Two-dimensional Fermion system in Triangular Geometry

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Strongly Correlated Electron Systems
(High-Tc superconductivity, organic conductors, one-dimensional electron systems, etc)

- Two-dimensional triangular systems (Hubbard model, t-J model)

  Half-filling (n = 1) i.e. Heisenberg spin system and
  Doped cases

Spin and charge are not separated in 2-dim.

⟺ ?

He on graphite (second layer)

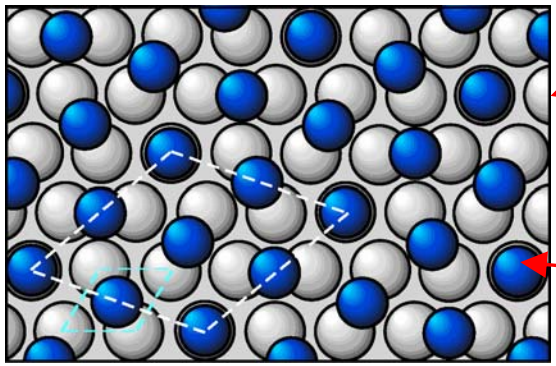
Helium on Graphite

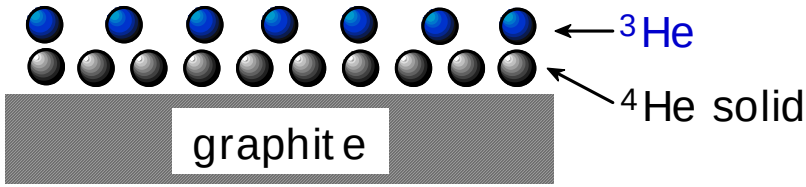
(Fukuyama group)

4/7 phase

1st layer 2nd layer

- **Localized due to potential corrugation ΔU = 1-3 K**





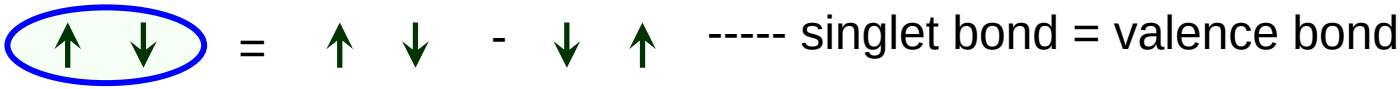
(H. Fukuyama)

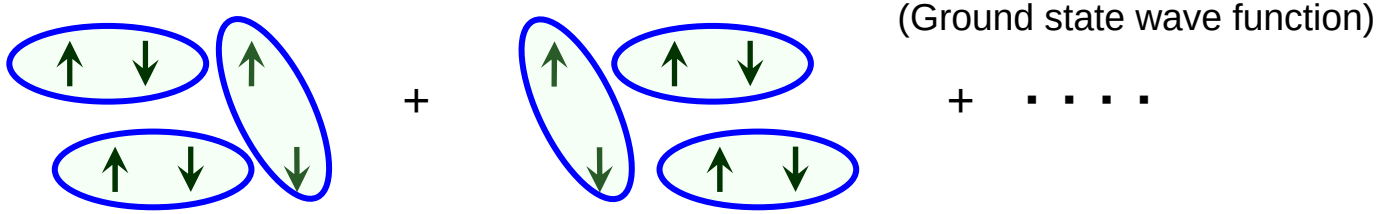
Density of He can be controlled

Triangular lattice (importance of Frustration)

- Heisenberg model (insulator)

Resonating Valence Bond (RVB) state (P. W. Anderson)



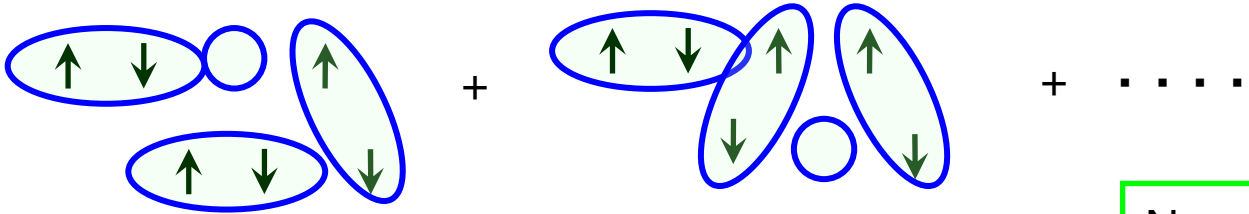


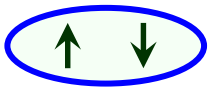
(Ground state wave function)

Resonating valence bond

A new state of spin liquid --- no conventional magnetic order

- Carrier doping into RVB state



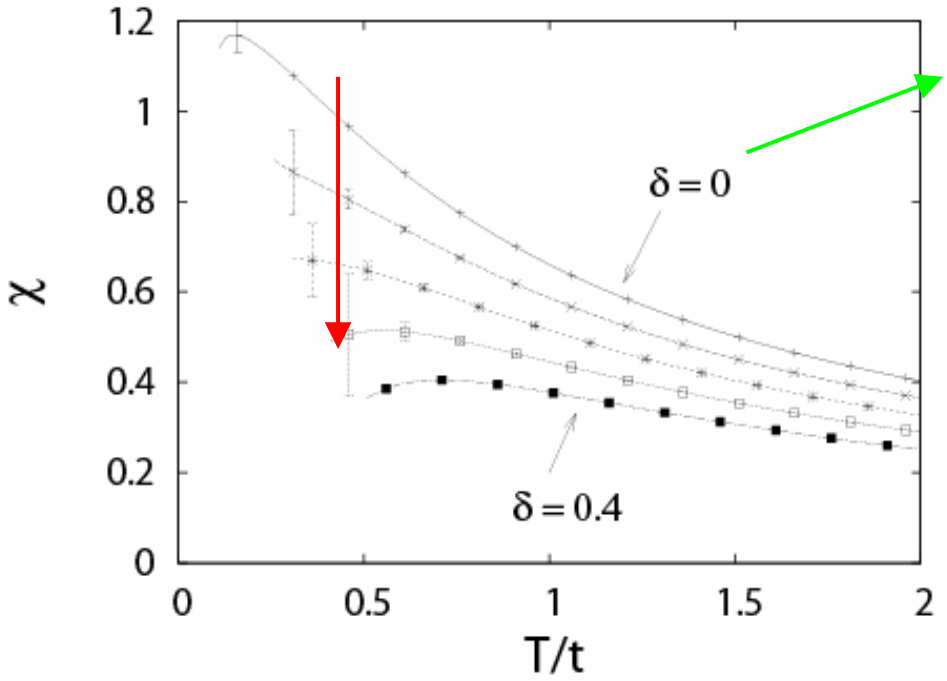


= mobile singlet bond = Cooper pair !

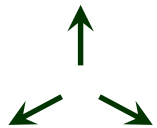
New-type of superconductivity

High Temperature expansion study for Triangular lattice

Koretsune-Ogata, PRL 89, 116401 (2002)



Heisenberg model (no carrier case)
Ground state will not be RVB state.
Instead 120 degree AF state
is realized.

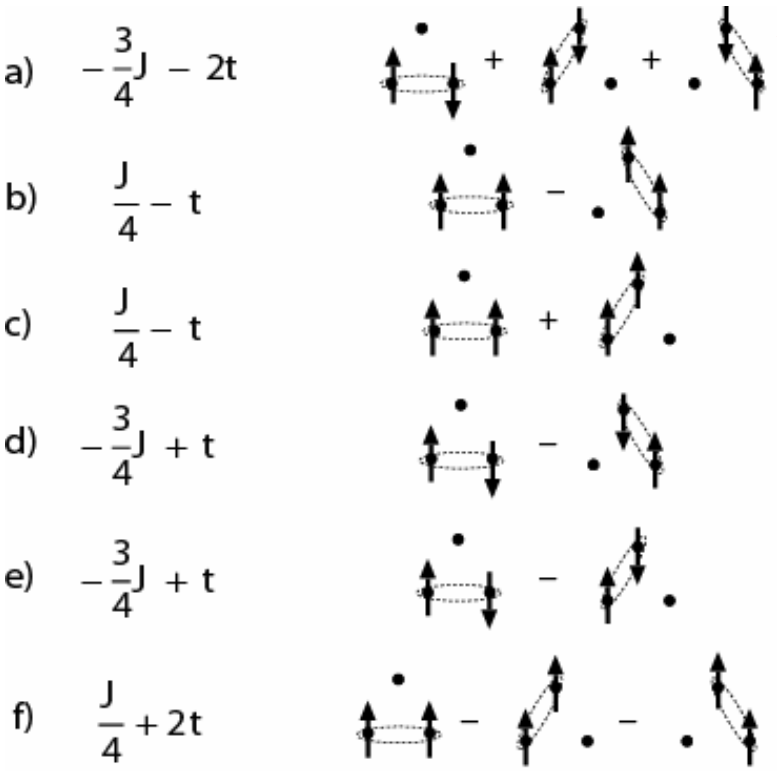


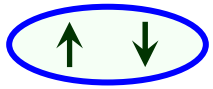
(ABC sublattice)

Carrier doping decreases χ .
(χ shows a spin-gap behavior) --- doping induced RVB state !

- Typical ground state configuration at $\delta = 1/3$

lowest-energy state





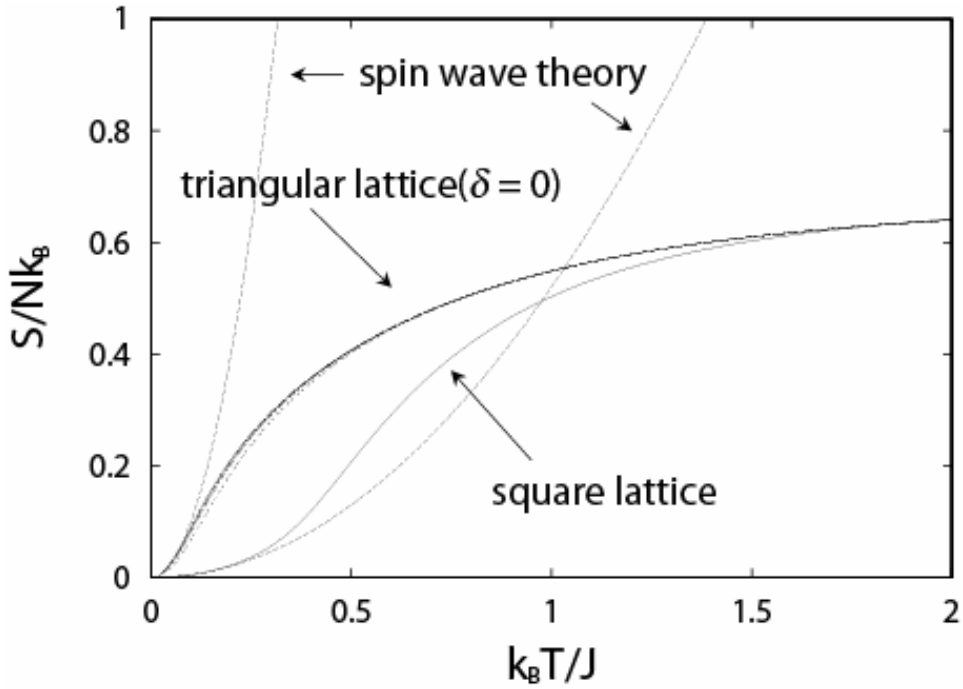
singlet bond = valence bond

Lowest-energy state is actually an RVB state.

Spin frustration is released by doping.

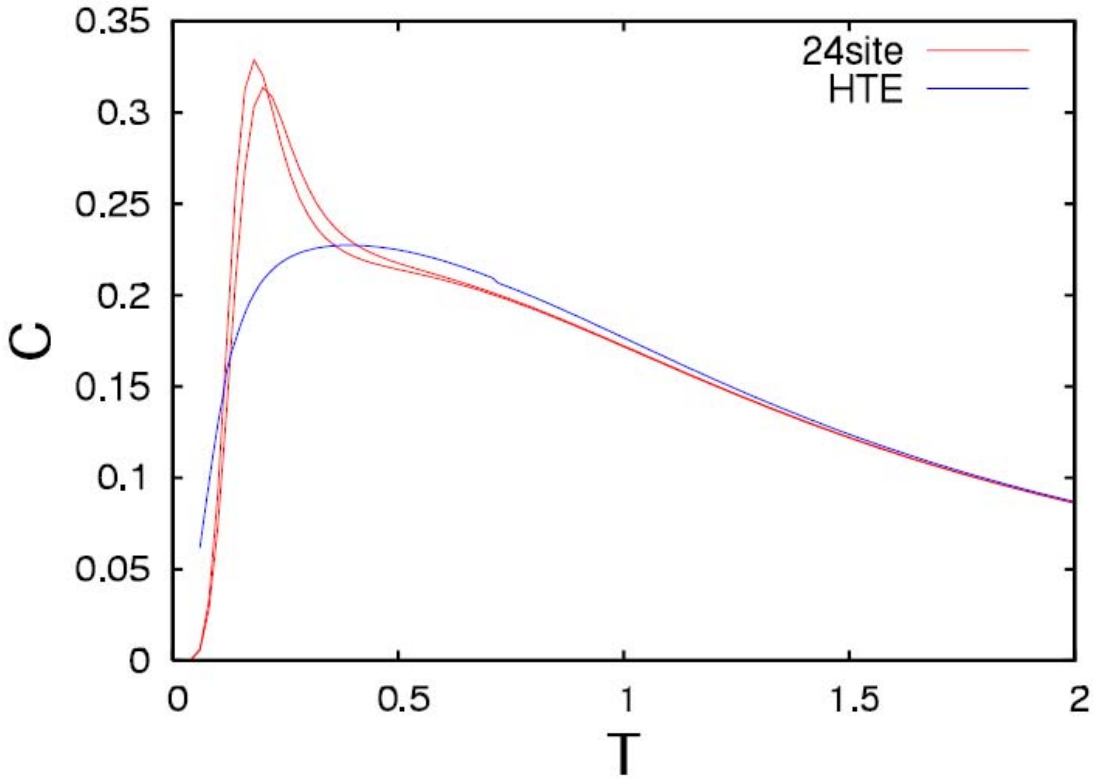
Entropy for Triangular lattice (Heisenberg model)

Koretsune-Ogata, PRL 89, 116401 (2002)



Specific heat for Triangular lattice (Heisenberg model)

T. Koretsune



High temperature expansion
vs.
Finite temperature Lanczos

Single peak i.e. No Spin-Charge separation …

To be studied

Specific heat (Super Clean)
Susceptibility
Possibility of spin-charge separataion
Dynamics of vacancies

New-type of superconductivity ?

Exact diagonalization,
High temperature expansion
Variational Monte Carlo