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What drives the kinematic evolution of galaxies?

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One important result from recent large integral field spectrograph (IFS) surveys is that the intrinsic velocity dispersion of galaxies increases with redshift. Massive, rotation-dominated discs are already in place at z˜2, but they are dynamically hotter than spiral galaxies in the local Universe. Although several plausible mechanisms for this elevated velocity dispersion (e.g. star formation feedback, elevated gas supply, or more frequent galaxy interactions) have been proposed, the fundamental driver of the velocity dispersion enhancement at high redshift remains unclear. We investigate the origin of this kinematic evolution using a suite of cosmological simulations from the FIRE (Feedback In Realistic Environments) project. These simulations reproduce the observed trends between intrinsic velocity dispersion , SFR, and z, but the intrinsic velocity dispersion traced by the star-forming gas in the simulated galaxies is systematically lower than the observed values. In both the observed and simulated galaxies, the velocity dispersion is positively correlated with SFR. The velocity dispersion increases with redshift out to z˜1 and then flattens beyond that. In the FIRE simulations, the velocity dispersion can vary significantly on timescales of less than 100 Myr. These variations closely mirror the time evolution of the SFR and gas inflow rate. By cross-correlating pairs of velocity dispersion, gas inflow rate, and SFR, we show that the increased gas inflow leads to subsequent enhanced star formation, and enhancements in the velocity dispersion tend to temporally coincide with increases in gas inflow rate and SFR.

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