X03a JWST Insights into Galactic Thin and Thick Disc Formation

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Present-day disc galaxies often exhibit distinct thin and thick discs. The formation mechanisms of the two discs and the timing of their onset remain open questions. To address these questions, we select edge-on galaxies from flagship JWST programs and investigate their disc structures in rest-frame, near-infrared bands. For the first time, we identify thick and thin discs at cosmological distances, dating back over 10 Gyr, and investigate their decomposed structural properties. We classify galaxies into those that require two (i.e. thin and thick) discs and those well fitted by a single disc. Disc radial sizes and vertical heights correlate strongly with the total galaxy mass and/or disc mass, independent of cosmic time. The structure of the thick disc resembles discs found in single-disc galaxies, suggesting that galaxies form a thick disc first, followed by the subsequent formation of an embedded thin disc. The transition from single to double discs occurred around 8 Gyr ago in high-mass galaxies ($10^{9.75} - 10^{11} M_{\odot}$), earlier than the transition which occurred 4 Gyr ago in low-mass galaxies ($10^{9.0} - 10^{9.75} M_{\odot}$), indicating that sequential formation proceeds in a "downsizing" manner. The thin disk formation time of the Milky Way progenitor agrees with that inferred for the Milky Way from stellar ages. Based on a comparison between our stellar structural measurements and gas kinematics (such as v/σ) from ALMA and other ground-based telescopes, we propose that Toomre Q-regulated disc formation naturally explains the delayed thin disc formation in low-mass galaxies.