Exchange-assisted tunneling

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Synopsis Exchange interaction and correlations radically change behaviour of of a quantum particle in a classically forbidden region. Exchange produces a power-law decay instead of the usual exponential decrease of the wave function. Exchange-assisted tunneling enhances annihilation of positron with inner-shell electrons and produces other observable effects.

Exchange interaction strongly influences the long-range behavior of localized electron orbitals and quantum tunneling amplitudes. It produces a power-law decay instead of the usual exponential decrease at large distances. For inner orbitals inside molecules decay is $1/r^2$, for macroscopic systems $cos(k_F r)/r^\nu$, where k_F is the Fermi momentum and $\nu = 3$ for one-dimensional, $\nu = 3.5$ for two-dimensional, and $\nu = 4$ for three-dimensional crystals [1]. Correlation corrections do not change these conclusions [1, 2, 3]. Slow decay increases the exchange interaction between localized spins and the underbarrier tunneling amplitude. The underbarrier transmission coefficients in solids (e.g., for point contacts) become temperature dependent.

Exchange-assisted tunneling enhances annihilation of positron with inner-shell electrons [4].

References

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