NMR studies on La-Fe-As-O based high-$T_c$ superconductors


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In solid solution system of two superconductors LaFeAsO$_{0.9}F_{0.1}$ (~26 K) and LaFePO$_{0.9}F_{0.1}$ (~5 K), the $T_c$ of LaFeAs$_{1-x}$P$_x$(O$_{0.9}F_{0.1}$) increases up to 28K when $x=0.4$[1]. We have performed $^{31}$P-NMR study on LaFeAs$_{1-x}$P$_x$(O$_{0.9}F_{0.1}$) compounds, and revealed that the low-energy antiferromagnetic spin fluctuations (AFMSF) develop especially on $x=0.4$, while not on $x=0.8$. It suggests that the AFMSF are one of the key factors to increase the $T_c$ in LaFeAs$_{1-x}$P$_x$(O$_{1-y}F_y$) compounds. However, in La-based high-$T_c$ superconductor Y$_{0.95}$La$_{0.05}$FeAsO$_{1-y}$(Y$_{0.95}$La$_{0.05}$)1111 with $T_c=50$ K, the low-energy AFMSF does not exhibit a critical enhancement, but it develops moderately in the normal state [2], suggesting that the AFMSF are not only the factor to increase the $T_c$ in Fe-pnictide superconductors. Incorporating the theory based on band calculations, the high $T_c$ value in Y$_{0.95}$La$_{0.05}$1111 may attribute to the higher multiplicity of Fermi-surfaces than in other La1111 compounds with $T_c=28$ K [3]. We would like to discuss the origin of superconductivity through the relation between $T_c$ and other parameters such as local structure of Fe-As plane, Fermi surface topology, AFMSF, and so on.