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Editorial

KAGRA and beyond: Gravitational wave physics and astronomy. Part 1

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The year 2015 is one hundred years after Albert Einstein proposed his general theory of relativity, and it will be remembered as the year of the first detection of gravitational waves and the beginning of gravitational wave physics and astronomy, which is revolutionizing our understanding of the universe. This historical achievement, specifically the detection of gravitational waves from a stellar mass binary black hole coalescence, was made possible by the advanced Laser Interferometer Gravitational wave Observatory (aLIGO) in the United States of America. Together with the Virgo gravitational wave observatory built in Italy, the LIGO–Virgo Collaboration has so far reported 50 gravitational wave events as of March 2021. Among those events, the one on 17 August 2017 was notable as we experienced an exciting long-dreamed-of campaign of multi-messenger astronomy: simultaneous observations of a binary neutron star coalescence not only with gravitational waves but also with electromagnetic waves and neutrinos.

The gravitational wave observatory KAGRA, built at Kamioka, Japan, is known for its unique features of utilizing cryogenic mirrors to deal with thermal noise and of being built under a mountain to reduce seismic noise. The KAGRA project was funded in 2010 by the Japanese government. The installation of the instruments for the designed configuration was mostly completed in 2019. After the year-long commissioning, KAGRA conducted its first observing run from February to April, 2020. Although KAGRA could not have a joint observing run with LIGO and Virgo during this period due to the COVID-19 situation, KAGRA-GEO600 (a gravitational wave detector in Germany) did conduct a joint observing run, called O3GK, and its results will be reported elsewhere. The joint LIGO–Virgo–KAGRA collaboration is now planning the next observing run, called O4, for 2022 after commissioning works for further sensitivity improvements.

While waiting for the next exciting discoveries in the near future by the international gravitational wave observatory network, now is a good time to summarize and review the findings so far and future prospects. This special section is intended to present such a survey. As the future prospects for the LIGO–Virgo–KAGRA observatories are well summarized in, e.g., Ref. [1], the papers in this special section focus on overviews of the status of the KAGRA observatory and its future prospects, including possible future science by KAGRA as well as the international observatory network in the coming decade. As for electromagnetic wave follow-up campaigns for gravitational wave events,

we invited the J-GEM (Japanese collaboration for Gravitational-wave Electro-Magnetic follow-up) Collaboration to review their work, findings, and prospects. A unique feature of this special section is the series of invited papers on the projects of the space-borne gravitational wave observatories DECIGO, LISA, TianQin, and Taiji.

We thank all the authors for accepting our invitation and contributing to this special section. In particular, we are grateful to Prof. Jun'ichi Yokoyama, who originally proposed this special section featuring gravitational wave physics and astronomy.

The special section of the present issue consists of eight papers as Part I. Part II, to be included in a coming issue, is expected to contain five papers.

Reference

[1] B. P. Abbott et al., Liv. Rev. Rel. **23**, 3 (2020).