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14th INTERNATIONAL WORKSHOP ON CONDENSED MATTER THEORIES
(held at Marciana Marina, Isola d'Elba, Italy; 18-23 June 1990)

- sponsored by the European Research Office of the United States Army

[Final Report (Informal Workshop Proceedings) for the sponsor, in connection
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This report concerns the fourteenth of an approximately annual series of *International Workshops on Condensed Matter Theories*. The first of these meetings took place in 1977 in São Paulo, Brazil, and successive workshops have been held in Trieste, Italy (1978), Buenos Aires, Argentina (1979), Caracas, Venezuela (1980), Mexico City, Mexico (1981), St. Louis, USA (1982), Altenberg, Federal Republic of Germany (1983), Granada, Spain (1984), San Francisco, USA (1985), Argonne, USA (1986), Oulu, Finland (1987), Taxco, Mexico (1988), and Campos do Jordão, Brazil (1989). The present meeting was held on the island of Elba, Italy during the period 18-23 June, 1990, and used the facilities of the International Physics Center which is housed at Marciana Marina on the island.

The early history of this series of Workshops is strongly rooted in Latin America. Thus, the first meeting in 1977 was conceived as a Pan-American Workshop, and with the idea of bringing together scientists, primarily from North and South America, for the purpose of cross-fertilization of the ideas used in different areas of condensed matter physics, and to foster collaborations among the participants. After the St. Louis meeting in 1982 it was already clear that the Workshops had become truly international in scope and outlook, and this is the position they have retained ever since.

An important objective throughout has been to work against the ever-

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present trend for physics to fragment into increasingly narrow fields of specialization, between which communication is difficult. The Workshops have traditionally sought to emphasize the unity of physics. By bringing together scientists working in many different areas of condensed matter theory, for the dual purpose of promoting collaborations between them and encouraging the exchange of ideas between various disciplines, a common language has been exposed and developed. The International Advisory Committee has always believed that given a proper forum, scientists working in such diverse areas as band-structure calculations and neutron stars, and as density functional techniques and lattice gauge field theory, can still come together, understand each others' research and borrow ideas from one area to another. In these days of specialization, this is an uncommon thing, but we believe that it is important for the cross-fertilization of different fields and for the overall understanding of the physical world around us.

There is no doubt that, once again, the meeting this year in Elba has met, and even extended, all of the above traditions and expectations. The Workshop attracted (approximately) 46 participants, all of whom had been invited personally. A detailed list of the participants is appended to this report. By nationality they represented fourteen different countries, including 11 from North America, 6 from Latin America, 25 from Europe (of whom 11 were from the host country, Italy), and 4 from elsewhere. In common with its predecessors, this Workshop has successfully fostered truly international collaborations between scientists divided not only by interdisciplinary barriers but also by geographical boundaries.

The detail schedule which lists the authors and titles of the 37



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invited papers given at the *14th International Workshop on Condensed Matter Theories* is appended to the end of this report. The written versions of the talks will comprise the formal conference proceedings, which will be published by Plenum Press as Volume 6 of the series "Condensed Matter Theories". Four copies of the published volume will be supplied after its publication next year. In the meantime, I take this opportunity to highlight some of the specific papers given and other aspects of the present meeting which were especially noteworthy.

The first point to make in this regard is that the overall quality of the talks was exceptionally high, even by the standards of this series of Workshops which has a record of excellence in this regard. Indeed, it becomes almost invidious to single out particular papers for specific mention. Secondly, in keeping with the previous aims and spirit of the series as outlined above, the individual papers all belonged to condensed matter theory interpreted broadly. Most of the talks dealt either with such methods as Jastrow variational approaches and the method of correlated basis functions, coupled cluster theory, Green function techniques and parquet theory, density functional methods, quantum molecular dynamics, and quantum Monte Carlo methods, or with such physical systems as quantum fluids, finite nuclei and nuclear matter, highly correlated electronic systems, and superfluid or superconducting systems. However, some of the papers also dealt with subjects and/or techniques that, while nonstandard in the traditional subject groupings of condensed matter physics, certainly served to open up new perspectives on related problems or systems in the more standard areas. Several examples are given below.

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The first session on Monday morning dealt broadly with nuclear systems, ranging from traditional nuclear matter to quantum chromodynamics (QCD) and subnucleonic degrees of freedom. Particularly noteworthy were the talks of Krotscheck and Migdal. In the former case, an extremely lucid discussion of the spin correlations in nuclear matter was given, and it was demonstrated how these could now for the first time be calculated very accurately using techniques developed and honed for use with liquid helium. Professor Migdal (Moscow) is one of the fathers of modern microscopic nuclear theory. He was the first to use and extend to finite atomic nuclei Landau's ideas and techniques of Fermi liquid theory. He gave a particularly fascinating account of how this early work had now been extended in energy scale to deal with the comparable subnucleonic degrees of freedom inherent in hadronic structure. The session on Monday afternoon continued with the appearance of many of the same ideas and techniques being applied to superfluid ^4He and other bosonic systems. Noteworthy here were the clear formal advances that have been made over the last few years which now enable us to address microscopically the detailed behaviour of structure functions, critical phenomena, and inhomogeneous as well as homogeneous systems.

The two sessions on Tuesday dealt loosely with the extensions of existing microscopic methods of quantum many-body theory to novel situations. Particularly interesting in this regard were the description of an application of a recently developed microscopic method to the study of critical phenomena near phase transitions, and the two applications of known techniques to quantum lattice models. In the first case, Ciftan reported on an extension of an earlier quantum molecular dynamics (QMD) type of approach

which he and Brown had successfully used within the field of quantum optics, where the emergent collective phenomena are much more commonly modelled by (one-body) nonlinear field theories. Secondly, the two most powerful and most universal formulations of quantum many-body theory that exist, namely coupled cluster theory and the method of correlated basis functions (CBF), were applied by Bishop and Ristig separately to low-dimensional quantum spin systems and to the U(1) lattice gauge treatment of quantum electrodynamics (QED). Considerable interest and excitement was engendered by all three of these papers, with regard to future applications. On the same day, Silver gave a nice talk on the application of quantum Monte Carlo (QMC) techniques to the Anderson model, with the incorporation of maximum entropy ideas which are more commonly used in the field of image-enhancement. Finally, Tao gave a lucid description of the intriguing subject of electric-field-induced solidification, in which he pointed out possible technological applications of this phenomenon.

In the Wednesday morning session, both the formal and practical aspects of density functional theory shared place with some newly emerging fields. Campbell gave a beautiful talk on the so-called shape spectroscopy of fluids in which he emphasised the evolution of CBF ideas. Also noteworthy were the talks on diffusion in an important class of modern materials, namely superionic conductors, and on a diagrammatic perturbation-theory approach to the dielectric response of a broad class of composite materials which include many examples of technological interest.

Most of the talks in the two sessions on Thursday were concerned with various aspects of high-temperature superconductivity. These included a

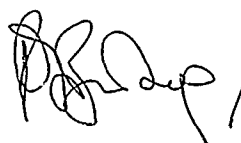
cluster approach based on the Gutzwiller ansatz; an electron-hole two-component liquid model developed by the group in Oulu, Finland; a correlated lattice fermion formalism based on an expansion about the infinite-dimensional limit; and various exactly or partially soluble models based on abnormal occupation of the electronic states or on abnormal mean-field situations. One striking aspect of most of these (and many of the earlier) talks was that it is clearly now becoming possible to apply the known methods of quantum many-body theory, which have already been well tested on the traditional strongly-interacting condensed matter systems, to the novel situations in strongly-correlated electronic systems. In this way we should soon be able to bypass the need continually to invent increasingly simplified versions of the best available model interaction Hamiltonians, and new specialized approximations.

The above perceived trend was also reinforced by most of the talks in both sessions on Friday, which again demonstrated the power of such many-body techniques as the coupled cluster method (CCM) and density-functional theory (DFT) to such fields as few-body systems (e.g. the light atomic nuclei, ^3H and ^4He), complex nuclei, and atoms in strong magnetic fields. In all of these cases, what have already become well known in traditional condensed matter theory as the most powerful and most universal microscopic techniques, were now also seen to be at least as accurate as the much more restricted techniques which have been especially developed for use in the above specific areas, but which have no wider applicability.

In conclusion, most of the speakers admirably stressed the wider

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perspectives of their particular applications or methodology. Both the talks presented and the ensuing discussions have enabled the community to make future projections and plans. These concern both the numerical and theoretical techniques which have recently been developed in QMD, QMC, and DFT, and such older very powerful and very general formulations of quantum many-body theory as the CCM and CBF theory. The intention had been to determine their applicability to still wider cross-disciplinary and nonstandard fields. The results on all fronts presented look very positive and encouraging for the future vitality of this important field. In this report, I wish to close by expressing the gratitude of all of the participants to the Local Organizing Committee, and for the excellent facilities of the Elba International Physics Center. I express my personal thanks to the European Research Office of the United States Army for the support which enabled the meeting to be the undoubted success that it was.

 / 20 July 1990

PROFESSOR RAYMOND F. BISHOP
(Principal Investigator)

XIV WORKSHOP ON CONDENSED MATTER THEORIES

Elba International Physics Center (EIPC)

Marciana Marina, Livorno, Italy

18 - 23 June, 1990

Program

Monday, 18

Chairman: R. Guardiola

9.00

opening

9.10

chairman: R. Guardiola

A. Migdal (Academy of Science, Moscow)

"The Physics of QCD and Hadron structure"

10.00

A. Green (Helsinki University)

"Meson-Meson Scattering as a Many-Body Problem"

10.40

J. Dabrowski (Warsaw University)

"On Narrow Σ -Hypernuclear States with Positive Energy"

11.20-11.40

coffee-break

11.40

E. Krotscheck (Texas A&M University)

"Spin Correlation in Nuclear Matter"

12.20

A. Polls (Barcelona University)

"Spectral function of Nuclear Matter (?)"

17.00-17.30

coffee

17.30

chairman: Percus

L. Reatto (Milan University)

"Critical Phenomena in 4-He"

18.20

S. Stringari (Trento University)

"Sum Rules and the Spectral Function of Superfluid 4-He"

19.00

R. Smith (Texas A&M University)

"Inhomogeneous boson systems made planar"

Tuesday, 19

9.00	chairman: J. Clark E. Bashkin (Academy of Science, Moscow) "Collective Spin Waves in maxwellian e-plasma"
9.40	M. Ciftan (Duke University) "Microscopic Methods in the Study of Critical Phenomena"
10.20	R. Bishop (UMIST, Manchester) "Quantum Spin Chains: A coupled Cluster Approach"
11.00-11.30	coffee-break
11.30	M.L. Ristig (Koln University) "The U (1) ₁ lattice gauge vacuum"
12.10	H. Glyde (Alberta University) "Single Particle and Collective Dynamics of Fermi Liquids using self consistent Green functions"
17.00-17.30	coffee
17.30	chairman: R. Bishop R.N. Silver (LANL, Los Alamos) "Universal Spectral Function and Transport Coefficients of Anderson Model: GMC and Maximum Entropy Study"
18.10	J.P. Rino (Sao Carlos University) "Bragg Intensities and Diffuse Scattering on Ag ₂ Se: A Molecular Study"
18.50	R. Tao (Carbondale University) "Electric Field Induced Solidification"

Wednesday, 20

9.00

chairman: M. Dellano

M. Kobayashi (Niigata University)

"Diffusion Process in Superionic Conductors"

9.40

E.V. Ludena (IVIC, Caracas)

"Non-Born-Oppenheimer Functional Theory in
the Context of Local-Scaling Transformations"

10.20

B. Malik (Carbondale University)

"Energy Density Formalism in Alpha-Nucleus
Interaction"

11.00-11.30

coffee-break

11.30

C. Campbell (Minnesota University)

"Shape Spectroscopy and Dynamics of Fluids"

12.20

R.G. Barrera (UNAM, Mexico)

"New Diagrammatic Summation for the
Dielectric Response of Composites"

afternoon free

Thursday, 21

Chairman A. Plastino

9.00 P. Fazekas (Koln University)
"Cluster Gutzwiller Approximation"
9.40 A. Kallio (Oulu University)
"Electron-Hole Liquid Model for High-TC
Superconductivity"
10.20 R. Cenni (Genoa University)
"Many body functional technique: the
longitudinal response in Nuclear Matter"

11.00-11.30 coffee-break

Chairman M. Ciftan

11.30 A. Migdal (Academy of Sciences, Moscow)
"Some historical remarks about many-body
theories"
12.10 P. Van Dongen (Technische Hochschule Aachen)
"Correlated Lattice Fermions in High
Dimensions"

17.00-17.30 coffee

17.30 A. Plastino (La Plata University)
"High-TC Superconductivity in exactly
Solvable Models"
18.20 M. De Llano (North Dakota State University)
"Abnormally Occupied Electronic States and
TF-Scaled High-TC Superconductivity"
19.10 J.N. Piradashvili (Tbilisi)
"Magnetic Properties and Energy Spectrum of
Semiclassical Emery Model"

Friday, 22

Chairman C. Campbell

9.00	J.W. Clark (Washington University) "Artificial Neural Networks that learn Many-Body Physics"
9.50	F.V.Kusmartsev (Landau Institute) "Flux Quantization on a Lattice"
10.30	S. Fantoni (Lecce University) "From Nuclear matter to complex nuclei"
11.00-11.30	coffee-break
11.30	M. Cambiaggio (CNEA, Buenos Aires) "Time Dependent Hartree-Bose-Bogoliubov Description of a Two-Level Bosonic Model"
12.10	A. Proto (CNEA, Buenos Aires)
17.00-17.30	coffee
	Chairman B. Malik
17.30	J. Percus (New York University) "Tests of density functional approximation for an atom in intense magnetic field"
18.10	S. Rosati (Pisa University) "Correlated hyperspherical harmonics for boson and light Fermi systems"
18.50	M. Flynn (Valencia University) "Coupled Cluster Theory and Light Nuclear Systems"
19.30	Closure

List of Participants 14th International Workshop on Unified Field Theories, EPR, CMB, etc.

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