論文の内容の要旨

論文題目

Toward the Direct Detection of Continuous Gravitational Waves from Compact Stars

(連続重力波の直接検出実現に向けた研究)

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This thesis is a compilation of the author's study on continuous gravitational waves (GWs) which are long-duration, nearly periodic gravitational waves from a compact star. A rapidly spinning neutron star is believed to be the most interesting emitter of a detectable continuous GW by second generation ground-based interferometric GW detectors. Detections of continuous GWs would give clues to GW generation mechanisms and equations of state of neutron stars that are yet unclear.

First, we focus on a torsion-bar antenna (TOBA) that is a low-frequency terrestrial GW antenna. A unique feature of a TOBA is the ability to explore a low-frequency region inaccessible by the current large-scale interferometric detectors due to seismic noise. We give an overview on a newly proposed multi-output TOBA. Subsequently, we perform a first all-sky search for low-frequency continuous GWs in the frequency range from 6 Hz to 7 Hz using data from a phase-II TOBA that is a prototype of the multi-output TOBA.

Next, we turn to the first Japanese km-scale interferometric GW detector, KAGRA that is now under construction at Kamioka Mine in Gifu Prefecture, Japan. Unlike the currently existing other interferometers, KAGRA will operate in underground and in a cryogenic temperature, which would reduce seismic noise and thermal noise, and thus would provide quiet and stable environment for GW observations. We perform a

targeted search for known isolated pulsars with data from the initial KAGRA test run. The main purposes of this study are to validate the search pipeline, to find program-related problems at the early stage, and to prepare for the full configuration operation of KAGRA. And then, we report the results of the end-to-end test for the targeted search and summarize future prospects for continuous GW search using KAGRA.

Finally, we propose a new veto method for continuous GW search for electromagnetically undiscovered sources. Our veto method aims to exclude sharp spectral noise lines that frequently hampers detection sensitivity to continuous GW signals. The main feature of our veto method is the applicability to a single-detector search and coincident lines in a multi-detector network. We conduct performance tests of our veto method using an actual data set from the initial LIGO. We show that the new veto method excludes line noise effectively and improve detection efficiency in noisy data.