【Grant-in-Aid for Specially Promoted Research】

Science and Engineering (Mathematics/Physics)

Title of Project : Detection of gravitational waves with a cryogenic interferometer

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Research Project Number : 26000005　Researcher Number : 40185773
Research Area : Mathematical and physical science
Keyword : Cosmology/Gravitation (experiment)

【Purpose and Background of the Research】

Gravitational wave (GW), distortion of the space-time structure propagating at the speed of light, by accelerating masses was predicted by Albert Einstein from his theory of general relativity. There are various astrophysical phenomena that could produce strong GW such as mergers of binary neutron stars or binary black-holes, or supernova explosions.

A 3km baseline laser interferometer KAGRA will be the key infrastructure in this research. We plan to achieve the world's highest sensitivity, operate the instrument for more than a year, and observe the GW signal for the first time and create a new scientific filed of "gravitational wave astronomy".

【Research Methods】

Key features of KAGRA include the seismically quiet underground site of Kamioka mine and the reduction of thermal noises by cooling the interferometer mirrors down to 20K (Figure 1).

We plan to carry out various research and developments (R&D's) in order to achieve the very high sensitivity in the GW signal detection. These R&D's include the advanced suspension system for the cryogenic mirrors, the method to accelerate the cooling speed, and the advanced interferometer control system.

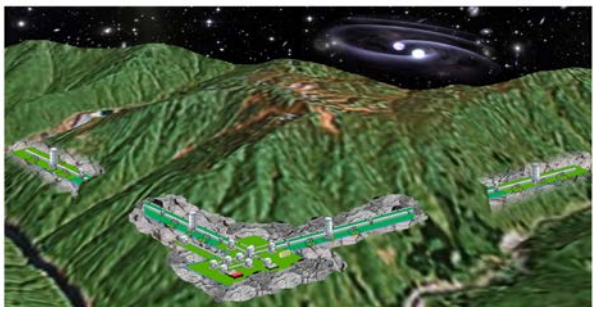

Figure 1 KAGRA detector

After these R&D's, we plan to operate the instrument for more than a year during this research period.

【Expected Research Achievements and Scientific Significance】

We expect to observe the GW signals from the following astrophysical phenomena:

1) Merger of binary neutron stars (Figure 2). The expected event rate is more than a few per year. Therefore, this is the primary candidate for the first detection of the GW signal.

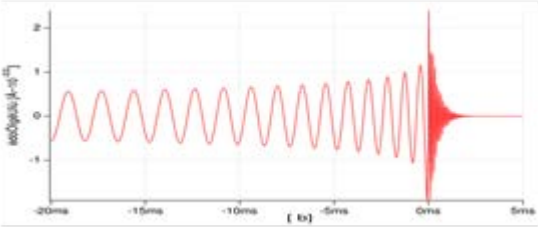

Figure 2 Expected GW signal for a merger of binary neutron stars (x- and y-axes show time and the amplitude, respectively.)

2) Merger of binary black-holes. (The event rate has a large uncertainty.)
3) Supernova explosion. (The event rate is low (1 per 10 years?)).

Observation of GW signals from one or some of the sources will open the new scientific filed of "gravitational wave astronomy".

【Publications Relevant to the Project】

・"Reduction of thermal fluctuations in a cryogenic laser interferometric gravitational wave detector" Takashi Uchiyama, Shinji Miyoki *et al.*, Phys. Rev. Lett. 108 (2012) 141101

・"Observing gravitational waves – from the investigation of the existence to the detection ", ed. Takashi Nakamura, Norikatsu Mio, and Masatake Ohashi, Kyoto Univ. Press (1998) (in Japanese).

【Term of Project】

FY2014-2018

【Budget Allocation】

446,800 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.icrr.u-tokyo.ac.jp/gr/SPR/index.html