Powering the extreme jets of active galaxies

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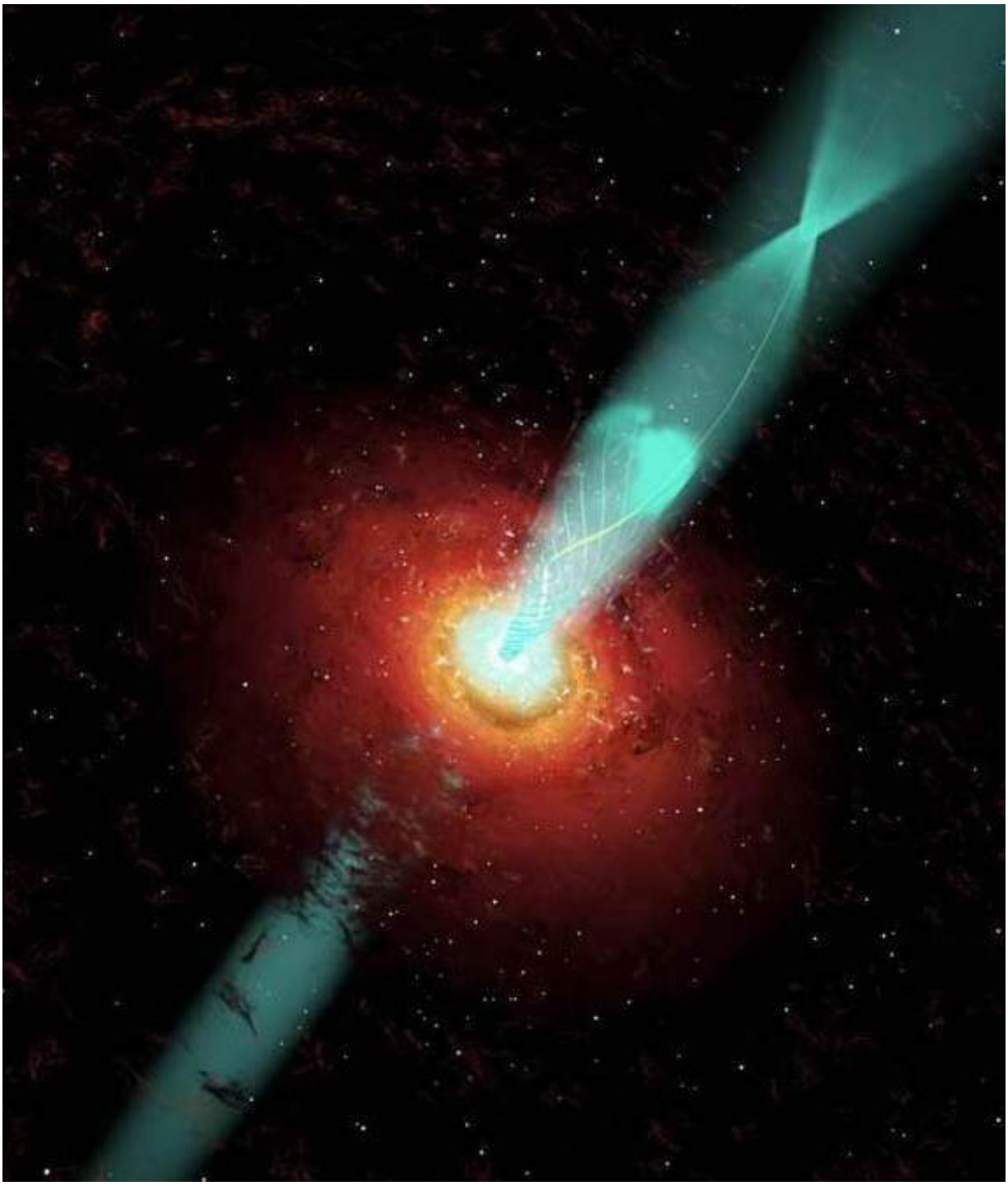

Black-hole-powered galaxies called blazars have powerful jets that are thought to be fortuitously aimed directly toward Earth. Astronomers have used multi-band observations, from the gamma-ray to the radio, to study the powerful jets and their driving sources. Credit: NASA; M. Weiss/CfA

An active galaxy nucleus (AGN) contains a supermassive black hole that is vigorously accreting material. It typically ejects jets of particles that move at close to the speed of light, radiating across many wavelengths, in particular the X-ray, in processes are among the most energetic phenomena in the universe. The jets are often also highly collimated and extend far beyond their host galaxy, and if they happen to be pointed along our line of sight they are the most spectacular class of this phenomenon: blazars.

A few years ago astronomers noticed that some types of blazars have jet powers that appear to exceed the power provided by the accretion. Two ideas were put forward to explain the difference: the jets are also extracting power from the spin of the black hole or from the magnetic flux around the object. How either process happens—if indeed they do happen—is hotly debated, but one popular line of argument asserts that the processes are somehow related to the mass of the supermassive black hole, with the most massive cases (more than a hundred million solar-masses) being the most anomalous. Recently the Fermi Gamma-Ray Space Telescope detected gamma-rays (even more energetic photons than X-rays) coming from jets in a class of galaxies called Seyferts, spiral galaxies with relatively small supermassive black hole masses, typically about ten million solar-masses. Astronomers speculated that these relatively low-mass yet powerful emission engines might provide keys to sorting out the various sources of jet power.

CfA astronomer Mislav Balokovic and his colleagues completed a multi-wavelength study of the bright blazar-like Seyfert galaxy PKSJ1222+0413 and included data from the gamma-ray to the radio, both archival and new observations, including new results from the NuSTAR space observatory They then undertook a complete modeling of this source, the most distant one of its type known—its light has been

traveling towards us for about eight billion years. They detected the pronounced signature of an accretion disk, and estimated the mass of the supermassive black hole from the widths and strengths of the emission lines to be about two hundred million solar-masses, about ten times higher than most other Seyferts of its type. The jet luminosity is only about half the accretion luminosity, unlike cases like galaxies whose jet power exceeds the accretion. But the object nonetheless clearly falls into a transition regime for jet strengths, enabling future studies to study in more detail the origins of jet power both Seyfert galaxies and in blazars.

More information: Daniel Kynoch et al. The relativistic jet of the γ-ray emitting narrow-line Seyfert 1 galaxy PKS J1222+0413, *Monthly Notices of the Royal Astronomical Society* (2019). DOI: 10.1093/mnras/stz1193

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