Polycyclic aromatic hydrocarbon (PAH) luminous galaxies in the JWST CEERS data

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Introduction

Why PAH?

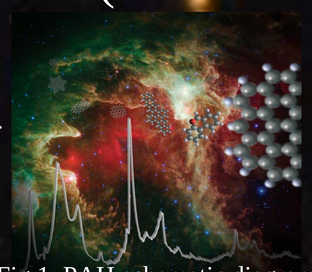

Fig.1, PAH schematic diagram.

PAH is a chemical compound, that contains hydrogens and carbons, with multiple aromatic ring structures, and PAH is everywhere in the galaxies. The PAH molecules around the star-forming region will absorb the UV/optical photon and re-emit in infrared (IR), which appear on 3.3, 6.2, 7.7, 8.6, and 11.3μm broadband features. There is a good correlation between galaxy star formation rate and PAH strength or PAH luminosity. According to the PAH features, we can find faint IR galaxies at redshift > 1.

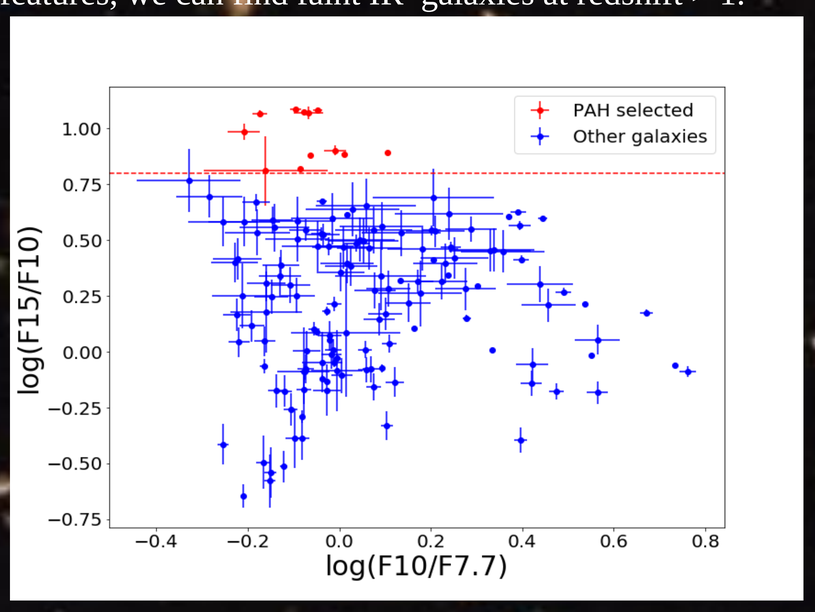

Fig.2, PAH galaxies selected criteria.

JWST

James Webb Space Telescope (JWST) is a new infrared telescope launched in 2021 December. JWST has a 6.5m mirror which is ten times larger than AKARI and Spitzer. It provides a better opportunity to select much fainter and more distant galaxies in the near-IR and mid-IR.

CEERS DATA

Cosmic Evolution Early Release Science Survey (CEERS) had 6 bands of MIRI observation at 7.7, 10.0, 12.8, 15.0, 18.0, and 21.0 μm. Also, we cross-match the other telescopes such as CFHT, HST, WIRCam, and Spitzer. We had 21 photometric data from UV to mid-IR to do the SED fitting. There are 300 galaxies (122 in 15 um) in the CEERS field. We selected 12 sources which flux density ratios larger than 0.8 F1500W/F1000W > $10^{0.8}$ as the PAH-selected galaxies (Takagi et. al. 2009), in Fig.2.

SED fitting

Spectral energy distribution (SED) fitting is a method to analyze a galaxy's physical properties by fitting the photometric data with the energy balance principle. We utilized Code Investigating GALaxy Emission (CIGALE) model analyzing photometric redshift, total IR luminosity… galaxies' physical properties. We present the example of SED fitting in Fig.3.

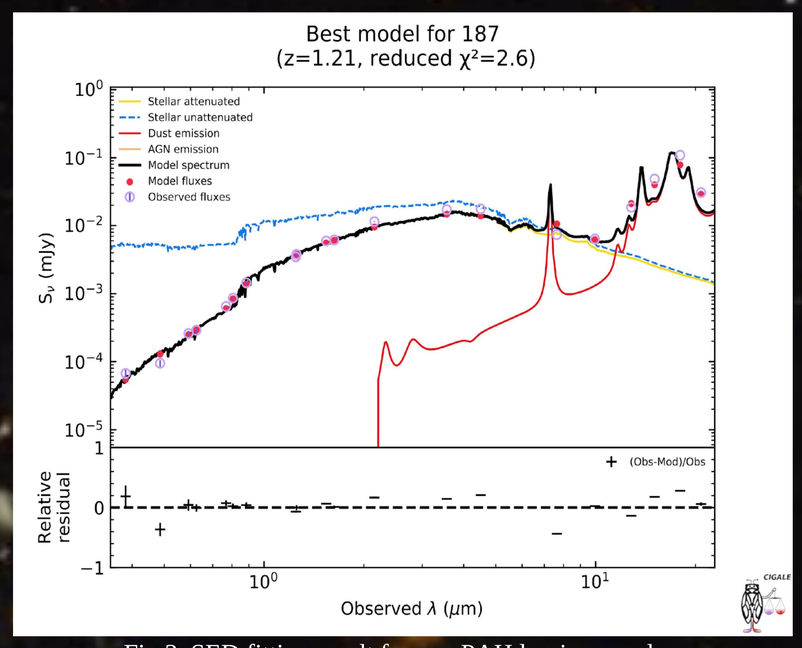

Fig.3, SED fitting result for one PAH luminous galaxy.

The new world for faint/normal star-forming galaxies at redshift > 1 by JWST

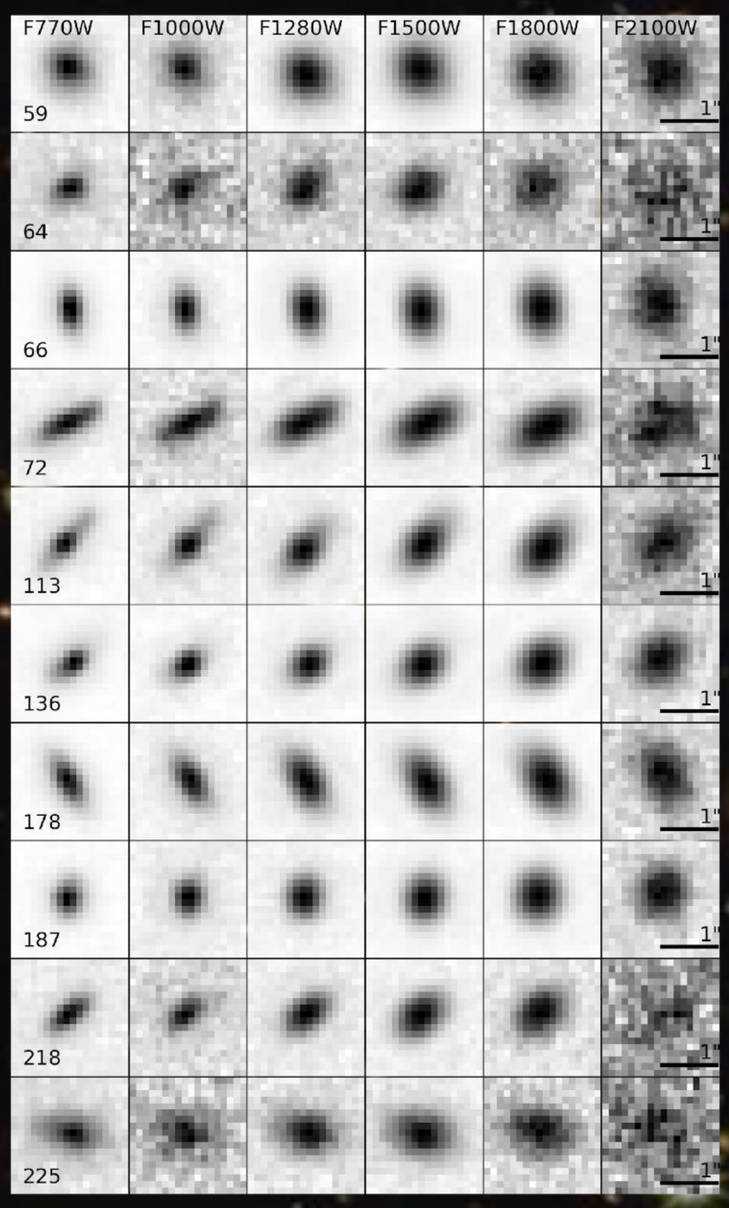

Fig.4, PAH galaxies' images.

Results

1. 10 of the 12 PAH-selected galaxies have good SED fitting results with reduced chi-square < 10. In Fig.4, we show ten PAH luminous galaxies in JWST MIRI 6bands observations.
2. In Fig.5, we analyzed the photometric redshift, and the PAH luminous galaxies are located at redshift ~ 1, which corresponded to the 7.7μm PAH feature.
3. In Fig.6, we calculated total infrared luminosity and PAH peak luminosity at 7.7 μm. We found that most of the sources are one order fainter than previous work, and have strong PAH features.

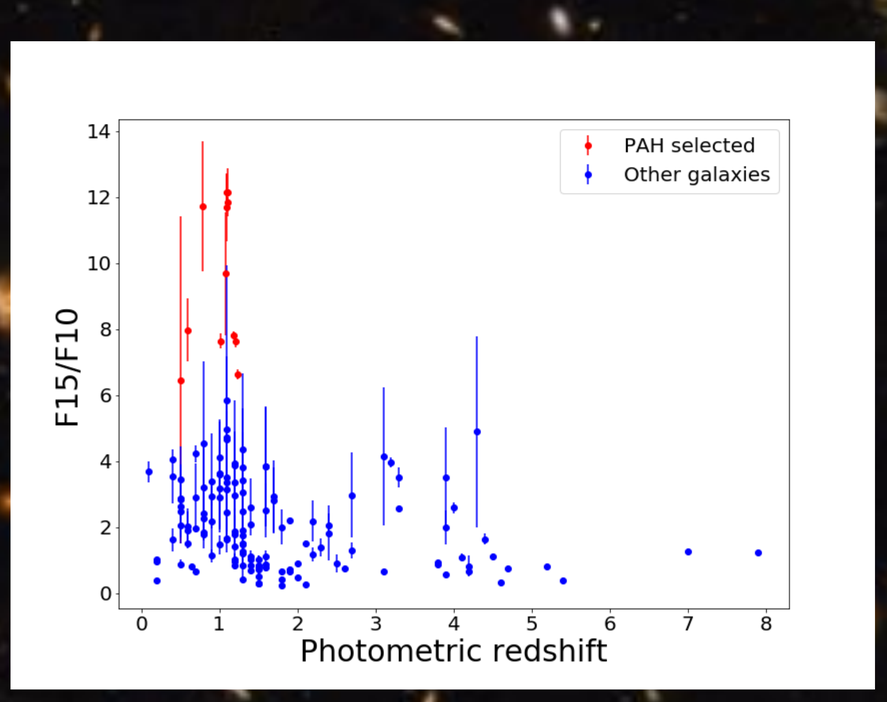

Fig.5, Redshift distribution.

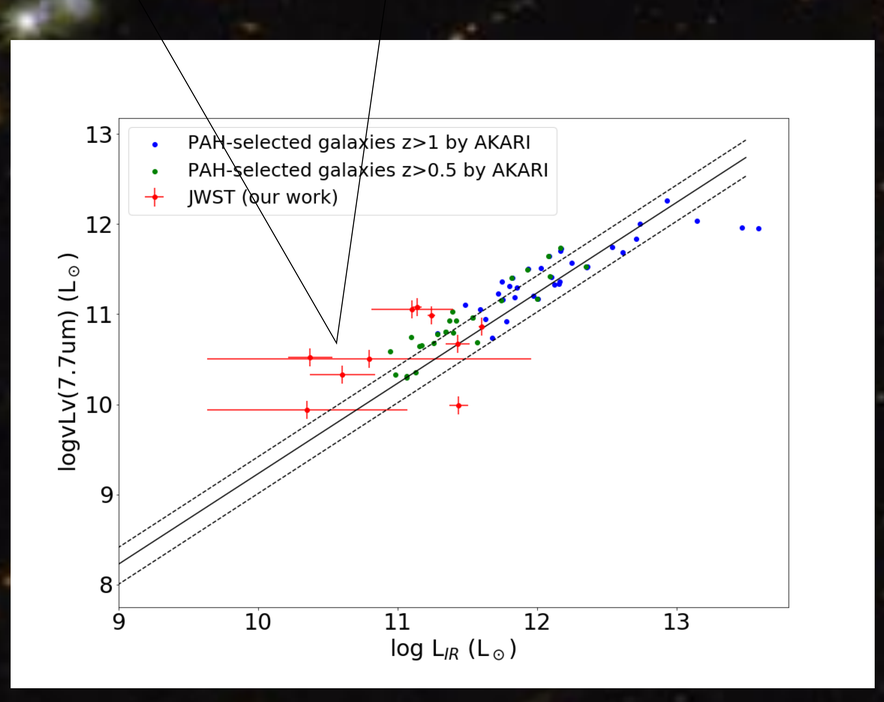

Fig.6, Total IR luminosity to PAH peak luminosity.