

X33a Upper limit on HF(1–0) absorption in a dusty star-forming galaxy at $z = 6$: Constraints on early fluorine enrichment

辻田旭慶 (東京大学)、小林千晶 (ハートフォードシャー大学)、吉村勇紀、河野孝太郎 (東京大学)、但木謙一 (北海学園大学)、前田郁弥 (大阪電気通信大学)、梅畑豪紀、黄燦 (名古屋大学)、廿日出文洋 (国立天文台)、江草芙実、諸隈佳菜 (東京大学)、田村陽一 (名古屋大学)、西村優里 (筑波大学)

Wolf-Rayet (WR) stars have recently attracted attention as possible drivers of early chemical enrichment, including for fluorine—an element whose nucleosynthetic origin remains debated. To test the contribution of massive stars to fluorine production in the early Universe, we conducted Atacama Large Millimeter/submillimeter Array Band 5 spectroscopy of the HF(1–0) absorption line toward a dusty star-forming galaxy at $z = 6.024$. This galaxy has a known gas-phase metallicity and is too young for low-mass AGB stars to have contributed significantly, providing a clean environment to isolate massive-star yields. We do not detect significant HF absorption ($\sim 2\sigma$) and derive a conservative 5σ upper limit of $N_{\text{HF}}/N_{\text{H}_2} < 2.2 \times 10^{-9}$. This limit is about an order of magnitude below typical local measurements, indicating inefficient fluorine enrichment ~ 0.9 Gyr after the Big Bang. Comparison with chemical-evolution models shows that our constraint is consistent with scenarios without WR yields at this epoch. Expanding the sample of HF absorption measurements in high-redshift galaxies with well-characterized metallicities will be crucial for tracing the onset of WR enrichment and fluorine production across cosmic time.