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NEWS FOCUS

AMERICAN ASTRONOMICAL SOCIETY MEETING:
Three-Headed Quasar Promises to Shed Light on Universe's Past

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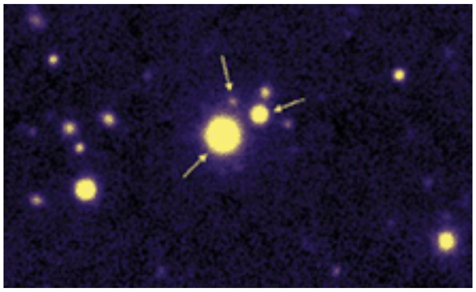
Triple plays are rare in baseball, but not as rare as triplet formations of quasars in space. In fact, images depicting multiple quasars in close proximity have always been routinely interpreted as mirages, different views of a single real quasar.

But not always. Of roughly 100,000 known quasars--cosmic beacons that beam luminous radiation across the universe--about 100 have been identified as being pairs. Quasars are powered by massive black holes in the cores of galaxies, and when two such galaxies collide, their central black-hole quasars retain their separate identities, so pairs can survive at least for a while.

Collision of a third quasar with such a doublet would be an extremely rare event, but astronomers say they have now witnessed the birth of quasar triplets.

"We have found the first case of a physical triple-quasar system," said astronomer George Djorgovski of the California Institute of Technology (Caltech) in Pasadena, leader of an international team reporting the discovery at the meeting. Two of the quasars in the group, designated QQQ 1432-0106, were discovered before 1989. Astronomers originally believed that the pair was an illusion created by gravitational lensing of a single quasar. Such lensing, an effect of Einstein's general theory of relativity, occurs when an intervening mass's gravity bends the light arriving from distant objects. In many known cases, such lensing bends the light from a distant quasar so much that it appears to arrive at Earth from multiple pathways, creating the impression of more than one object.

Real deal. Rare triple quasar at center of image was thought to be an



optical illusion.

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Later observations of that quasar system questioned the mirage interpretation, however. Many astronomers concluded that it consisted of two distinct nearby quasars at a redshift of 2.1, corresponding to a time when the universe was about 3 billion years old.

More recently, astronomers from Caltech and the École Polytechnique Fédérale de Lausanne in Switzerland, using data from the Keck Telescope in Hawaii, spotted evidence for a third nearby quasar, fainter than the others but also at about the same redshift distance. Further observations with the European Southern Observatory's Very Large Telescope in Chile confirmed the Keck finding.

Efforts to explain the triplet as a gravitational-lensing effect have failed, Djorgovski said, as have efforts to find any intervening massive body that could have acted as a lens. And scrutiny of the colors of light emitted by the quasars revealed subtle differences, further suggesting that the three quasars are distinct. "This is almost certainly not a gravitational lens," Djorgovski said, "so we are left with the alternative explanation that it is a physical triple-quasar system."

Although such systems should be rare, they are not entirely surprising, and their existence could aid efforts to understand the dynamics of galaxy mergers in the early universe. Light from the triplets departed on its journey to Earth more than 10 billion years ago, at a time when galaxies occupied a smaller universe and crowding led to frequent collisions.

"These interactions are in fact quite common," said Frederic Rasio of Northwestern University in Evanston, Illinois. In fact, his computer simulations show that galaxies would often collide and merge to form larger galaxies, and when two galaxies containing central black hole-powered quasars merged, the two black holes would begin orbiting each other similarly to a binary star system.

Eventually, such orbiting black holes will swirl closer together and collapse into each other. Before that happens, however, another colliding galaxy could bring a third black hole to the dance, at which point the interactions get more complicated, Rasio's simulations show. "The three black holes interact rather violently and unpredictably," Rasio said. "What happens at the end ... is these black holes basically kick themselves out of the center of that galaxy."

Their rapid exit occurs after the latecomer black hole pairs up with one of the original two, giving the remaining loser a gravitational kick that hurls it out of the galaxy. The new pair recoils in the opposite direction. In both cases, the black holes depart their parent galaxies at speeds reaching thousands or even tens of thousands of kilometers per second.

"These speeds are high enough that the black holes recoil certainly out into the halos of the galaxies and sometimes can even be kicked all the way out, ... meaning they become wandering black holes that go through empty intergalactic space," Rasio said.

In the observed triplet quasar system, the black holes have just begun to come together to perform their partner-swapping dance; they are still about 100,000 light-years apart. The entire process of merging and eventual splitting up will take about 100 million years, Rasio's simulations indicate.

"The process that Dr. Rasio has modeled is very, very far in the future," said astronomer Virginia Trimble of the University of California, Irvine. "So in some sense, the prediction has been verified by the observation, and the observation has been explained by the theory." But 100 million years is a long time to wait to see whether the future behavior of the triplet really matches the theoretical forecast.

Evidence that such triplet interactions occur could come sooner, however. A recoiled pair of black holes would soon merge and generate gravitational waves that might be detectable, Rasio said. And there also exists the possibility of detecting a wandering black hole speeding through space, ideally not heading too close to Earth.

Tom Siegfried is a writer in Los Angeles, California.

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