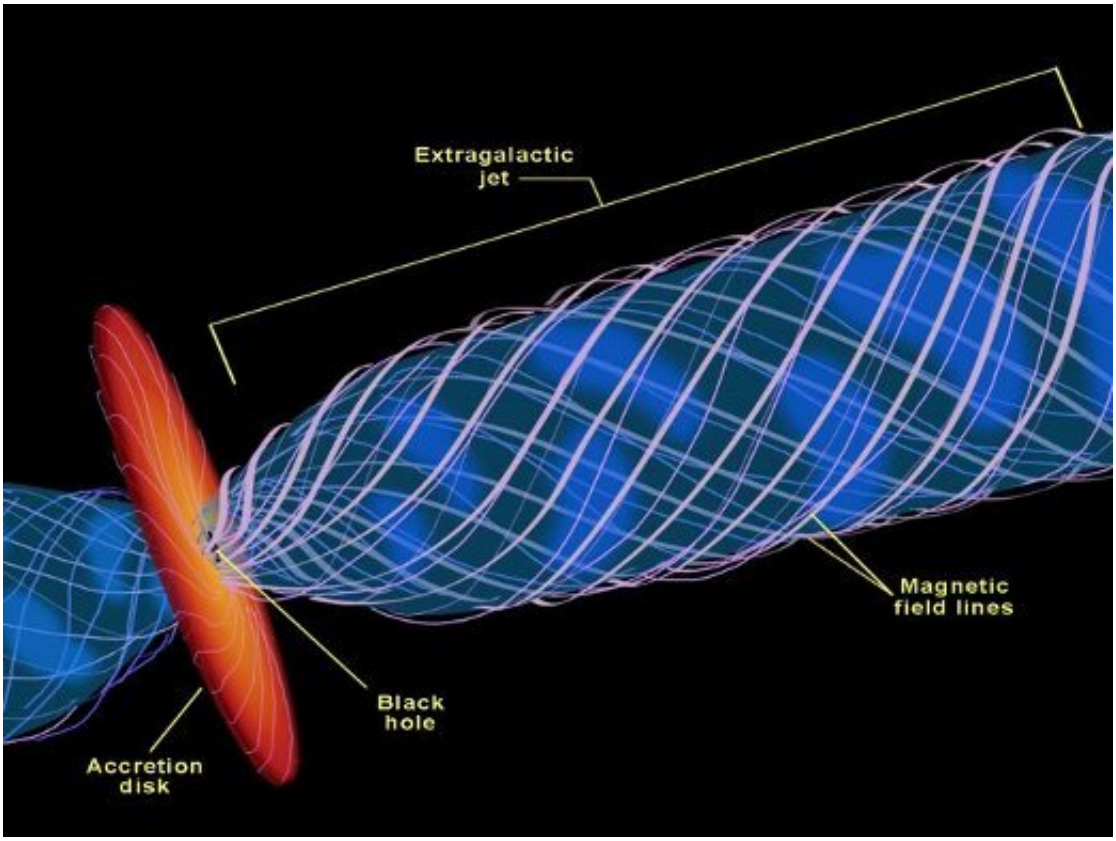
Jets and winds from galaxy cores appear to share a common cause

May 8 2019



Credit: SRON Netherlands Institute for Space Research

Astronomers have a rough understanding of how galaxies emit jets from their cores. Galaxy cores also blow out winds of ionized gas, for which researchers lack a general explanation. SRON astronomers have now found a correlation between jets and winds, suggesting magnetic fields

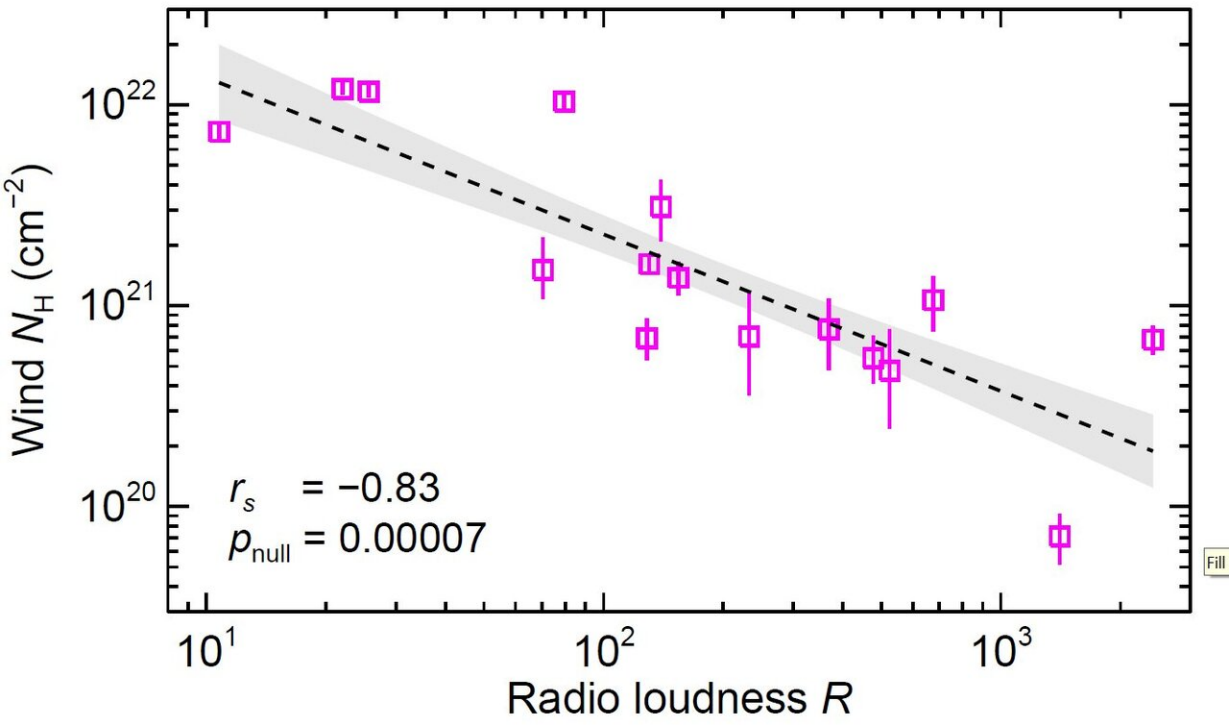
as a common cause. The study is published in *Astronomy & Astrophysics*.

Astronomers suspect that every galaxy harbors a supermassive black hole at its core, just like the recently photographed black hole in M87. With a mass of over 1 million suns, these black holes play a key role in the evolution of galaxies. Some black holes gobble up vast amounts of stardust and gas from their host galaxies. Those so-called active galactic nuclei (AGN) spit out some of the material that is falling onto them in the form of jets and winds. Astronomers have a fairly established idea about the mechanism behind jets, but the winds remain a mystery.

Common mechanism

Magnetic fields are important players in a wide range of objects in the universe. In AGN, the magnetic field drives jets of relativistic particles in opposite directions along the rotation axis of the black hole (see figure 1). SRON astronomers Missagh Mehdipour and Elisa Costantini have now found a relation between jets and winds, suggesting a common driving mechanism.

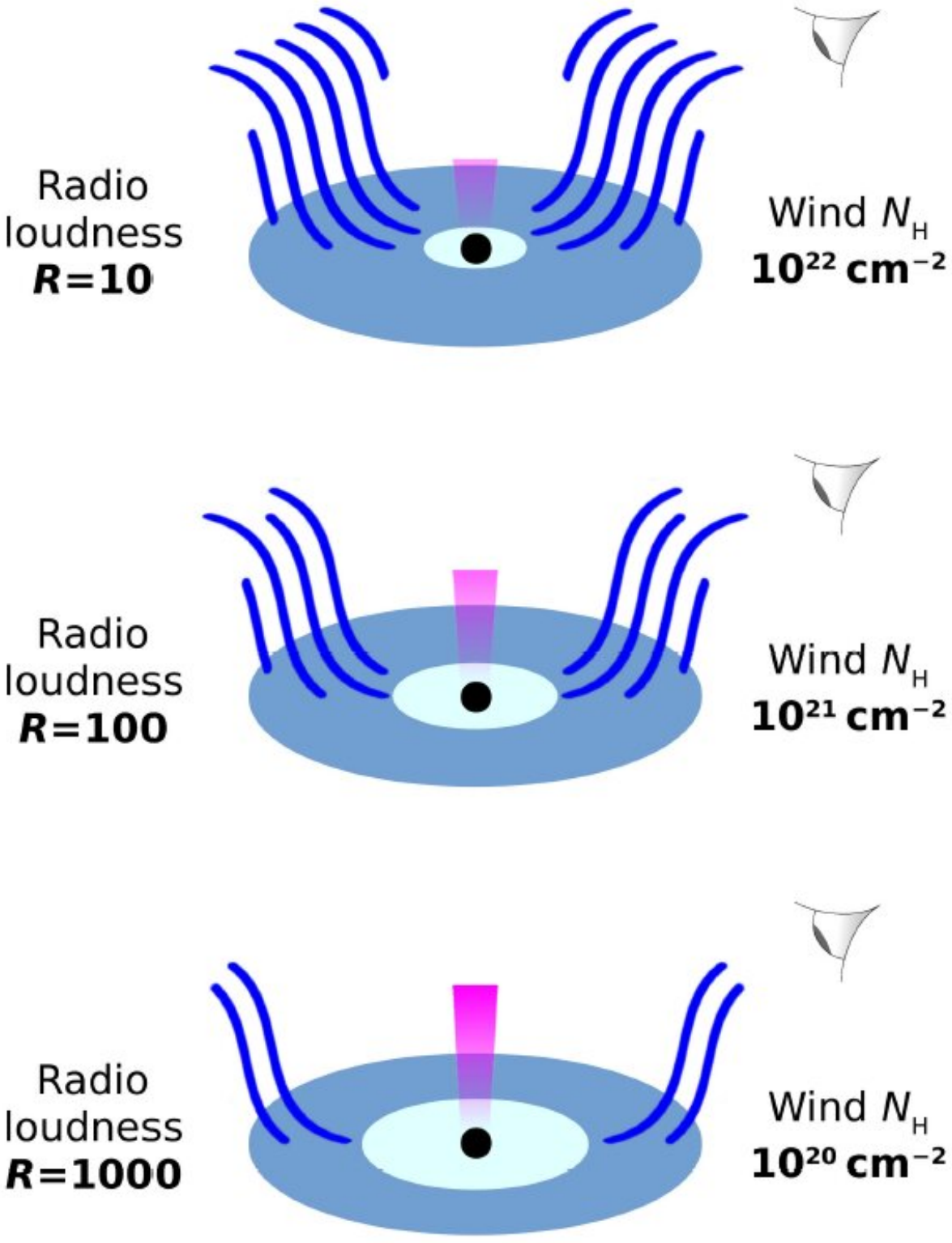
There turns out to be an inverse correlation between the radio emission from the jet and the amount of gas in the AGN's wind along our line of sight (see figure 2). Depending on the spin of the black hole and the configuration of the magnetic field, the outflowing power is distributed differently to the jet and the wind. A more powerful jet means a weaker wind, and vice versa (see figure 3). The results suggest that, just like jets, winds are magnetically driven. Mehdipour and Costantini confirmed this by excluding other possible mechanisms for the observed correlation.



The amount of gas in the AGN's wind along our line of sight (vertical) versus the radio emission from the jet (horizontal). Credit: SRON Netherlands Institute for Space Research

X-ray and radio synergy

The SRON researchers used XMM-Newton observations to see how the wind alters the shape of the X-ray spectrum from the AGN along our line of sight. This enabled them to derive the parameters of the wind, particularly the amount of gas in it along our line of sight. They used radio measurements from the literature to calculate the power of the jets and modelled all data with the SPEX code—developed at SRON by Jelle Kaastra and his team.


Radio loudness
R=10
Wind N_H
10^{22} cm^{-2}
Radio loudness
R=100
Wind N_H
10^{21} cm^{-2}
Radio loudness
R=1000
Wind N_H
10^{20} cm^{-2}

Depending on the spin of the black hole and the configuration of the magnetic field, the outflowing power is distributed differently to the jet and the wind. A more powerful jet means a weaker wind, and vice versa. Credit: SRON Netherlands Institute for Space Research

"For our investigation, AGN had to shine bright enough in X-rays and have a favourable inclination angle," says Mehdipour. "This means we ended up with sixteen AGN in our sample. Although our discovered correlation is statistically significant with a probability of no correlation much smaller than 1 percent, a larger sample is desirable for a more general characterization. Future X-ray telescopes, in particular Athena, will enable us to detect the wind in fainter AGN. This would increase the sample size and make our conclusion stronger."

More information: Missagh Mehdipour et al. Relation between winds and jets in radio-loud AGN, *Astronomy & Astrophysics* (2019). DOI: 10.1051/0004-6361/201935205

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