**Model mapped RPA: first-principles method to determine a Hubbard model Hamiltonian**

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Curious physical phenomena such as superconductivity may often be driven by electron correlations. Such correlations are usually investigated by assuming Hubbard type models. The hopping integrals can be evaluated from first-principles calculations by calculating Maximally Localized Wannier Functions [1]. For the evaluations of Hubbard interactions *U*, the constrained random phase approximation (cRPA) is often adopted [2,3,4]. However, cRPA contains several problems [5]. For example, interaction parameters calculated in cRPA become finite between distant sites because cRPA removes the metallic screenings for Coulomb interactions.

To amend such problems, we have introduced a new method named model-mapped RPA (mRPA) [5]. The mRPA method requires the constraint *W* =*W*M on *U*, where *W* and *W*M are the screened interactions calculated in first-principles calculations and Hubbard model calculations, respectively. Owing to the constraint, we can obtain short-ranged model interactions. The method of mRPA may be technically simpler and theoretically clearer than that of cRPA.

The method of mRPA also includes the procedure to remove the double counting of one-body terms. The mean-field terms given by two-body Hamiltonians should be removed because one-body Hamiltonian derived from first-principles contains such effects [5]. This is crucial for multi-orbital models.

We will present the value of *U* assuming two-orbital model for the cuprate superconductors La2CuO4 and HgBa2CuO4. We analyze the material dependence of *U* given by the apical oxygen height [6]. Through the analysis, *U* obtained from mRPA results in different tendency with cRPA. This implies that the value of *U* may be ambiguous in principles.

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