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Exotic insulating states of $(t_{2g})^4$ Hubbard model with spin-orbit coupling TOSHIHIRO SATO, RIKEN, TOMONORI SHIRAKAWA, RIKEN CEMS, SEIJI YUNOKI, RIKEN, RIKEN CEMS, RIKEN AICS — We numerically study electronic properties of a t_{2g}-orbital Hubbard model with a relativistic spin-orbit coupling (SOC) at four electrons per site. Our approach is a multi-orbital dynamical mean field theory with a continuous-time quantum Monte Carlo solver based on a strong coupling expansion. The main issue is the variation of electronic structure in the parameter space of the SOC and the Coulomb interactions at temperature fixed. For larger Coulomb interactions, a Van Vleck-type nonmagnetic insulating state with a total angular momentum $J = 0$ is induced by the SOC. When the SOC decreases, the insulating state is magnetically ordered along with increasing the hybridization between a nonmagnetic $J = 0$ state and an excited $J = 1$ state. Moreover, for smaller Coulomb interactions, we demonstrate that an excitonic insulating state without magnetic order appears, in addition to metallic and band insulating states. The exciton condensation is formed by an electron-hole pairing between the local effective total angular momentum $j = 1/2$ and $j = 3/2$ based bands.

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