Condensed Matter Theory Center Seminar

Tuesday, April 14
11:00 am – 12:00 pm
2205 Toll Physics Building

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"Correlation Diagrams: an Intuitive Approach to Correlations in Quantum Hall Systems"

A trial wave function $\Psi(1,2,\ldots,N)$ of an N electron system can always be written as the product of an antisymmetric Fermion factor $F\{z_{ij}\}=\Pi_{i<j}z_{ij}$, and a symmetric correlation factor $G\{z_{ij}\}$. F results from Pauli principle, and G is caused by Coulomb interactions. One can represent G diagrammatically [1] by distributing N points on the circumference of a circle, and drawing appropriate lines representing correlation factors (cfs) z_{ij} between pairs. Here, of course, $z_{ij} = z_i - z_j$, and z_i is the complex coordinate of the i^{th} electron. Laughlin correlation for the $\nu=1/3$ filled incompressible quantum liquid (IQL) state contain two cfs connecting each pair i,j. For the Moore-Read state of the half-filled excited Landau level (LL), with $\nu=2+1/2$, the even value of N for the half-filled LL is partitioned into two subsets A and B, each containing N/2 electrons[2]. For any one partition {A,B} the contribution to G is given by $G_{AB}=\Pi_{i<j\varepsilon A}z^2_{ij}\Pi_{k<l\varepsilon B}z^2_{kl}$. The full G is equal to the symmetric sum of contributions G_{AB} over all possible partitions of N into two equal subsets. For Jain states at filling factor $\nu=p/q<1/2$, the value of the single particle angular momentum ℓ satisfies the equation $2\ell=\nu^{-1}N-c_\nu$, with $c_\nu = q+1-p$. The values of $(2\ell,N)$ define the function space of $G\{z_{ij}\}$, which must satisfy a number of conditions. For example, the highest power of any z_i cannot exceed $2\ell+1-N$. In addition, the value of the total angular momentum L of the lowest correlated state must satisfy the equation $L=(N/2)(2\ell+1-N)-K_G$, where K_G is the degree of the homogeneous polynomial generated by G. Knowing the values of L for IQL states (and for states containing a few quasielectrons or a few quasiholes) from Jain's mean field CF picture allows one to determine K_G. The dependence of the pair pseudopotential $V(L_2)$ on pair angular momentum L_2, suggests a small number of correlation diagrams for a given value of the total angular momentum L. Correlation diagrams and correlation functions for the Jain state at $\nu=2/5$ and for the Moore-Read stated will be presented as examples.

[1] J.J. Quinn, Waves in random and complex media (2014) 898867

[2] S.B. Mulay, J.J. Quinn, and M.A. Shattuck, submitted to J. Math. Phys. (2014)

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