Physicists propose using atomic clocks of GPS network to detect exotic ultralight fields

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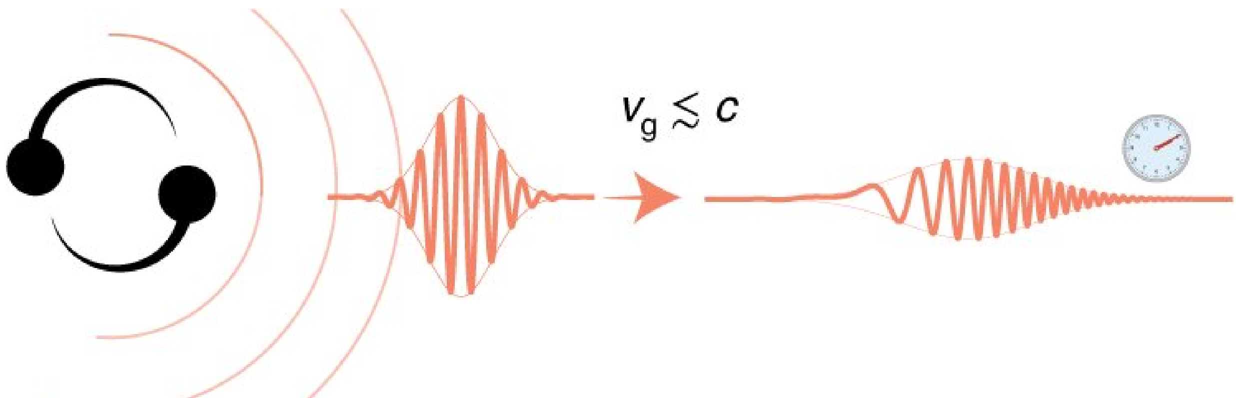

Effect of dispersion on the expected ELF signal at a precision quantum sensor. A schematic of the production, propagation and detection of an ELF wave packet (shown in red). A BBH merger (left) emits a burst of ELFs and gravitational waves. As the ELF burst propagates with the group velocity vg ≲ c to the detector (right), it lags behind the emitted gravitational waves, which propagate at c. Given that the more energetic ELF components propagate faster, the detected ELF wave packet exhibits a characteristic frequency chirp, depicted by the wave packet shown on the right. Credit: *Nature Astronomy* (2020). DOI: 10.1038/s41550-020-01242-7

A team of physicists from the U.S., Poland and Germany proposes to use quantum sensor networks such as atomic clocks of the GPS network or sensors from the Gnome collaboration (a network of shielded atomic magnetometers made up of 13 stations placed strategically on four continents—each of which is equipped with a magnetometer that has sub-picotesla sensitivity) to detect exotic ultralight fields (ELDs). In their paper published in the journal *Nature Astronomy*, the group describes theoretical calculations to predict the types of signals that might make up ELDs and how they might be detected.

Over the past several years, multi-messenger astronomy has arisen as a means for studying signals from certain astrophysical events such as merging black holes, which release energy in the form of signals that travel across the vastness of space. Multi-messaging astronomy involves focusing several types of telescopes and sensors at the same point to detect the different kinds of signals produced by the same event.

The researchers with this new effort note that physicists have many questions surrounding such signals, one of which is whether theories regarding exotic fields with light quanta are valid. They note that for such theories to gain credence, physical evidence must be found. To that end, they suggest that quantum sensor networks could likely do the job. They show that existing sensors could be strong enough to detect ELDs. They further suggest that ELDs produced by astrophysical events might be detected by existing sensors used for other applications. Their math suggests that the rates and distances of gravitational wave sources, their delays and signal amplitudes could be of the type that existing systems such as the GPS network's atomic clocks or the Gnome network could detect. Thus, they further suggest that such systems could work as ELF telescopes with the ability to detect a wide variety of ELD bursts.

More information: Conner Dailey et al. Quantum sensor networks as exotic field telescopes for multi-messenger astronomy, *Nature Astronomy* (2020). DOI: 10.1038/s41550-020-01242-7