MEASUREMENTS OF THE 3.3 μm DIFFUSE GALACTIC EMISSION FEATURE WITH AROME

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ABSTRACT. *AROME** is a balloon-borne experiment which was built to carry out measurements of IR emission features in the diffuse galactic flux. The field of view is 0.5° and surface brightness gradients are detected through azimuthal scanning at a constant elevation angle. The detection of a feature is done by comparison of the fluxes measured in narrow and wide photometric bands centered on the feature's wavelength. Two flights have been performed (August 1987, October 1988), which detected a 3.3 μm feature in the direction of the galactic plane $-6° < b < 6°$, $60° > l > -50°$. Since this feature is characteristic of aromatic C-H bonds, we assigned it to the emission of transiently heated polycyclic aromatic hydrocarbon molecules (PAHs). With this assumption, *AROME* measurements show that PAHs are an ubiquitous component of the interstellar matter which contain about 10% of the available cosmic carbon.

The *IRAS* infrared (IR) survey has shown the ubiquity of the diffuse galactic emission, both in the spectral (l = 12, 25, 60, and 100 μm) and the spatial (cirrus clouds) domains. It is now well established that this emission originates from interstellar grains whose sizes range from a micrometer to a few angstroms (Draine and Lee 1984; Desert, Boulanger, and Puget 1989). The smaller grains (i.e. large molecules) are responsible for the shorter-wavelength emission because they are subjected to thermal fluctuations. Their existence was established by the *IRAS* detection of the 12 and 25 μm diffuse galactic emission. It thus appeared necessary to identify those grains by detecting selected spectral features. In the hypothesis of large-molecule PAHs, the characteristic emission bands at 3.3, 6.2, 7.7, 8.6, and 11.3 μm should be present in the spectrum of the diffuse galactic light. In terms of surface brightness, the diffuse galactic emission is 10 to 100 times fainter than the emission of nebulae (H II, planetary and reflection) in which the aromatic IR bands (AIBs) are currently observed with ground-based or airborne (KAO) instruments. Thus, we started the *AROME* program in order to achieve this particular goal of detecting the AIBs in the diffuse galactic emission.

The instrument consists of two 15 cm Cassegrain telescopes with cooled (60 K) detectors and optics. The detected flux has been made as large as possible by maximizing both the transmittance (~0.5) and the throughput ($= 0.4 \times 10^{-7}$ m^2 sr, 0.5° field of view) of the optics. A feature is detected by comparing the integrated fluxes measured in narrow and wide photometric bands, both centered on the feature's wavelength. Spatial modulation is provided by oscillating secondary mirrors (20 Hz) in combination with a slow azimutal scan at a constant elevation angle. The 3.3 μm feature was chosen as our first aim because of the reduced thermal background at this wavelength. The sensitivity of the instrument is 0.8×10^{-7} W m^{-2} sr^{-1} Hz$^{-1/2}$ in terms of the integrated energy at the 3.3 μm feature.

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Two flights of the instrument have now been performed (August 1987, October 1988). They allowed the first detection of the 3.3 μm emission feature in the diffuse galactic light (Giard et al. 1988). Maps of the feature's emission over a large area of the galactic plane ($-6° < b < 6°$, $10° < l < 35°$) have been restored (Giard et al. 1989). These maps show that this emission is intense and ubiquitous. The feature's intensity is clearly correlated with the far-IR emission and thus should find its source in the interstellar medium (ISM). In addition to the thin disk emission, $b < 1°$, the 3.3 μm emission has been detected at higher galactic latitudes of $2° < b < 6°$. With the data obtained during the second flight, we were able to build the longitude profile of this mid-latitude emission in the longitude range of $-10° < l < 60°$. This profile is shown in Figure 1 and is compared with the profile of the diffuse 100 μm emission at a latitude of $b = -1°$ from Perault (1987). In this last case, "diffuse" means that the sources' emission has been subtracted. The emission observed at such galactic latitudes comes from interstellar clouds that are similar to the cirrus clouds seen at higher latitudes but that are far away from the Sun ($d \approx 5$ kpc). The step in both profiles at $l \approx 30°$ is explained by the decrease of the averaged interstellar radiation field with the galactocentric radius (Perault 1987).

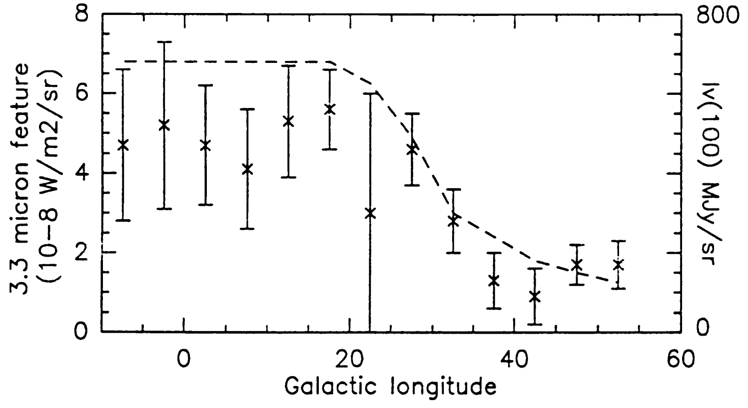

Figure 1. The crosses show the longitude profile of the 3.3 μm feature's intensity at $b = \pm 2°$. Error bars are drawn to $\pm 2\ \sigma$. The dashed line is the 100 μm "diffuse" emission at $b = -1°$ from Perault (1987).

The averaged energy in the feature is 10^{-7} W m^{-2} sr^{-1} in the direction of the inner parts of the Galaxy. In the hypothesis of PAHs, this means that approximately 10% of the cosmic carbon is in the form of such molecules. This makes PAHs a molecular species as abundant as gaseous CO by mass. This is, of course, of considerable importance for the chemistry and physics of the ISM.

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