Impurity bound-state as a prove of order-parameter symmetry in iron-pnictide superconductors

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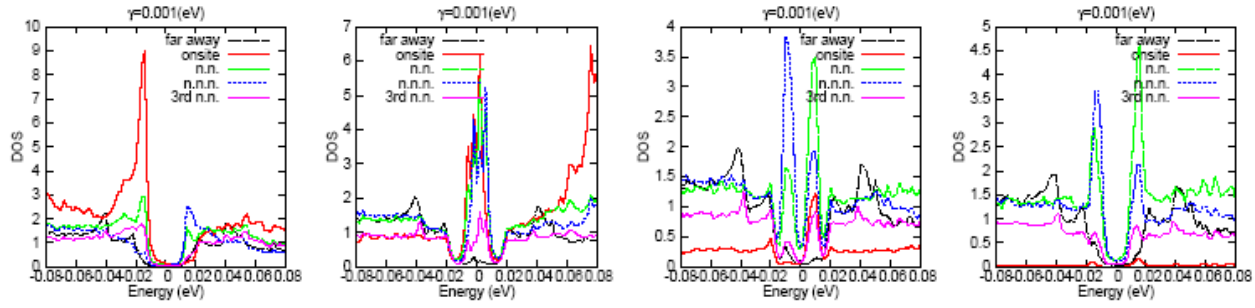
It has been clarified experimentally and theoretically that the superconducting gap functions in iron-based superconductors have a wide variety [1]. It seems that there are both materials with nodeless and nodal gap functions. Theoretically it has been pointed out that the gap function is very sensitive to the structure of its multiple Fermi surface [2]. In such situations, it is desirable to develop a systematic way to understand the material dependence and so on.

We proposed a simple way to parameterize the gap function in iron pnictides [3]. The key idea is to use orbital representation, not band representation, and to assume real-space short-range pairing. Although this parameterization is very simple, we find that it reproduces fairly well the structure of gap functions obtained in microscopic calculations. Furthermore, it naturally describes the differences of the gap function on each Fermi surface, as well as its anisotropy. Since the present method is simple enough, it is useful for obtaining an intuitive picture and for developing phenomenological theories. Using this method, we studied the temperature dependences of NMR $1/T_1$ [4], such as the coherence peak and T^n behavior below Tc.

In this talk, we discuss a single impurity problem by solving Bogoliubov-de Gennes equation in the five-orbital model constructed from the above analysis. We study the local density of states around a non-magnetic impurity and discuss the bound-state peak structures. These results can be used for distinguishing s+− and s++ superconducting states [5]. The figures below show the local density of states near the impurity for various values of impurity potential. A bound state with nearly zero-energy is found for the impurity potential I~1.0 eV, while the bound-state peaks stick to the gap edge in the unitary limit. Novel multiple-peak structure originated from the multi-orbital nature of the iron pnictides is also found, which is characteristic to the iron pnictides.



(a) $I = 0.5$ eV (b) $I = 1.0$ eV (c) $I = 2.0$ eV (d) $I = 8.0$ eV

Figure: Local density of states for various strength of the impurity potential [5].

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