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

Science and Engineering (Mathematical and Physical Sciences)

Title of Project : Study of cosmic star-formation history based on an unbiased survey of millimeter- and submillimeter-wave emission-line galaxies

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Research Project Number : 17H06130 Researcher Number : 80321587
Research Area : Astronomy
Keyword : Mm/submm waves, cosmic star formation history, emission-line galaxies, superconductors

【Purpose and Background of the Research】

The history of star formation over time (i.e., redshift or z) is closely related to the evolution of the universe, and hence is one of the key subjects in astronomy. In this study we will tackle major unresolved problems of it, including the precise physical mechanism that governs the variation of star formation activities, by conducting an extensive survey of emission-line galaxies at mm and submm waves. Specifically, we will (1) survey star-forming galaxies at z = 4-8 with the [CII] 158 μm line, which is the brightest line in the far-infrared band, to measure the [CII] luminosity functions and star- formation rate densities (SFRD) at the early epoch, and (2) conduct an unbiased survey of relatively low-J CO lines, which are a tracer of the molecular gas, to constrain the CO luminosity functions and then detect the variation of molecular gas mass density at z = 0-2.

【Research Methods】

To achieve the goals, we will develop DESHIMA, a mm/submm-wave imaging spectrograph covering from 210 to 360 GHz instantaneously (about 13 times wider than the single tuning of ALMA) by exploiting the state-of-the-art superconducting technology. DESHIMA equipped with a few 10s of spatial pixels will enable us to conduct ultra-wide-band spectroscopy over a field of view comparable with, or wider than, that of ALMA. We plan to install this instrument on the LMT 50 m telescope, which is one of the world largest mm-wave single-dish telescopes, and to conduct extensive surveys of emission-line galaxies.

【Expected Research Achievements and Scientific Significance】

This program will produce the first astronomical observational results of spectroscopy for a wide bandwidth of 150 GHz. It will be a showcase of the unique and new technology, i.e., on-chip super-conducting spectrograph, proposed by a Japanese scientist.

To determine the SFRD based on the observations of the galaxies that emit the [CII] 158 μm line has the following two major advantages over conventional dust-continuum surveys. First, it immediately gives their spectroscopic redshifts. Second, it enables us to make a systematic search for a new class of star-forming galaxies that have bright emission lines with suppressed dust continuum emission. They would be good targets for ALMA follow-up observations and would no doubt lead to the significant scientific outcome from Japan.

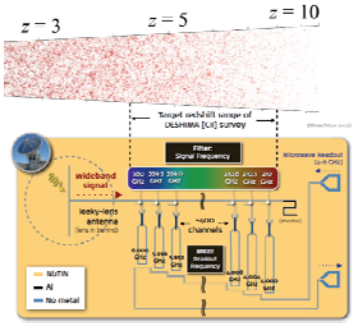

Figure 1 DESHIMA, an on-chip spectrograph based on super-conducting resonators, for z=4-8 [CII] lines.

【Publications Relevant to the Project】

・Yamaguchi, Y., Tamura, Y., Kohno, K., et al., "SXDF-ALMA 2 arcmin² deep survey: Resolving and characterizing the infrared extragalactic background light down to 0.5 mJy", Publ. Astron. Soc. Japan, 68, id. 82, 15 pp. (2016)
・Endo, A., et al., "Design of an Integrated Filterbank for DESHIMA: A submillimeter Imaging Spectrograph Based on Super-conducting Resonators", J. Low Temp. Phys., 167, 341-346 (2012)

【Term of Project】 FY2017-2021

【Budget Allocation】 163,700 Thousand Yen

【Homepage Address and Other Contact Information】

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