Research News

Could we harness energy from black holes?

Study indicates that energy can be extracted from black holes

A new study indicates that, someday, energy could be extracted from black holes.

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A remarkable prediction of Einstein's theory of general relativity -- the theory that connects space, time and gravity -- is that rotating black holes have enormous amounts of energy available to be tapped.

For the last 50 years, scientists have tried to come up with methods to unleash this power.

Now, in a U.S. National Science Foundation <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1903412&HistoricalAwards=false> -funded study published in *Physical Review D* (/cgi-bin/good-bye?https://journals.aps.org/prd/abstract/10.1103/PhysRevD.103.023014), physicists Luca Comisso of Columbia University (/cgi-bin/good-bye?https://news.columbia.edu/energy-particles-magnetic-fields-black-holes) and Felipe Asenjo of the Universidad Adolfo Ibáñez in Chile have found a new way to extract energy from black holes by breaking and rejoining magnetic field lines near the event horizon, the point at which nothing, not even light, can escape a black hole's gravitational pull.

"Black holes are commonly surrounded by a hot 'soup' of plasma particles that carry a magnetic field," said Comisso. "Our theory shows that when magnetic field lines disconnect and reconnect in just the right way, they can accelerate plasma particles to negative energies, and large amounts of black hole energy can be extracted."

The U.S. National Science Foundation <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1903412&HistoricalAwards=false> -funded research results could allow astronomers to better estimate the spin of black holes and possibly discover a source of energy for the needs of an advanced civilization, Comisso said.

Comisso and Asenjo built their theory on the premise that reconnecting magnetic fields accelerates plasma particles in two different directions. One plasma flow is pushed against the black hole's spin, while the other is propelled in the spin's direction and can escape the clutches of the black hole. That releases power if the plasma swallowed by the black hole has negative energy.

"It is like a person could lose weight by eating candy with negative calories," said Comisso, who explained that essentially a black hole loses energy by eating negative-energy particles. "This might sound weird," he said, "but it can happen in a region called the ergosphere, where the spacetime continuum rotates so fast that every object spins in the same direction as the black hole."

Inside the ergosphere, magnetic reconnection is so extreme that the plasma particles are accelerated to velocities approaching the speed of light.

While it may sound like the stuff of science fiction, mining energy from black holes could be the answer to our future power needs.

"Thousands or millions of years from now, humanity might be able to survive around a black hole without harnessing energy from stars," Comisso said. "It is essentially a technological problem. If we look at the physics, there is nothing that prevents it."

Added Vyacheslav Lukin, a program director in NSF's Division of Physics, "The ideas and concepts in this work are truly fascinating, as is the potential translation of these studies of black hole astrophysics into the practical realm."

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