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Takuro Sato

Transport and NMR Studies of Charge Glass in Organic Conductors with Quasi-triangular Lattices

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Transport and NMR Studies of Charge Glass in Organic Conductors with Quasi-triangular Lattices

Doctoral Thesis accepted by
the University of Tokyo, Japan

Springer

Author
Dr. Takuro Sato
RIKEN Center for Emergent Matter Science
Dynamic Emergent Phenomena Research Unit
Wako, Saitama
Japan

Supervisor
Prof. Kazushi Kanoda
Department of Applied Physics
The University of Tokyo
Bunkyō, Tokyo
Japan

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Supervisor's Foreword

The Ph.D. thesis of Takuro Sato is a report on his work which experimentally demonstrates that an electronic glass emerges on geometrically frustrated lattices. Glass is a ubiquitous state that appears in atomic or molecular assemblies. Such a state has been substantiated in electronic systems, as described in this thesis.

The Coulomb repulsive force between electrons makes them localized to form an electronic crystal; however, its periodicity does not always match that of the atomic or molecular lattices in materials. This situation is called geometrical frustration. If the lattice of materials is triangular and electron (or hole) density is a half per lattice point, the geometrical frustration is so strong that the electrons may not find a stable crystal but form a nontrivial state; an electronic glass is a possible state. The materials dealt with in this thesis work, layered organic compounds with anisotropic triangular lattices, are in such a situation. The hallmarks of the glass state are nonequilibrium properties, slow dynamics, and short-ranged order; all of them are captured by the experiments of charge transport, its noise, and X-ray scattering, respectively, in this work. Furthermore, the phenomena of aging, dynamical heterogeneity, and crystal growth, which have so far been exclusively the issues of soft matter physics, are observed in strongly correlated electron systems. The present work creates a novel interdisciplinary platform that integrates the science of correlated electrons and the science of soft matter. It is a great pleasure to me that Sato's thesis is published in the Springer theses series.

Tokyo, Japan
July 2017

Prof. Kazushi Kanoda

Parts of this thesis have been published in the following journal articles:

[1] F. Kagawa, T. Sato, K. Miyagawa, K. Kanoda, Y. Tokura, K. Kobayashi, R. Kumai, Y. Murakami "Charge-cluster glass in an organic conductor" *Nat. Phys.* **9**, 2642 (2013)

[2] T. Sato, F. Kagawa, K. Kobayashi, K. Miyagawa, K. Kanoda, R. Kumai, Y. Murakami, Y. Tokura "Emergence of nonequilibrium charge dynamics in a charge-cluster glass" *Phys. Rev. B* **89**, 121102(R) (2014)

[3] T. Sato, F. Kagawa, K. Kobayashi, A. Ueda, H. Mori, K. Miyagawa, K. Kanoda, R. Kumai, Y. Murakami, Y. Tokura "Systematic Variations in the Charge-Glass-Forming Ability of Geometrically Frustrated θ-(BEDT-TTF)$_2$X Organic Conductors" *J. Phys. Soc. Jpn.* **83**, 083602 (2014)

[4] T. Sato, K. Miyagawa, K. Kanoda "Fluctuation Spectroscopy Analysis Based on Dutta-Dimon-Horn Model for the Charge-Glass System θ-(BEDT-TTF)$_2$ CsZn(SCN)$_4$" *J. Phys. Soc. Jpn.* **85**, 123702 (2016)

[5] T. Sato, K. Miyagawa, K. Kanoda "Electronic crystal growth" Submitted to *Science* (under Review)

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