X66a A PAH deficit in the starburst core of a distant spiral galaxy

Zhaoxuan Liu (UTokyo/Kavli IPMU/CEA-Saclay), John Silverman (UTokyo/Kavli IPMU), Emanuele Daddi (CEA-Sacley), Boris Kalita (Kavli IPMU/KIAA), Annagrazia Puglisi (USouthampton), and the COSMOS Team

We present observations and analysis of a starburst galaxy (PACS-830) at $z = 1.46$ whose dust-obscured morphology is revealed by NIRCam to be that of a grand-design spiral thus favoring a scenario where intense star formation is not due to a major merger. We assess the strength and distribution of star formation using multiple tracers: (1) Polycyclic Aromatic Hydrocarbons (PAHs) emission detected at 8 μm (L_8) with a MIRI/F1800W image, and (2) $L_{\rm IR}$, inferred from the CO (J=5–4) ALMA map. In particular, we detect of one of its spiral arms with all tracers including CO (J=5–4) which contributes $21 \pm 6\%$ to the total flux. Within a dust-obscured starbursting core, the spatial profiles of the $L_{\rm IR}$ and L_8 are dissimilar thus leading to a significant deficit of mid-IR (L_8) emission in the core. This may be due to the destruction of PAH molecules by the intense ionizing radiation field, similar to star-forming regions in nearby galaxies and AGN host galaxies, and consistent with the global properties of distant starbursts. This study directly reveals spatial variations in the L_8 to $L_{\rm IR}$ ratio for the first time in the distant universe, in agreement with expectations from theory. Our analysis underscores the pivotal role of joint high-resolution observations with JWST and ALMA in discerning the different phases of the interstellar medium (ISM) and revealing internal physics in galaxy substructures.