The survey of near-infrared diffuse interstellar bands

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Diffuse interstellar bands (DIBs) are ubiquitous absorption lines in the spectra of reddened stars, which originate from foreground interstellar clouds. Although the carriers of any DIBs have not been successfully identified yet, they are considered to arise from the gas-phase large-sized molecules, such as polycyclic aromatic hydrocarbons (PAHs) and fullerenes, which would be deeply related to the formation and evolution of dust grains. Recent extensive observational studies have discovered no less than about 600 DIBs from the near-UV to the near-infrared (NIR) wavelength range. In particular, the NIR wavelength range is very useful in exploring DIBs toward the stars with heavy interstellar extinction because of its higher transmittance in interstellar clouds compared to the optical wavelength range. Using the DIBs in the NIR wavelength range, it become possible to investigate the behavior of the DIB carrier molecules in various environments, which will contribute to the identification of the DIB carriers. Also, the DIBs in the NIR wavelength range are expected to be the electronic transitions of ionized PAHs and fullerenes. However, there was no systematic study of NIR DIBs despite their potential importance probably because the NIR high-resolution spectroscopy have some difficulties compared to the optical, such as the lower performance of the spectrographs and many strong telluric absorption lines.

We are conducting the first comprehensive survey of NIR DIBs with the newly developed NIR high-resolution ($R = 28,300$) spectrograph WINERED, which offers a high sensitivity in the wavelength coverage of 0.91-1.36 micron. Using the WINERED spectrograph attached to the Araki 1.3m telescope in Japan, we plan to obtain the high-quality spectra of about one hundred reddened early-type stars to investigate the properties of NIR DIBs in various environments, such as diffuse interstellar clouds, dark clouds and star-forming regions. In our first results of the survey (Hamano et al., 2015, ApJ, 800, 137), we successfully identified 15 new NIR DIBs in 0.91-1.36 micron, where only five fairly strong DIBs had been identified previously. In addition, their properties, such as the correlation of their equivalent widths (EWs) with the reddening of the stars and the intrinsic molecular profiles, were investigated with an unprecedented accuracy. We found that all of the NIR DIBs are moderately correlated with the reddening of the stars, but their correlation coefficients seem to be systematically lower than those of some representative optical DIBs, suggesting that the EWs of the NIR DIBs are affected by other physical parameters of intervening gas clouds, such as UV field, than the column density. In this conference, we will present the some results and future prospects of the NIR DIB survey.