The influence of spin relaxation and locally strong spin exchange on magneto-spin effects in radical pairs in high magnetic fields

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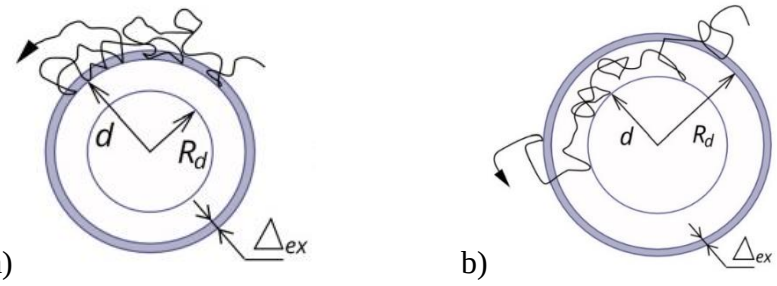
Based on the generalization of gyroscopic model description of electron spin evolution of radical pair available in the literature, recombination yield and stationary chemically induced electron spin polarization (CIDEP) in high magnetic fields are analytically investigated. General model includes into consideration arbitrary recombination (from singlet and triplet states), additional dephasing rates, arbitrary exchange interaction, and both transverse and longitudinal spin relaxation, and is valid for any model of the system. Using the Green function formalism, we formulated general approach to the calculation of recombination yield and stationary chemically induced electron spin polarization (CIDEP) in the case of spherically symmetric system and contact recombination. For this case, approximation for calculation of spin effect for locally strong exchange dephasing induced by non-local exchange interaction of radicals is developed. It has been shown that longitudinal spin relaxation essentially influences effective radius of dephasing induced by non-local exchange interaction of the radicals.



a) b)

Fig.1. Contribution of exchange interaction (filled area is exchange interaction "zone"). Δ_{ex} is exchange interaction layer thickness, d is distance of closest approach of radicals, R_d is dephasing radius, J is contact value of exchange interaction :

a) locally weak exchange interaction $\left(R_d \le d, \quad j_c = 2J\frac{\Delta_{ex}^2}{D} << 1 \right)$. Dephasing is due to re-contacts and can be integrally strong $\left(j_e = 2J\frac{\Delta_{ex} d}{D} > 1 \right)$;

b) locally strong exchange interaction $(R_d > d, \quad j_c \ge 1)$. Dephasing occurs on a single passage through the exchange interaction "zone".