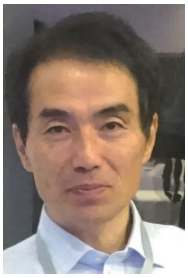
【Grant-in-Aid for Scientific Research (S)】

Broad Section B



Title of Project : Creation of a new discipline, quantum glass, for electronic systems and its development to material science

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Research Project Number : 18H05225 Researcher Number : 20194946
Keyword : molecular solid, strongly correlated electron system, liquid and glass, soft matter

【Purpose and Background of the Research】

The physics of strongly interacting electrons has advanced into a fertile field owing to their diverse and emergent phenomena with microscopic orders of charges and spins. Recent studies, however, suggest that interaction may cause heterogeneous self-organizations of electrons on scales far larger than molecular size and their extremely slow dynamics – the very characteristics of soft matters.
In the present study, we investigate electronic systems exhibiting spatiotemporal variation on anomalously large scales in terms of soft matters, aiming to establish a new notion, "quantum glass of electrons", that possesses charge and spin of quantum nature, not available in conventional glasses. This research project tries to create a new interdisciplinary filed linking two sciences of strongly correlated electrons and soft matters, so far developed separately (Fig.1).

【Research Methods】

The project is conducted in close collaboration between three groups performing physical property measurements, material synthesis and theoretical studies, seeking quantum glass matters, their control and a new notion of electronic rheology.
The measurement group studies the spatiotemporal variation of electronic states by NMR, electron transport and permittivity measurements and scanning microspectroscopy, and further tackles non-equilibrium phase control (Fg.2). The synthesis group designs and synthesizes materials for

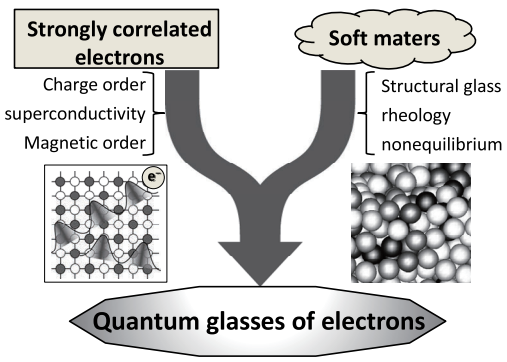

Figure 1

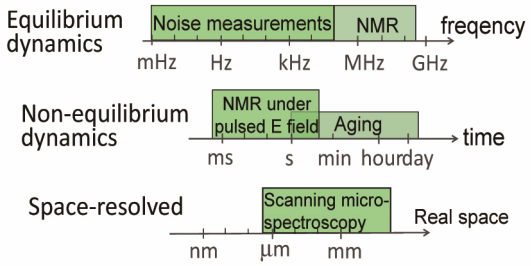

Figure 2

electronic glasses by the chemical modification of molecules and the introduction of proton electron interactions. The theory group elaborates effective models for electronic glasses to elucidate the origin of the slow dynamics.

【Expected Research Achievements and Scientific Significance】

We aim to develop a new research area, quantum glass, which originates from interacting electrons. This project tackles an essential issue of how soft matters so-far studied in the classical framework meet electrons of quantum nature. It is expected that soft matters of quantum nature come out and novel phase control exploiting slow dynamics and non-equilibrium nature is developed.

【Publications Relevant to the Project】

・T. Sato, K. Miyagawa and K. Kanoda, "Electronic crystal growth", Science **357**, 1378-1381 (2017).
・T. Itou, E. Watanabe, S. Maegawa, A. Tajima, N. Tajima, K. Kubo, R. Kato and K. Kanoda, "Slow dynamics of electrons at a metal–Mott insulator boundary in an organic system with disorder", Sci. Adv. **3**, e1601594-1-6 (2017).

【Term of Project】 FY2018-2012

【Budget Allocation】 151,400 Thousand Yen

【Homepage Address and Other Contact Information】

http://park.itc.u-tokyo.ac.jp/kanoda_lab/