Detection of gravitational wave 'lensing' could be some way off

October 1 2020

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Gravitational wave scientists looking for evidence of "lensing," in which the faintest gravitational wave signals become amplified, are unlikely to make these detections in the near future according to new analysis by scientists at the University of Birmingham.

A team in the University's School of Physics and Astronomy and the

Institute for Gravitational Wave Astronomy has analyzed currently available gravitational wave data to predict that these elusive signals are likely to remain undetected by the instruments currently operated by the LIGO and Virgo Collaboration.

The existence of gravitational lensing was predicted by Einstein and is a well-recognized phenomenon in relation to light waves. Light emitted by distant objects in the Universe is bent by the gravitational pull of other massive objects, such as galaxies when the light source passes behind them. When detected by the earth's telescopes, this distortion might make the light-emitting object seem larger or closer to earth than it actually is.

Scientists predict that the same will be true of signals from gravitational waves—but we won't find them just yet. In a paper published in *Physical Review Letters*, the Birmingham team drew together available information on the sensitivity of the current observatories with another key ingredient—the as-yet undetected background—to predict the statistical likelihood of lensing events.

This background is composed of the potentially huge numbers of gravitational wave signals that can only be analyzed by their statistical probability because they are too small or too far away to be detected individually.

The team predicted that in order to detect one signal significantly affected by lensing, the observing teams would need to collect at least tens of thousands of them.

Lead author Dr. Riccardo Buscicchio explains: "The number of gravitational wave events detected by the LIGO/Virgo Consortium has already reached several dozen (many of them yet to be confirmed) and over the next few years these will expand into hundreds of new

detections. As we start to accumulate gravitational wave statistics, it's likely that we will start to see many new phenomena, so in principle, detecting gravitational lensing becomes more likely. In general, however, these events are particularly difficult to positively identify—it's very hard to tell if the signal a is very distant one that has been amplified through lensing, or if it is simply closer and therefore easier to detect. Our analysis suggests not only that there is actually quite a low probability of seeing this phenomenon given the sensitivity of current instruments, but also that existing detections thought to be potential candidates are in fact unlikely to be examples of lensing."

More information: Buscicchio et al., Constraining the lensing of binary black holes from their stochastic background. arXiv:2006.04516 [astro-ph.CO]. arxiv.org/abs/2006.04516

Riccardo Buscicchio et al. Constraining the Lensing of Binary Black Holes from Their Stochastic Background, *Physical Review Letters* (2020). DOI: 10.1103/PhysRevLett.125.141102

Provided by University of Birmingham