Ultraluminous infrared galaxies in JWST

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Ultra-Luminous Infrared Galaxies (ULIRGs) are rich in gas and formed through mergers [2]. There are three types of galaxies: spiral, elliptical, and irregular. Spiral galaxies have a (1) flat, white disk composed of hot ionized gas and (2) a yellow, central bulge called a "halo". An example is our Milky Way Galaxy [1]. Elliptical galaxies lack a significant disk population and are more red/yellow, round, and elongated. Last but not least, irregular galaxies are white and dusty like spiral galaxies, yet lack a distinct pattern or shape [1]. ULIRGs primarily have irregular morphologies and eventually evolve into elliptical galaxies [6, 8].

Each ULIRG is characterized by an Active Galactic Nucleus (AGN) with a luminosity of at least $10^{12}\ L_{\odot}$ [4, 2]. With the AGN constantly accreting matter, as it is a supermassive black hole, 10–40% of mass-energy is converted into thermal energy and ultimately infrared radiation [1]. Galaxies can even accrete gas that was expelled by other nearby galaxies [9].

Unfortunately for the ravenous black hole, a mechanism called "feedback" regulates its *diet*. Feedback in general limits star formation by spewing gas, thus affecting galaxy evolution [2, 9]. There are two types—AGN and stellar feedback. In the former, which is relevant to the research at hand, gas does not fall directly into the black hole; instead, it falls towards it, forming a swirling, energetically violent, hot, and highly luminous accretion disk before spewing out gas via jet streams. On the other hand, stellar feedback involves starbursts that trigger shock waves and winds that blow gas out of the galaxy [1]. Both AGN and intense star formation can cause powerful galactic winds that spew out gas [3]. Conclusively, star formation is limited because the expelled gas is a constituent of stars [9].

There are two modes of AGN feedback: radiative and kinetic. The radiative or quasar mode involves photon emission with high accretion rates, causing explosive outflows [4, 7]. Conversely, the kinetic or radio mode low accretion rates and continuous heating via radio jets [4, 7].

Objects such as IRAS 20100-4156 and IRAS 03158+4227 exhibit fast molecular outflows with maximum velocities of ($\sim$1600-1700 km/s) [7]. Also, JWST MIRI detected a warm, bi-conical outflow with a high median ($\sim$1100 km/s) and maximum ($\sim$3000 km/s) in nearby ULIRG F08572+3915 [2]. Studying properties of ULIRGs proves challenging, especially those of quasars as they are the most luminous ($L_{\rm bol} \gtrsim 10^{45}\ {\rm erg\ s^{-1}}$) [5, 7]. A method of subtracting the quasar's contribution from the raw data is necessary for reliable measurements. Likewise, outflows may contaminate emission lines [5].

References

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