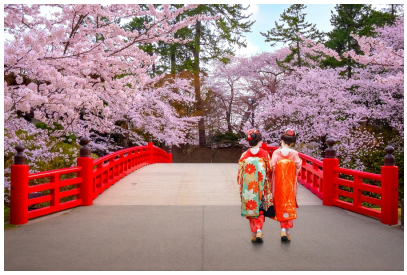

ID de Contribution: **82** Type: **Non spécifié**

Quantum squeezing for Virgo and future generation gravitational-wave detectors

mercredi 29 mars 2023 09:15 (15 minutes)

The 2nd generation gravitational wave detectors network, including LIGO, Virgo, and KAGRA, ushered the era of gravitational wave (GW) astronomy, detecting more than 90 GW signals in the last years from the merging of binary compact objects. They are expected to start their fourth observation run (O4) in May this year, with improved sensitivity. The main limitation to the sensitivity comes from the quantum vacuum fluctuation coupling to the interferometer through the detector dark port. In the last observation run (O3) both LIGO and Virgo implemented a sophisticated technology (known as squeezing), in which vacuum fluctuations are modified to reduce their impact on the sensitivity. This led to an improvement in the detection rate of up to 50%. However, this technique allows for improving only the high-frequency part of the quantum noise spectrum. In order to achieve a broadband improvement it is necessary to reflect squeezed states by a long optical cavity and obtain the so-called frequency-dependent squeezing (FDS). For this reason, an FDS system, including a 285 m cavity, was constructed in Virgo and is currently under commissioning. In this presentation, after recalling the theory of quantum squeezing for gravitational-wave detectors, I will report on the recent results achieved with this system and on the expected impact on Virgo sensitivity. Finally, I will explain how the squeezing should be improved for future generation gravitational-wave detectors.

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Classification de Session: Dark and Primordial Universe & Gravitational Waves

Classification de thématique: Gravitational Waves