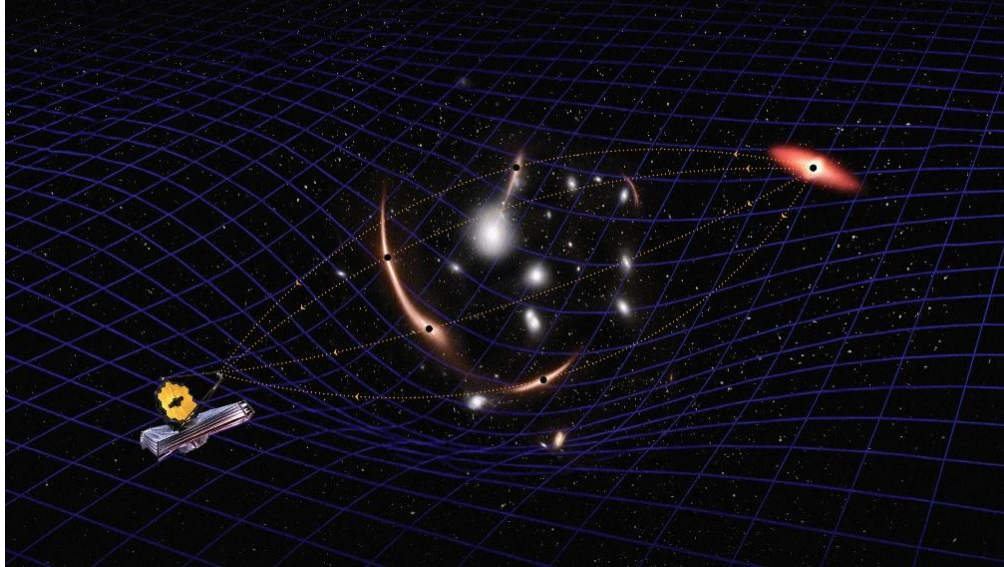


Press release

For immediate release

## HKU-HKIAA Astronomer Joins International Study to Weigh Inactive Black Hole Seen 10 Billion Years Ago

5 July 2026



*Image 1: Artist's illustration showing JWST, aided by gravitational-lensing, enabled the team to measure the mass of an inactive black hole in the early Universe. Image credit: Navid Marvi/Carnegie Science.*

An international team of astronomers, including Professor Meng GU, an affiliated member of the Hong Kong Institute for Astronomy and Astrophysics (HKIAA) at The University of Hong Kong (HKU), has directly measured the mass of an inactive supermassive black hole in the early Universe for the first time. The breakthrough opens a new window onto how supermassive black holes and their host galaxies grew together.

The study was recently published in *Science* and was led by Dr Andrew NEWMAN at Carnegie Observatories. Professor Gu, the second author of the paper, was affiliated with HKU Department of Physics at the time of the research and is now an affiliated member of HKIAA.

### **Black Holes at the Centres of Galaxies**

Supermassive black holes are thought to lie at the centres of most massive galaxies. Although black holes themselves cannot be seen directly, their presence can be revealed by the way their gravity affects the motion of nearby stars. This same principle led to the discovery of the supermassive black hole at the centre of our own Milky Way, where Reinhard GENZEL and Andrea GHEZ resolved and tracked individual stars to measure its mass with high precision. They shared the 2020 Nobel Prize in Physics for this work.

Later studies measured black hole masses from the integrated motions of unresolved stars in nearby galaxies, typically within about 650 million light years from Earth. Pushing this approach to more distant galaxies, however, is extremely difficult: the region where a black hole's gravity dominates is very small, making it usually impossible to resolve the sphere of influence across billions of light years.

In this study, the team observed MRG-M0138, a massive galaxy seen as it was about 10 billion years ago, when the Universe was only about one quarter of its current age. At its centre, they found a dormant supermassive black hole with a mass of around six billion Suns.

The black hole is inactive, meaning it is not currently feeding strongly on surrounding gas and therefore does not shine brightly like a quasar. Instead of detecting it through light, the team detected it through gravity: the motions of stars near the galaxy's centre revealed an enormous, highly concentrated mass, far too compact to be a cluster of stars and best explained by a single supermassive black hole.

### **How the Team Weighed the Black Hole**

The measurement was made possible by the James Webb Space Telescope and gravitational lensing. A massive foreground galaxy cluster acted as a natural cosmic magnifying glass, magnifying the light of MRG-M0138 by about 30 times. This allowed the team to study the motions of stars near the galaxy's centre in exceptional detail.

The result is surprising because the black hole appears too massive for its host galaxy — but only in one sense.

Compared with the galaxy's bulge mass, the black hole is about 12 times more massive than expected from galaxies in the nearby Universe. Bulge mass refers to the mass of stars in the dense central part of a galaxy. In simple terms, MRG-M0138 had not yet built up enough stars to match such a huge black hole by today's standards.

Yet compared with the galaxy's stellar velocity dispersion, the black hole looks normal. Stellar velocity dispersion measures how much the stars' speeds vary, reflecting the depth of the galaxy's central gravitational potential.

Together, these two findings give astronomers an important clue. The black hole and the galaxy's central stellar motions were already in place, while the galaxy still had to build up its stellar mass.

In other words, the central engine was already fully grown, but the galaxy around it was still catching up.

### **Rethinking How Black Holes and Galaxies Grow**

The study helps address a major question in astronomy: do supermassive black holes and galaxies grow together in step, or can one mature before the other? This discovery suggests that, at least in some massive galaxies, the black hole and central core may grow rapidly in the early Universe, while the host galaxy continues to build up its stellar mass later, possibly through mergers with other galaxies.

By directly weighing a dormant black hole from the early Universe, the team has provided a rare benchmark for testing the growth timeline of black holes and galaxies across cosmic history. The finding also shows that, with JWST and gravitational lensing, astronomers can now study distant inactive black holes that were previously beyond reach.

“It is remarkable that we can study a galaxy seen 10 billion years ago in such detail. This would not be possible without strong gravitational lensing acting like nature's magnifying glass, and the power of JWST,” said Professor Meng Gu, now an Assistant Professor in the Department of Astronomy at Tsinghua University. “What excites me most is that we can now extend this direct way of weighing black holes back to such an early phase.”

For more details, please refer to the journal paper “[A stellar dynamical mass measurement of an inactive black hole at redshift 2](#)” published in *Science*.

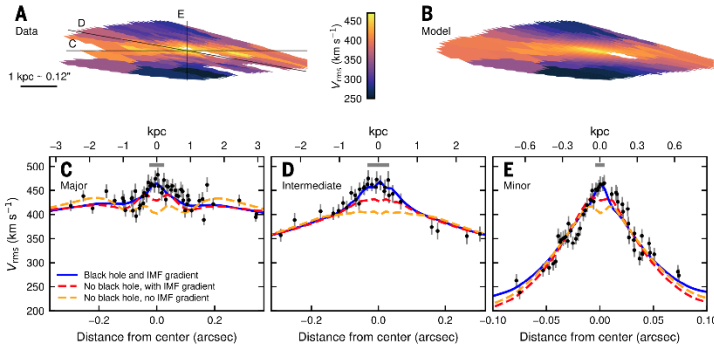


Image 2: Stellar kinematics of MRG-M0138 compared with dynamical models. The prominent central peak in the stellar second velocity moment can only be reproduced when the model includes a black hole of about six billion solar masses; models without a black hole cannot explain the observations. Image adapted from *Newman et al., Science 392, 1065–1068 (2026)*.

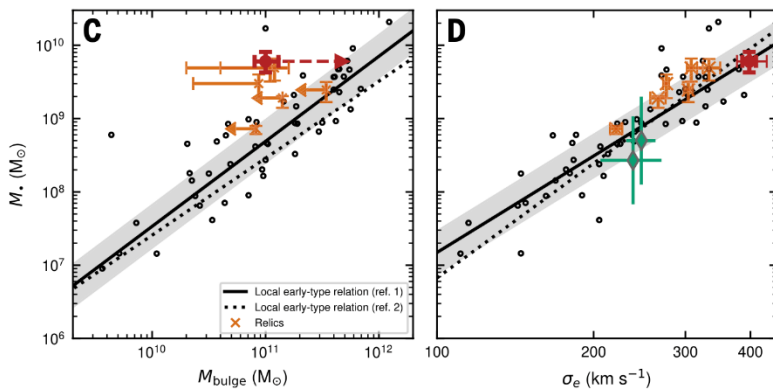


Image 3: In the relation between black hole mass and stellar velocity dispersion, MRG-M0138 appears similar to nearby galaxies. However, when compared with bulge mass, its black hole appears unusually overmassive, about 12 times more massive than expected from the local black hole-bulge mass relation. Image adapted from *Newman et al., Science 392, 1065–1068 (2026)*.

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