Science News Release

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FUELLING THE CENTRAL STAR FACTORY IN NGC 6946

European astronomers have discovered a massive stream of cold gas reaching into the very centre of a spiral galaxy, known as NGC 6946. The core of NGC 6946 is currently forming stars in large abundance but, without such a steady supply of fresh gas, star formation there could not be maintained for a long time. These new results provide an important step towards understanding which mechanisms can fuel prolonged bursts of star formation in the centre of otherwise normal spiral galaxies. They are being presented today at the meeting of the American Astronomical Society in Denver, Colorado, by Torsten Böker of the European Space Agency, in Noordwijk, The Netherlands.

The spiral galaxy NGC 6946, similar in shape to our own Milky Way, is located 18 million light-years away in the northern constellation Cepheus (named after the mythological king of Aethiopia). Unlike the Milky Way, however, NGC 6946 is furiously forming stars. In particular, observations from the ground and with NASA/ESA's Hubble Space Telescope have revealed a bright star-forming region right at its centre, where about three new stars are formed every year, a rate comparable to that of the entire Milky Way.

Since stars are made of gas, astronomers believe that the formation of so many new stars can be sustained only if there is a fresh and steady supply of gas. Indeed, previous observations had long shown that NGC 6946 contains a lot of gas, collected in big clumps some tens of light-years across and distributed throughout the disc of the galaxy. However, scientists still did not know whether these gas clouds could move into the galaxy core.

Part of the answer has now come thanks to new observations obtained by German astronomer Torsten Böker and his colleagues using the interferometer of the Institut de Radio Astronomie Millimetrique (IRAM) in the French Alps. The new images reveal for the first time a stream of molecular gas (observed via the emission from the carbon monoxide molecule or CO) that extends along the galaxy stellar spiral arms all the way into the centre. "What we are seeing suggests that gas is continuously falling into the core of NGC 6946," Böker said. "Within the central 300 light-years, there is an amount of gas equivalent to the mass of four million Suns. All of it is available to form new stars in the future," he added.

The IRAM interferometer used to obtain the new data combines the signals from multiple radio telescopes to achieve a spectacular resolution, approaching that of the Hubble Space Telescope. The IRAM maps show details in NGC 6946 that are 50 light-years across, equivalent to viewing a golf ball from a distance of 15 km. But whilst Hubble observes the visible and near-infrared light emitted by the stars themselves, the IRAM interferometer is sensitive to the millimetric radiation from the cold molecular gas that is the raw material for star formation.

Because of the high spatial resolution of the IRAM data, Böker and his colleagues could compare the distribution of the cold molecular gas with that of the newly formed stars with unprecedented accuracy. Surprisingly, the team found that stars and gas do not overlap. "There is a clear offset between clumps of molecular gas and young stellar clusters: they seem to chase each other," said another team member, Eva Schinnerer from the National Radio Astronomy Observatory in Socorro, New Mexico. She explains that in the centre of NGC 6946, newly born stars are mostly seen next to gas clouds, but rarely coinciding with them.

Schinnerer speculates that stars are nevertheless forming also inside the dense gas clouds, but that they are still obscured by a thick cocoon of dust. "In star forming regions, gas and dust go hand in hand," she explains. A few million years after their birth, however, massive stars produce strong ultraviolet radiation that acts like a powerful wind and blows away the remaining gas around them. "That is probably why we no longer see any gas where stars have formed," Schinnerer added.

The discovery of a stream of fresh gas flowing into the core of NGC 6496 is certain to receive the attention of scientists who study the dynamics of gas and stars inside galaxies. Their task will be to explain which are the physical mechanisms that make it possible for the gas clumps to leave their orbit around the galaxy and drift into the centre, thus enabling the vigorous nuclear star formation seen in many spiral galaxies.

Böker and his colleagues, however, believe that more galaxies will have to be studied in similar detail before a clear picture of these dynamical phenomena can emerge. They expect a quantum leap in their research when the ESO/NSF Atacama Large Millimetre Array (ALMA) and the NASA/ESA James Webb Space Telescope (JWST) become operational in the coming years. "The exquisite spatial resolution of ALMA and the powerful infrared sensitivity of JWST should leave little doubt as to what makes such gas streams possible," Böker concluded.

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Figure caption

Left: false color image of the central 3000 light-years of NGC 6946, with red denoting the cold carbon monoxide (CO) gas, green denoting current star formation (as traced by ionised hydrogen) and blue denoting old stars (as traced by near-infrared emission). The gas (red clumps) is located predominantly between young star clusters with intense ultraviolet radiation (green clumps).
Right: higher resolution map of the central CO distribution. Note the concentration of gas in the centre and the S-shaped spiral pattern connecting the nucleus to the outer galaxy. Dense clumps of gas are falling towards the centre along the spiral arms.

The figure will be available, when the embargo is lifted, at the following ftp site at various levels of resolution:

ftp://astro.esa.int/pub/gdemarchi/ngc6946high.tif [size 20 MB]
ftp://astro.esa.int/pub/gdemarchi/ngc6946med.jpg [size 2 MB]
ftp://astro.esa.int/pub/gdemarchi/ngc6946low.jpg [size 1 MB]

Note to Editors:

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