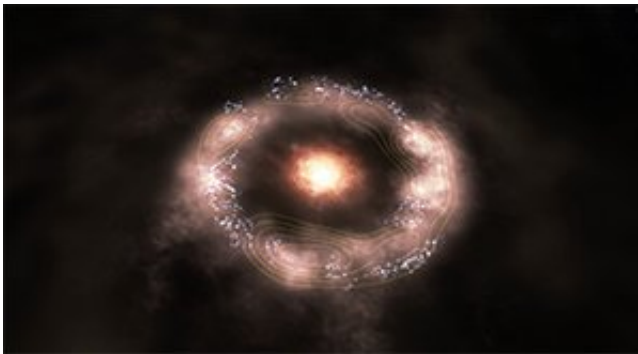


Why is massive star formation quenched in galaxy centers?

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Magnetic fields control the collapse of the molecular clouds in the nuclear ring of the galaxy NGC 1097. As a result, formation of massive stars is suppressed in zones of strong magnetic field (contours). Credit: Gabriel Pérez, SMM (IAC)

The current cosmological model to explain the universe, the "Big Bang" model, aims to describe all observable phenomena, including the evolution of galaxies from earliest times to the present day. One of the major problems in the Standard Model is that it predicts a star formation rate that is far too high. All the star-forming material in galaxies should have coalesced into stars when the universe was only a fraction of its present age of 13.8 billion years. However, over half the galaxies we see, mainly spirals, are actively forming stars right now. This discrepancy between theoretical prediction and observation has forced researchers to look much more closely at star formation quenching processes that can slow down the rate of star formation over the lifetimes of galaxies.

Without this quenching, the standard Big Bang model fails to predict the universe as we know it.

Researchers have proposed a number of mechanisms for quenching, including "feedback" from supernovae or [active galactic nuclei](#), which breaks up the star-forming clouds and reduces the [star formation](#) rate. Another mechanism has just been reported in *Nature Astronomy* in a study led by Instituto de Astrofísica de Canarias (IAC) researcher Fatemeh Tabatabaei. The study finds magnetic fields and cosmic rays responsible for the slow formation of massive [stars](#).

A detailed study of the star formation parameters of the central region of the spiral galaxy NGC 1097 revealed that the presence of a relatively large [magnetic field](#) is acting as a quenching agent, exerting pressure within a gas cloud that can inhibit its tendency to collapse and form stars. The researchers have also shown that this mechanism is, in fact, working around the center of NGC 1097. They combined observations in the visible and the near-infrared from the Hubble Space Telescope with radio observations from the Very Large Array and the Submillimeter Array to explore the effect of turbulence, stellar radiation and magnetic fields on massive star formation in the galaxy's nuclear ring. This ring contains a number of distinct zones where stars are forming inside huge molecular cloud complexes. The principal result they obtained was an inverse relation between the [star formation rate](#) in a given molecular cloud and the magnetic field within it—the larger the field, the slower the star formation rate.

"To do this, we made a specific separation of the magnetic field and its energy from other sources of energy in the interstellar medium, which are the thermal energy, and the general non-thermal but non-magnetic energy," explains Fatemeh Tabatabaei. "Only by combining the high quality observations at very different wavelengths could we do this and when we separated these energy sources the effect of the magnetic field

was surprisingly clear."

Almudena Prieto, another of the authors, says, "Although I have been working on the central zone of NGC 1097 at optical and infrared wavelengths for some time, only when we took into account the magnetic field could we realize its relevance in decreasing the rate at which stars are formed."

This result has several interesting consequences and throws light on several types of interrelated astrophysical puzzles. First, as the magnetic field does not allow very large molecular clouds to collapse and form stars, star formation can occur only after the clouds break up into smaller [clouds](#). This means that this region will have a higher fraction of low-mass stars than in other zones of the galaxy. The tendency of very massive galaxies to contain a high fraction of low-mass stars at their centers is a recent discovery, and is still in some ways controversial, but is reinforced by the work reported here. Also of interest is the fact that the presence of supermassive black holes in the centers of galaxies does tend to enhance the nuclear magnetic [field](#), so that this quenching mechanism should be most effective in the bulges of [galaxies](#).

More information: F. S Tabatabaei et al, Discovery of massive star formation quenching by non-thermal effects in the centre of NGC 1097, *Nature Astronomy* (2017). [DOI: 10.1038/S41550-017-0298-7](https://doi.org/10.1038/S41550-017-0298-7)

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