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Sub-kpc gas kinematics of a massive rotating disk 700 Myr after the Big Bang

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Recent studies have revealed the existence of particularly massive galaxies within the first Gyr after the Big Bang. These findings push the limits of galaxy evolution models, but our understanding of the formation of such galaxies is limited due to a lack of sub-kpc resolution observations of bright, spectroscopically-confirmed targets.

The REBELS ALMA large program have observed [CII] and dust continuum emission in ~30 massive z>6.5 galaxies. One particularly exciting galaxy within this sample, REBELS-25 (redshift z~7.3), shows a clear [CII] velocity gradient, a clumpy UV morphology, an ultra-luminous IR luminosity (ULIRG) and a possible outflow or companion. However, the resolution of the original dataset is too low to determine the mechanisms powering its extreme IR luminosity or how it's building its stellar mass. Follow-up [CII] and dust-continuum ALMA observations at ~780 pc scales (a factor of ~10 improvement in resolution) are now in hand, providing an unprecedented view of massive galaxy formation in the early Universe.

Preliminary analysis indicates that this galaxy is well-fit by a rotation-dominated disk model. By contrast, current cosmological simulations struggle to reproduce such an observation, and predict more chaotic, dispersion-dominated systems at z>3. Well-tested 3D fitting tools (e.g. 3DBarolo and CANNUBI) will be used to obtain robust estimates of the geometric and kinematic properties of this galaxy, and to investigate how it compares to other high redshift populations. Analysis of this exciting, massive rotating disk galaxy just 700 Myr after the Big Bang can therefore place stringent constraints on galaxy formation scenarios.

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