Research Report
ICRR Inter-University Research Program 2019

Research Subject:

Development of frequency dependent squeezed light source for KAGRA

Principal Investigator:

Ray-Kuang Lee (National Tsing Hua University, Taiwan)

Participating Researchers:

Chien-Ming Wu, National Tsing Hua University, Taiwan

Shu-Ron Wu, National Tsing Hua University, Taiwan

Yi-Ru Chen, National Tsing Hua University, Taiwan

Hsun-Chun Wu, National Tsing Hua University, Taiwan

Matteo Leonardi, National Astronomical Observatory of Japan

Eleonora Capocasa, National Astronomical Observatory of Japan

Yu-hang Zhao, National Astronomical Observatory of Japan

Raffaele Flaminio, National Astronomical Observatory of Japan

Shinji Miyoki, The University of Tokyo

Summary of Research Result :

With ICRR and NAOJ, in this ICRR Inter-University Research Program 2019, entitled “Development of frequency dependent squeezed light source for KAGRA,” we have developed frequency independent squeezer first, and then frequency dependent squeezer to upgrade the sensitivity of KAGRA.

In particular, with the collaboration with Prof. Matteo Leonardi, who is the local leader for TAMA filter cavity at the National Astronomical Observatory of Japan (NAOJ), a Fabry-Pérot filter cavity, i.e., a 300 m filter cavity, is ready to test a potential improvement of the KAGRA sensitivity: the frequency dependent squeezed light production.

In FY2019, for the first time in the world, with the support of this proposal by ICRR, we produced frequency dependent squeezing able to reduce the impact of the quantum noise in GW detector in the entire detection bandwidth. Such result has been published by Yuhang Zhao et al., "Frequency-dependent squeezed vacuum source for broadband quantum noise reduction in advanced gravitational-wave detectors," Phys. Rev. Lett. 124, 171101 (2020); Editors' Suggestion; Featured in Physics; Synopsis: Feeling the Squeeze at All Frequencies.

During FY2019, two of my group members, Dr. Chien-Ming Wu and Dr. Yao-Ching Wu, had been working in NAOJ to contribute to the implementation of squeezed light, in April-May 2019, and October-December 2019, respectively. Both of them, are also listed as the co-authors in the recent published PRL paper mentioned above.

On behalf of our collaboration team, Dr. Yao-Ching Huang also gave a report, entitled "Development of frequency dependent squeezed light source for KAGRA", to the "research result presentation meeting" of the ICRR Inter-University Research Program held on 13-14 December at ICRR, Kashiwa, Japan.

At the same time, Mr. Yuhang Zhao also visited us for three weeks in December 2019 – January 2020, working on the squeezed light and related metrology in Hsinchu, Taiwan.

Moreover, Dr. Yao-Ching Huang and Mr. Hsun-Chun Wu were also partially supported by this Program for the KAGRA shift in January 2020, by covering their local expenses and transportation to Kamioka. Unfortunately, the another two scheduled KAGRA shifts for the other two members in my groups, for Miss Yi-Ru Chen and Dr. Tsung-Ju Yang, were both cancelled due to the commission and COVID-19 pandemic.

No.