Powerful jets from non-spinning black holes

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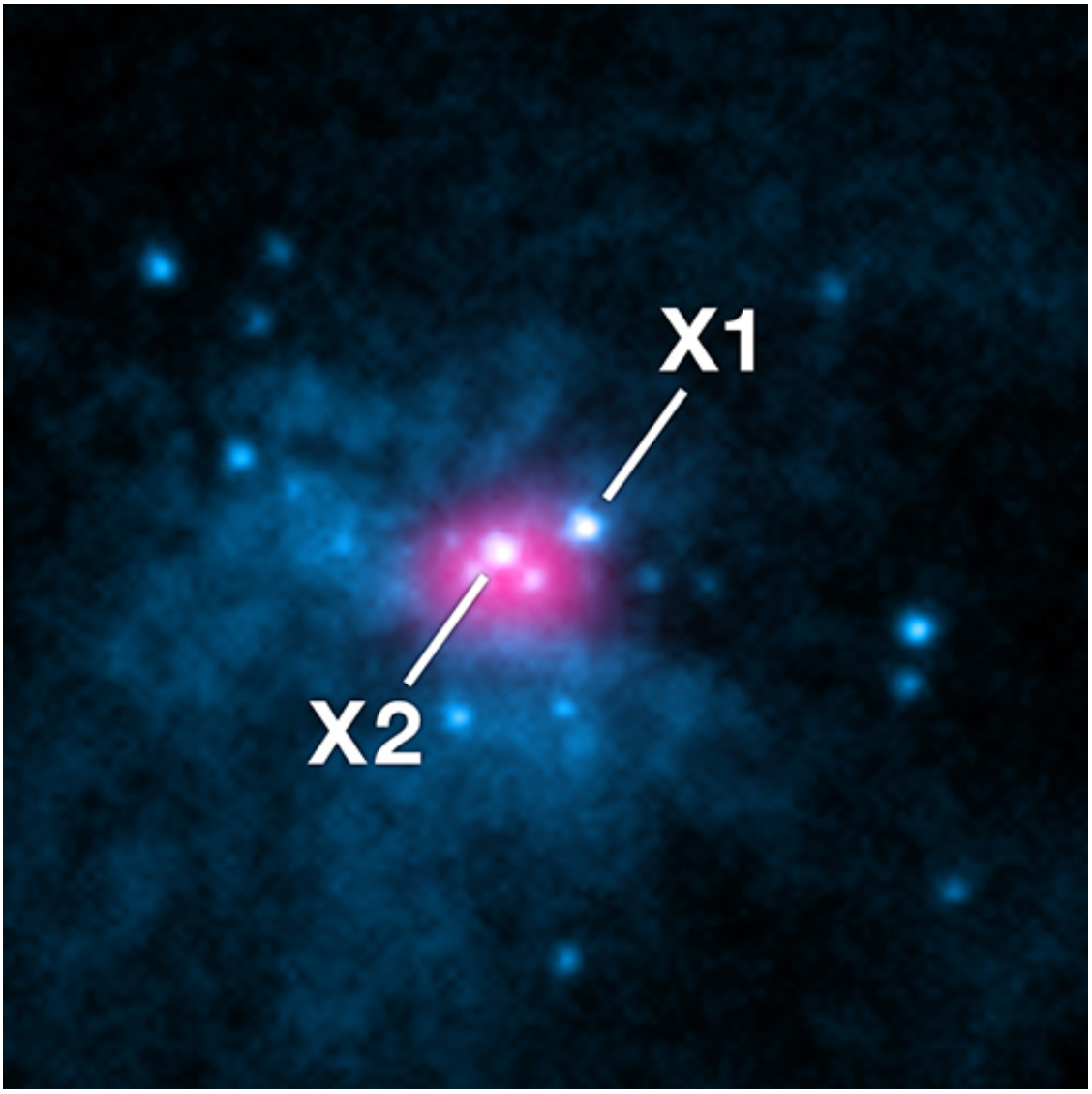

A multi-wavelength image of the ultra-luminous X-ray source X2 in the galaxy M82. Scientists have had a difficult time understanding the mechanisms powering its intense emission. A new paper successfully proposes an alternate explanation to magnetically dominated black hole rotation, namely, that the X-ray jets are radiatively driven. Credit: X-ray: NASA/CXC/Univ. of

Toulouse/M.Bachetti et al, Optical: NOAO/AURA/NSF

A black hole is so simple (at least in traditional theories) that it can be completely described by just three parameters: its mass, its spin, and its electric charge. Even though it may have formed out of a complex mix of matter and energy, all the other specific details are lost when it collapses to a singular point. The environment of a black hole is not so simple, however. As material flows in towards the black hole, a hot accretion disk develops. In galaxies with active black hole nuclei, the disks facilitate the production of powerful jets of ionized matter. In some cases the jet particles are driven to velocities close to the speed of light. These jets are thought to be powered by the rotational energy of the spinning black hole, with magnetic fields playing a pivotal role.

CfA astronomer Ramesh Narayan and his colleague have discovered an alternative explanation for the driving mechanism of the jets. Instead of rotation-powered, magnetically dominated jets, they find that non-spinning black holes can also drive powerful jets by means of the intense radiation emitted by hot gas. The gravity of the black hole attracts the radiation, which becomes concentrated enough that its pressure can drive the jet's particles at speeds up to about half the speed of light, at least under appropriate disk geometries.

Their result provides an alternative explanation for some puzzling astrophysical observations. Ultraluminous X-ray sources around the sky are thought to arise around black holes of about ten solar-masses in size, but the models can't explain the energetics of all of the observations unless the X-ray emission is emitted in narrow beams rather than isotropically. In the new alternative scenario, in which radiation drives the jets, the source naturally emits particles in narrow beams.

More information: Aleksander Sądowski et al. Powerful radiative jets in supercritical accretion discs around non-spinning black holes, *Monthly Notices of the Royal Astronomical Society* (2015). DOI: 10.1093/mnras/stv1802