

### Motivation

The advanced experimental technique in atomic physics allows us to create an artificial crystal, so-called “optical lattice”, inside ultracold atomic gases by laser lights. We theoretically study the quantum properties of this system and explain the recent experimental results quantitatively.

### Originality

Cold atoms trapped in optical lattices are ideal model systems for investigating the many-body problems which have been studied for many years in condensed matter physics. This system is thus considered as a quantum simulator. Our numerical analyses provide the precise information about complicated quantum many-body states of cold atoms.

### Impact

The unresolved problems in condensed matter physics such as metal-insulator phase transition and high-T<sub>c</sub> superconductivity can be clarified via cold atoms. One can also realize a quantum computer by using atoms on the lattice sites as quantum bits.

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### Optical lattice: an artificial crystal created by laser lights

