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Einstein-Podolsky-Rosen squeezing experiment for future gravitational-wave detectors

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Gravitational-wave astronomy began its remarkable legacy on September 14th, 2015, with the ground-breaking detection of a GW signal produced by the coalescence of two black holes. The exciting outcomes from this young research field range from cosmology and multimessenger astrophysics to fundamental physics. The current GW detectors are broadband (10 - 10000 Hz) Michelson interferometers that cope with quantum noise by squeezing the vacuum quantum states of the light entering the antisymmetric port of the instrument.
The present generation of detectors make use of a long and detuned resonator, called Filter Cavity (FC), to optimize the quantum readout from the instrument at each frequency band, and enhance the overall performance.
However, there is another approach aiming at the same outcome without the employment of a FC. The scientific goal of the experiment illustrated here is to effectively implement this new scheme, based on the parallel homodyne detection and combination of a pair of Einstein-Podolsky-Rosen (EPR) entangled squeezed beams. This experiment is under implementation in the site of the Virgo GW detector, the European Gravitational Observatory (EGO) found in Cascina (Pisa, Italy).
The scientific results from the EPR experiment can impact the layout of the foreseen upgrades for the Virgo detector, and above all for the next generation detectors such as the Einstein Telescope and Cosmic Explorer, which are currently thought to use km-long multiple FCs.

Primary experiment

Virgo Collaboration

Authors: DE MARCO, Francesco (Sapienza University of Rome & Istituto Nazionale di Fisica Nucleare, Sezione di Roma1); DI PACE, Sibilla; AHN, Hojae; ALI, Wajid; BAWAJ, Mateusz (INFN - National Institute for Nuclear Physics); DE LAURENTIS, Martina; GARAVENTA, Barbara; KIM, Chang-Hee; KIM, Kyungmin; LEE, Sumin; Dr NATICCHIONI, Luca (INFN Roma); PARK, June-Gyu; SORRENTINO, Fiodor (INFN e Universita Genova (IT)); PAK, Soojong; LEE, Sungho; SEQUINO, Valeria

Presenter: DE MARCO, Francesco (Sapienza University of Rome & Istituto Nazionale di Fisica Nucleare, Sezione di Roma1)

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