Polycyclic aromatic hydrocarbon and the ultraviolet extinction bump at the cosmic dawn

Qi Lin[1,2], Xuejuan Yang[1,2], Aigen Li[2] , and Joris Witstok[3,4]

1 Hunan Key Laboratory for Stellar and Interstellar Physics and School of Physics and Optoelectronics, Xiangtan University, Hunan 411105, China

2 Department of Physics and Astronomy, University of Missouri, Columbia, MO 65211, USA

3 Cosmic Dawn Center (DAWN), Copenhagen, Denmark

4 Niels Bohr Institute, University of Copenhagen, Jagtvej 128, 2200 Copenhagen, Denmark

First detected in 1965, the mysterious ultraviolet (UV) extinction bump at 2175 Å is the most prominent spectroscopic feature superimposed on the interstellar extinction curve. Its carrier has remained unidentified over the six decades since its first detection, although many candidate materials have been proposed. Widely seen in the interstellar medium of the Milky Way as well as several nearby galaxies, this bump was recently also detected by the James Webb Space Telescope (JWST) at the cosmic dawn in JADES-GS-z6-0, a distant galaxy at redshift z ≈ 6.71, corresponding to a cosmic age of just 800 million years after the big bang. Differing from that of the known Galactic and extragalactic interstellar sightlines, which always peak at ~2175Å, the bump seen at z ≈ 6.71 peaks at an appreciably longer wavelength of ~2263 Å and is the narrowest among all known Galactic and extragalactic extinction bumps. Here we show that the combined electronic absorption spectra quantum chemically computed for a number of polycyclic aromatic hydrocarbon (PAH) molecules closely reproduce the bump detected by JWST in JADES-GS-z6-0. This suggests that PAH molecules had already been pervasive in the Universe at an epoch when asymptotic giant branch stars had not yet evolved to make dust.