"Big Bang 2" linked by UCSD astrophysicists to the birth of a supermassive black hole

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"BIG BANG 2" LINKED BY UCSD ASTROPHYSICISTS TO THE BIRTH OF A SUPERMASSIVE BLACK HOLE

The incredible burst of gamma rays detected last December 14, surpassed in power only by the original Big Bang, may be the lingering cry of millions of stars being engulfed by a newly born monster black hole at the edge of the universe.

According to a new theory by astrophysicists at the University of California, San Diego, the fury of energy released could be best explained by the formation of a super black hole at least thousands of times more massive than our own sun.

"Gamma ray bursts such as these are perhaps the last SOS signals from matter sinking into a black hole of 'titanic' scale," said Dr. Xiangdong Shi, a UCSD astrophysicist and co-author of a paper presented today to the American Astronomy Society's 192nd meeting in San Diego, Calif.

"Whenever in physics we smell a gigantic energy scale, as with this gamma ray burst, that immediately makes you suspicious that it has something to do with a gravitational collapse," said UCSD astrophysicist Dr. George Fuller. "There really isn't any other way to get that much energy." Also participating in the study was graduate student Key Abazajian.

Generally lasting just about 10 seconds each, the amount of energy released by a typical gamma ray burst in such a short time period rivals or even surpasses the total energy of a supernova, or exploding star. The energy released by a "garden variety" supernova is generally more than a hundred times the energy output of the sun during its entire lifetime.

Though spacecraft have recorded gamma ray bursts since the 1960s, until last year researchers had no reliable distance estimates for any of these.

But then astronomers from the California Institute of Technology detected a cosmic gamma ray burst about 100 times more energetic than previously theorized, located about 12 billion light years from earth when the universe was in its youth.

The burst, officially designated GRB 971214 but nicknamed "Big Bang 2," lasted 50 seconds and was detected by the Italian/Dutch BeppoSAX satellite and NASA's Compton Gamma Ray Observatory satellite.

The discovery of such a huge burst of energy--unprecedented in astronomy except for the Big Bang itselfsent theorists to their notepads and computers in search of an explanation.

One prevailing model pointed to the merger of two orbiting neutron stars, the end- product of a supernova explosion. According to this model, bursts of gamma rays are released shortly before the orbiting neutron stars, tugged by each other's gravity, plunge into a final death spiral and merge to form a black hole with a mass about three times that of the sun. The resulting hot debris coalesces into a fireball that expands near the speed of light, generating gamma rays.

About a half-dozen such orbiting binary neutron stars have been observed in our own galaxy. It's also recognized that, owing to Einstein's general theory of relativity, these objects will spiral into one another.

However, according to the same theory, their masses must be limited to less than a few times the mass of our sun.

"Such a limited energy cannot explain the gigantic energy of a gamma ray burst," said Shi, "unless the energy is focused into a very narrow beam, just as a search light beam appears to be brighter.

"But how energy can be focused into a very narrow beam at the final moment of a neutron star-neutron star binary is, however, as mysterious as gamma ray bursts themselves."

Prior to last December's discovery, the UCSD astrophysicists began seeking an alternate explanation for gamma ray bursts following the earlier detection of another giant flash last May. "We were very excited when heard the news of 'Big Bang 2'," Shi said, "we felt vindicated."

Their thoughts turned to the formation of a supermassive black hole, at least thousands of times more massive than our sun. In recent years, giant black holes have been observed at the center of many galaxies, including our own Milky Way, and are believed to lie at the centers of extremely energetic quasars billions of light years away.

However, questions surrounding how these gargantuan black holes formed were as profound as the mystery of the gamma ray bursts. The theory proposed by the UCSD researchers, in effect, suggests a solution to both.

"We're suggesting that the events that give rise to distant energetic gamma bursts could also give rise to supermassive black holes in galaxies," said Fuller.

According to the UCSD model, the genesis of a supermassive black hole could begin with the merger of hundreds of thousands or millions of stars drawn together by their own gravitational forces. As the coalescing and colliding stars interact with one another, matter is ripped away from the stellar surfaces until it settles into a single, unstable and short-lived super star, and/or produces a hot plasma of electrons and positrons. In either case, a tremendous amount of mass more than thousands of times that of the sunplunges through an "event horizon." A supermassive black hole is born.

In its wake, massive amounts of energy would be released in the form of neutrinos and anti-neutrinos that, when they come into contact with other, annihilate into a huge fireball whose byproduct is the emission of gamma rays.

The UCSD calculations suggested that the energy released by such an event would have no problem matching the energy detected by the recent gamma ray bursts.

"The main problem our model faces is a technical one," said Fuller. "That's getting the neutrino energy deposited in a region where the amount of matter, the density of matter, is very low. It has to be low in order for the conversion to gamma rays to be efficient."

Shi noted that it's also possible that supermassive events could account for the most powerful gamma ray bursts, while other less energetic bursts could be triggered by other cosmic events, including the merger of two orbiting neutron stars.

"There may be more than one population of gamma ray bursts," said Shi. "But we think our model explains the most energetic population."

Their model could be tested. For example, the neutrino burst from the birth of a nearby supermassive black hole may be detectable in the proposed ICECUBE neutrino detector in Antarctica, a joint venture of U.S. and several European countries. If a gamma ray burst is seen at the same time as the neutrino burst, "we will be truly vindicated," said Shi.

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