BLACK HOLE PHYSICS

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5. Highlights of black hole astrophysics

PROBING THE SPACETIME AROUND SAGITTARIUS A* WITH RADIO PULSARS

(Astrophysical Journal , 615:253–258, 2004)

Eric Pfahl and Abraham Loeb

ABSTRACT

The supermassive black hole at the Galactic center harbors a bound cluster of massive stars that should leave neutron star remnants. Extrapolating from the available data, we estimate that 1000 radio pulsars may currently orbit Sgr A* with periods of P 100 yr. Optimistically, 1–10 of the most luminous of these pulsars may be detectable with current telescopes in periodicity searches at frequencies near 10 GHz, where the effects of interstellar scattering are alleviated. Long-term timing observations of such a pulsar would clearly reveal its Keplerian motion and possibly show the effects of relativistic gravity. We briefly discuss how pulsar timing can be used to study the dynamical and interstellar environment of the central black hole and speculate on the prospects for astrometric observations of an orbiting pulsar

"A strong magnetic field around the supermassive black hole at the centre of the Galaxy", Nature (501), 391–394 (19 September 2013)

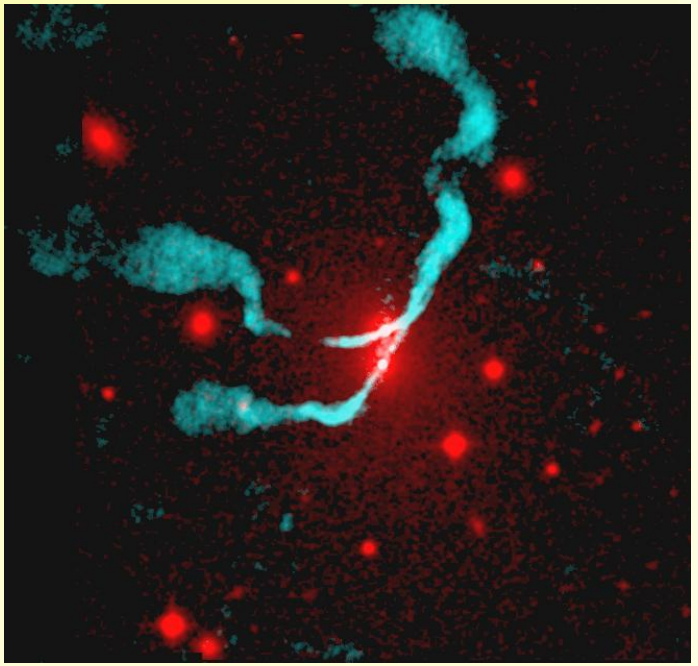
Here we report multi-frequency radio measurements of a newly discovered pulsar close to the Galactic Centre and show that the pulsar's unusually large Faraday rotation (the rotation of the plane of polarization of the emission in the presence of an external magnetic field) indicates that there is a dynamically important magnetic field near the black hole. If this field is accreted down to the event horizon it provides enough magnetic flux to explain the observed emission—from radio to X-ray wavelengths—from the black hole.

PSR J1745-2900, a pulsar (magneter) (a very high gamma ray repeater, SGR J1745-29) at 3arcsec from Syg A*.

Estimated magneic field near the black hole 10-100 Gauss

3C 75 is a binary black hole system in the Abell 400 cluster of galaxies. It has four radio jets (two from each accreting black hole). It is travelling at 1200 kilometers per second through the cluster plasma, causing the jets to be swept back. The binary supermassive black holes are themselves contained in the dumbbell shaped galaxy NGC 1128. (Wiki)

Astronomers conclude that these two super-massive black holes are bound together by gravity in a binary system in part because the jets' consistent swept back appearance is most likely due to their common motion as they speed through the hot cluster gas at 1200 km/sec. Such spectacular cosmic mergers are thought to be common in crowded galaxy cluster environments in the distant universe. **(Astronomy Picture of the Day,** 2010 March 14)



"Constraints on the nature of CID-42: recoil kick or supermassive black hole pair? "

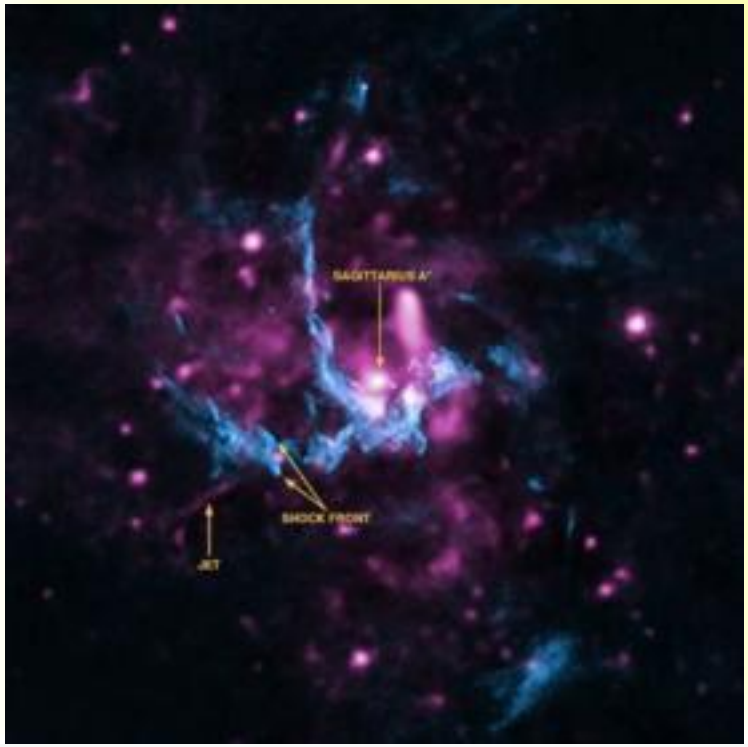
Blecha, Civano, Elvis,Loeb; MNRAS, Volume (428) 1341 (2013)

ABSTRACT

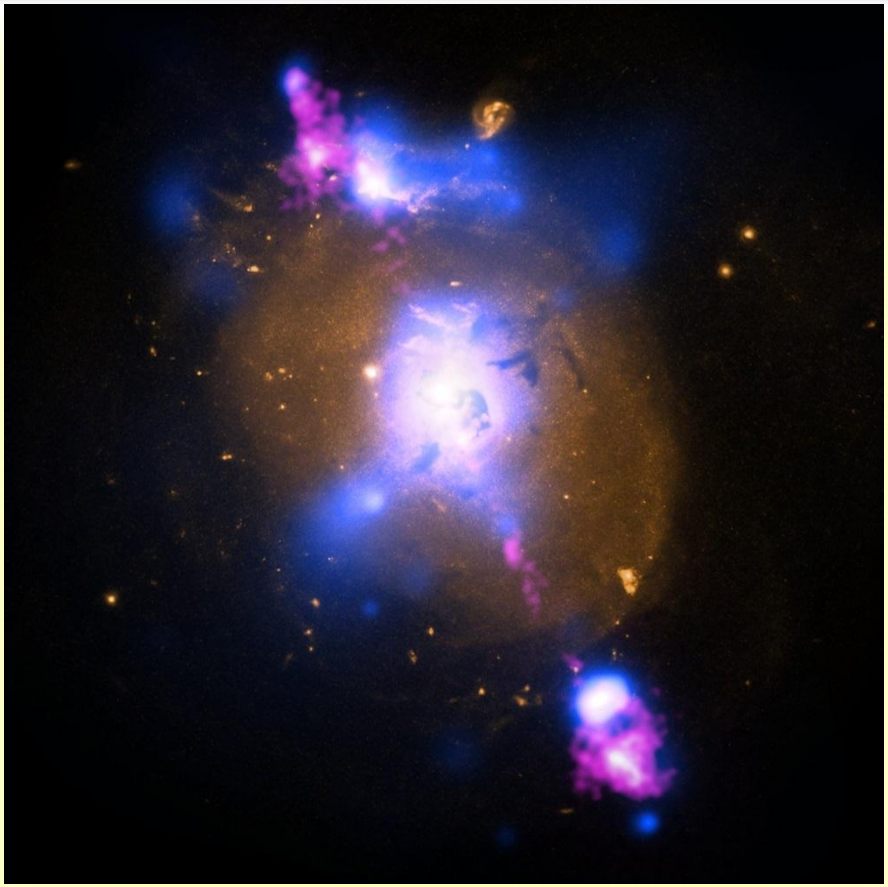
The galaxy CXOC J100043.1+020637, also known as CID-42, is a highly unusual object. An apparent galaxy merger remnant, it displays signatures of both an inspiraling, kiloparsecscale active galactic nucleus (AGN) pair and of a recoiling AGN with a kick velocity > 1300 km/s. Among recoiling AGN candidates, CID-42 alone has both spatial offsets (in optical and X-ray bands) and spectroscopic offsets.

Scientific American, November 25, 2013 ; "Milky Way's Black Hole Is Shooting Particle Jets"

X-ray and radio observations offer the best evidence yet that, as long suspected, high-energy particles stream from the heart of our galaxy

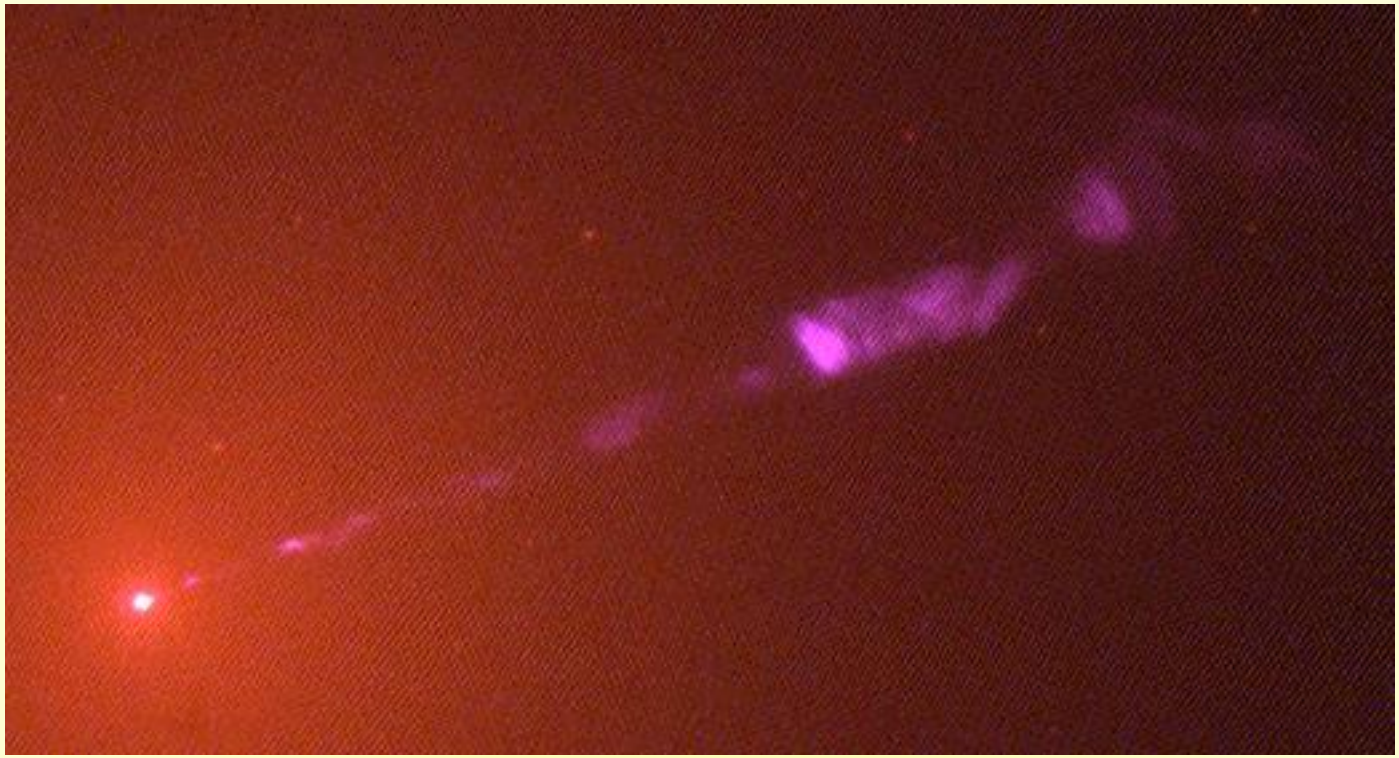


This composite photo of the Milky Way's center, showing x-rays from the Chandra telescope (purple) and radio data from the Very Large Array (blue), offers new evidence that particle jets are shooting from our galaxy's supermassive black hole. Image: X-ray: NASA/CXC/UCLA/Z.Li et al; Radio: NRAO/VLA

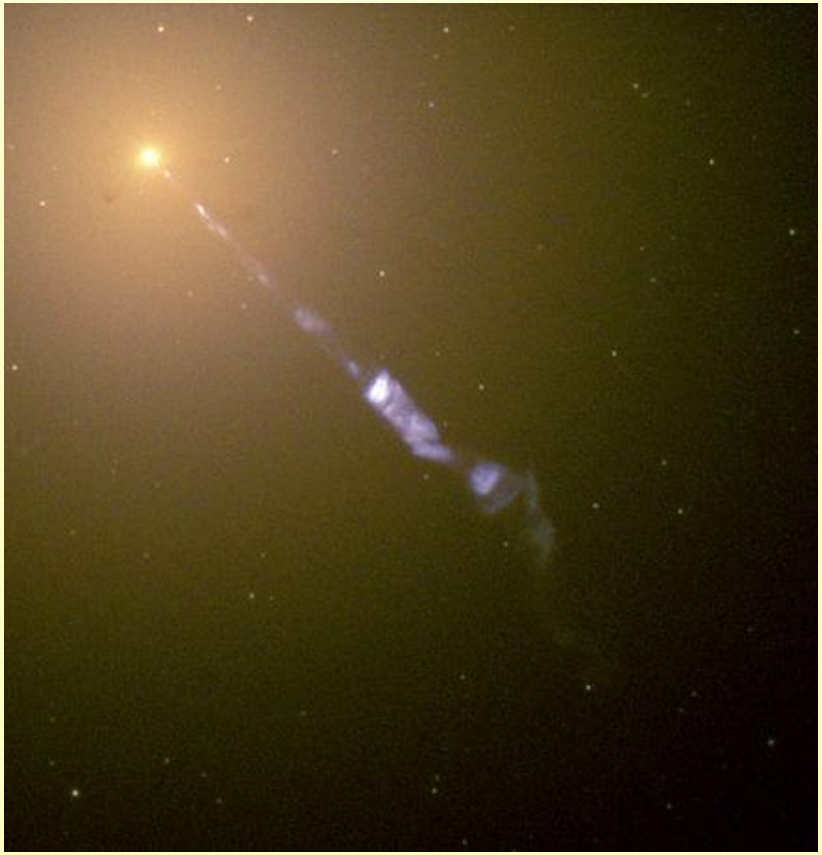


Credit: NASA

The image contains X-ray data from NASA's Chandra X-ray Observatory (blue), optical light obtained with the Hubble Space Telescope (gold) and radio waves from the NSF's Very Large Array (pink). This is 4C+29.30, a galaxy located some 850 million light years from Earth. The radio emission comes from two jets of particles that are speeding at millions of miles per hour away from a supermassive black hole at the center of the galaxy. The estimated mass of the black hole is about 100 million times the mass of our Sun. The ends of the jets show larger areas of radio emission located outside the galaxy.



Hubble picture of a jet from M87 black hole.



This Hubble Space Telescope photograph shows the jet of matter ejected from M87 at nearly light speed, as it stretches 1.5 kpc (5 kly) from the galactic core (wiki).

The **`heaviest'** supermassive black hole has a mass equivalent to 17 billion suns and is located inside the galaxy NGC 1277 in the constellation Perseus. It makes up about 14 percent of its host galaxy's mass, compared with the 0.1 percent a normal black hole would represent, scientists said.

http://www.space.com/18668-biggest-black-hole-discovery.html

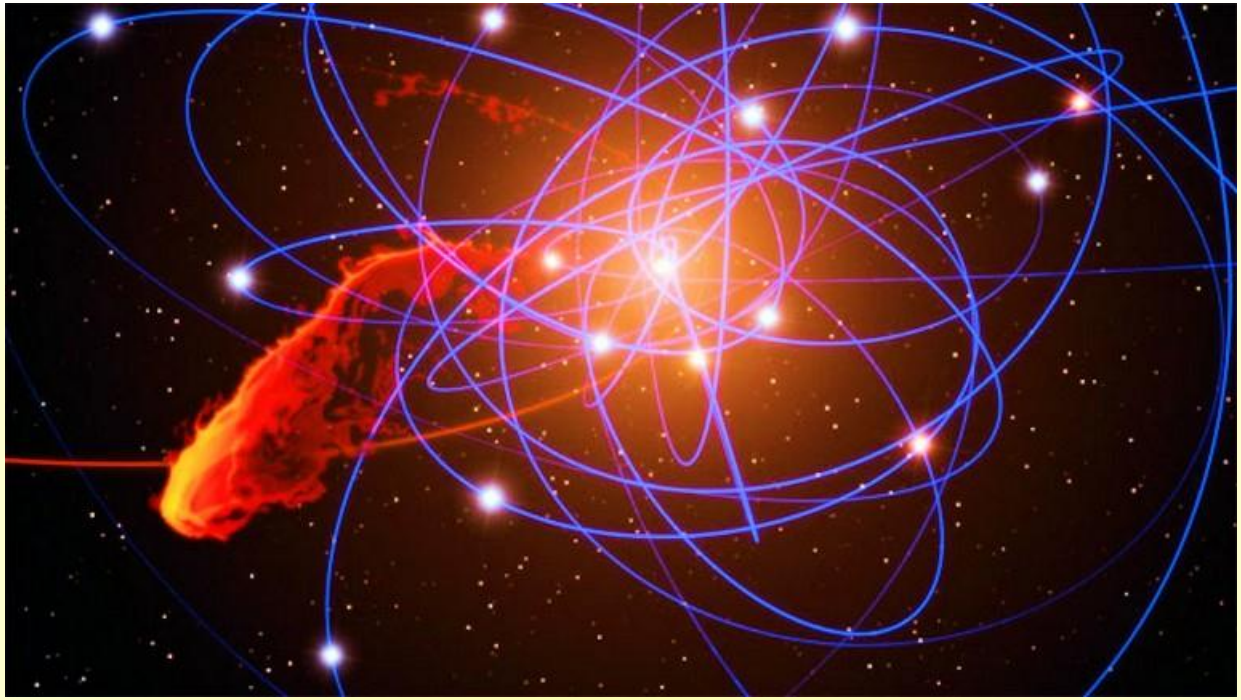
“Tidal disruption of a super-Jupiter by a massive black hole”, by Nikolajuk and Walter

Astronomy & Astrophysics, 552, A75 (2013); ArXiv:1304.0397v1

A strong, hard X-ray flare was discovered (IGR J12580+0134) by INTEGRAL in 2011, and is associated to NGC 4845, a Seyfert 2 galaxy never detected at high-energy previously.

The mass of the central black hole in NGC 4845 is estimated as $3 \times M_{\odot}$. The observed flare corresponds to the disruption of about 10% of an object with a mass of 14-30 Jupiter.

Wiki: Swift J1644+57 (**GRB 110328A**) is the name of the event, the tidal disruption of a star by a supermassive black hole. It has been detected by the Swift Gamma-Ray Burst Mission on March 28, 2011 in the center of a small galaxy in the Draco constellation, about 3.8 billion light-years away. It's one of the most puzzling cosmic blasts of high-energy radiation ever observed when it comes to brightness, variability and durability. It probably occurred when a white dwarf wandered too close to the central black hole in the galaxy, and was gravitationally torn apart and swallowed by it. Debris now encircles the black hole in an accretion disk, which launches bipolar jets at near the speed of light.



G2, a three-Earth mass gas cloud near the galactic center, is viciously disrupted by a close encounter with Sagittarius A*, the galaxy's supermassive black hole. Careful observation of this rare event is expected to provide an enormous amount of information on the environment of the central light month (about 6,000 AU) immediately surrounding the black hole.

(Image: M. Schartmann and L. Calcada/ESO)