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A Renewal Proposal and Research Report

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MASTER

for Research in

THEORETICAL HIGH ENERGY PHYSICS

for the Period

October 1, 1975 - September 30, 1976

Submitted by

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May 1975

DISCLAIMER

Percentages of Time Devoted to Project by Investigators

October 1, 1974 - September 30, 1975

Name		% of Time	Period
Professors	N. H. Christ	100	3 summer months
		~12	academic year
	G. Feinberg	100	3 summer months
	H. M. Foley	100	1½ summer months
	T. D. Lee	100	3 summer months
	A. H. Mueller	100	3 summer months
		~17	academic year
	R. Serber	100	3 summer months
	G. C. Wick	100	3 summer months
Associate Professor	R. Friedberg	100	1 summer month
Assistant Professors	M.-Y. Chen	~ 7	academic year
	J. Finkelstein	100	3 summer months
		50	academic year
	E. Weinberg	100	2 summer months
		50	1 academic month
Research Associates	A. Guth	100	12 months
	J. Koplik	100	12 months

Note: During the academic year, the average teaching load for our faculty members is one course. A considerable amount of research (in addition to that specified above) is performed by the several investigators during those nine months.

Professor Chen and Dong-Liang Lin, a graduate student, have completed a study on the "Nuclear Matrix Element of Neutral Current in Muonic Atom Decays". The nuclear matrix elements of the parity-violating effects of neutral currents have been examined for ^{6}Li, ^{7}Li and ^{9}Be. The matrix elements are related to the magnetic scattering data. For ^{6}Li, for which such data are available, the calculated matrix elements contain the least uncertainty from nuclear structure. For ^{7}Li and ^{9}Be, for which data are unavailable, the j-j coupling model and the intermediate coupling model have been employed in computing the matrix elements. With these nuclear matrix elements, the calculated photon asymmetry parameters change by $\sim 40\%$ for ^{6}Li and $\sim 10\%$ for ^{7}Li and ^{9}Be from the simple estimates from the Schmidt model. These changes are unimportant for the qualitative studies at the present time. In the future, however, when the proposed experiments on parity-violating neutral current interactions in muonic atoms of nuclei with non-zero spin are successfully carried out, more accurate calculations of the nuclear matrix elements, such as those of this work, will become essential.

For his work in the near future, Professor Chen notes that the experiments on possible neutral current interactions in muonic atoms are in the feasibility testing stage for Li, Be and B. The theoretical work has been calculated only for the Li isotopes and Be. The calculation of nuclear matrix elements for ^{11}B is somewhat involved, as the p shell is just half-filled. In view of the experimental interest, it will be carried out, especially if the feasibility test proves to be successful.

Research Report | Professor Norman H. Christ

During the summer and fall of 1974 Professor Christ continued his attempts to find a generalization of Dirac's theory of magnetic monopoles to a non-abelian gauge theory, with positive results. It is possible to construct such a theory provided one extends the usual symmetry operations to include non-abelian transformations among the field strengths $F_{\mu\nu}$ and their duals $\tilde{F}_{\mu\nu}$. Such a symmetry group is necessarily non-compact which makes quantization of the theory difficult. Consequently his work to date has been limited to the classical theory. The conclusions have appeared in Physical Review Letters 34, 355 (1975). This winter and spring, Professor Christ temporarily left this subject and begin working, in collaboration with Professor Lee, on the problem of developing a quantum field theory expansion about soliton solutions to classical, non-linear field equations. Their method follows the usual canonical quantization and expresses the quantum mechanical problem as a power series in a coupling constant g. In contrast with the ordinary Dyson-Wick expansion, the leading term in their expansion is of order $1/g^2$ and is the W.K.B. approximation to the classical solution that they are attempting to quantize. They have applied the method to soluble one-dimensional field theories where its use appears quite straightforward and economical.

In the coming year Professor Christ intends to continue this work on soliton solutions, principally searching for more realistic classical solutions, perhaps approximating to some extent the properties of hadrons. In addition, he hopes to develop further the non-abelian theory of magnetic monopoles described earlier, studying the quantization of the theory with only vector particles and examining classical solutions to the field equations.

Research Report Professor Gerald Feinberg

1. Research from summer 1974 to the present:

a) Further work on the decay of muonic atoms as a test of neutral current interactions. A second paper was written with M. Y. Chen, discussing the effects of hyperfine structure on the various asymmetries that might be observed in the $2S_{\frac{1}{2}} \rightarrow 1S_{\frac{1}{2}} + 1\gamma$ decay in light muonic atoms. It is shown that because of these effects it should be possible to measure both the nuclear spin-dependent and nuclear spin-independent parity-violating nucleon-muon interactions.

b) A paper has been submitted for publication on the radiative decay modes of the recently discovered ψ mesons. It is suggested in this paper that for the ψ(3.1 GeV), such radiative decays may be the dominant decay mode.

c) A paper is in preparation with J. Sucher on the description of polarizability in quantum field theory. This work is relevant to energy levels of muons and other "exotic" atoms.

2. Research for the next year:

a) Professor Feinberg expects to continue work on radiative decays of ψ mesons, particularly on the magnetic dipole transitions between ψ(3.7) and ψ(3.1). The calculation of this decay is an application of techniques that he and Professor Sucher invented several years ago to test M1 decays in heliumlike atoms.

b) Professor Feinberg still plans to calculate the electric dipole moment of certain nuclei, that would be induced by an electric dipole moment for the individual nucleon.

Research Report　　　　Assistant Professor Jerome Finkelstein

During the past year Professor Finkelstein has been investigating the properties of the pomeron, the singularity which controls high energy diffractive scattering, in particular the question of why this singularity should exhibit factorization properties if it is not a simple pole. This work, reported in Physical Review D, involves developing techniques for calculating the amplitudes for high energy diffraction processes in a way which is independent of specific models. In the year ahead, Professor Finkelstein's investigations of the properties of the pomeron will continue, and he is attempting to understand the properties of multiparticle production processes that follow from some simple ideas about the pomeron.

Another topic which Professor Finkelstein has studied is the behavior of production processes at large values of transverse momenta. In collaboration with Professor K. Kajantie he has, in an article published in Nuclear Physics, proposed a scaling law for the distribution function of a large-transverse-momentum particle produced in association with several charged low-momentum particles.

Professor Finkelstein has also been attempting to understand the properties of the newly-discovered ψ particles, and of their interactions with other hadrons. In an investigation reported in preprint CO-2271-53, he pointed out that the assumption that the ψ is composed of charmed quarks, when taken together with the assumption of conventional dynamics of states produced in ψ-proton collisions, does not account for the value of the ψp total cross section. His attempts to understand the ψ particles are continuing.

Other questions on which Professor Finkelstein expects to work are the compatibility of the 'Reggeon calculus' of Gribov with unitarity, and the possibility of understanding the different energy dependencies of high energy elastic and non-elastic processes.

Research Report

Professor Henry M. Foley

Professor Foley's research is in the following two areas:

1. It has been known for a very long time that the magnetic fine structure of excited alkali atomic states with $\ell > 1$ is reversed in sign (or is almost vanishing), with respect to 'single electron' expectations, in almost all cases. This paradoxical property of these presumably very simple atomic states has never been explained. Recent experiments in nuclear hyperfine spectra have shown that similar reversals are found in the magnetic hyperfine interactions in these same states. It was conjectured here that both of these effects arise from the electrostatic exchange interaction with inner p shells which results in spin and orbital "polarization" of these shells. A recent calculation for Na 30 confirmed this conjecture. It is intended that a series of calculations of the nuclear hyperfine and the electronic spin orbit interactions will be carried out in collaboration with R. Sternheimer of Brookhaven National Laboratory.

2. The project previously reported, on the cascade mechanisms of the exotic atoms $p\text{-}\mu^-$, $p\text{-}\pi^-$, $p\text{-}K^-$, $p\text{-}\bar{p}$, etc. (with student David Chang) is nearly complete. They have proposed that in addition to the usual radiative and Auger processes, the inelastic transfer of internal energy of the negative 'mesic' particle to the translation of the heavy particles may be a significant process. This was borne out in detailed calculations, and the dependence of the cascade rate on the energy and on the mass of the negative particle has been determined. It seems that the proposed inelastic process is more significant and dominates the cascade for the heavier negative particles.

Professor Friedberg has been working in the following areas:

a) He has written, in collaboration with J.M. Luttinger, a paper describing a "large hole" result ("Density of Electronic Energy Levels in Disordered Systems"). The behavior of the density of electronic energy levels for a simple model of a disordered system is studied in the limit of very low energies. By reformulating the problem as one in Brownian motion, it proves possible to obtain the leading term and the first correction to it. The leading term is just the one already conjectured by E.M. Lifshitz. Professors Friedberg and Luttinger are now working on a refinement of the method that ought to overcome special difficulties arising in the application to a one-dimensional system.

b) Professor Friedberg (with D. Paul of the Engineering School) has written a paper on the coercive field for grain boundaries in anisotropic magnetic materials. By considering the variation of magnetic state through the domain wall, they find an approximate formula for coercive field that matches the order of magnitude of observed values over a very wide range. In particular, they show that the very high coercive field observed in certain highly anisotropic cobalt alloys may be the natural consequence of the narrowness of the domain wall, but that this does not require an abandonment of the "continuous" approach.

c) Professor Friedberg, together with Dr. R. Rosen, has studied the stability of a monochromatic wave passing through a medium with nonresonant losses and a pumped resonant line whose inhomogeneous width is much larger than the Rabi frequency.

They found the well-known steady-state to be unstable against pulsing, under even wider conditions than others have found for a narrow line. They are now looking for steady-state solutions for the case where the field is not monochromatic but noisy and broadened, with a view to investigating their stability as well.

In the year ahead, Dr. Friedberg and Dr. Rosen would like to prove that coherent pulsing (SIT-like solutions) can develop from a noisy broad-band field. This pertains particularly to astrophysical masers.

Research Report   Dr. Alan H. Guth

During the past year, Dr. Guth has been working with Davison E. Soper of Princeton University on the analysis of the short distance (i.e., large momentum) behavior of the Bethe-Salpeter wave function. They have analyzed the Bethe-Salpeter equation for two spin-1/2 quarks bound by the exchange of a vector meson in the ladder approximation. (Their method can trivially be modified to discuss the exchange of a scalar or pseudoscalar meson.) For this model, they have derived a rigorous asymptotic series for the large momentum behavior of the wave function.

In the year to come, Dr. Guth and Dr. Soper intend to continue the general line of research which they have begun. They are planning to extend the work in two directions.

First, they hope to extend the results beyond the ladder approximation. This approximation is apparently reasonable for a large class of theories (i.e., field theories which have an ultraviolet stable fixed point of the renormalization group at a non-zero value of the coupling constant), but they would like to determine how significant the corrections to this approxmation are likely to be. They would also like to extend the calculations to other types of theories for which the approximation is invalid (i.e., gauge theories and, in particular, asymptotically free theories).

Secondly, they intend to use these results concerning the Bethe-Salpeter wave function to derive results concerning quantities which are at least in principle measurable. They will start by analyzing the electromagnetic form factor of mesons, and will then look at meson-meson scattering.

Eventually, it is hoped that this general line of study will lead to a method by which one could extract from a given field theory the high energy behavior of processes involving bound states.

Research Report Dr. Joel Koplik

Dr. Koplik has been engaged on the following research projects:

1) Multiperipheral model of direct muon production (with G. Chu, LBL Berkeley): The production of direct lepton pairs in hadron collisions was proposed a few years ago as a test of parton models, but has proved an embarrassment in that detailed numerical calculations badly disagree with experiment. Stimulated by this discrepancy, and the fact that multiperipheral models are moderately successful in describing ordinary hadronic production, they have constructed a simple pion-exchange model for the direct lepton cross section. After adjusting the parameters of the model to agree with pion inclusive data, they find rather good numerical agreement with the available lepton data. In addition, they have made predictions for future experiments and derived some potentially useful theoretical cross section formulae, including a simple scaling law.

2) Regge theory and hadron-nucleus scattering (with A. Mueller): They have studied the consequences of the short-range correlation description of high energy hadronic interactions for hadron-nucleus scattering. Their main interest is to understand the following experimental facts within this framework: approximately "geometric" total cross sections, (relatively) low multiplicities of produced particles, and the existence of fast secondaries. Since a nucleus can be a large object on the normal hadronic length scale (the pion Compton wavelength) it has proven useful to examine both hadronic and nuclear scattering in space-time as well as in momentum space. The space-time description does lead to a qualitative understanding of the phenomena, and they are presently using momentum space methods to obtain more precise results.

In the year to come, Dr. Koplik plans to do the following:

1) Attempt to understand particle production processes in Reggeon field theory, with emphasis on the consequences of the latter at available energies and the relevance of asymptotic results. More generally, unitarity constraints on models of particle production in strong interactions.

2) Study high-transverse-momentum phenomena by attempting to extrapolate what is known about general features of low-transverse-momentum dynamics (e.g., space-time structure).

3) Study consistency of the properties of ψ, ψ', and other new particles with earlier beliefs and models (once better data is available).

During the period from Summer 1974 through Spring 1975, the research activities of Professor Lee have extended over the following areas of particle physics:

1. Abnormal nuclear states

The search for possible new superheavy elements, either stable or metastable, has always been one of the main purposes in investigating collisions between heavy ions at high energy. Recently, T. D. Lee and G. C. Wick have put forward some new theoretical speculations. Based on a fairly general theoretical argument [T. D. Lee and G. C. Wick, Phys. Rev. D9, 2291 (1974); T. D. Lee, Revs. Mod. Phys. 47, 267 (1975)], they arrived at a rather surprising conclusion: namely, under suitable conditions there may exist an extensive region of stable and metastable nuclei with nucleon number and charge varying from several hundreds to several thousands (or even higher). These nuclear states are of an entirely different nature from the familiar ones; therefore, they are called "abnormal nuclear states". Each nucleon in the abnormal state has zero rest mass, instead of the usual 940 MeV. Because of the kinetic energy of the nucleons and the potential energy of the meson field, the mass of the nucleus is, of course, not zero. The actual binding energy depends on certain physical parameters: the mass of the 0^+ resonance and its coupling constant. Neither is well determined at present. If one accepts their typical values used in the literature, then one obtains a binding energy of about 150 MeV per nucleon for the abnormal states. This is to be compared with the usual 16 MeV (bulk) binding energy per nucleon for the normal states.

The existence of the abnormal nuclear states is not sensitive to the details of the 0+ resonance. It only requires that there should be some 0+ resonance with strong interactions. From direct measurements of $\pi\pi$ phase shifts, one knows that there is at least one broad 0+ resonance at about 700 MeV. In the literature, there is also detailed analysis of nuclear forces which suggests the coupling of the 0+ resonance must be quite strong, comparable to that of the ρ-meson. In order to produce the abnormal nuclear state, one must have, over a fairly large volume (linear dimension about or greater than 10^{-12} cm), the nuclear density exceeding a certain critical value. If one takes the mass and the coupling constant of the 0+ resonance to be those given in the literature, then the critical density is about two times that in the normal nucleus.

To reach such a high density over a large volume, the most effective way is to collide two heavy nuclei at high energy, say uranium on uranium at about $\frac{1}{2}$ to 1 GeV per nucleon. The energy must be sufficiently high, at least in the few hundred MeV per nucleon range, so that the two nuclei can merge with a substantial increase in density. Yet, the collision energy must not be too high, not more than a few GeV per nucleon, so that the 940 MeV change in the nucleon rest mass can play an important dynamical role in the formation of the abnormal nuclear state. This energy range falls well within the capability of the proposed heavy ion accelerator at Berkeley. It is hoped that these experiments will be performed in the future.

2. Interaction of a dense fermion medium with a scalar meson field

The Lee-Wick analysis of the abnormal nuclear state is based on a quasi-classical treatment only, similar to that used in a Thomas-Fermi model for the atomic system. Questions naturally arise as to other effects not included in such a quasi-classical solution, especially those related to quantum fluctuations because of multi-loop diagrams. This problem is examined in great detail by Professor Lee and M. Margulies, his student. They examine the nature of the phase transition from the normal to the abnormal state and the problem of quantum fluctuation. Both the one- and two-loop diagrams are calculated. By developing a variational formalism involving only two-line irreducible diagrams, they derive a suitable high-density expansion for the energy. The quasi-classical solution emerges as the lowest order term in this expansion. Therefore, when the expansion is valid, the overall description of the transition given by the quasi-classical solution remains correct with the inclusion of quantum corrections. This work has been published in Physical Review D.

3. Quantum expansion of soliton solutions

The non-linear field equations which form the basis of quantum field theory have long been known to possess a rich array of solutions on the classical level, some of those classical solutions having rather remarkable particle-like properties. Recently, Professors Lee and Christ [preprint CO-2271-55] have succeeded in developing a general quantization procedure which permits the quantum mechanical interpretation of these classical solutions and the computation of quantum corrections to them. Furthermore, when the nonlinear coupling g is small, the Hamiltonian is $O(g^{-2})$ and its quantum eigenstate becomes of a W. K. B. form, giving a direct connection between the quantum description and the corresponding classical soliton solution, which can be in any dimension, either time-dependent or time-independent.

4. Besides the above-mentioned topics, Professor Lee is continuing his work on CP nonconservation and spontaneous symmetry breaking, questions related to vacuum excitation and vacuum stability, structure of new resonances, the possible existence of the intermediate boson and the heavy proton, further applications of field algebra, high energy neutrino reactions, scaling properties, and, above all, a possible unification of the electromagnetic, weak and strong interactions.

In the years to come, Professor Lee expects to continue working on basic problems in particle physics. These should include all the areas mentioned above, plus whatever new discoveries we may uncover in the near future.

[illegible] | [illegible] A. [illegible]

Since early last fall Dr. Joel Koplik and Professor Mueller have been studying the scattering of high energy particles off nuclei. Their model for the nucleus is that of N completely independent nucleons confined to a sphere of radius R. (Correlations are not expected to alter their description in any way.) Their main object is to decide which experimental quantities in hadron nucleus scattering follow directly from conventional strong interaction theory. In particular, taking the multiperipheral model as a guide to proton-proton scattering, they draw the following conclusions:

i) The usual Glauber expansion, and all expansions of proton-nucleus scattering in terms of proton-proton scattering that they are aware of, is inconsistent at very high energy. The amount of inconsistency grows with energy and in fact becomes a strong violation of unitarity.

ii) The coupling of a single Reggeon and of two or more Reggeons is given. The single Reggeon is not completely absorbed, as a Glauber model would indicate, and hence the remnants of the final states which occur in proton-proton scattering are clearly visible. Thus there should not be a great <u>qualitative</u> difference in proton-proton reactions and proton-nucleus reactions, at least for rapid secondaries.

iii) The simplest way to avoid the multiple counting of states which occurs in Glauber-type expansions is to use an on-shell coordinate space formalism which they have studied in some detail.

At the moment, Drs. Mueller and Koplik are looking at charge exchange reactions and in more detail at the differences between proton-proton and proton-nucleus reactions.

Research Report | Professor Robert Serber

Professor Serber, impressed by the work of Professors Lee and Wick on abnormal nuclear matter, had the idea of applying similar consideration to nuclear matter in its normal state. The result has been a nuclear model (for common garden-variety nuclei) whose main attractiveness is its simplicity, which permits all properties of the model to be calculated in detail. The principal forces between nuclei are supposed to be an attractive Yukawa potential, independent of spin and isospin, such as would be produced by a neutral scalar meson (σ-meson), and a repulsive core. A small exchange potential is permitted, which presumably represents the contribution of π-mesons. The model has four constants: the radius of the repulsive core, r_c; the σ-meson coupling constant, g, and mass μ (i.e. the range of the Yukawa force); and a constant λ_{ex} which gives the strength of the exchange force. The fit to nuclear properties is made as follows: g^2/μ^2 is determined to give the nuclear matter its observed density, r_c to give it the right compressibility, μ to give the right surface energy, and λ_c to give the right binding energy. The values found for the constants are not unreasonable: $r_c = 0.61$ f, $\mu = 735$ MeV, $g^2/4\pi = 6.37$, $\lambda_c = 7.4$ MeV. The most interesting feature of the model is its detailed prediction of nuclear properties such as the shape of the matter and charge densities. The latter is, in its main features, quite similar to that determined by the electron-nucleus scattering experiments of Hofstadter.

It is expected that further work with this model, and the writing of a paper to describe it, will occupy Professor Serber for some time to come.

Research Report — Assistant Professor Erick Weinberg

Professor Weinberg will take up his appointment at Columbia as of July 1st.

During the coming year he plans to continue working in his present field of interest, the use of semi-classical approximations in quantum field theory. Recently many have speculated that these methods may be useful in understanding composite states in quantum field theory; ultimately they may lead to a realistic description of the hadrons. In particular, he intends to work on the following problems:

1) In attempting to do perturbation theory about a classical solution in field theory one commonly encounters apparent infrared divergences arising from the existence of a family of classical solutions which differ only by spatial translation. Several methods have been suggested for eliminating this divergence, but he finds none completely satisfying.

2) One of the more interesting theories to have been studied is the sine-Gordon, which is exactly soluble at the classical level and which appears to remain a "perfect" system even at the quantum level. An interesting question is to what extent it is possible to modify such "perfect" theories and yet still use the special properties of the "perfect" system to develop a perturbative treatment.

3) Most research in this field has been oriented toward showing the existence of composite states. Professor Weinberg would like to investigate the interactions between such composite objects, using the semi-classical methods.

Research Report Professor Gian Carlo Wick

Professor Wick's work since his last report has been, in a certain sense, a continuation of the research connected with "Abonormal States of Nuclear Matter". The latter work was started by Professors Lee and Wick, originally as an investigation into the stability of abnormal states of the vacuum. The first paper on this subject left certain questions unsolved; one of them was the evaluation of "surface energy terms".

In order to study this question, it seemed most simple to study a one-dimensional situation, that is, one in which the basic scalar field depends only on one cartesian coordinate. The problem then becomes very similar to the various one-dimensional "soliton" models that have been studied by a number of authors.

Professor Wick spent a certain amount of time familiarizing himself with the "classical" results on solitons, and he has obtained some results that as far as he knows were not common knowledge. As an example, he showed that all the "conserved currents" of the "sine-Gordon" field equation that have been obtained by the "infinitesimal Bäcklund transformation" method are trivial, in the sense that the time component, or density, of each of these currents is a space derivative. The corresponding conserved quantity is, therefore, nothing more than a surface term, dependent merely on the number of solitons. He was able, however, to modify the Bäcklund transformation method in such a way as to obtain for it a non-trivial conserved quantity, which is the infinitesimal generator of a one-parameter group of transformations having some similarity to the Bäcklund transformation. The relation of this integral of the motion to the integrals obtained by Faddeev and others by the inverse scattering method is being studied. The possible application of such an integral to the quantization problem is also being investigated, together with a different method based on the study of Green's functions.

The Green's function method has been applied to soliton problems by Jackiw and Goldstone with modest success. In Professor Wick's opinion, their method should be modified at the very beginning. He is, however, still involved in sorting out the self-consistency conditions of the system of relations between the successive Green's function. He believes that if this problem can be solved, it may yield an important method in the study of extended objects in non-linear field theories.

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Publication List

1. C. K. Au and G. Feinberg, "Effects of Retardation of Electromagnetic Self-Energies of Atomic States", Phys. Rev. A9, 1794 (1974).

2. M. Y. Chen and G. Feinberg, "The $2S_{\frac{1}{2}} \to 1S_{\frac{1}{2}} + 1$ Photon Decay of Muonic Atoms and Parity Violating Neutral Current Interactions", Phys. Rev. D 10, 190 (1974).

3. N. H. Christ, "Theory of Magnetic Monopoles with Non-Abelian Gauge Symmetry", Phys. Rev. Letters 34, 355 (1975).

4. N. H. Christ and T. D. Lee, "Quantum Expansion of Soliton Solutions", to be published in Phys. Rev. D.

5. G. Feinberg and M. Y. Chen, "Hyperfine Effects in Parity-Violating Muonic-Atom Decays", Phys. Rev. D 10, 3789 (1974).

6. G. Feinberg, "Decays of Ψ Mesons", to be published in Phys. Rev. D.

7. J. Finkelstein, "Diffraction Scattering and Factorization below the Asymptotic Region", Phys. Rev. D 10, 3783 (1974).

8. J. Finkelstein and K. Kajantie, "Semi-Inclusive Scaling for Large p_T Events", Nucl. Phys. B85, 517 (1975).

9. J. Finkelstein, "An Analysis of the ψp Total Cross Section", to be published in Phys. Rev. D.

10. R. Friedberg, "Creation of Circular Polarization by a Twisted Birefringent Polarizing Medium", Phys. Rev. A 10, 21 (1974).

11. R. Friedberg, "Dual Trees and Resummation Theorems", J. Math. Phys. 16, 20 (1975).

12. R. Friedberg and D. I. Paul, "New Theory of Coercive Force of Ferromagnetic Materials", Phys. Rev. Lett. 34, 1234 (1975). Errata PRL 34, 1415 (1975)

13. R. Friedberg and J. M. Luttinger, "Density of Electronic Energy Levels in Disordered Systems", submitted to Phys. Rev. B.

14. A. H. Guth and D. E. Soper, "Short Distance Behavior of the Bethe-Salpeter Wave Function", submitted to Phys. Rev. D.

15. J. Koplik and G. Chu, "Multiperipheral Model of Direct Muon Production", to be published in Phys. Rev. D.

16. J. Koplik and G. Chu, "Direct Muon Production in a Multiperipheral Model", to be published in Phys. Letters B.

17. J. Koplik and J. W. Dash, "Energy Scales and Diffraction Scattering", submitted to Phys. Rev. D.

18. T. D. Lee, "Abnormal Nuclear States and Vacuum Excitations", a talk given at the Annual Bevatron Users Meeting, Berkeley, January 1974, Revs. Mod. Phys. 47, 267 (1975).

19. T. D. Lee and G. C. Wick, "Vacuum Stability and Vacuum Excitation in a Spin 0 Field Theory", Phys. Rev. D9, 2291 (1974).

20. T. D. Lee, "Spontaneous CP Nonconservation", a lecture delivered at the 1974 International School of Subnuclear Physics, Erice, to be published in the proceedings.

21. T. D. Lee, "Abnormal Nuclear States and Vacuum Excitations", a lecture delivered at the 1974 International School of Subnuclear Physics, Erice, to be published in the proceedings.

22. T. D. Lee, "A Possible New Form of Matter at High Density", a talk given at the BeV/Nucleon Workshop, Bear Mountain, November 30, 1974, to be published in the proceedings.

23. T. D. Lee and M. Margulies, "Interaction of a Dense Fermion Medium with a Scalar Meson Field", to be published in Phys. Rev. D.

24. D. L. Lin and M. Y. Chen, "Nuclear Matrix Element of Neutral Current in Muonic Atom Decays", submitted to Nuclear Physics.

25. D. L. Lin and G. Feinberg, "Radiative Corrections to Relativistic Magnetic Dipole Decays of Hydrogenlike Ions", Phys. Rev. A 10, 1425 (1974).

26. A. H. Mueller and J. Kogut, "On the Abramovskii, Kancheli, Gribov Reggeon Cutting Rules", submitted to Physics Letters.

27. G. Parisi, "Detailed Predictions for the P - N Structure Functions in Theories with Computable Large Momenta Behavior", Phys. Letters 50B, 367 (1974).

28. G. Parisi, "Quark Imprisonment and Vacuum Repulsion", Phys. Rev. D 11, 970 (1975).

29. G. Parisi, "Values of Fundamental Constants", Phys. Rev. D11, 909 (1975).

30. R. Rosen, "Slow Amplification of Infinitely Long Self-Induced Transparency Waves", to be published in Phys. Rev. A.

31. M. A. Ruderman and P. G. Sutherland, "Theory of Pulsars: Polar Gaps, Sparks, and Coherent Microwave Radiation", Ap. J. 196, 51 (1975).

32. A. Soni, "Signatures of Neutral Currents and Heavy Leptons in Weak Inelastic Processes", Phys. Rev. D11, 624 (1975).

33. W. Yueh, "Comments on Vacuum Polarizations and Non-Classical Monopole Theory", submitted to Phys. Rev.

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Silver, L., "Correlation Correction to Oscillator Strengths: the Lithium Isoelectronic Sequence", 1975

Soni, A., "Weak Inelastic Production and Leptonic Decays of Heavy Leptons", 1974

Yueh, W., "The Pair Production Processes and Final Stage Action", 1974