Supersymmetric Quantum Hall Effect

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The content of this talk is based on Ref.[1].

Recently, it was discovered that the non-anticommutative (NAC) field theory is naturally realized on D-branes in R-R field or graviphoton background. (See[2] for instance.) Also, it has been shown that, in the supermatrix model, fluctuations on a fuzzy supersphere yield supersymmetric NC field theories [3]. Besides, some interesting relations between NAC geometry, Landau problem and QH systems are reported. Especially, on a fuzzy supersphere, a supersymmetric extension of QH liquid was explicitly constructed in Ref.[4]. While mathematical properties of NAC theories have been well investigated their emergent physical consequences have not been satisfactorily understood yet. The supersymmetric QH system provides a rare "physical" set-up whose underlying mathematics is given by NAC geometry. Since two dimensional and higher dimensional QH systems manifest peculiar properties of NC geometry, it would be reasonable to expect that explorations of supersymmetric QH liquids may reveal yet unknown physical aspects of the NAC geometry.

By taking a planer limit of the fuzzy supersphere, we constructed QH liquids on a NC superplane. Unlike ordinary supersymmetric quantum mechanics, the supersymmetry in the present quantum Hall liquid represents a real boson-fermion symmetry. The NAC fermionic coordinates are related to spin degrees of freedom, and bring the super-chiral property to the LLL. Since, on the NC superplane, the bosonic and the fermionic center-of-mass coordinates are decoupled, the Laughlin wavefunction and topological excitations have their superpartners unlike the QH liquid on the fuzzy supersphere. With use of the identification between the fermionic harmonic operators and the "spin"-1/2 ladder operators, supersymmetric QH systems are mapped to bilayer QH systems. The LLL in supersymmetric QH systems is regarded as the LLL in the symmetric layer state of bilayer QH systems.

References

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