常次研究室 Tsunetsugu Group

研究テーマ Research Subjects

1. *d* 電子、*f* 電子化合物など強相関電子系の電子状態と異方的超伝導
   Electronic states and unconventional superconductivity in strongly correlated systems with *d*- or *f*-electrons
2. フラストレーション系の統計力学
   Statistical physics of frustrated systems
3. 量子磁性体の新奇量子相の理論
   Theory of novel phases in quantum magnets
4. 量子系の非平衡ダイナミクス
   Nonequilibrium dynamics of quantum systems

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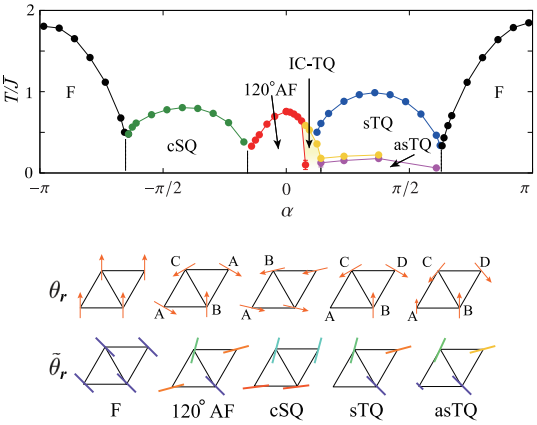
専攻 Course
理学系物理学
Phys., Sci.

遷移金属化合物、希土類・アクチノイド化合物などの電子間クーロン相互作用が強い強相関電子系の物性の理論を研究している。これら強相関電子系においては、低温で新奇な磁性状態や異方的超伝導、密度波などの多種多様な物性が出現する。これらの複雑な物性の統一的な理解を目標とするとともに新しい現象の発見を目指している。

主なテーマは、フラストレーション系や強磁性超伝導体などのスピン・電荷・軌道の複合自由度を持つ系における新しいタイプの量子秩序や量子ゆらぎである。秩序と臨界現象の特徴、電子状態や輸送現象をはじめとするダイナミクスがどのような影響を受けるのかを調べている。また、最近はカイラルな結晶構造のもたらす新規なフォノンおよび電子物性の研究にも取り組んでいる。

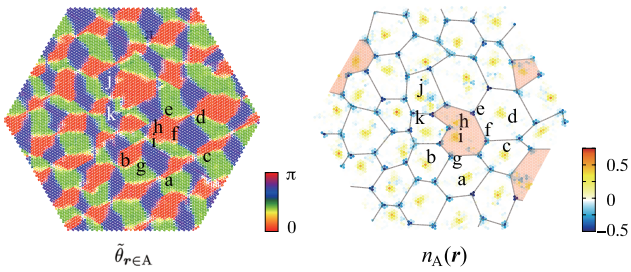
Strongly correlated electron systems, particularly transition metal compounds and rare-earth or actinide compounds are the main subjects of our theoretical research. In these systems, strong electron-electron interactions lead to a variety of interesting phenomena emerging at low temperatures, such as various types of exotic magnetic orders, unconventional superconductivity and density waves. We aim to establish a unified theory for those complex properties and also predict novel phenomena in those systems.

Targets of our recent study include novel types of quantum order and quantum fluctuations in frustrated spin and strongly correlated electronic systems with multiple degrees of freedom such as charge, spin, and orbital. In these systems, many soft modes of fluctuations are coupled to each other, and this affects the nature of quantum phase transitions, as well as electronic states and dynamical properties including transport phenomena. We also study systems with chiral structure and explore novel behaviors of their phonon and electronic properties related to their chirality.



（上）三角格子上 2 成分四極子模型の相図。$J=\bar{J}\cos\alpha$ と $K=\bar{J}\sin\alpha$ は隣接四極子間の等方的 / 異方的相互作用。（下）秩序相の四極子構造。θ_r は四極子の向き、$\tilde{\theta}_r=-\theta_r/2$ はディレクターの向き。

(top) Phase diagram of two-component quadrupoles in a triangular lattice. $J=\bar{J}\cos\alpha$ and $J=\bar{J}\sin\alpha$ are isotropic and anisotropic couplings of neighboring quadrupoles. (bottom) Quadrupole configurations in the ordered phases. θ_r is the direction of local quadrupole moment, while $\tilde{\theta}_r=-\theta_r/2$ is the corresponding director direction.



（左）IC-TQ 相の A 副格子ディレクターの瞬間配置は 3 種のドメインに分裂。（右）ディレクター渦度 $n_A(r)$ は渦格子を形成し、朱色の部分に存在する転位がコステリッツ・サウレス転移の出現を示唆。

(left) Snapshot of director directions on A-sublattice sites in the IC-TQ phase. The system is divided to three types of domains. (right) Local vorticity $n_A(r)$ of A-sublattice directors shows a distorted vortex lattice pattern. Dislocations exist at the vermillion polygons indicating an appearance of Kosterlitz-Thouless transition.

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