Discovery of a Population of Close Binary Active Galactic Nuclei: Observing the Hierarchical Assembly of Supermassive Black Holes

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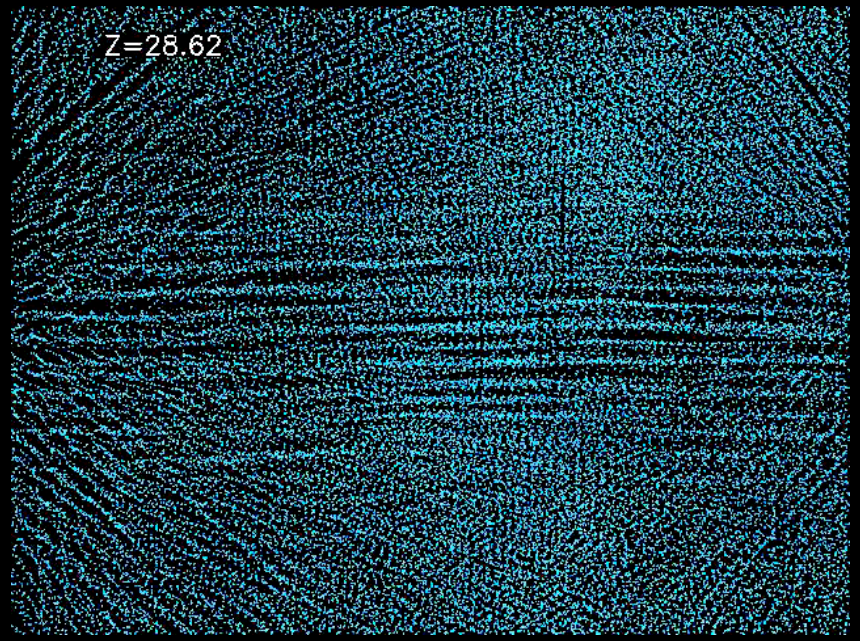
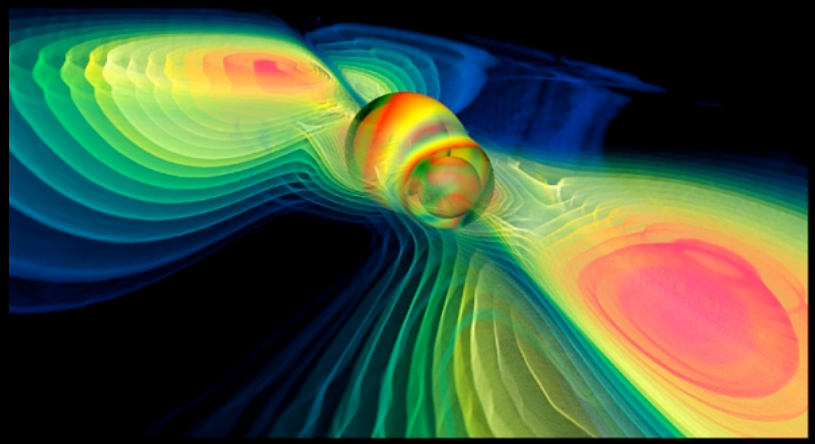
Press Conference Presentation, AAS Meeting, January 2011

Structure in the universe forms through a hierarchical merging of galaxies



Simulation by A. Kravtsov

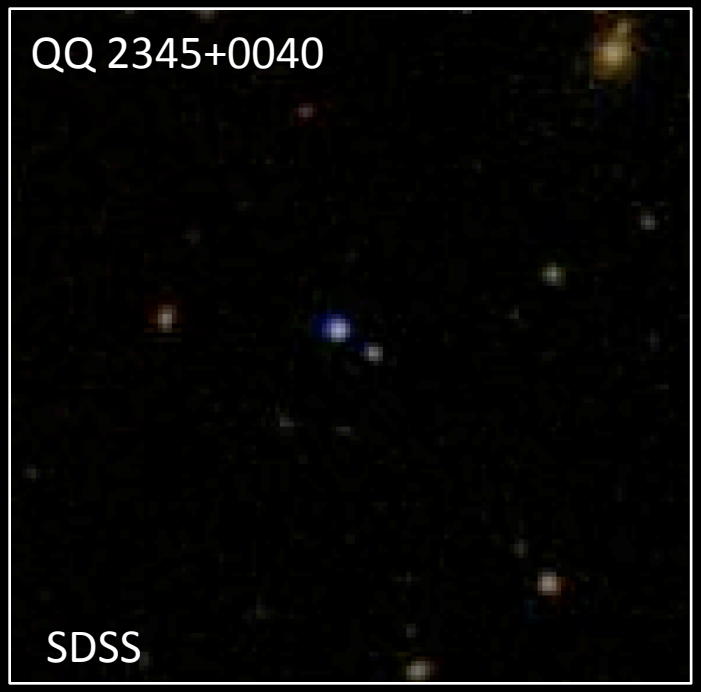
As galaxies merge, so should their central massive black holes, emitting gravitational wave bursts at the end



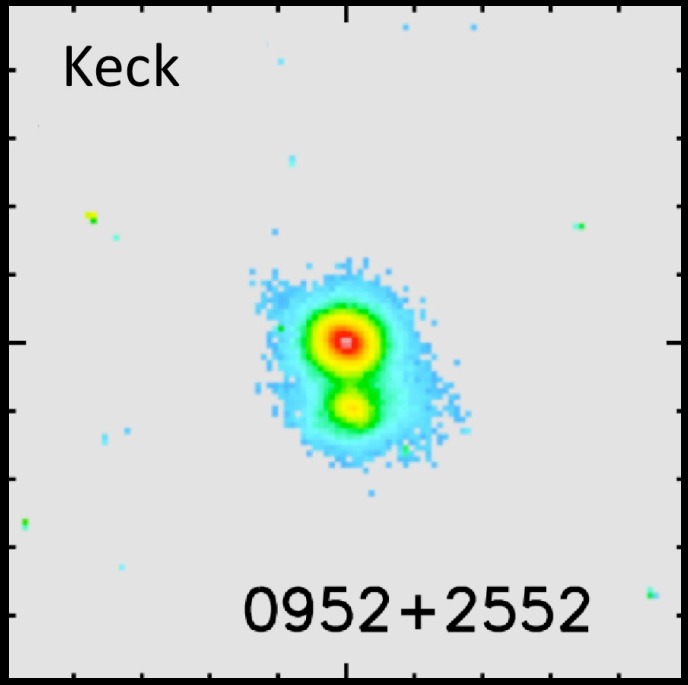
The goal is to understand better this process

http://www.astro.caltech.edu/~george/bbh

What we did is to find a whole population of super-massive black hole pairs, a hundred times closer than those previously known



Binary quasars,
typically ~ 100 kpc apart



Newly found pairs,
typically ~ 1 kpc apart

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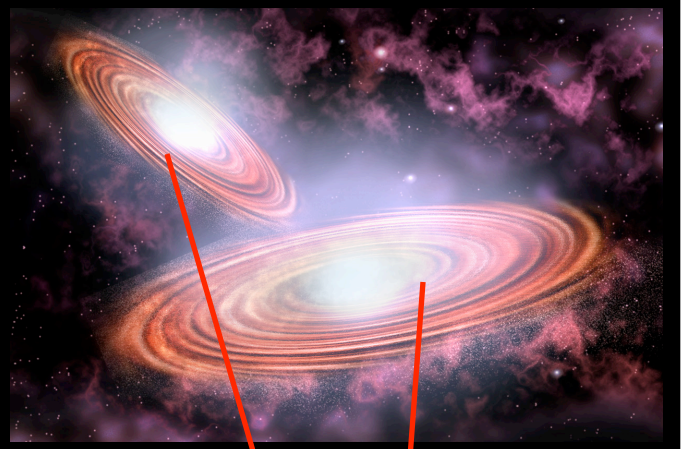
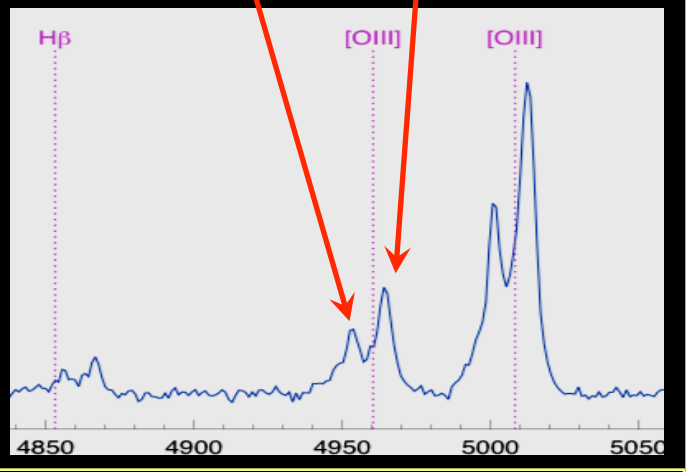
What we did:

Active Galactic Nuclei (AGN) are powered by super-massive black holes, they are bright and easy to see

We selected targets from the known AGN with doubled emission lines in their spectra, possibly indicative of a close pair of AGN in the process of merging





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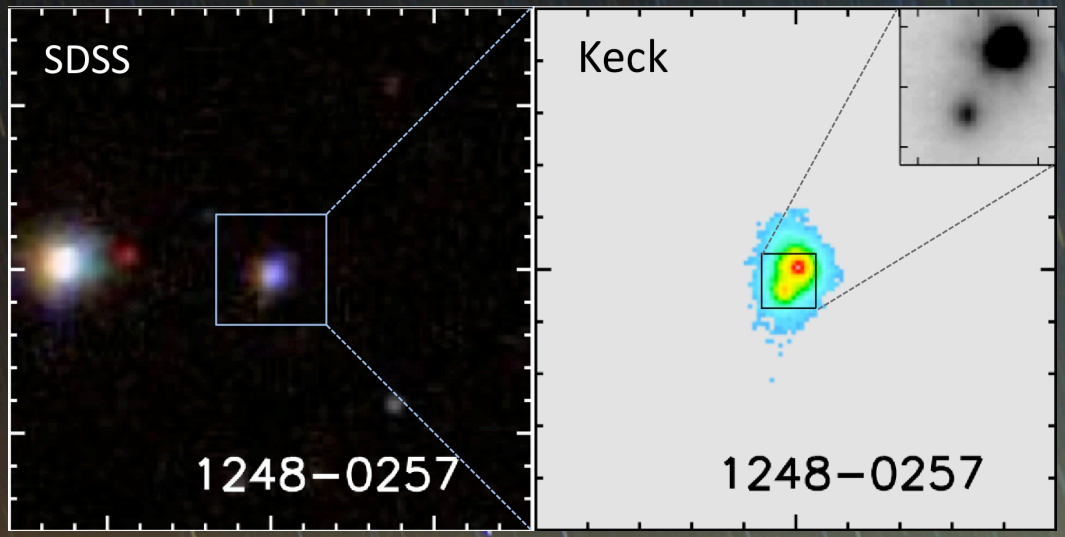
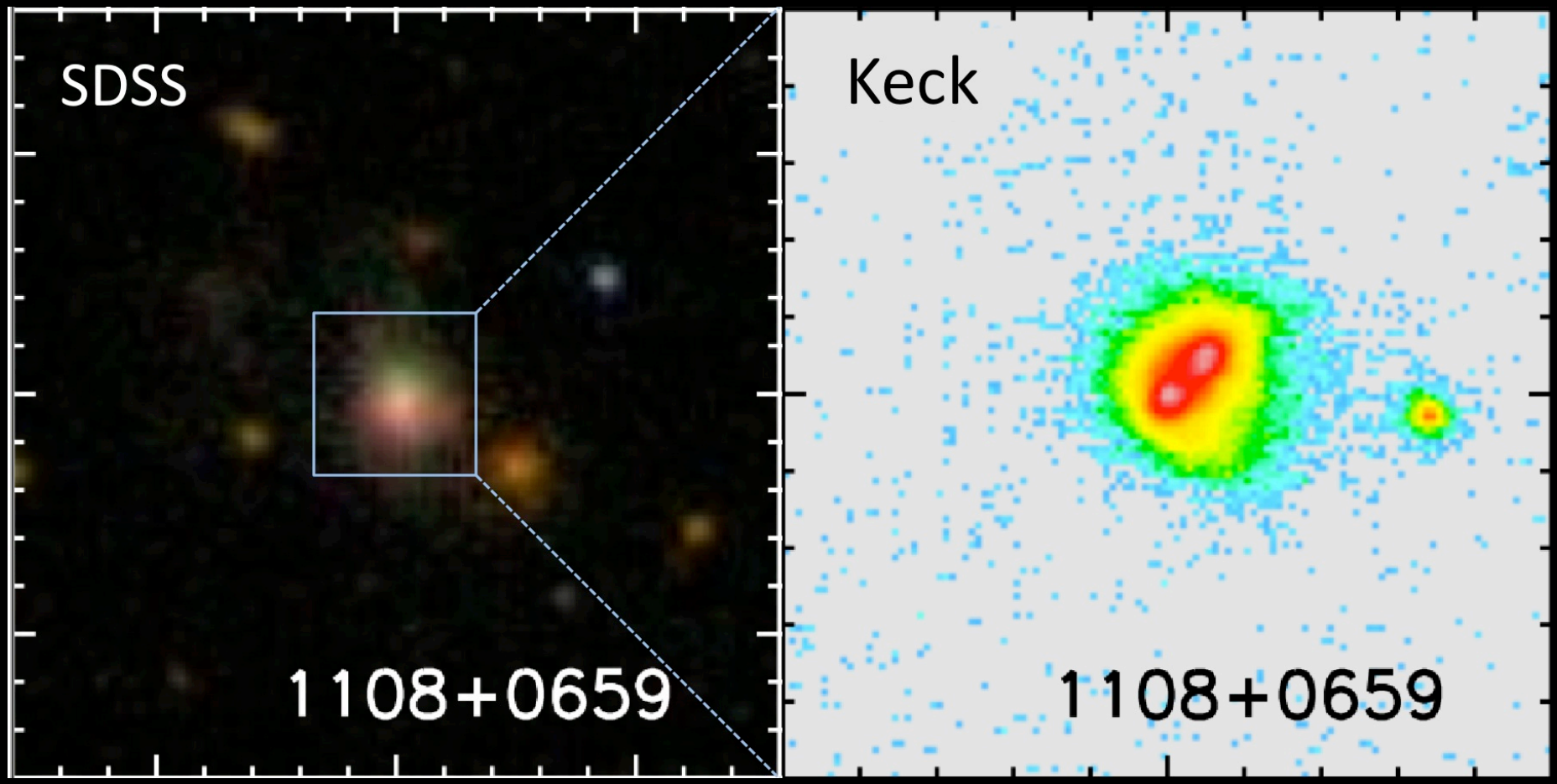
We obtained sharp images using Laser Guide Star Adaptive Optics at the Keck telescope, to remove the atmospheric blur



That enabled us to see a 100 times closer than we would in the normal, “seeing-limited” images



Resolution ~ a dime seen from a 100 miles away

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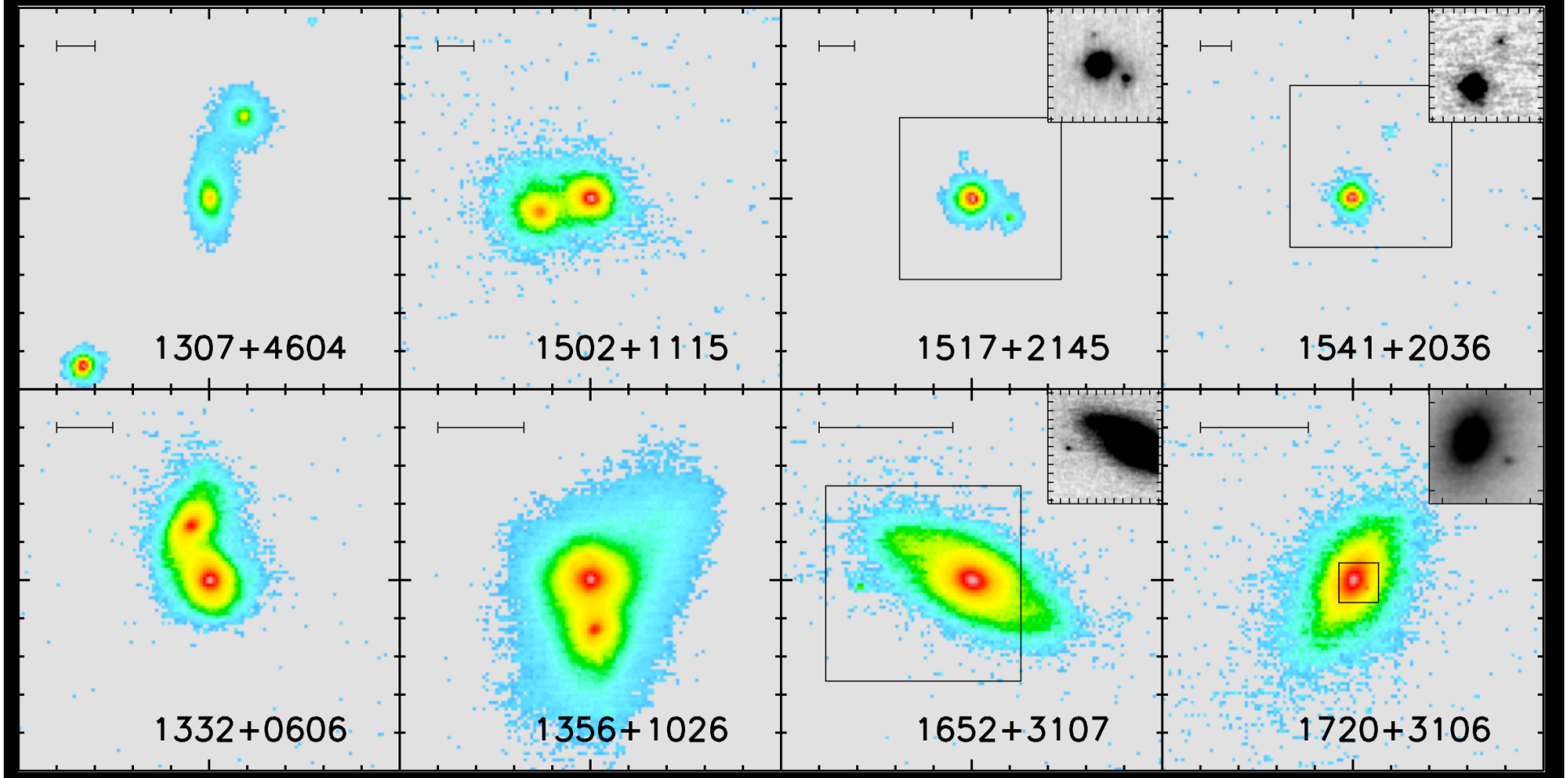
We found 16 close pairs out of the 50 targets observed



Many of them show signs of galaxy merging

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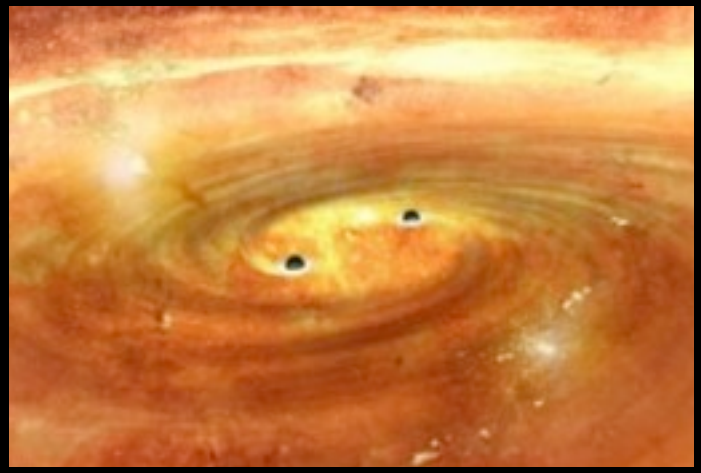
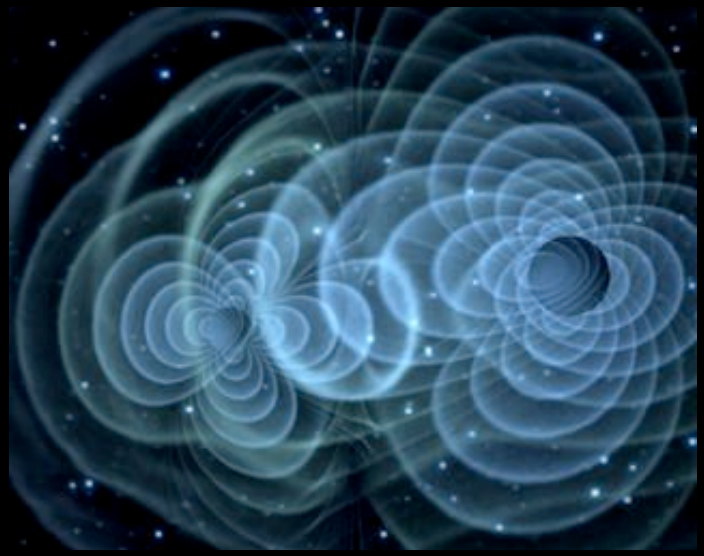
What does it mean?

It supports our ideas about the structure formation and assembly of super-massive black holes



This is the "parent population" of the expected sources of gravitational waves, which are yet to be detected



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