

## Summary of past researches

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I have been studying the detection of the gravitational waves and the dark matter. The gravitational waves and some dark matter can oscillate the arrival time of the light. Previous studies have clarified how polarized gravitational waves change the arrival time of the light. Then, using the data in which the arrival time of the light emitted from the pulsar was recorded, it was investigated whether the dark matter signal was included in the observation data.

### **【Construction of gravitational wave detection theory】**

**Article : Ryo Kato and Jiro Soda, “Probing circular polarization in stochastic gravitational wave background with pulsar timing arrays”, Phys. Rev. D, American Physical Society Journals, Vol.93, pp.062003-1-062003-18, (2016).**

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. The results obtained by this study are the following two.

1. Circular polarization of the gravitational waves can be detected using pulsar.
2. When the gravitational waves are distributed isotropically, the polarization could not be detected using pulsar.

### **【Dark matter search】**

**Article : Ryo Kato and Jiro Soda, “Search for ultralight scalar dark matter with NANOGrav pulsar timing arrays”, JCAP 09, 036 (2020).**

In this study, 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.

- (1) As a result of the data analysis, it was found that the hypothesis that there is no signal from the ultralight scalar field cannot be rejected.
- (2) When the mass of the ultralight scalar field is in the range from  $0.945 \times 10^{-23}$  to  $1.34 \times 10^{-23}$  eV, the energy density can be more strongly restricted than in previous studies.