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Squeezed light at 2128 nm for future gravitational-wave observatories

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All gravitational-wave observatories (GWOs) have been using the laser wavelength of 1064 nm. Ultra-stable laser devices are at the sites of GEO 600, Kagra, LIGO and Virgo. Since 2019, not only GEO 600 but also LIGO and Virgo have been using separate devices for squeezing the uncertainty of the light, so-called squeeze lasers. The sensitivities of future GWOs will strongly gain from reducing the thermal noise of the suspended mirrors, which involves shifting the wavelength into the 2 µm region. Our work aims for reusing the existing high-performance lasers at 1064 nm. Here, we report the realisation of a squeeze laser at 2128 nm that uses ultra-stable pump light at 1064 nm. We achieve the direct observation of 7.2 dB of squeezing, as the first step at MHz sideband frequencies. The squeeze factor achieved is mainly limited by the photodiode's quantum efficiency, which we estimated to 92 %. Reaching larger squeeze factors, also in the required audio and sub-audio sideband, seems feasible provided photo diodes with sufficiently low dark noise will be available. Our result promotes 2128 nm as the new wavelength of GWOs.

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