REBELS-25 is a dynamically cold disk galaxy, observations find

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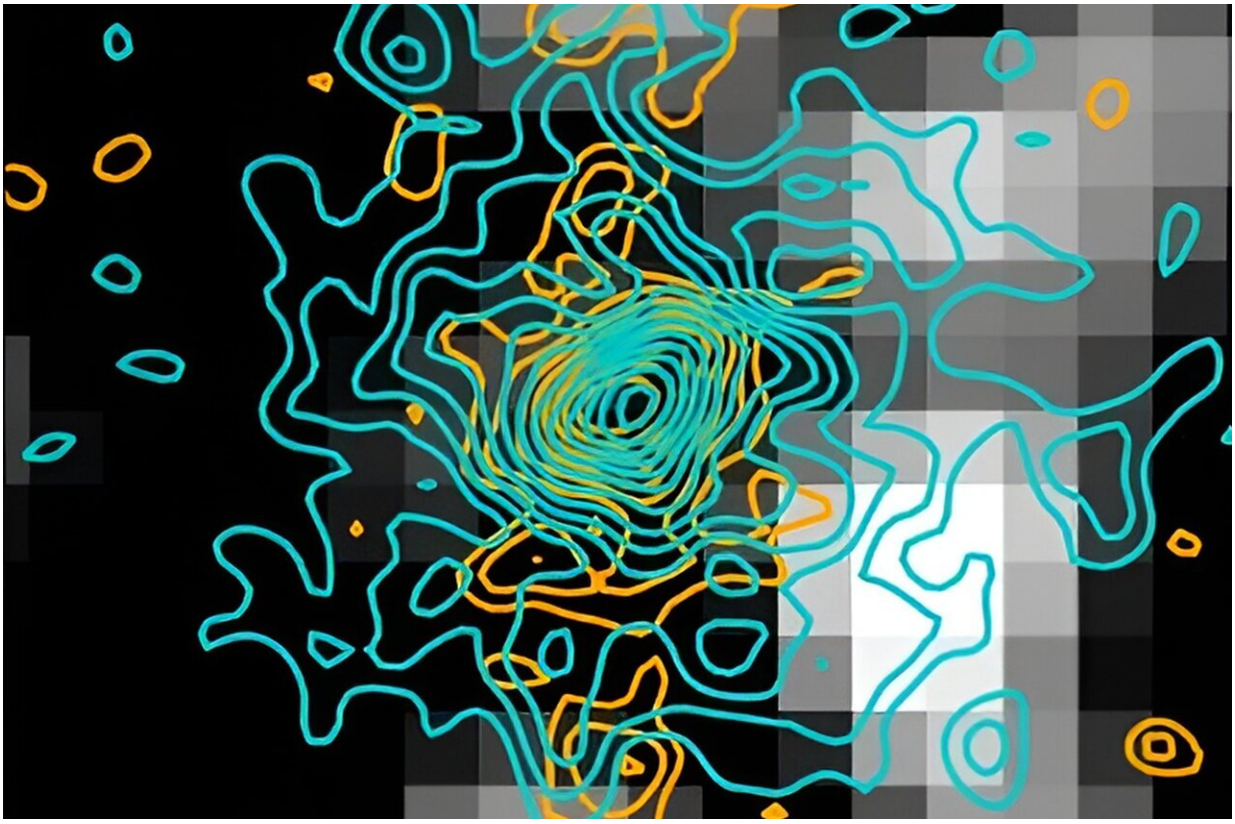

HST WFC3 F160W image of REBELS-25 from the COSMOS-DASH mosaic with the [CII] emission and dust continuum shown by the turquoise and orange contours, respectively. Credit: Rowland et al., 2024.

An international team of astronomers has observed a high-redshift massive star-forming galaxy known as REBELS-25. They found that

REBELS-25 is a dynamically cold disk galaxy. This finding was presented in a research paper published May 9 on the pre-print server *arXiv*.

At a redshift of 7.31, which corresponds to a luminosity distance of about 236 billion light years, REBELS-25 is an infrared luminous galaxy. It has a stellar mass of some 8 billion solar masses and its star-formation rate is estimated to be at a level of 199 solar masses per year.

Recently, a group of astronomers led by Lucie E. Rowland of the Leiden University in The Netherlands, decided to perform high-resolution and dust continuum observations of REBELS-25 in order to shed more light on its properties. For this purpose, they employed the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile.

"In this paper, we have presented follow-up high-resolution (~710 pc) ALMA [CII] and dust (~150□□m) continuum observations of REBELS-25; a massive star-forming galaxy at □□=7.31, originally targeted as part of the ALMA Reionization Era Bright Emission Line Survey (REBELS) large program (LP)," the researchers wrote.

The observations found that REBELS-25 has a relatively low velocity dispersion of about 33 km/s and a high ratio of ordered-to-random motion—at a level of 11.0. These results indicate that REBELS-25 is a dynamically cold disk galaxy.

However, although REBELS-25 seems to be dynamically cold, the astronomers have observed some evidence of non-circular motions. These motions could be due to inflows or outflows, a minor merging component, as well as due to a central bar or spiral arms.

The observations also found that REBELS-25 has a total dynamical mass of about 120 billion solar masses. Based on this, the researchers

estimated that the galaxy's gas mass is some 110 billion solar masses, but this result is highly uncertain due to dust obscuration and requires further studies.

The authors of the paper underlined that their discovery makes REBELS-25 one of the most distant robustly confirmed cold disk galaxies observed to date. They added that finding such a very distant and very dynamically cold disk galaxy challenges current theoretical predictions and simulations. It also suggests that such galaxies could be more common in the high-redshift universe than previously thought.

"We therefore expect that future, high resolution studies of cold gas kinematics at high-z will reveal even more cold, massive disks. In particular, ongoing ALMA observations of other REBELS galaxies will enable robust kinematic modeling of additional rotating disk candidates at ⍰⍰~6–8," the scientists conclude.

More information: Lucie E. Rowland et al, REBELS-25: Discovery of a dynamically cold disc galaxy at z = 7.31, *arXiv* (2024). DOI: 10.48550/arxiv.2405.06025