# Coexistence of antiferromagnetism and superconductivity within $t$-$J$ model with strong correlations and in applied Zeeman field

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9.7 cm

The coexistence of antiferromagnetism with superconductivity is theoretically studied within the $t$-$J$ model with the Zeeman term included. The strong electron correlations are accounted for by means of the extended Gutzwiller projection method [1] within a statistically-consistent approach proposed recently [2]. The phase diagram on the band filling - magnetic field plane is obtained, and subsequently the system properties (magnetization curves, superconducting gaps, free-energy profiles) are analyzed for the band filling $n = 0.97$. In this regime the results resemble those observed recently in the heavy fermion systems $CeCo(In_{1-x}Cd_x)_5$ and $CeRhSi_3$. Namely, (a) with the increasing magnetic field the system evolves from AF+SC coexisting phase, through antiferromagnetic phase, towards normal state with nonzero spin polarization (ferromagnetic state); (b) the onset of superconducting order circumscribes antiferromagnetic magnetization. The superconducting gap has both singlet and staggered-triplet components, a consequence of its coexistence with antiferromagnetism. The work was supported by Ministry of Higher Education and Science, Grants Nos. N N202 173735 and N N202 128736.

[1] N. Fukushima, Phys. Rev. B **78**, 115105 (2008).
[2] J. Jędrak, JK., and JS., arXiv:1008.0021; J. Jędrak and JS., PRB **83**, 104512 (2011).

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