We apply low-rank approximation of the dense matrix for solution of integral equations. This method allows to construct special approximations and performes multiplication of matrix of size $N \times N$ by vector of size N in $\mathcal{O}(N \log(N))$ or $\mathcal{O}(N)$ operations instead of original $\mathcal{O}(N^2)$. We apply iterative method (GMRES) for solution of system with big dense matrix, represented in low-rank format.
The matrix is ill-condition in the case of the great wavenumber, so we have to use preconditioner. We build the preconditioner from the noncompressed matrix block to decrease a number of iteration of GMRES method. The preconditioner is a sparse matrix. We exploit MUMPS package to solve the system with sparse matrix on high perfomance computers.

A Monte Carlo Evaluation of Current and Low Frequency Current Noise at Spin-Dependent Hopping in Magnetic Tunnel Junctions

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Single electron hopping between trap levels is the main transport mechanism in non-degenerate semiconductors. The hopping is conveniently simulated by a Monte Carlo method: The rate of an electron to escape from an occupied trap is given by the sum of all rates from the trap to empty traps. Thus, the current transport is represented as a set of the consecutive electron hops between the occupied and empty traps.
In the case of single electron hopping through a trap between a ferromagnetic source and drain the escape rate from the trap depends on the electron spin at the trap, which is determined by the spin-dependent source-to-trap and trap-to-drain rates. This prevents traditional Monte Carlo techniques from being used to evaluate the current.
However, if the trap-to-drain transition rate is determined from the transition matrix which couples the trap's spin and occupation relaxation, the transport process, like in the spin-independent case, is represented by a cyclic repetition of consecutive hops. The initial spin of an electron on the trap is defined by the source electrode spin polarization.
Peculiarities of the current at spin-dependent trap assisted hopping are investigated. It is shown, that, in contrast to spin-independent hopping, the low frequency current fluctuations are considerably enhanced due to the current blocking, when the spin of the electron on the trap is opposite to the drain magnetization, so it cannot escape to the drain. The obtained results are important for evaluating the role of oxide defects in magnetic tunnel junctions used in modern non-volatile magnetoresistive random access memory.

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