PS-B-1

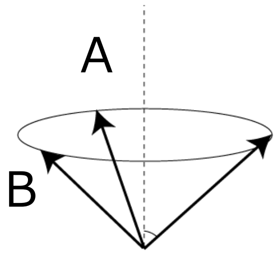
Spin-chirality ordering and kinetic-driven effective interactions in geometrically-frustrated ferromagnetic Kondo-lattice systems

Yutaka Akagi[A], Masafumi Udagawa[A,B], and Yukitoshi Motome[A]

Department of Applied Physics, University of Tokyo[A], Max-Planck-Institut für Physik Komplexer Systeme[B]

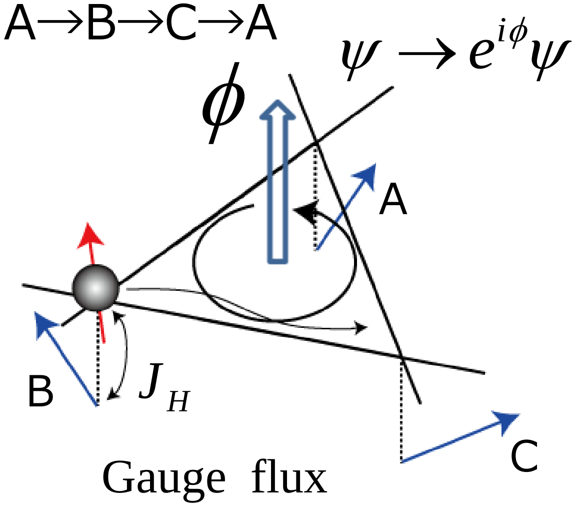
Unconventional anomalous Hall Effect

Spin configuration with a finite solid angle

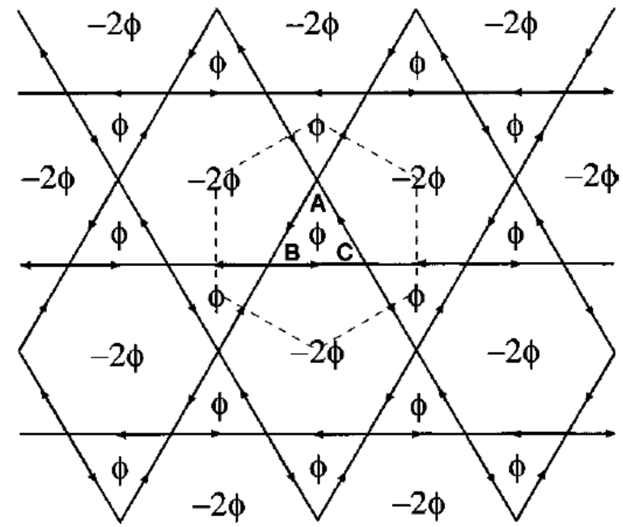


Scalar chirality
$\vec{S}_A \cdot (\vec{S}_B \times \vec{S}_C)$

Berry phase from electron hopping A→B→C→A



Distribution of flux on a kagome lattice



finite scalar chirality → Berry phase (effective magnetic field that electron feels) → Unconventional Anomalous Hall Effect

K. Ohgushi, S. Murakami, and N. Nagaosa, Phys. Rev. B **62**, R6065 (2000).
R. Shindou and N. Nagaosa, Phys. Rev. Lett. **87**, 116801 (2001).
I. Martin and C. D. Batista, Phys. Rev. Lett. **101**,156402 (2008).

Motivation

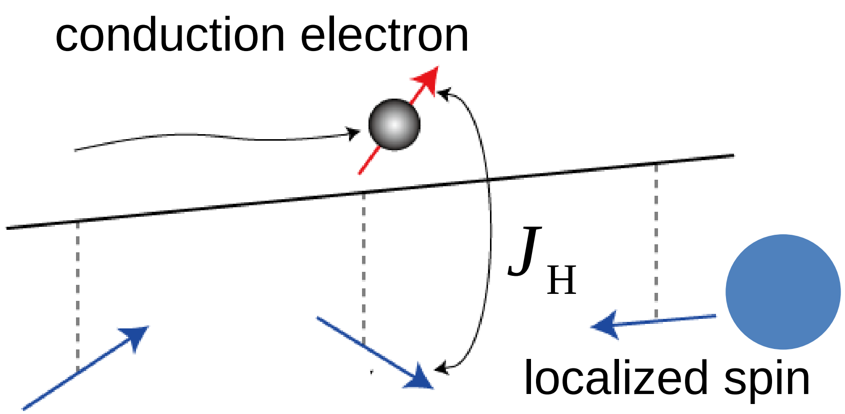
In the previous theories, the noncoplanar chiral order is given by hand.
(Spin pattern is not affected by the electron motion.)

However, in the spin-charge coupled systems, electronic state and magnetic state are self-consistently determined to optimize the free energy.

- To clarify whether the chiral ordering is stabilized in the spin-charge coupled systems by examining the ground state phase diagram
- To clarify the stabilization mechanism of the chiral ordering

Ferromagnetic Kondo lattice model

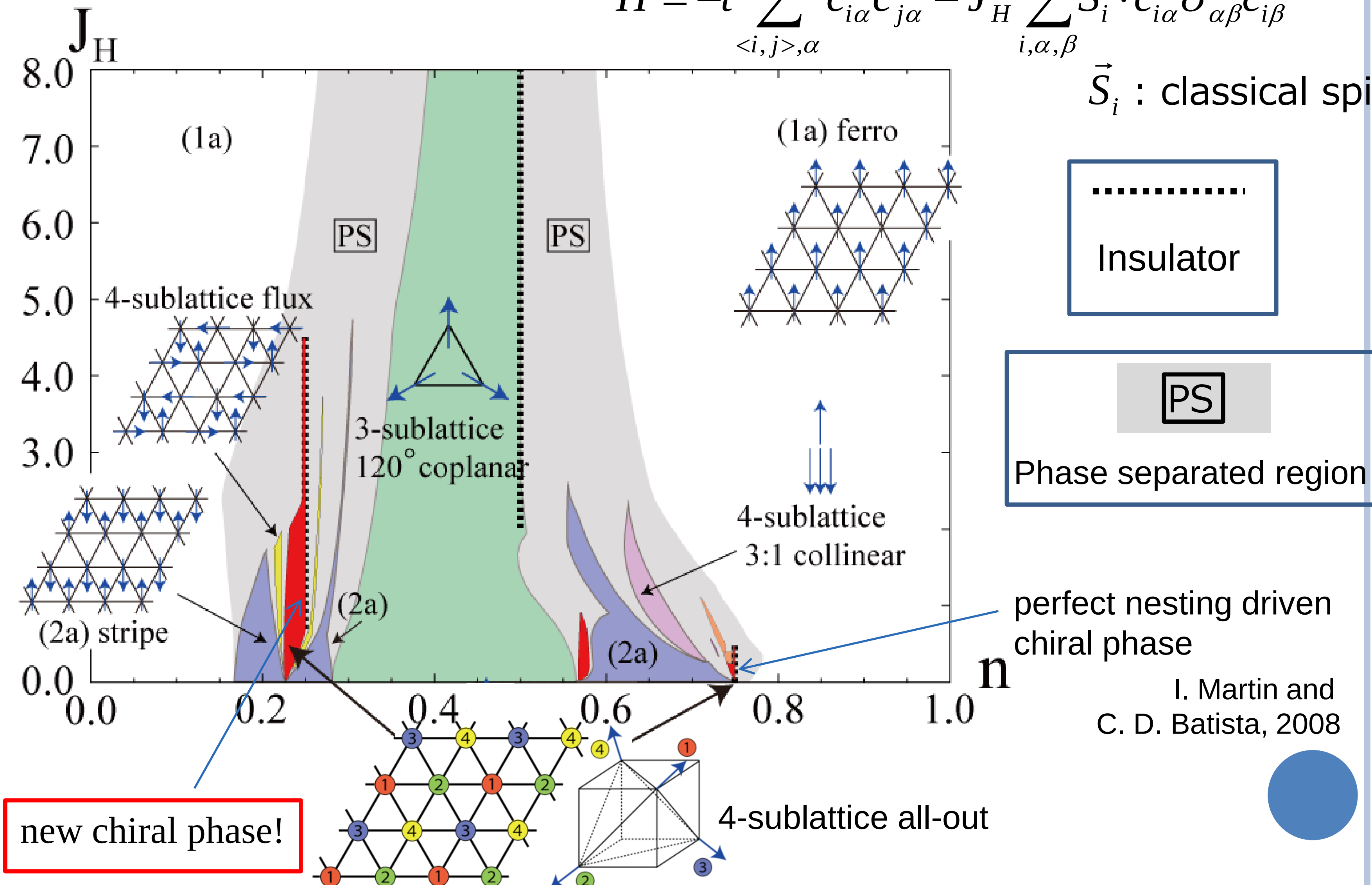
$$H = -t \sum_{<i,j>,\alpha} c_{i\alpha}^{\dagger} c_{j\alpha} - J_H \sum_{i,\alpha,\beta} \vec{S}_i \cdot c_{i\alpha}^{\dagger} \vec{\sigma}_{\alpha\beta} c_{i\beta}$$



Ground state phase diagram on triangular lattice

Ferromagnetic Kondo lattice model (=double-exchange model)

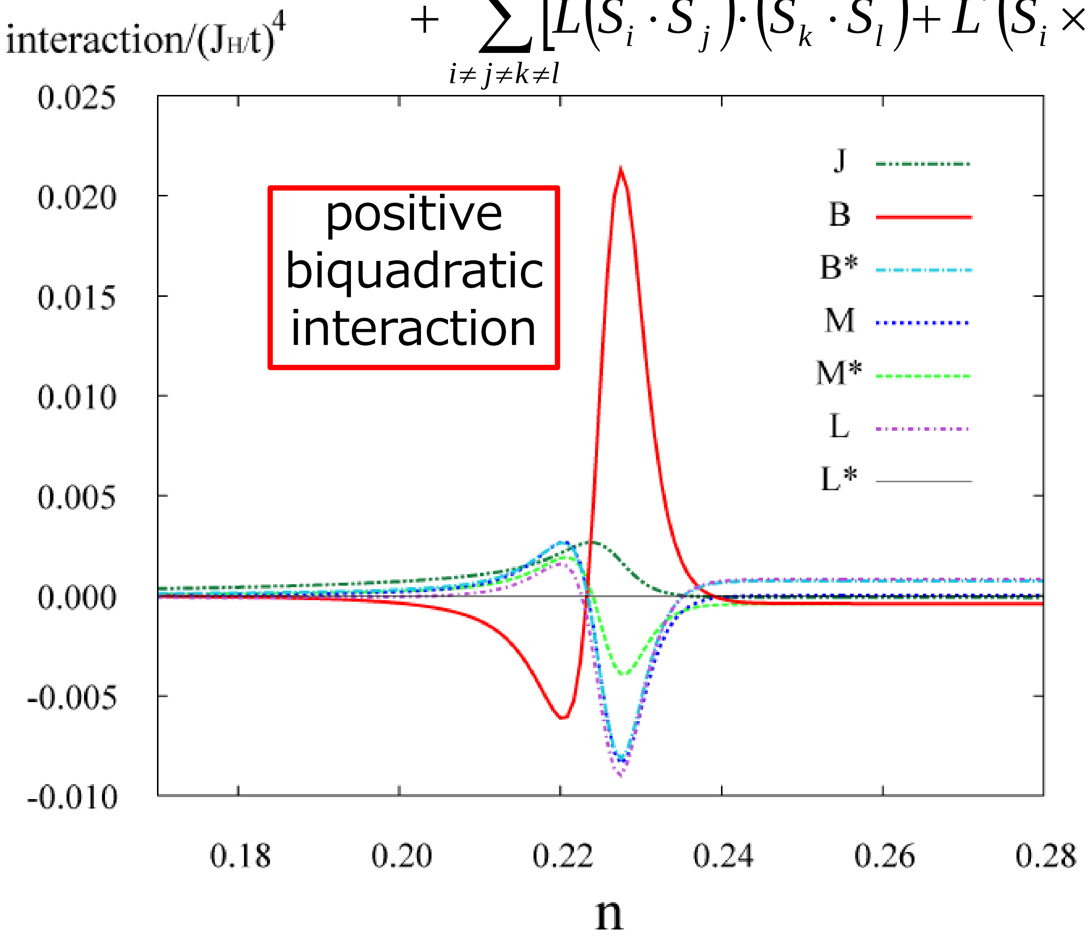
$$H = -t \sum_{<i,j>,\alpha} c_{i\alpha}^{\dagger} c_{j\alpha} - J_H \sum_{i,\alpha,\beta} \vec{S}_i \cdot c_{i\alpha}^{\dagger} \vec{\sigma}_{\alpha\beta} c_{i\beta}$$



Y. Akagi and Y. Motome, J. Phys. Soc. Jpn. **79**, 083711 (2010).

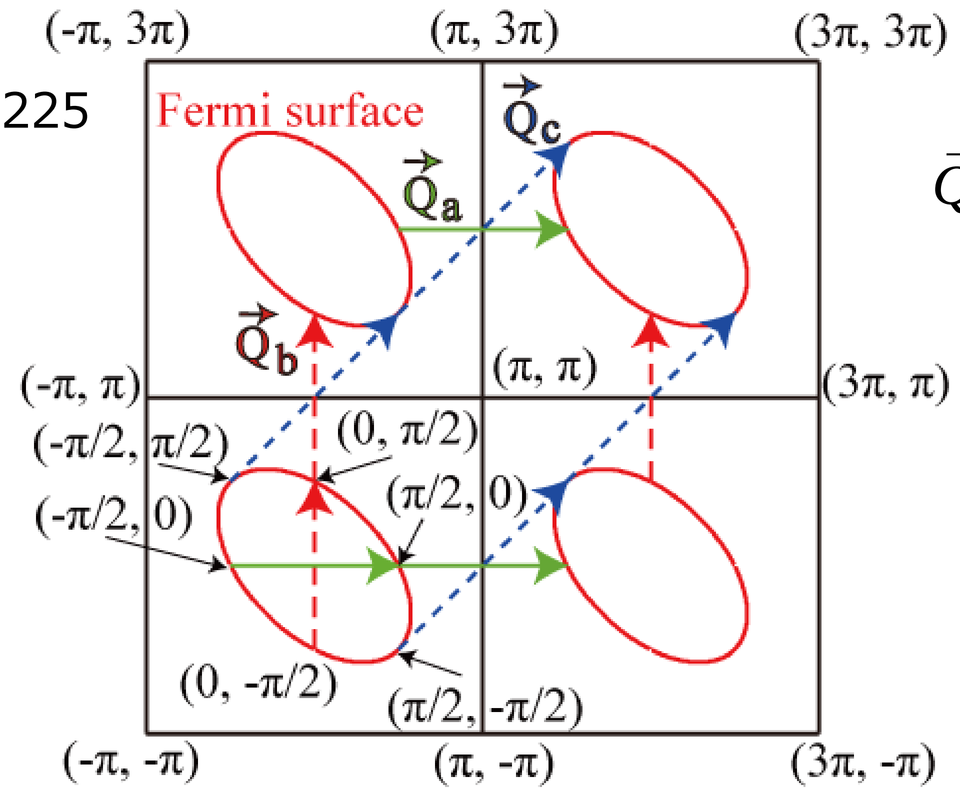
Effective Hamiltonian (4th order perturbation in J_H/t)

$$H_{eff}^{(4)}/(J_H/t)^4 = \sum_{1\le i<j\le 4}\left[J\vec{S}_i\cdot\vec{S}_j + \underline{B\left(\vec{S}_i\cdot\vec{S}_j\right)^2} + B^*\left(\vec{S}_i\times\vec{S}_j\right)^2\right]$$
$$+\sum_{i\ne j\ne k}\left[M\left(\vec{S}_i\cdot\vec{S}_j\right)\left(\vec{S}_i\cdot\vec{S}_k\right) + M^*\left(\vec{S}_i\times\vec{S}_j\right)\cdot\left(\vec{S}_i\times\vec{S}_k\right)\right]$$
$$+\sum_{i\ne j\ne k\ne l}\left[L\left(\vec{S}_i\cdot\vec{S}_j\right)\cdot\left(\vec{S}_k\cdot\vec{S}_l\right) + L^*\left(\vec{S}_i\times\vec{S}_j\right)\cdot\left(\vec{S}_k\times\vec{S}_l\right)\right]$$



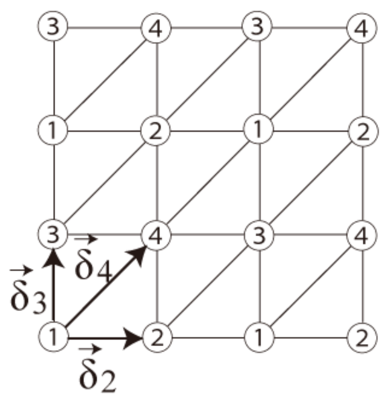
Origin of positive biquadratic interaction

n=0.225



$\vec{Q}_a, \vec{Q}_b, \vec{Q}_c$: 4-sublattice ordering wave vectors

triangular lattice



Fermi surface connection

cf. Kohn anomaly

Our topics
- ground-state phase diagram with scalar chiral ordering
- positive biquadratic interaction in the fourth-order perturbation
- higher-order Kohn anomaly by Fermi surface connection