Excitonic Representation for Quantum Hall Systems

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The Excitonic Representation (ER) allows to avoid problems related to the Landau level (LL) degeneracy peculiar to the basis states of the single-electron Hamiltonian (a clean case is considered). In the ER technique, a different basis is used [1-2]. This one, corresponding to exciton states, diagonalizes not only the single-electron part but also a considerable part of the Coulomb-interaction Hamiltonian. The excitonically diagonalizable terms may be extracted from the total Hamiltonian and considered in the ER as the unperturbed Hamiltonian while the rest may be, e.g, taken into account perturbatively. The exciton basis states, being characterized by two-dimensional momenta (which are natural quantum numbers due to the LL translational invariance), are non-degenerate. These states are created by exciton operators [1-3] acting on 'vacuum' describing the ground state. The exciton operators, being not of Bose or Fermi type, satisfy however certain commutation rules forming a Lie algebra. The ER technique at integer filling factors of the 2DEG in a perpendicular magnetic field leads to asymptotically exact results in 2DEG spectra calculations. (The calculations are performed in terms of expansion in the parameter $r_s = E_/\hbar\omega_c$ considered to be small; E_C is the characteristic e-e interaction energy, ω_c is the cyclotron frequency.) In this talk, application of the ER is presented (i) by the second-order calculation of the 'spin-flip' energy in the $\nu=2$ spin-unpolarized electronic system (where it is exactly the second order in r_s that yields the leading approximation in the experimentally relevant case of zeroth momentum) [1], and (ii) in the $\nu = 1$ case by calculation of the 'cyclotron spin-flip excitation' (CSFE) where a double-exciton component formed by coupled magnetoplasma and spin-wave excitons essentially participates contributing to the CSFE energy [4]. In the first case a considerable negative exchange shift relative to the cyclotron gap is established for the spin-flip state which under these conditions presents the lowest-energy excitation. This shift is independent of the magnetic field. In the second case the CSFE shift from the cyclotron gap is positive, being presented by a discrete line against the background of a continuous spectrum of free excitons. Comparison with available experiments is performed. Application of the ER to fractional Quantum Hall systems is discussed.

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