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Title	Multichannel Kondo effect due to orbital dynamics of Cooper pair in unconventional superconductors(New Developments in Strongly Correlated Electron Systems)
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Citation	物性研究 (2001), 76(5): 698-698
Issue Date	2001-08-20
URL	http://hdl.handle.net/2433/97035
Right	
Type	Departmental Bulletin Paper
Textversion	publisher

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Multichannel Kondo effect due to orbital dynamics of Cooper pair in unconventional superconductors

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The Kondo effect in unconventional superconductors is studied theoretically by using the Wilson's numerical renormalization group method. For the unconventional superconductors, the angular momentum of Cooper pair plays an important role in the Kondo effect. It produces multichannel exchange couplings with a local spin. Here we focus on a $p_x + ip_y$-wave state which is a full gap system. We find that the ground state is always a spin doublet and the local spin cannot be quenched over all the $T_{\rm K}/\Delta$ region, where $T_{\rm K}$ and Δ are the Kondo temperature and the superconducting energy gap, respectively. This is different from the s-wave pairing case where the Kondo singlet is realized for large $T_{\rm K}/\Delta$ values. The strong coupling ($T_{\rm K}/\Delta \to \infty$) analysis shows that the orbital dynamics of the $p_x + ip_y$-wave Cooper pair destabilizes the Kondo singlet. On the other hand, the Kondo singlet is realized for a $d_{x^2-y^2}$-wave in the large $T_{\rm K}/\Delta$ region. As we argue in the $p_x + ip_y$-wave and $d_{x^2-y^2}$-wave cases, this type of multichannel Kondo effect reflects the symmetry of the conduction electron system.