A Relativistic Treatment of the Bose-fermi Transmutation in Second Quantized Theories I and II

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The purpose of these talks (I and II) is to explain the bose-fermi transmutation in a relativistic field theory. We studied a massive scalar field coupled to an abelian Chern-Simons gauge field. Our main result is an equality that the partition function of a massive scalar field coupled to the Chern-Simons field is identical with that of a free Dirac field. The equality indicates that the transmutation of the charged scalar field into the Dirac field has been proved within a frame work of a relativistic field theory. Differences from non-relativistic theories should be noted. Since fermions have half-odd-integer spin in relativistic theory, it is necessary to clarify how bosons can aquire the spin degrees of freedom. The self-energy of the charged scalar particle should be evaluated to understand this problem.

In part I, a random walk representation for charged scalar and free Dirac particles in three dimensions is explained. This method enables us to calculate the partition function of the bosons nonperturbatively and to describe the propagation of the fermions in terms of bosonic functional integral. Thus we can prove the equality of the transmutation. Although this method was first employed by Polyakov to investigate the propagators of the charged scalar and the Dirac particles, there have been a lot of unclear points in Polyakov's paper [1]. Therefore we justify and extend his method [2].

References

[1] A.M.Polyakov. Mod. Phys. Lett. **A3** (1988) 1541
[2] S.Iso, C.Itoi and H.Mukaida, Phys. Lett. **236**(1990) 287 and preprint UT-559, NUP-A-90-4, TIT/HEP-156 to appear in Nucl. Phys. B.

A Unified Description of Anyon Superconductivity and the Fractional Quantum Hall Effect

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By extracting effects of vortex excitations field-theoretically as Laughlin's quasi-particles or bound states of anyons, we derive a Landau-Ginzburg theory of the fractional