Academia Sinica Institute of Astronomy and Astrophysics Press Release

Astronomers See the Source of a Gigantic Black Hole's Energetic Jet for the First Time

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An international team that involves Dr. Paul Ho and Dr. Makoto Inoue at Academia Sinica Institute of Astronomy and Astrophysics (ASIAA) in Taiwan sees for the first time the source of the energetic jet from the very vicinity of the gigantic black hole at the heart of the active galaxy Messier 87 (M87). The result of this important observation was recently published in Science magazine in September 27, 2012. This research work not only allows one to get closer to the highly distorted space-time near the edge of a black hole, it also suggests that the gigantic black hole in M87 is spinning at a high speed. In the near future, it is expected that we will be able to directly see the massive black hole's "Event Horizon", the region of no return, for the first time when the "Greenland Telescope" (GLT) under construction by ASIAA with international partners is included in the observation.

M87 is a giant elliptical galaxy about 50 million light-years away from the Earth. At the very center of this galaxy lies a gigantic black hole whose mass weighs sixty billion times more than our Sun. In addition, M87 owns a luminous jet extended from its center to outer space, with a length of 5000 light-years. This energetic jet is composed of ionized gas moving nearly as fast as light. Astrophysicists think that the formation of a high-speed energetic jet like the one in M87 is due to strong magnetic fields around a gigantic black hole which exert magnetic force to throw some of the materials being sucked into the black hole into distant space at high speeds.

While astronomers have observed M87's high-speed jet for many decades, direct observation of the base of the jet at the vicinity of the central massive black hole was not yet feasible due to insufficient resolution of existing telescopes, and as a result theoretical astrophysicists' ideas about the origins of these jets still wait to be tested with real observations. However, in recent years, an international team that involves researchers from the United States, Taiwan, Japan, Germany, and Canada made a

breakthrough in improving the telescope resolution significantly. By using the technique called the “Very Long Baseline Interferometry” (VLBI), the research team connected radio telescopes located in California, Arizona, and Hawaii in the United States to “simulate” a telescope effectively half as big as the Earth.

“The angular resolution of this kind of “virtual” telescope is so high that one will be able to see the head of a rabbit on the moon clearly ! It is because of this extremely high resolution that allows astronomers directly see the base of the black hole jet for the first time !”, said Dr. Inoue at ASIAA.

The size of a black hole is usually defined by the so called “Schwarchild radius”. Any objects including light will not be able to escape the gravitational attraction of a black hole once these objects fall inside the Schwarchild radius. The region within this “point of no return” is called the “Event Horizon” of a black hole. According to current theories, jets are thought to originate in a region within several Schwarchild radii from the black hole, but the actual location of jet formation may depend on how fast black hole spins and the moving direction of the materials that are being sucked into the black hole.

“This observation of M87 shows that the high-speed jet originates within 5.5 Schwarchild radii from the central black hole. In addition, based on the comparison between theory and observation, the researchers infer that M87’s central giant black hole whose size is nearly as big as the solar system is not sitting quietly, but is rotating its heavy body at an appreciable fraction of the speed of light !”, said Dr. Paul Ho, the director of ASIAA.

Although the research team makes a breakthrough in achieving the first high angular resolution observation of the jet base in M87, the resolution is yet to be improved to image the event horizon of M87’s giant black hole directly. Currently, ASIAA is building the 12-meter Greenland Telescope (GLT) at the summit of Greenland, and is planning to operate the telescope from late 2015.

“When included in the observation of M87 along with other radio telescopes in the US, Europe, and Chile using the VLBI technique” Dr. Paul Ho added, “the resultant

virtual telescope that includes the GLT will be effectively as big as the Earth, and achieve a resolution that enables us to obtain the first image of the event horizon of the black hole at the heart of M87. This image will not only provide a direct proof of the existence of black hole, it will also carry detailed information about black hole physics and impose a stringent test for Einstein's theory of general relativity. The imaging of the black hole's event horizon will be a milestone in the history of science ! ".

Related Websites:
http://www.sciencemag.org/content/early/2012/09/28/science.1224768.abstract
http://www.sciencenews.org/view/generic/id/345421/title/Team_glimpses_black_hole%E2%80%99s_secrets
http://www.nature.com/news/closest-look-yet-at-a-distant-black-hole-1.11498
http://web.mit.edu/newsoffice/2012/measuring-a-black-holes-event-horizon-0927.html
http://www.eventhorizontelescope.org/news.html

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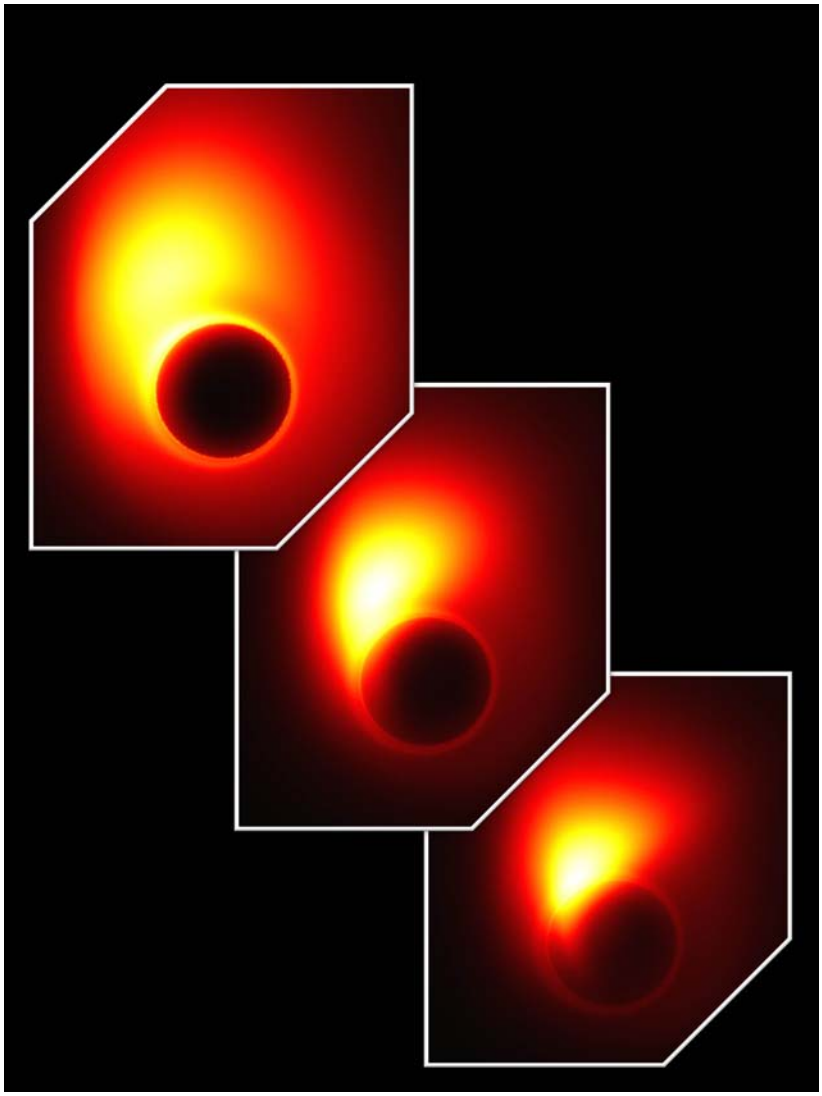

Image 1: Simulated event horizon-resolving images for the ultra-relativistic jet launched from the 7 billion solar mass black hole at the center of the giant elliptical galaxy M87. Each snapshot shows a jet model associated with a different black hole spin, and different locations of intitial jet acceleration. Note the presence of the shadow cast by the black hole at the center of the image, corresponding approximately to the size constraint implied by recent interferometric observations at millimeter wavelengths.

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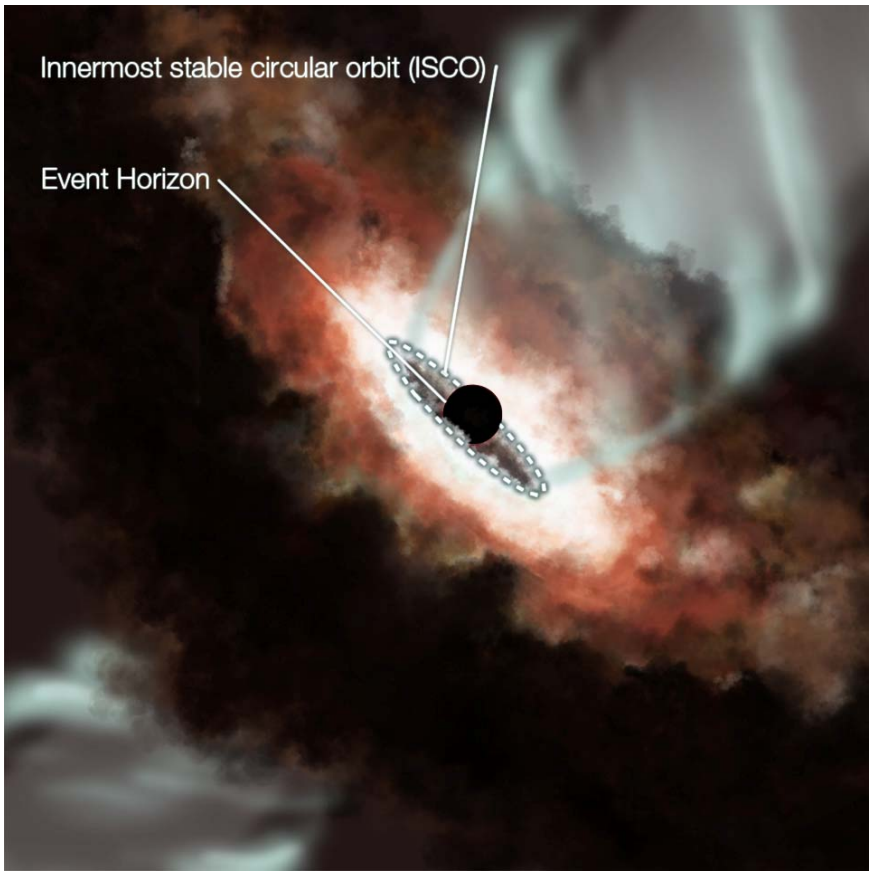

Image 2: This artist's conception shows the region immediately surrounding a supermassive black hole (the black spot near the center). The black hole is orbited by a thick disk of hot gas. The center of the disk glows white-hot, while the edge of the disk is shown in dark silhouette. Magnetic fields channel some material into a jet-like outflow - the greenish wisps that extend to upper right and lower left. A dotted line marks the innermost stable circular orbit, which is the closest distance that material can orbit before becoming unstable and plunging into the black hole.

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