the photoelectric heating process that in many circumstances provides the heat input to neutral interstellar gas. This in turn was decisive input physics for the studies that followed shortly afterwards (e.g. Tielens & Hollenbach 1985) of the structure of the so-called PDRs, which are the interface between luminous young stars and surrounding gas.

It is interesting, however, that some of the puzzles posed by Léger and Puget, such as the lack of detection of the UIR bands in absorption, has still not been completely resolved. On the other hand, the results of the ISO and SPITZER missions (e.g. Genzel & Cesarsky 2000; Werner et al. 2004) depend in no small part on the analysis of the "UIR bands", and that in turn is based upon the Léger-Puget paper. In fact, for many purposes, precise knowledge of PAH physics has not prevented their use as an empirical tracer of star formation. History suggests, however, that in the long run understanding the underlying physics will be needed and, for this purpose, the Léger-Puget study remains an essential input.

References

Donn, B. 1968, ApJ, 152, L129
Duley, W. W., & Williams, D. A. 1983, MNRAS, 205, 67
Genzel, R., & Cesarsky, C. J. 2000, ARA&A, 38, 761
Léger, A., & Puget, J.-L. 1984, A&A, 137, L5
Omont, A. 1986, A&A, 164, 159
Platt, J. R. 1956, ApJ, 123, 486
Sellgren, K. 1984, ApJ, 277, 623
Tielens, A. G. G. M., & Hollenbach, D. J. 1985, ApJ, 291, 722
Valiante, E., Lutz, D., Sturm, E., et al. 2007, ApJ, 660, 1060
Werner, M. W., Uchida, K. I., Sellgren, K., et al. 2004, ApJS, 154, 309

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