Near-infrared continuum emission and associated dust features in the Orion Bar

Takashi Onaka[1], Emmanuel Dartois[2], Els Peeters[3], Olivier Berné[4], Emilie Habart[5], Christiaan Boersma[6], Jan Cami[3], Asunción Fuente[7], Javier R. Goicoechea[8], Ozan Lacinbala[2], Yoko Okada[9], Alexander G. G. M. Tielens[10], Dries Van De Putte[3], Francois Boulanger[11], Thomas Pino[2],and Yong Zhang[12]

[1]University of Tokyo, Japan, [2]ISM d'Orsay, France, [3]University of Western Ontario, Canada, [4]IRAP, France, [5]IAS, France, [6]NASA Ames, USA, [7]CSIC-INTA, Spain, [8]CSIC, Spain, [9]University of Cologne, Germany, [10]Leiden University, The Netherlands, [11]ENS, France, [12]Sun Yat-sen University, China

Conspicuous excess emission is present in the near-infrared (NIR) region in various celestial objects, including reflection nebulae, planetary nebulae, and nearby galaxies. However, the spatial distribution and spectral shape of the excess emission remain poorly understood.

Using the three-dimensional spectroscopic data of the Orion Bar taken with the integrated field unit of NIRSpec on JWST from the Early Release Science program "PDRs4All", we study the NIR continuum emission spectroscopically and obtain its spatial distribution relative to the aromatic infrared band (AIB) at 3.3 μm in the Orion Bar proto-typical photo-dissociation region (PDR). After contribution from the foreground ionized gas is subtracted. the observed regions are divided into nine physically distinct regions and an average spectrum is derived for each region. The nine regions, including the ionized gas, atomic PDR, and molecular PDR, clearly show remaining continuum in the region 1–4.5 μm. The continuum at wavelengths longer than 2.7 μm shows good correlations with the 3.3 μm AIB, while the correlation of continuum around 1.2 μm is not significant. We further find that the NIR continuum in the Orion Bar can be approximated by a summation of two blackbodies. The low-temperature component shows a good correlation with the AIB, while the high-temperature component does not.

We discuss possible origins of the NIR continuum, among which recurrent fluorescence from carbon clusters would better explains the observed low-temperature component. In addition, the average spectra show absorption features at 3.0 and 4.27 μm, which are attributed to the water ice and CO_2 ice. The presence of ice species suggests that there must be a contribution from a deeper layer of the PDR along the line-of-sight producing characteristic ice absorption features.