Early universe bristled with starburst galaxies

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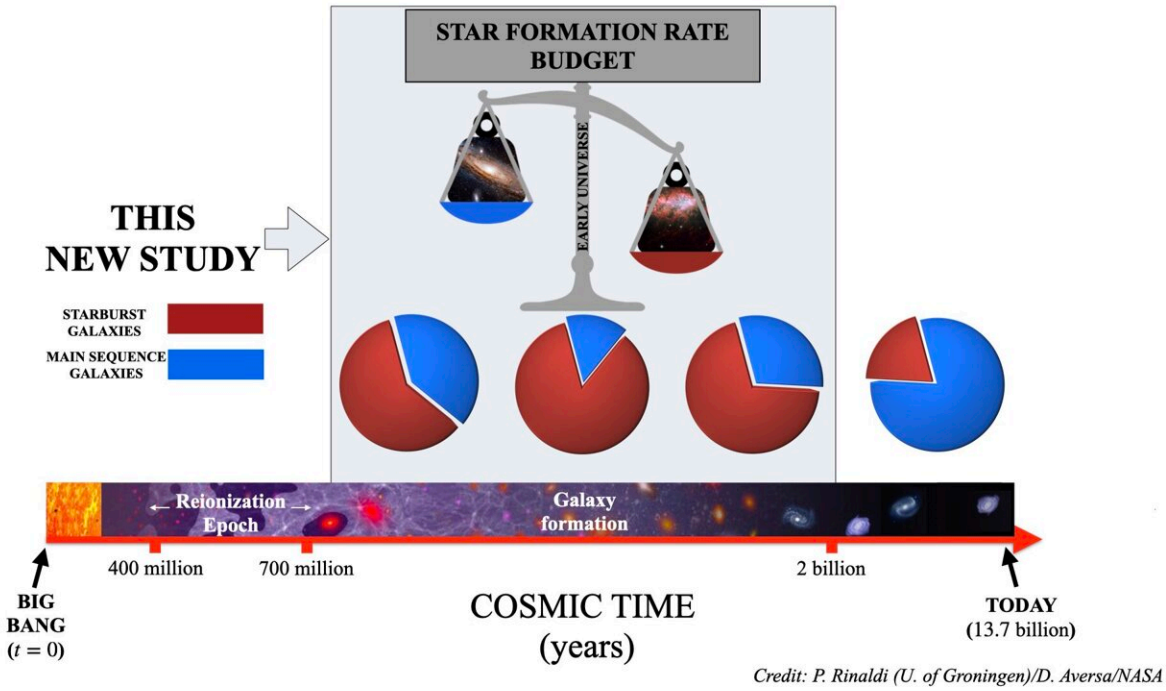


Credit: P. Rinaldi (U. of Groningen)/D. Aversa/NASA

The research of Rinaldi and colleagues at a glance. The first three predominantly red pie charts show that in the first few billion years after the Big Bang, about 60 to 90% of the new stars were created by galaxies in a growth spurt. Now, in the fourth pie chart, the universe is much quieter and only about 10% of new stars are born in starburst galaxies with a growth spurt. Credit: P. Rinaldi (RUG)/D. Aversa/NASA

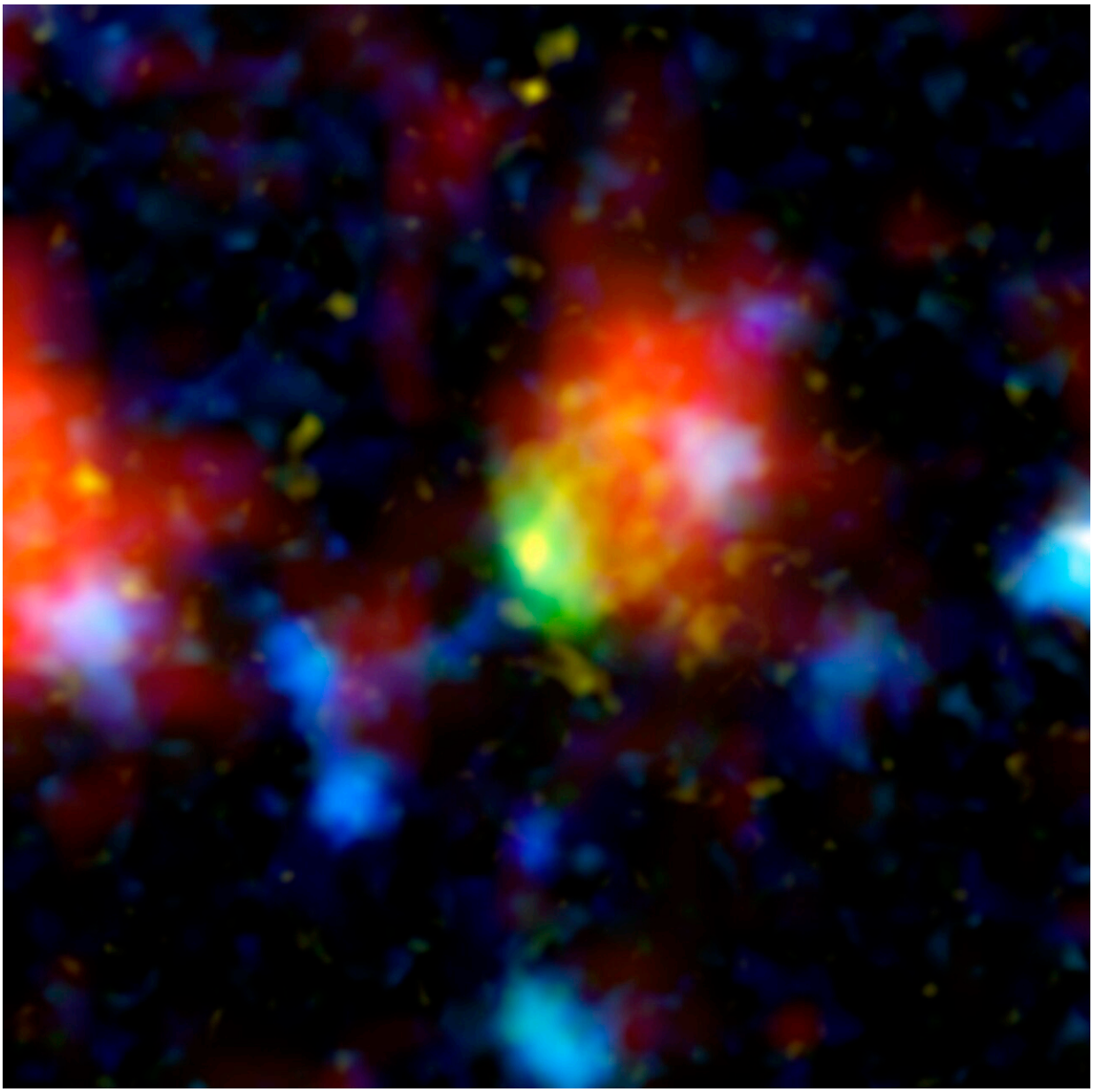
In the first few billion years after the Big Bang, the universe contained

far more so-called starburst galaxies than models predict. As many as 60 to 90% of the stars in the early universe appear to have been produced by galaxies undergoing a growth spurt. This is what an analysis of more than 20,000 distant galaxies show. The team, led by astronomers from University of Groningen (the Netherlands) will soon publish its findings in *The Astrophysical Journal*.

Starburst galaxies are galaxies in a growth spurt. They produce many more stars than normal in a relatively short period of time. A stellar growth spurt lasts 10 to 100 million years. Galaxies often live for billions of years and can undergo several growth spurts. To trigger a growth spurt, a sudden inflow of gas is needed, otherwise the building blocks for new stars will soon run out. Such an inflow can occur, for example, when two galaxies approach each other.

A research team led by Pierluigi Rinaldi, Ph.D. student at the University of Groningen (the Netherlands), studied the data of more than 20,000 distant galaxies. This data was collected in recent years with the Hubble Space Telescope, with the MUSE instrument on the European Very Large Telescope in Chile and with the Spitzer Space Telescope. The telescopes looked so far back in time that the researchers were able to study galaxies that formed 11 to 13 billion years ago. The Big Bang was 13.7 billion years ago.

The analysis shows that in the first few billion years after the Big Bang, about 20 to 40% of all star-forming galaxies were starburst galaxies. These galaxies in a growth spurt accounted for 60 to 90% of the new increase in stars. By comparison, today the Universe is much quieter and only about 10% of new stars are born in starburst galaxies.



The baby-boom galaxy is an example of a distant galaxy with a growth spurt. Credit: NASA/JPL-Caltech/Subaru/STScI/P. Capak

Furthermore, the analysis shows that growth spurts occur more often in smaller galaxies than in larger ones. It even appears that many small starburst galaxies have been captured by the telescopes just when they

are forming. "In this sense, you can compare it to the growth spurt in humans. That is also strongest during infancy," says Rinaldi.

The results came as a surprise because until recently, starburst galaxies were considered unusual and of minor importance in the formation and growth of galaxies. "Even the latest and most sophisticated models of galaxy formation had not predicted this," said Rinaldi. " It seems likely that the physical processes occur at too small a scale for the models to account for them."

Karina Caputi (University of Groningen), Rinaldi's supervisor adds: "Of course, it gives us something to think about with regard to those models. And that's a good sign." In the coming period, Caputi wants to further investigate the origin and evolution of the first galaxies. She can do this because she was recently awarded a NWO Vici grant and because the James Webb Space Telescope will also be focusing its mirrors on distant galaxies.

More information: Pierluigi Rinaldi et al, The galaxy starburst/main-sequence bimodality over five decades in stellar mass at z ~ 3-6.5. Accepted for publication in *The Astrophysical Journal*. arXiv:2112.03935v3 [astro-ph.GA], arxiv.org/abs/2112.03935

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