Researchers suggest LISA should be able to see ultralight bosons near supermassive black holes

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An international team of researchers has found evidence that suggests the Laser Interferometer Space Antenna (LISA) should be able to "see" ultralight bosons if they exist. In their paper published in the journal

Nature Astronomy, the group describes calculations they made to assess whether ultralight boson clouds forming outside of the event horizons of black holes could be detected by LISA, and what they found.

LISA is a European space-based mission set for deployment in 2034—it will consist of three spacecraft fitted with interferometers placed in a solar orbit in a triangular formation the same distance from the sun as the Earth. In such an arrangement, gravitational fields can be detected and measured by noting precisely the changes in distance between the three spacecraft. The purpose of the mission is to measure gravitational waves in a way not possible from here on Earth. The researchers with this new effort believe its unique capabilities should allow for detecting ultralight boson clouds if they exist at the event horizons of black holes.

Ultralight bosons are theoretical particles such as axions—theory has also suggested that they might comprise dark matter. Other theories have suggested that if ultralight bosons do exist, they probably form in clouds around the event horizons of black holes. And if they do, they would probably have a Compton wavelength. Because such wavelengths are inversely proportional to their mass, the Compton wavelength for an ultralight boson would be quite large.

The researchers note that superradiance should happen if the Compton wavelength of an ultralight boson cloud turns out to be similar to a Schwarzschild radius (the distance from its center to its event horizon) of a given black hole. Superradiance refers to boson fields coupling with a black hole as it spins and pulling energy from it to the point that the boson cloud rotates at the same rate as the black hole. The researchers note that superradiance would change the gravitational wave signal generated from the black hole—something that LISA could detect because it would be able to filter out extraneous noise that typically limits the abilities of ground-based systems.

More information: Otto A. Hannuksela et al. Probing the existence of ultralight bosons with a single gravitational-wave measurement, *Nature Astronomy* (2019). DOI: 10.1038/s41550-019-0712-4