Physics Colloquium

“Beyond the Standard Models of Condensed Matter Systems”

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Most of our basic understanding of the properties of condensed matter systems are based on the Fermi liquid theory and computational approaches formulated around the density functional theory; they collectively laid the foundation of the “standard model” of condensed matter systems. However, in correlated electronic systems where the interaction energy between the valence electrons overwhelms the kinetic energy resulting in a strongly coupled many-body ground states, the standard model fails to describe experimental observations. The best-known examples are the heavy fermions and recently, two-dimensional materials. Computationally, describing strongly correlated systems is one of the hardest problems in condensed matter physics. In this colloquium, I will present a general overview of the concepts of correlated electron systems and the many-body typical medium dynamical cluster approximation, which is a non-perturbative method of describing correlated electron systems even when material imperfections are present. I will give specific materials applications and conclude with an outlook of the current challenges and the perspective for national materials design,

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