NATURE | NEWS

Stellar winds in galactic nurseries stifle star birth

Outflows from star-forming regions could cap the growth of galaxies.

Ron Cowen

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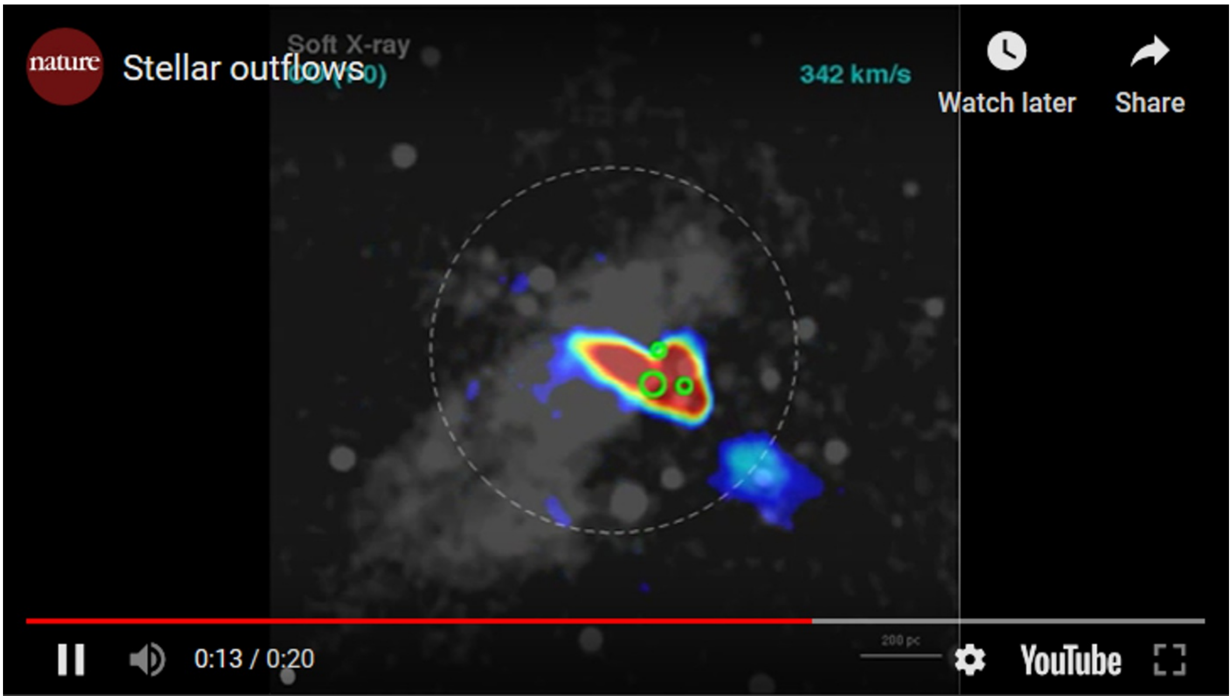

Stellar outflows

Carbon monoxide gas is launched out of the galaxy NGC 253 in these observations from the ALMA radio telescope array.

Credit: Alberto Bolatto, University of Maryland

Astronomers have presented the first detailed portrait of the fierce winds, associated with star birth, that blow out from a galaxy's core. The findings are a visual confirmation of the way in which winds from newborn stars hinder subsequent star formation in the region and, ultimately, constrain the overall size of a galaxy.

A team led by Alberto Bolatto of the University of Maryland in College Park used the Atacama Large Millimeter Array (ALMA), a network of radio telescopes in the Atacama Desert of northern Chile, to study the movement of cold, molecular gas in the nearby starburst galaxy NGC 253. Such galaxies make stars at rates similar to or greater than the Milky Way (which makes about three stars per year), but starburst galaxies instead pack the newborns into a small, central region of the galaxy.

In these regions, clouds of gas cool and condense until they reach a critical mass and a star's fusion is triggered. The newly formed stars release electromagnetic radiation and strong winds of fast-moving particles that compress and push out surrounding gas. Adding to this effect are short-lived, massive stars that explode as supernovas and generate even more powerful winds.

Optical and X-ray observations of starburst galaxies have traced only the hot, ionized components of outward streaming gas — thin filaments that underplay the overall amount of gas being pushed out. But over the past few years, radio telescopes have started to detect the heftier outflows of cold molecular gas.

Cold component

Using ALMA, Bolatto's team found several faint streamers of carbon monoxide gas billowing out from the starburst region in the central disk of NGC 253. The streamers are about 450 parsecs long, less than 50 parsecs wide and contain as much as 2 million solar masses worth of gas. Their shape and location closely match the known but more tenuous filaments of ionized gas. The findings are described in this week's issue of *Nature*[1].

"These molecules are the essential ingredients in dense gas clouds that lead to star formation," says astronomer Joss Bland-Hawthorn of the University of Sydney in Australia, who was not part of the latest study. "If you push them all away, you must suppress the next generation of stars."

The observations also allowed the team to measure the speed of the outflow. "We have spectra, we have images — everything we need to calculate a mass-loss rate," says Bolatto. The researchers estimate that the winds are expelling gas three times faster than the rate at which gas falls into the starburst region. Similar winds in the early Universe — the time at which the cosmos formed most of its stars — are likely to have capped the mass of galaxies. This may explain why heavy galaxies are less abundant than predicted by simple models that do not account for stellar winds.

Powerful jets generated by material falling into a supermassive black hole in the centre of a galaxy can also remove gas from a galaxy's core. But if NGC 253 has such a central powerhouse, it is currently quiescent — giving Bolatto confidence that the outflows he observed are all because of stellar winds.

Bolatto and his collaborators made their observations during ALMA's earliest phase of operations, when only 16 radio antennas were in use. The array currently has 59 antennas and should be complete with 66 by the end of the year. The team has scheduled more observations of NGC 253 to take advantage of ALMA's full capabilities.

But already, Bland-Hawthorn says that the team has nailed a key constraint on star birth. "There is no ambiguity here, for the first time," he says.

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References

1. Bolatto, A. D. *et al*. *Nature* **499**, 450–453 (2013).