Research area in the Strategic Objective "Development of new material properties and frontier of information sciences based on the advanced control of quantum states"

6.1.7 Creation of an innovative quantum technology platform based on the advanced control of quantum states

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Overview

The objective of this research area is to create an innovative quantum technology platform that contributes to the development of society by exploring physics and technologies for high-level control of the quantum state on the basis of photonics, solid state science, nanostructure/materials science, and informatics to pioneer discoveries in the frontier of quantum science. We also aim at realizing new quantum information processing and element/system functions that are superior to prior technologies in terms of performance. This research area focuses on the following two pillars in promoting research and development: "creation of new sources" to explore physics for quantum state control and develop pertinent technologies and "creation of innovative system functions" to provide quantum technologies for social and industrial innovation in the future.

Specific examples of the research include the following: sophistication of the state control of various quantum systems such as quantum dots and superconductors and subsequent development into quantum information processing technology; the realization of a new hybrid quantum system via a highly-controlled quantum system and a high-sensitivity sensor element; and the development of super-precision measurement technology through a sophisticated use of quantum effects and quantum optics. Furthermore, we also aim at the realization of innovative quantum system functions and the subsequent integration thereof to contribute to the construction of future infrastructures. In addition, we expect proposals on research and development embracing a broader quantum technology initiative based on a new idea or approach.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

(1) Background and basic policy

Science and technology based on quantum mechanics, such as semiconductors, superconductivity, and lasers, have had considerable impacts on industries and society. Element technology for quantum state control and basic research on quantum information processing was initiated around the 1990s. Comprehensive and high-level utilization of quantum mechanics is generating seeds for the development of new academic and technological systems. Considering developments thus far, by combining our strengths in photonics, solid state science, nanostructures, materials science, and informatics it is important to deliver quantum technology that serves as a

core for the creation of a platform for new industries and technologies. We also aim to lead pioneering work in the frontier of quantum science from long- and medium-term viewpoints.

In this research area, we emphasize research and development for high-level control of quantum states to respond to various economic and social needs; additionally, we aim for the development of new quantum properties of materials and quantum information systems. In so doing, we aim to create sources for a wide range of innovation and establish basic technologies for implementing quantum technologies and systems that are foundational to a radically reformed profile of society.

We solicit proposals covering a wide range of research areas to put the above ideas into practice. The preferred content of research proposals applied to this research area is explained below.

(2) Area and content of research proposals

In this research area, we aim for high-level control of various quantum states, ranging from isolated quantum systems to many-body systems and macroscopic condensed matter in order to explore unknown physical phenomena and functions/properties of matter. We also intend to pioneer in the area of quantum informatics based on new concepts and create seeds for new technologies. We also aim to develop basic quantum technologies and systems to stimulate forward-looking mergers and breakthroughs in existing technological areas (photonics, electronics, spintronics, and the like).

For this research area, we solicit proposals that are expected to challenge current limitations by exploring the sophisticated control of quantum states and technological advances for quantum information processing and research and development for the construction of platforms to provide society with various quantum technologies. Such innovations include the realization of sensors and devices much superior to current technologies in terms of performance. A proposal needs to present a clear vision about the social significance of the results as well as a convincing research plan high academic value—specifically, in terms of science and technology for the high-level control of quantum states. Please show that the proposal would make discontinuous progress from past technologies and provide benchmarks for progress.

In this research area, we solicit proposals for one of the following two categories:

(A) Creation of new sources; exploration of physics for quantum state control and its technological development
(B) Creation of innovative system functions; providing quantum technologies for social and industrial innovation in the future

Needless to say, both categories refer to goal-oriented basic research. Therefore, whether a proposal belongs to (A) or to (B), it is required to explicitly present a vision that shows how its achievement bears fruit as a system for a future society.

In this research area, we promote research issues to establish leading quantum technologies through integration and collaboration of photonics, solid state science, nanostructure/materials science, and informatics in an integrated

and multi-layered manner. Although any proposal that brings innovation to quantum technology will be welcome regardless of its content, it is essential that the proposal be excellent in terms of both academic value and anticipated social value. We also look for proposals from teams of theorists. Examples of areas into which research and development proposals for this research area may be categorized are provided below:

① Realization of core technology related to quantum information processing through sophistication of the state control of quantum systems
② Realization of scalable quantum information processing technology through materialization of innovative quantum system functions
③ Realization of new quantum simulation technology through control of quantum many body systems
④ Realization of quantum communication element technology through sophisticated quantum state control of photons and electrons and system verification
⑤ Realization of a new hybrid quantum device through the development of nanotechnology and new materials technology
⑥ Realization of super-precision measurement and sensor technology through the sophisticated use of quantum effects and quantum optics
⑦ Realization of innovative biotechnology and medical measurement technology through sophisticated quantum state control
⑧ Development of quantum technology based on a new concept and its application and development

(3) Implementation structure of research and management policies for the research area

We expect joint research within an adopted proposal (research issue, hereafter) to be promoted by research teams of complementary researchers in order to turn a research plan of a proposer into reality. Although it is required to undertake research as a team for research issues of (A), the team needs not be large. Emphasis will be placed on digging deeply into creative research by the research proposer.

Please assume a research period of five and a half years for a proposal solicited in this fiscal year. The upper limit of the budget set for an (A) proposal is 200 million yen; for a (B) proposal, the upper limit is 350 million yen.

In conducting research, collaboration and integration among research teams are expected to develop through activities in the research area, although it is a premise for a research to proceed according to the proposal. Therefore, we will aim to provide opportunities for research teams to deepen their mutual understanding. In addition, the research budget will be boldly adjusted for an increase or decrease on the basis of research progress evaluated at the mid-term (planned as two years from the start of the research period). Consequently, it may be necessary to change group members on teams or in research areas. The entire research area will be directed toward favorable results in the process of research and development.

Generally speaking, the number of research issues associated with (A) is anticipated to be larger than that of (B).

Please clearly state whether a proposal aims for (A) or (B) in the introductory explanation of the proposed research issue.

It is recommended that proposals are suited to shared research facilities and instruments; examples of common facilities are the Tsukuba Innovation Arena and the Nanotechnology Platform of the Ministry of Education, Culture, Sports, Science and Technology.

(4) Collaboration and cooperation with other research areas

In managing the research area, we will attempt to promote collaboration and cooperation not only with PRESTO's "Quantum state control and functionalization" research area, which shares the same strategic objective, but also with CREST's "Advanced core technology for creation and practical utilization of innovative properties and functions based upon optics and photonics" and PRESTO's "Fully controlled photons and their proactive usage for new era creation." If necessary, research area conferences and workshops will be held jointly. Furthermore, we stimulate collaboration with associated academic societies and research organizations, and plan to hold an international symposium to disclose achievements.

A briefing on the call for proposals in this research area will be held according to the following schedule. We hope to see many interested researchers in attendance. The briefing will be held jointly for this research area and the PRESTO research areas "Quantum state control and functionalization." and "Creation of Life Science Basis by Using Quantum Technology"

Date & Time	Venue
April 18 (Tue) 14:00-16:20	JST Tokyo Headquarters Annex 1st Floor Hall K's Gobancho,7,Chiyoda-ku

For more information, please visit the following site: http://senryaku.jst.go.jp/teian-en.html.