CH^+(1-0) in z~2-4 starburst galaxies: probes of multi-phasic turbulent gas reservoirs

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Starburst galaxies at redshifts $z \sim 2$ to 4 are among the most intensely star-forming galaxies in the universe. The way they accrete their gas to form stars at such high rates is still a controversial issue. We have detected the CH+(1-0) line in emission and/or in absorption in all the gravitationally lensed starburst galaxies observed so far with ALMA in this redshift range [1]. The unique spectroscopic and chemical properties of CH+ allow its transition to highlight the sites of dissipation of mechanical energy. Whilst the absorption lines reveal highly turbulent reservoirs of low-density molecular gas extending far out of the galaxies, the broad emission lines with widths up to a few thousands of km/s, arise in myriad molecular shocks powered by the feedback of star formation and possibly active galactic nuclei [1,2]. The CH+(1-0) lines therefore probe the sites of prodigious energy releases, mainly stored in turbulent reservoirs before being radiated away. These turbulent reservoirs act as extended buffers of mass and energy over timescales of a few tens to hundreds of Myr. Their mass supply involves multiphasic gas inflows from galaxy mergers and/or cold stream accretion, as supported by *Keck*/KCWI Lyα observations of one of these starburst galaxies [3].

References

[1] Falgarone, Zwaan et al. 2017, Nature 548 430
[2] Godard, Pineau des Forêts et al. 2019 A&A 622, A100
[3] Li, Cai, Prochaska et al. 2019, ApJ 875 130