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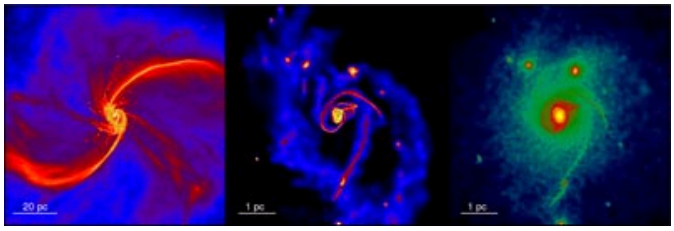
Supermassive black holes spawned by galactic merger

Aug 26, 2010 12 comments



Density map during supermassive black hole formation

Lurking at the centre of nearly every galaxy and gobbling up stars in their vicinity, supermassive black holes are a truly menacing feature of the universe. Now, an international team of astronomers claims to have solved the mystery of how legions of these galactic monsters were born during the early history of the universe.

Supermassive black holes (SMBH) are thousands or even millions of times more massive than our Sun. We know that they exist from the impact they have on their surroundings: causing nearby stars to orbit galactic centres at breakneck speeds, for instance. Once SMBHs reach a critical size they can transform into quasars, which are extremely bright objects as small as a star but as luminous as an entire galaxy. But the relative abundance of quasars in the first billion years of the universe has puzzled astrophysicists.

This is because the "seed" for a blackhole is believed to take at least 10^8 years to form and then several more billion years to grow into a SMBH, followed in some cases by quasars. This was based on the assumption that SMBHs form in a similar way to stellar-mass black holes, marking the final phase in the lifespan of massive stars that have exhausted all their fuel for fusion.

Galaxies merging

Lucio Mayer at the University of Zurich, working with colleagues in Chile and the US, now offers an alternative exploration for how these SMBHs formed. The group proposes that the right conditions for black hole formation could have been created by the merging of two or more galaxies during their primordial stages when they were still emerging from vast clouds of dust.

Using computer simulations, involving more than 3 million computing hours, Mayer's team found that when two young galaxies come together it can cause dust to spiral rapidly towards to a confluence at the centre. For galaxies above a critical size, more than 100 million solar masses of dust can be channelled towards the centre within just 100,000 years, creating a dense cloud in the centre.

"The high concentration of gas at the disk-like nuclei of the interacting galaxies causes tidal forces that

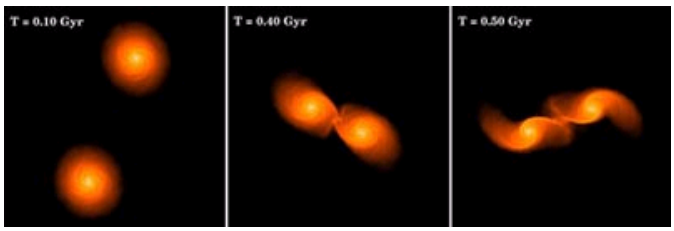
> Our result shows that big structures – both galaxies and massive black holes – build up quickly in the history of the universe
>
> **Stelios Kazantzidis**

cause the gas to effectively lose angular momentum and spiral to the centre," explains Mayer. Shortly after this, the core of the cloud collapsed to form the seed of a black hole, and after 10^8 years the supermassive blackhole had grown to a billion solar masses.

Contradicts prevailing wisdom

If the findings are accepted by the community, they will turn around the prevailing wisdom among astronomers that galaxies evolved hierarchically – that is, gravity drew small bits of matter together first, and those small bits gradually came together to form larger structures.

"Our result shows that big structures – both galaxies and massive black holes – build up quickly in the history of the universe," says Stelios Kazantzidis, another member of the team based at Ohio State University. "[The findings] add a new milestone to the important realization of how structure forms in the universe."



Gas simulation

The model does not, however, explain how smaller galaxies such as our own have evolved to contain an SMBH at their centre. In the case of the Milky Way, Mayer speculates that a similar gas-consuming process could have occurred later in its history when it had reached a critical mass after three to four billion years.

Further testing required

Andrew Jaffe, an astrophysicist at Imperial College London agrees that it would be useful to extend this model to cover a wider range of galaxy types. "As a further test of their modelling, it would be very nice to see whether they reproduce the dynamics of merging galaxies in other, more well-studied, situations – such as mergers of modern-day galaxies."

The research may aid astronomers who are searching the skies for gravitatational waves, which would provide direct evidence of general relativity. According to Einstein's theory, any ancient galaxy mergers would have created massive gravitational waves – ripples in the space–time continuum – the remnants of which should still be visible today.

Over the coming decade, several space-based missions have been planned to search for these elusive phenomena using interferometry equipment. "As the authors correctly point out, the way their blackholes form from direct collapsing has a profound impact on the gravitational wave signal expected in missions such as LISA," says Francesco Haardt an astronomer at the University of Insubria.

The Laser Interferometer Space Antenna (LISA) is a joint mission between NASA and the European Space Agency scheduled for launch in 2025.

This research is described in *Nature*.

About the author

James Dacey is a reporter for *physicsworld.com*

12 comments

Comments on this article are now closed.

1 **andwor**
Aug 26, 2010 4:33 PM

Suprmassive Black Holes

It is quite likely that supermassive black holes arose from large primordial black hole remnants of the big Bang. Otherwise it is very diffucult to explain, using the bottom up argument, how galaxies evolved so quickly. There is little doubt that galaxy collisions were important in the later Universe - but it does not

explain how the galaxies arose so quickly in the first place.

In this new model, which has by the way been published in a scientific journal (see below), the Big Bang arose from a cosmic black hole some billion times heavier that our observable Universe. It was at this stage effectively a black hole within a black hole and all its energy was binding energy and as such it had to explode into the Big Bang, with subsequent inflation.

There would have been large hyperdense primordial black hole remnants resulting from such a Big Bang which would have seeded the formation of galaxies -the rest as they say is history.

Available online

1.An advanced dynamic adaptation of Newtonian equations of gravity. Physics Essays 21: 222-228. dx.doi.org…1.3027501

2. String quintessence and the formulation of advanced quantum gravity. Physics Essays 22: 364-377. dx.doi.org…1.3182733

3. The formulation of harmonic quintessence and a fundamental energy equivalence equation. Physics Essays 23: 311-319 dx.doi.org…1.3392799

2

r2vettes
Aug 27, 2010 3:37 AM

Don Hudson's wisdom added totally!

Quote:

> *Originally posted by* ***andwor***
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3

cspowell
Aug 27, 2010 10:40 AM
New York, United States

A couple corrections

First of all, the researcher's name is Lucio Mayer (not Mayor--perhaps confusing him with planet-hunter Michel Mayor?). Second, this is not a brand new theory, but an elaboration of a model already published in Science in 2007.

More information from the University of Zurich is here at this media release. (Also available in English.

4

James Dacey
Aug 27, 2010 11:55 AM
United Kingdom

Quote:

> *Originally posted by* ***cspowell***
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Thank you for pointing out the spelling of Lucio's surname. The article has now been updated.

5 **John Duffield**
Aug 29, 2010 2:37 PM
United Kingdom

Quote:

> *Originally posted by* ***andwor***
> ...An advanced dynamic adaptation of Newtonian equations of gravity. Physics Essays 21: 222-228.
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It isn't general relativity that predicts black hole singularities, Andrew. It's the Misner/Thorne/Wheeler "geometrical interpretation" of general relativity. See The Formation and Growth of Black Holes for mention of the alternative Weinberg "field interpretation". People tend not to know about this, and it's a reminder of the distinction between a theory and an interpretation of a theory.

Offensive? Unsuitable? Notify Editor

6 **andwor**
Aug 29, 2010 5:10 PM

Quote:

> *Originally posted by* ***John Duffield***
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Offensive? Unsuitable? Notify Editor

7 **andwor**
Aug 29, 2010 5:43 PM

Advanced Newton/advanced quantum gravity

/ Quote:

> *Originally posted by* ***John Duffield***
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.

Thank you for your interseting and helpful comment.

Whether you use the geometrical interpretation, where r=0 at the centre of the black hole, or the field interpretation, where r=0 at the event horizon, or even the older "frozen star" interpreation, you still have to use some pretty amazing logic to get an object like a black hole to be consistent, particularly with regards simultaneity (some models sugget two entirely seperate timelines).

With GTR you also have the "Cauchy problem" - solved by chosing a set of specific coordinates.

What the advanced Newtonian/quantum gravity does is the behave in a truly covariant way. That is you can chose any set of coordinate systems and you get the same answer. THat is the increased force felt by an observer at the event horizon is the same as the force seen by the external observer. This is in keeping with F = ma, and in keeping with that, the dimensions of that time and space seperate out. Specifically if you want to maintain F=ma (F= MLT^-2) for all observers you can see that time must be affected more than space at the event horizon.

This also solves your simultaneity problem.

Having said this you solve another problem specifically the apparent presence of dark matter at the centre of the galaxy, as time is slowed for the observer at the event horizon, but not for the distant observer, the distant observer will infer more mass at the centre of the black hole (given the same value F=ma), and there you have an explanation for the presence of dark matter specifically at the center of the galaxy.

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8 **Imre von Soos**
Aug 29, 2010 6:17 PM

As long as the cosmos will be treated with the attitude of it being an ad hoc and "pointless" (Hawking) conglomeration of unrelated and just as ad hoc elements, some of them being even truly menacing

galactic monsters that gobble up some others just for the hell of it; and some parts are smashed against each other to smithereens in order find out where the music comes from; while other, nowhere found parts have to be conjured up in order that the great theories about the functioning of the cosmos work, taking a stab at everything like the proverbial dog, only the number of the "scientific belief-systems" will expand till they burst and produce the only big bang that has ever happened.
Why not try at least to observe the universe with wonder and to understand it as a living organism and to look at every of its fractions, as also at oneself, as being integral constituents of it?
Why not look at the black/white hole as being a vital constituent of a self-sustaining galactic metabolism?

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9 **gyro5d**
Sep 4, 2010 5:20 AM

I've heard the structure of the Universe is like soap bubbles, with all its' mass in the soap skin area. Its like, after the grand expand, liquid bubbles (of quark-gluon plasma?, liquid matter) blew up. Its surface tension pulling the mass into spheres(creating gravity) and creating eddys from the surface structure change (blackholes).

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10 **robertpmc**
Sep 10, 2010 2:52 PM

Fundamental Physics

Have any of you guys taken the time to check the fundamental principles of Physics? It is truly worth a "look-see". Black Holes, for example = Glorified Guess. Einsteins Theories (general and special) contradict each other and therefore "event horizons" as depicted today do not exist. Many are using uncorrected postulates to create research that is flawed at core levels. Einstein himself wanted to point out his own errors with the result that he was sidelined and ignored.
This makes for huge falsehoods in modern Particle Physics that have been left unadressed.

Are there no "Brave New Physicists" out there willing to challenge the current status quo?
Isn't this the basis of good science?

The OED's 3rd definition of science is "to know" from the Latin "scientia" and "scire".

I want to know. I don't want to guess. If I do guess, I'll keep quiet until I do know. If I sense error, I am bound to check it out. Why does it seem, that since Heisenbergs principle came into being, guesses outweigh truths?
Please guys and gals, check out the basics as there are really big black holes in those fundamental principles. Those black holes in knowledge form superstrings of supposition that are taken as fact.
I fear for the science of Physics. We do need another hero (the few we have are not yet enough). One who will be prepared to return to basics and re-emerge armed with true science.
Come on guys and gals, this is your chance at eminence and truth. The path won't be easy, but neither is the path of true love.

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11 **gyro5d**
Sep 22, 2010 6:20 AM

Our Universe moves toward greater entropy. Schroedinger says life is negative entropy, more life less entropy.
Does this explain the dual-slit experiment. Sub-atomic particles move toward entropy(waves)+ negentropy (life)= particles. If a chimp was the recorder, would it's high lifeform be high enough (negentropy)to create particles? Or would the chimp tell the humans the next day which would create particles?

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12 **sofieprice**
Sep 24, 2010 8:28 AM

Black holes are like mystery to us. We need to study them in order to unravel the mystery of this universe.
Enlarge Maxx

Offensive? Unsuitable? Notify Editor