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Improved cluster-effective-field study on frustrated quantum spin systems in 2D YOSHIHIKO NONOMURA, Computational Materials Science Unit, National Institute for Materials Science, Tsukuba 277-0062, Japan — Although frustrated quantum spin systems in two dimensions are fascinating playground of novel quantum states, systematic numerical study with the quantum Monte Carlo method is difficult in such systems owing to the negative sign problem. Then, cluster-effective-field approach may be useful as an alternative numerical tool. Crucial points of formulation are to use periodic boundary clusters and to compare two different clusters. As an example, the J_1-J_2 model, where $S = 1/2$ Heisenberg spins are located on a square lattice with the nearest-neighbor and next-nearest-neighbor antiferromagnetic couplings J_1 and J_2. Classical Néel or sublattice Néel orders become unstable in the vicinity of $J_2/J_1 = 0.5$, where novel quantum states are expected to be stable. When the 16- and 20-spin clusters are used and the columnar or staggered dimer orders are taken as order parameters, we have coexisting regions of magnetic and dimer orders and first-order phase transitions between the columnar and staggered dimer orders. Further results based on larger clusters and improved formulations including multi-body effective fields are also discussed in the presentation.

Yoshihiko Nonomura
Computational Materials Science Unit, National Institute
for Materials Science, Tsukuba 277-0062, Japan

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