Near-Infrared Spectroscopy of the Diffuse Galactic Emission

T. Onaka¹, I. Sakon¹, R. Ohsawa¹, T. I. Mori¹, H. Kaneda², M. Tanaka³, Y. Okada⁴, F. Boulanger⁵, C. Joblin⁶ and P. Pilleri⁷

¹Department of Astronomy, The University of Tokyo, Tokyo 113-0033, Japan
email: onaka@astron.s.u-tokyo.ac.jp
²Graduate School of Science, Nagoya University, Aichi 464-8602, Japan
³Center for Computational Sciences, University of Tsukuba, Ibaraki 305-8577, Japan
⁴I. Physikalisches Institut, Universität zu Köln, 50937 Köln, Germany
⁵Institut d’Astrophysique Spatiale (IAS), UMR 8617, CNRS & Université Paris-Sud 11, Bâtiment 121, 91405 Orsay Cedex, France
⁶Université de Toulouse, UPS-OMP, IRAP & CNRS, IRAP, 31028 Toulouse Cedex 4, France
⁷Centre de Astrobiología (INTA-CSIC), 28850 Torrejón de Ardoz, Spain & Observatorio Astronómico Nacional, Apdo. 112, 28803 Alcalá de Henares, Spain

Abstract. The near-infrared (NIR) spectral range (2–5 μm) contains a number of important features of gaseous and solid species in the interstellar medium (ISM). Absorption features of several major ices are observed at 3 μm (H₂O), 4.3 μm (CO₂), and 4.6 μm (CO) (e.g., Shimonishi et al. 2010). In this spectral range, there are also the fundamental vibration mode of CO gas (e.g., Rho et al. 2012) and several molecular hydrogen lines, from which we can estimate the physical conditions of the warm gas (e.g., Lee et al. 2011). In addition, it contains emission features of hydrocarbon dust around 3 μm, which allow us to investigate aromatic and aliphatic components (Boulanger et al. 2011; Kwok & Zhang 2011; Jones 2012). The 3.3 μm emission band, which is commonly attributed to polycyclic aromatic hydrocarbons (PAHs), is useful to study the size distribution and the processing of the band carriers in the ISM (e.g., Mori et al. 2012). Deuterated hydrocarbon features are also expected to be present in 4.4–4.7 μm (e.g., Peeters et al. 2004, Onaka et al. 2011). Despite these interests, however, this spectral range has barely been explored by instruments with high sensitivity.

The Infrared Camera (IRC: Onaka et al. 2007) onboard AKARI (Murakami et al. 2007) enabled for the first time high-sensitivity spectroscopy in the NIR, with a spectral-resolution of λ/Δλ ~ 100 (Ohyama et al. 2007). Even after the exhaustion of the cryogen, the IRC continued to carry out NIR observations and obtained a large number of NIR spectra in various celestial objects (Onaka et al. 2010).

As part of the Interstellar Medium in our Galaxy and Nearby Galaxies program (ISM-GN: Kaneda et al. 2009), we carried out NIR spectroscopy towards more than 100 positions in the Galactic plane. We describe here the 3 μm data. We fit the observed
features with two Lorentzians (3.3 and 3.4 $\mu$m) and one Gaussian (3.5 $\mu$m). This fit is merely technical due to the low spectral-resolution of the instrument, but correctly estimates the aromatic (the 3.3 $\mu$m band) and the aliphatic (the summation of the 3.4 and 3.5 $\mu$m bands) band intensities. Figure 1a shows an example of the IRC spectrum together with the fit. Figure 1b plots the ratio of the aliphatic to aromatic band intensities against the ionized gas indicator, the ratio of Br$\alpha$ to the 3.3 $\mu$m band intensities. A trend is seen that the aliphatic to aromatic ratio decreases towards the ionized region. This implies a preferential destruction of aliphatic bonds relative to aromatic bonds in the ionized gas as described in Joblin et al. (1996) or that the aliphatic component resides mostly in small band carriers, which are quickly destroyed in the ionized gas (Mori et al. 2012).

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References

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Figure 1. a) Example of AKARI/IRC NIR spectrum. The dotted lines indicate the decomposition of the 3.3, 3.4, and 3.5 $\mu$m bands (see text). The thick and thin solid lines represent the observed and fitted spectra, respectively. The dot-dashed line shows the continuum. b) The aliphatic to aromatic band ratio against the Br$\alpha$ to the 3.3 $\mu$m band intensity ratio (see text).

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