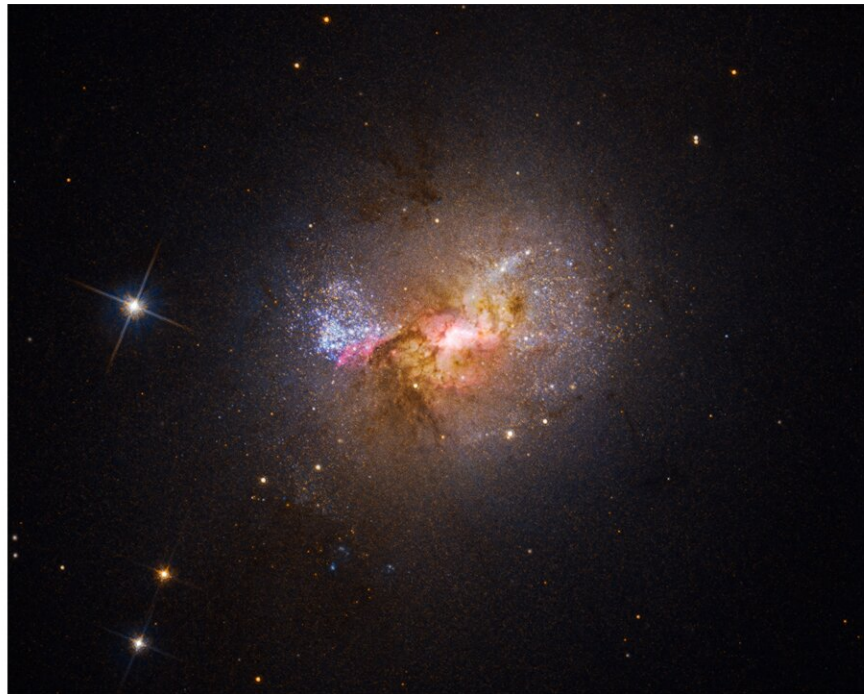


# Hubble finds a black hole igniting star formation in a dwarf galaxy

January 19 2022

---



Dwarf starburst galaxy Henize 2-10 sparkles with young stars in this Hubble visible-light image. The bright region at the center, surrounded by pink clouds and dark dust lanes, indicates the location of the galaxy's massive black hole and active stellar nurseries. Credit: NASA, ESA, Zachary Schutte (XGI), Amy Reines (XGI), Alyssa Pagan (STScI)

Black holes are often described as the monsters of the universe—tearing apart stars, consuming anything that comes too close, and holding light

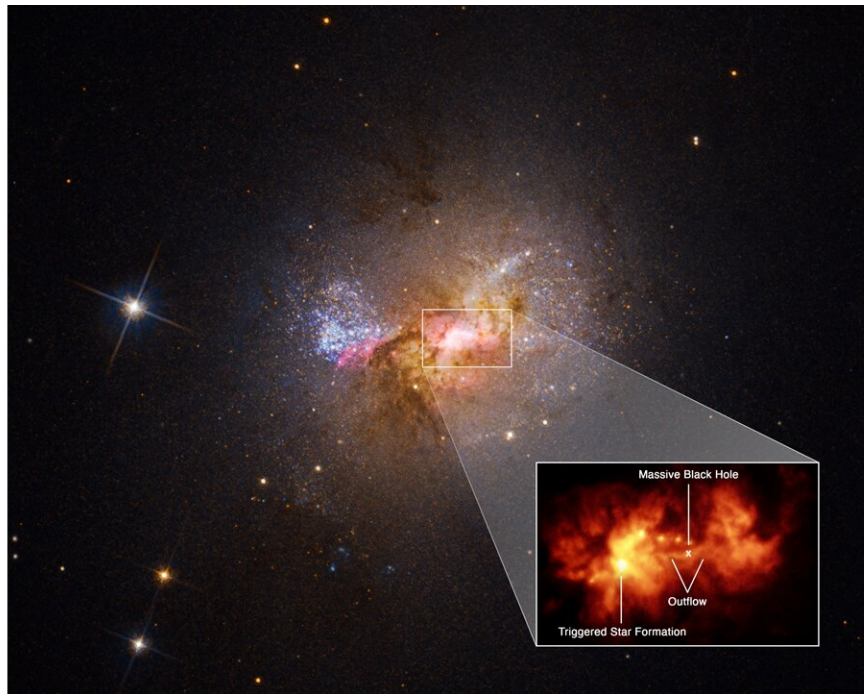
captive. Detailed evidence from NASA's Hubble Space Telescope, however, shows a black hole in a new light: Fostering rather than suppressing star formation. Hubble imaging and spectroscopy of the dwarf starburst galaxy Henize 2-10 clearly show a gas outflow stretching from the black hole to a bright star birth region like an umbilical cord, triggering the already dense cloud into forming clusters of stars. Astronomers have previously debated that a dwarf galaxy could have a black hole analogous to the supermassive black holes in larger galaxies. Further study of dwarf galaxies, which have remained small over cosmic time, may shed light on the question of how the first seeds of supermassive black holes formed and evolved over the history of the universe.

Often portrayed as destructive monsters that hold light captive, [black holes](#) take on a less villainous role in the latest research from NASA's Hubble Space Telescope. A black hole at the heart of the dwarf galaxy Henize 2-10 is creating stars rather than gobbling them up. The black hole is apparently contributing to the firestorm of new [star formation](#) taking place in the galaxy. The dwarf galaxy lies 30 million light-years away, in the southern constellation Pyxis.

A decade ago this small galaxy set off debate among astronomers as to whether dwarf galaxies were home to black holes proportional to the supermassive behemoths found in the hearts of larger galaxies. This new discovery has little Henize 2-10, containing only one-tenth the number of stars found in our Milky Way, poised to play a big part in solving the mystery of where supermassive black holes came from in the first place.

"Ten years ago, as a graduate student thinking I would spend my career on star formation, I looked at the data from Henize 2-10 and everything changed," said Amy Reines, who published the first evidence for a black hole in the galaxy in 2011 and is the principal investigator on the new Hubble observations, published in the January 19 issue of *Nature*.

"From the beginning I knew something unusual and special was happening in Henize 2-10, and now Hubble has provided a very clear picture of the connection between the black hole and a neighboring star forming region located 230 light-years from the black hole," Reines said.



A pullout of the central region of dwarf starburst galaxy Henize 2-10 traces an outflow, or bridge, of hot gas 230 light-years long, connecting the galaxy's massive black hole and a star-forming region. Hubble data on the velocity of the outflow from the black hole, as well as the age of the young stars, indicates a causal relationship between the two. A few million years ago, the outflow of hot gas slammed into the dense cloud of a stellar nursery and spread out, like water from a hose impacting a mound of dirt. Now clusters of young stars are aligned perpendicular to the outflow, revealing the path of its spread. Credit: NASA, ESA, Zachary Schutte (XGI), Amy Reines (XGI), Alyssa Pagan (STScI)

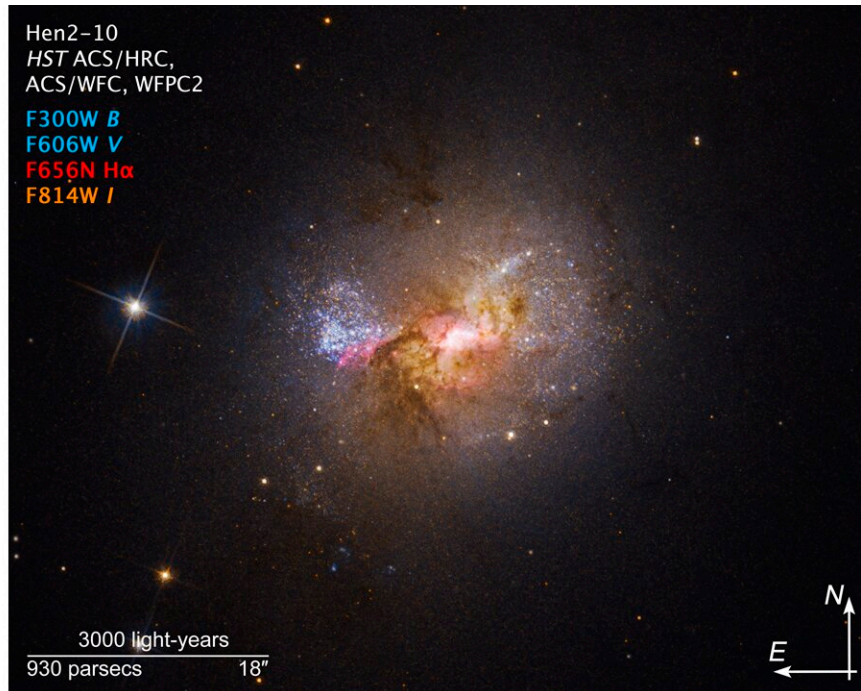
That connection is an outflow of gas stretching across space like an

umbilical cord to a bright stellar nursery. The region was already home to a dense cocoon of gas when the low-velocity outflow arrived. Hubble spectroscopy shows the outflow was moving about 1 million miles per hour, slamming into the dense gas like a garden hose hitting a pile of dirt and spreading out. Newborn star clusters dot the path of the outflow's spread, their ages also calculated by Hubble.

This is the opposite effect of what's seen in larger galaxies, where material falling toward the black hole is whisked away by surrounding magnetic fields, forming blazing jets of plasma moving at close to the speed of light. Gas [clouds](#) caught in the jets' path would be heated far beyond their ability to cool back down and form stars. But with the less-massive black hole in Henize 2-10, and its gentler outflow, gas was compressed just enough to precipitate new star formation.

"At only 30 million light-years away, Henize 2-10 is close enough that Hubble was able to capture both images and spectroscopic evidence of a black hole outflow very clearly. The additional surprise was that rather than suppressing star formation, the outflow was triggering the birth of new stars," said Zachary Schutte, Reines's graduate student and lead author of the new study.





Dwarf starburst galaxy Henize 2-10 compass. Credit: NASA, ESA, Zachary Schutte (XGI), Amy Reines (XGI), Alyssa Pagan (STScI)

Ever since her first discovery of distinctive radio and X-ray emissions in Henize 2-10, Reines has thought they likely came from a massive black hole, but not as supermassive as those seen in larger galaxies. Other astronomers, however, thought that the radiation was more likely being emitted by a supernova remnant, which would be a familiar occurrence in a galaxy that is rapidly pumping out massive stars that quickly explode.

"Hubble's amazing resolution clearly shows a corkscrew-like pattern in the velocities of the gas, which we can fit to the model of a precessing, or wobbling, outflow from a black hole. A supernova remnant would not have that pattern, and so it is effectively our smoking-gun proof that this is a black hole," Reines said.

Reines expects that even more research will be directed at dwarf galaxy black holes in the future, with the aim of using them as clues to the mystery of how supermassive black holes came to be in the early universe. It's a persistent puzzle for astronomers. The relationship between the mass of the galaxy and its black hole can provide clues. The black hole in Henize 2-10 is around 1 million solar masses. In larger galaxies, black holes can be more than 1 billion times our sun's mass. The more massive the host galaxy, the more massive the central black hole.

Current theories on the origin of supermassive black holes break down into three categories: 1) they formed just like smaller stellar-mass black holes, from the implosion of stars, and somehow gathered enough material to grow supermassive, 2) special conditions in the early universe allowed for the formation of supermassive stars, which collapsed to form massive black hole "seeds" right off the bat, or 3) the seeds of future supermassive black holes were born in dense star clusters, where the cluster's overall mass would have been enough to somehow create them from gravitational collapse.

So far, none of these black hole seeding theories has taken the lead. Dwarf galaxies like Henize 2-10 offer promising potential clues, because they have remained small over cosmic time, rather than undergoing the growth and mergers of large galaxies like the Milky Way. Astronomers think that dwarf galaxy black holes could serve as an analog for black holes in the early universe, when they were just beginning to form and grow.

"The era of the first black holes is not something that we have been able to see, so it really has become the big question: Where did they come from? Dwarf galaxies may retain some memory of the black hole seeding scenario that has otherwise been lost to time and space," Reines said.

**More information:** Zachary Schutte et al, Black-hole-triggered star formation in the dwarf galaxy Henize 2-10, *Nature* (2022). [DOI: 10.1038/s41586-021-04215-6](https://doi.org/10.1038/s41586-021-04215-6)

Provided by ESA/Hubble Information Centre

Citation: Hubble finds a black hole igniting star formation in a dwarf galaxy (2022, January 19) retrieved 24 April 2024 from <https://phys.org/news/2022-01-hubble-black-hole-igniting-star.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.