# Physical properties of weak-coupling quasiperiodic superconductors

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A superconductivity in quasicrystals has attracted considerable interests since the superconductivity in the system without translational symmetry is highly nontrivial. Recently, the first observation of bulk superconductivity in Al-Mg-Zn quasicrystal [1] was reported. These observations necessitate theoretical investigation of the emergent superconductivity in such a system.

We address the above issues in the attractive Hubbard model on the two-dimensional Penrose tiling. We studied a possible superconductivity emerging in the quasiperiodic system by means of real-space dynamical mean field theory (RDMFT) and Bogoliubov-de Genne (BdG) equation.

Our findings suggest that the emerging superconductivity is categorized into three different regions [2]. Especially, unconventional spatially extended Cooper pairs have been found in the weak-coupling region, which possibly consistent with the bulk superconductivity observed in Al-Mg-Zn quasicrystal. Furthermore, we calculate the physical properties which characterize this nontrivial weak-coupling superconductivity in the Penrose structure. We find that the jump of the specific heat is about 20% smaller than that obtained by the BCS theory, and is consistent with the experimental results obtained in the superconducting Al-Mg-Zn quasicrystalline alloy.

Furthermore, we calculate current-voltage characteristic and clarified that the convex down dependence appears in the Penrose structure whereas convex up dependence appears in the periodic system. These properties give us a clue to distinguish the weak-coupling superconductivity with extended Cooper pairs which are formed between the electrons with momenta $\mathbf{k}$ and $\mathbf{k}' \neq -\mathbf{k}$ from the BCS superconductivity [3].

[1] K. Kamiya, T. Takeuchi, N. Kabeya, N. Wada, T. Ishimasa, A. Ochiai, K. Deguchi, K. Imura, and N. K. Sato, Nature Communications **9**, (2018) 154.
[2] S. Sakai, N. Takemori, A. Koga, and R. Arita, Phys. Rev. B **95** (2017) 024509.
[3] N. Takemori, S. Sakai, and R. Arita, in preparation.

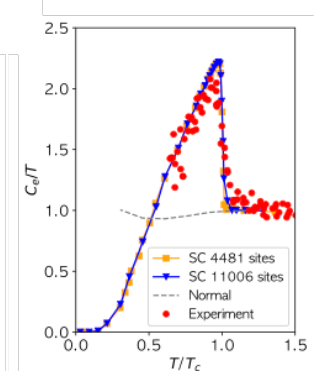


**Figure:** Temperature dependence of specific heat C/T obtained in the Penrose structure of 11006 sites and 4481 sites at quarter-filling for U=-3. We note that the specific heat is shown in the unit of $C_{en}/T_c$