Biggest black holes formed early, study finds

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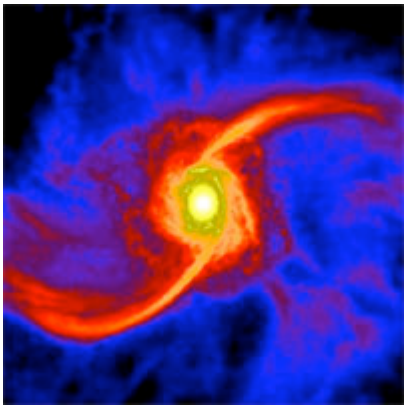
Courtesy of the University of Zurich
and World Science staff

The first "supermassive" black holes were formed shortly after the birth of the universe. That's the conclusion of physicists led by Lucio Mayer of the University of Zurich, Switzerland, reporting their findings in the current issue of the research journal *Nature*.

Black holes are celestial objects that are so compact or dense that their gravity becomes overpowering, trapping even light rays that pass too close. Particularly large, or supermassive, black holes lie at the centers of galaxies.



Gas near the center of a galaxy begins to condense to form a black hole, in a simulation by a research group led by Lucio Mayer of the University of Zurich. (Courtesy U. of Zurich)

These most powerful of black holes were formed through the collision of galaxies 13 billion years ago, according to Mayer's group, adding that the findings are important to help explain the origin of gravitation and cosmological structures.

In computer simulations, they modelled the formation of galaxies and black holes during the first billion years after the "Big Bang," a sort of explosion believed to have formed our universe. The results suggested the first supermassive black holes formed when those early galaxies collided with each other and merged.

For more than two decades, Mayer's group noted, science has assumed that galaxies grow hierarchically: small masses are pulled together by gravitation, and from them, larger structures form step by step. Mayer's group claims to have turned that assumption upside down. "Large structures such as galaxies and massive black holes formed quickly in the history of the universe," he explained.

"At first glance, this seems to contradict the standard theory with cold dark material which describes the hierarchical building of galaxies," he added. In this model, so-called dark matter, a substance detectable only through its gravitational effects and pervasive universe-wide, plays a leading role in the buildup of cosmic structures.

But actually, Mayer said, "normal matter, from which the visible parts of the galaxies and supermassive black holes are formed, collapses more strongly than dark material, forming quickly the most massive galaxies in the densest regions of the Universe." This leads to the relatively quick formation of galaxies and black holes, as material compacts itself into smaller and smaller regions because of gravity, he added.

Thus, Mayer went on, huge galaxies and supermassive black holes form early. Small galaxies, on the other hand, such as our own, the Milky Way and its relatively small black hole in the center, would have formed more slowly. Our galaxy's black hole is estimated to weigh only a million suns instead

of the billion suns of the black holes simulated by Mayer and colleagues.

The galaxies in the simulation would count among the biggest known today, Mayer said, about 100 times larger than the Milky Way. A galaxy that could have arisen from a collision in that way is our neighbouring galaxy M87 in the Virgo cluster, located at 54 million light years from us.

The new findings have consequences for cosmology, Mayer and colleagues said. A widespread assumption that the characteristics of galaxies and the mass of the black hole are related to each other because they grow in parallel might have to be revised: in Mayer's model, the black hole grows much more quickly than the galaxy, so the black hole's characteristics may influence the galaxy growth more than than the other way around.