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Stability of excitonic complexes in a multi-valley/band semiconductor HIROKI KATOW, University of Tokyo, JUNKO USUKURA, Tokyo University of Science, RYOSUKE AKASHI, University of Tokyo, KALMAN VARGA, Vanderbilt University, SHINJI TSUNEYUKI, University of Tokyo — Whether bound states are present for few-particle quantum systems is far from axiomatic and has been a hot topic for decades. For example, three-positronium and -/hydrogen bound states are not present in the vacuum. On the other hand, it has also been proposed that three excitons can be bound with each other in multi-valley/band semiconductors [J. S. Wang & C. Kittel, Phys. Lett. 42A, No. 3 (1972)]. Indeed, an array of photoluminescence peaks have been recently observed in diamond [J. Omachi et al., Phys. Rev. Lett. 111, 026402(2013)], which could suggest the existence of possible multi-exciton bound states. We theoretically examine if such bound states are possible by a variational method. For the electron-hole Hamiltonian including the valley and band degrees of freedom, we expressed trial many-body wave function with the correlated Gaussian bases and optimized it with the stochastic variational method [J. Mitroy et al., Rev. of Mod. Phys., 85, 2013]. We have shown bound states for N-exciton systems with N more than two. In the talk, we discuss the dependence of the bound states on the model settings and its relation to the experimental observation.

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