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Star Formation Efficiency in Superthin Galaxies

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Superthin galaxies are spiral galaxies that exhibit large axial ratios (>10) with no distinguishable bulge component. The sixth data release of the Sloan Digital Sky Survey showed approximately 15% of the observed edge-on disk galaxies to be bulgeless. Simulations have struggled to replicate this result in the context of the hierarchical and Lambda-CDM models since the superthin galaxies would have to be relatively undisturbed by mergers. One proposed explanation is that superthin galaxies have compact dark matter halos that help stabilize their discs. Observations have shown that superthin galaxies have maintained their gas and low surface brightness stellar discs for a Hubble time, despite predictions of instability in the discs that would result in high star formation efficiencies. Using the first CO(1-0) ALMA observations of a sample of superthin galaxies, our work established the star formation efficiency of each galaxy from their star formation rates and mass of hydrogen gas. Our analysis of the first ten target galaxies shows they have self-similar profiles. We also found that these galaxies have longer depletion times and lower star formation efficiencies than typical spiral galaxies. Low star formation efficiencies support the theory of compact dark matter halos, as the added stability from a halo would increase the disk stability parameter. Future dynamic modeling of these galaxies using these ALMA observations will further constrain their dark matter distribution.

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