【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Mathematical and Physical Sciences)

Title of Project : Calibration Standard and High-Precision Data Analysis toward the Observational Era of Gravitational Waves

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Research Project Number : 17H06133 Researcher Number : 50251484
Research Area : Mathematical and Physical Sciences
Keyword : Gravitational Wave, Relativity, Data Analysis, Laser Interferometer, Astrophysics

【Purpose and Background of the Research】

In 2015, the US experiment LIGO finally achieved the first gravitational wave detection. It is supposed that the source is a coalescence of black hole binary of about 30 solar mass, and has attracted great interest on physics, astrophysics and astronomy. Expecting LIGO and Virgo (in Europe) update plans and KAGRA project in Japan, the "gravitational wave observational era" with more frequent event observation will be started in the near future.

However, there is a systematic error of several to 10% in the current observation. Further, more highly accurate analysis is strongly desired.

In this research, we proceed with a collaboration of hardware and data analysis, (1) global standard of calibration, (2) high fidelity reproduction of time series gravitational wave signal *h(t)*, and (3) research on physics that be possible by high precision data analysis.

【Research Methods】

In this research, calibration, reproduction of signal, and high precision data analysis are main items.

The photon calibrator is a method to excite the displacement of the mirror by the radiation pressure of the laser light. It has already been introduced in LIGO and is also under construction in KAGRA. We will introduce an integrating sphere for an accurately measurement of the laser power,

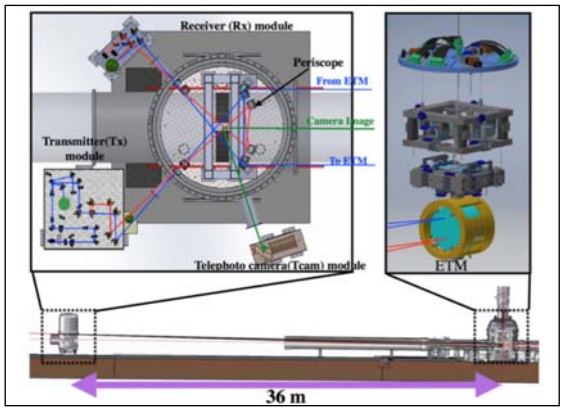

Figure 1. KAGRA Photon calibrator

and will measure in LIGO, KAGRA, respectively. By establishing the calibration standard for the international observation network, we are aiming at a systematic error of 1% or less.

We will develop high-fidelity *h(t)* reconstruction software. We will also develop more accurate analysis, and clarify whether new science can be expected by improving calibration precision.

【Expected Research Achievements and Scientific Significance】

The current amplitude error propagates an error of about 15% for the compact binary existence rate. This research may reduce this error about 3%. By suppressing the error of the observed waveform about 1%, the influence of the systematic error can be suppressed to less than the statistical error in the analysis with an order of 100 events.

In the second half of this research, KAGRA operation with a low temperature mirror is scheduled. Our research will be adopted on KAGRA.

【Publications Relevant to the Project】

・「初観測された重力波が開いた宇宙への新しい窓」, 神田展行、雑誌パリティ, (“New window for the universe opened by the first gravitational wave observation”, Nobuyuki Kanda, Parity, Maruzen), Vol. 31, No. 10, 14-18, (2016)

・"The detection rate of inspiral and quasi-normal modes of Population III binary black holes which can confirm or refute the general relativity in the strong gravity region", Tomoya Kinugawa, Akinobu Miyamoto, Nobuyuki Kanda, Takashi Nakamura, Mon. Not. Roy. Astron. Soc. 456 (2016) no.1, 1093-1114

【Term of Project】 FY2017-2021

【Budget Allocation】 139,600 Thousand Yen

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