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Origin of magnetic phase diagram of $CeOs_4Sb_{12}$

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Recently, anomalous magnetic phase transition from the paramagnetic metal to the insulating state was found at T_N=0.8K in filled-skutterudite compound $CeOs_4Sb_{12}$. The phase boundary is shifted to higher temperatures by applying the external magnetic field [1]. Although this shift of the phase boundary with the increase of the external field has been often observed in the systems with quadrupole-ordering, some experiments suggest that the crystal-field ground state of f electron is Γ_7 which has no quadrupole moment, and an spin density wave or a charge density wave transition occurs where an opening of a gap over a small portion of the Fermi surfaces of itinerant electronic states is realized.

By constructing the effective low-energy model with the dispersive f band, this metal-insulator transition observed in $CeOs_4Sb_{12}$ is investigated. Taking account of the experimental results and the band structure of the first principle calculation, the band structure with a semi-metallic character with small electron and hole pockets at Γ and H points is employed [2]. Using the random phase approximation, magnetic susceptibilities are calculated and the phase diagram is determined. The external field enhances the maximum value of the magnetic susceptibility perpendicular to the external field with the ordering vector $\mathbf{Q}$=(1,0,0), which does not change as far as the weak field region. This result indicates that the instability for the magnetic order is enhanced by the external field. Thus, the shift of the phase boundary to higher temperature region appears, which is qualitatively in accord with the experiments.

Furthermore, employing the two-band model with the parabolic dispersion, we study the general conditions of appearance of the anomalous magnetic phase diagram in low-carrier systems with a narrow gap or a small overlap. It is shown that the phase boundary strongly depends on the structure of the density of state in the vicinity of the Fermi level and finite temperature effects in low-carrier systems. In comparison with the insulating system with a small gap, the tendency is particularly conspicuous in the semi-metallic system.

[1] H. Sugawara, S. Osaki, M. Kobayashi, T. Namiki, S. R. Saha, Y. Aoki, and H. Sato: Phys. Rev. B **71** (2005) 125127.
[2] Y. Imai, K. Sakurazawa and T. Saso, J. Phys. Soc. Jpn. **75** (2006) 033706.