ALMA Reveals Potential Evidence for Spiral Arms, Bars, and Rings in High-redshift Submillimeter Galaxies - DTU Orbit (28/07/2019)

We present subkiloparsec-scale mapping of the 870 μm ALMA continuum emission in six luminous (LIR ∼ 5 × 10^{12}L_⊙) submillimeter galaxies (SMGs) from the ALESS survey of the Extended Chandra Deep Field South. Our high-fidelity 0.″07-resolution imaging (~500 pc) reveals robust evidence for structures with deconvolved sizes of ≤0.5–1 kpc embedded within (dominant) exponential dust disks. The large-scale morphologies of the structures within some of the galaxies show clear curvature and/or clump-like structures bracketing elongated nuclear emission, suggestive of bars, star-forming rings, and spiral arms. In this interpretation, the ratio of the “ring” and “bar” radii (1.9 ± 0.3) agrees with that measured for such features in local galaxies. The potential spiral/ring/bar structures would be consistent with the idea of tidal disturbances, with their detailed properties implying flat inner rotation curves and Toomre-unstable disks (Q <1). The inferred one-dimensional velocity dispersions (σr ≤ 70–160 km s^{-1}) are marginally consistent with the limits implied if the sizes of the largest structures are comparable to the Jeans length. We create maps of the star formation rate density (ΣSFR) on ~500 pc scales and show that the SMGs are able to sustain a given (galaxy-averaged) ΣSFR over much larger physical scales than local (ultra)luminous infrared galaxies. However, on 500 pc scales, they do not exceed the Eddington limit set by radiation pressure on dust. If confirmed by kinematics, the potential presence of nonaxisymmetric structures would provide a means for net angular momentum loss and efficient star formation, helping to explain the very high star formation rates measured in SMGs.

General information
Publication status: Published
Organisations: National Space Institute, Astrophysics and Atmospheric Physics, University of Durham, Leiden University, Max-Planck-Institut fur Astronomie, Australian National University, Max-Planck-Institut fur Radioastronomie, Pennsylvania State University, Dalhousie University, Lancaster University, Academia Sinica - Institute of Astronomy and Astrophysics, European Southern Observatory, National Institute for Astrophysics, Institut d’Astrophysique de Paris, Instituto de Astrofísica de Canarias, Chalmers University of Technology
Corresponding author: Hodge, J. A.
Number of pages: 16
Publication date: 2019
Peer-reviewed: Yes

Publication information
Journal: Astrophysical Journal
Volume: 876
Issue number: 2
Article number: 130
ISSN (Print): 0004-637X
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
Original language: English
Keywords: Galaxies: evolution, Galaxies: formation, Galaxies: high-redshift, Galaxies: starburst, Submillimeter: galaxies
DOIs: 10.3847/1538-4357/ab1846
Source: FindIt
Source-ID: 2447726538
Research output: Contribution to journal › Journal article – Annual report year: 2019 › Research › peer-review