Summary of past researches

Ryo Kato

There is an attempt to detect gravitational waves using a pulsar. The pulsar is a neutron star that rotates at high speed. The rotation period is very stable and comparable to the atomic clock. Therefore, by observing the rotation period of the pulsar, the gravitational wave between the earth and the pulsar can be detected. Pulsars distributed in the Milky Way galaxy are considered to be galaxy-scale gravitational wave detectors.

In the previous studies, we considered how to detect the gravitational waves by pulsars. We analyzed the observation data of the pulsar and tried to detect the dark matter. We also participated in the Indian Pulsar Timing Array project.

Construction of gravitational wave detection theory

We investigated how polarized gravitational waves change the pulsar observation data. Detection of the polarized gravitational waves is the evidence of the symmetry breaking of the space-time. When the gravitational waves are distributed isotropically, the polarization could not be detected using pulsar [1].

Dark matter search

We attempted to detect the ultralight scalar field, which is one of the dark matter candidates, using pulsar observation data. The ultralight scalar field has a feature to solve the core cusp problem which is an unsolved problem in astrophysics. The results obtained by this study are the following two. When the mass of the ultralight scalar field is in the range from 0.945×10^{-23} to 1.34×10^{-23} eV, the energy density can be more strongly restricted than in previous studies [2].

Pulsar Observation

The Indian Pulsar Timing Array project has been observing multiple pulsars for several years. We observed changes in the pulse waveform of PSR J1713 + 0747 [3]. Pulsars were observed in a wide frequency band [4]. Pulsar data released for the first time [5].

[1] Ryo Kato and Jiro Soda, Phys. Rev. D, American Physical Society Journals, Vol.93, pp.062003-1-062003-18, (2016).

[2] Ryo Kato and Jiro Soda, JCAP **09**, 036 (2020).

[3] J. Singha *et al.,* Mon. Not. Roy. Astron. Soc. **507** (2021) no.1, L57-L61

[4] K. Nobleson *et al*., Mon. Not. Roy. Astron. Soc. **512**, no.1, 1234-1243 (2022).

[5] P. Tarafdar *et al.*, Publ. Astron. Soc. Austral. **39** (2022).