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TECHNICAL PROGRESS REPORT

for

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The Theory of High Energy Collision Processes

for the period

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DISCLAIMER

During the past year, we have made progress in the following directions:

1. Because of the unexpected progress on the two-dimensional Ising model a year ago [3], most of the recent effort has been spent on further understanding of this problem and especially its possible implications in high-energy physics. Work in this connection has progressed in several directions.

(a) When there is spontaneous symmetry breaking, the propagator is found to have no pole. Instead there is a branch cut. This may be interpreted as confinement.

(b) The asymptotic behavior of the n-point function, in the presence of spontaneous symmetry breaking, is different depending on whether the points are nearly collinear or not. This is closely related to, but may not be the same as, the Nambu string.

(c) Because of (a) and (b) above, it is speculated that there may be elementary particles with indeterminate mass. If quarks are identified as such indeterminate-mass particles, then it is understandable why previous methods of searching for quarks should fail. Possible alternative methods are being studied [11].

2. Another solvable model in two dimensions is the SU(N) Yang-Mills theory in the leading 1/N expansion. It is known that the existing solution is not gauge invariant. An alternative solution has been found, and this new solution [10] gives a branch cut in the fermion propagator, very similar to the case of the two-dimensional Ising model.

3. In collaboration with Professor Yang, some properties of the monopole harmonics have been found [8].

4. Martin Rocek has been making excellent progress on problems of supersymmetry. In particular, his work has been on the coupling of the massive, self-interacting scalar multiplet to supergravity [7] and on the Volkov-Akulov

model [13].

5. Recently, there has been better data from CERN ISR on high-energy proton-proton elastic scattering. Making use of this data, it is possible to improve significantly the parameters of the impact picture obtained on this Contract several years ago. The most important improvement is to consider simultaneously the proton form factors [15]. Once this improvement has been carried out, it is natural to associate the proton spin with internal rotation via the Chou-Yang theory. If the rotation is further assumed to give rise to the isoscalar magnetic moment, then, without introducing any new parameter at all, the polarization and rotation P and R for proton-proton scattering can be determined. In particular, the values of R show interesting oscillations in the dip region for incident proton energy above 200 GeV.

6. Barbara Epstein has been making excellent progress on her study of the Tokamak plasma. Some progress has also been made on the approach to Maxwellian distribution [4], [6], but serious difficulties have now been encountered.

Papers Published During the Last Year

1. Painlevé Functions of the Third Kind (B. M. McCoy, C. A. Tracy, and T. T. Wu), J. Math. Phys. 18, 1058 (1977).
2. Spin-Spin Correlation Functions for the Two-Dimensional Ising Model (B. M. McCoy, C. A. Tracy, and T. T. Wu), in Statistical Mechanics and Statistical Methods in Theory and Application, edited by U. Landman (Plenum, New York, 1977).
3. Two-Dimensional Ising Model as an Exactly Solvable Relativistic Quantum Field Theory: Explicit Formulas for n-Point Functions (B. M. McCoy, C. A. Tracy, and T. T. Wu), Phys. Rev. Lett. 38, 793 (1977).
4. Exact Solutions of the Boltzmann Equation (M. Krook and T. T. Wu), Phys. Fluids 20, 1589 (1977).
5. Connection Between the KdV Equation and the Two-Dimensional Ising Model (B. M. McCoy, C. A. Tracy, and T. T. Wu), Phys. Lett. 61A, 283 (1977).
6. Exact Solution of Boltzmann Equations for Multicomponent Systems (M. Krook and T. T. Wu), Phys. Rev. Lett. 38, 991 (1977).
7. Massive, Self-Interacting Scalar Multiplet Coupled to Supergravity (A. Das, M. Fischler, and M. Rocek), Phys. Lett. 69B, 186 (1977).
8. Some Properties of Monopole Harmonics (T. T. Wu and C. N. Yang), Phys. Rev. D 16, 1018 (1977).
9. Failure of Bartels' Scheme of Applying Reggeon Field Theory to a Spontaneously Broken Yang-Mills Theory (B. M. McCoy and T. T. Wu), Phys. Lett. 71B, 97 (1977).
10. Two-Dimensional Yang-Mills Theory in the Leading 1/N Expansion (T. T. Wu), Phys. Lett. 71B, 142 (1977).
11. Speculations on Quark Observation (B. M. McCoy and T. T. Wu), Phys. Lett. 72B, 219 (1977).