中央研究院物理研究所年報

ANNUAL REPORT OF THE INSTITUTE OF PHYSICS ACADEMIA SINICA

VOLUME 22

JULY 1994

INSTITUTE OF PHYSICS, ACADEMIA SINICA

TAIPEI, TAIWAN, REPUBLIC OF CHINA

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第二十二卷

中央研究院物理研究所印行

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II

Review of Research Projects

HYDRODYNAMICS AND ATMOSPHERIC PHYSICS GROUP

The members in our group are actively involved in both academic and applied researches related to the physics of fluid. On the academic side, we have concentrated on the basic phenomenon of fluids. These phenomena include turbulence, flow instabilities and pattern formation in fluids, hydrodynamics of complex fluids, flow in porous medium. On the applied side, research projects are being conducted in environmental fluid mechanics, physics of the atmosphere, development of numerical scheme for computational fluid mechanics, and instrumentation in measurement of fluid. Followings are descriptions of selected ongoing research projects conducted by our group members.

I. REVIEW OF RESEARCH ACTIVITIES

A. FUNDAMENTAL PROBLEMS OF HYDRODYNAMICS

1. *Tubulence Modeling* - We are interested in the prediction of complex turbulent shear flows. We have been developing a Reynolds stress model with a cross diffusion k in the ε equation based on the more physical assumption that small turbulence eddies can be anisotropic. Our model can improve the predictability without tunning the model constants. Recently, we calculated the backward facing step flows by the LRRA of turbulence model with two-layer concept and obtained well predicted results. In the numerical solution of the time-averaged momentum equations, the Reynolds stresses are treated partially as diffusion and partially as source terms to avoid numerical instability. We are also developing an computational code for solving flow over obstacles and around river mouth with complex geometry boundaries in body-fitted coordinate system. The application of turbulence model in the real engineering environment will be conducted in the future.

2. *Physics of Compressible Flow* - We are interested in compressible flow where the characteristics of the shock wave-boundary layer interaction are of fundamental importance. The newly developed numerical schemes, such as multiple grid, adaptive grid, TVD and ENO are applied to obtain better resolution of the physical variables and geometry configurations. The scheme is incorporated in investigating hypersonic flow over blunt bodies. In order to simulate the real physical phenomena, real gas effects and chemical reaction are considered in the model.

B. APPLICATIONS OF HYDRODYNAMICS

1. *Fluid Dynamics of Filtration* - In order to understand the fluid dynamics due to fiber non-uniformity and poly-dispersity in filtration, we have set up a model to estimate the pressure drop and the efficiency of a real fiber filter. In this study, finite element method is utilized to calculate the pressure, the flow and the particle concentration field near fibers. PIV system is utilized to meausre the flow field and the particle movements near fibers. We find that effects of fiber non-uniformity is more obvious

at small packing density. In other words, high packing density reduces the effects of fiber non-uniformity. In the future we are going to improve our model by choosing more effective parameters for describing the fiber non-uniformity and poly-dispersity. On the experimental side, we are improving our PIV measurement system so that the three dimensional effects of flow field can be clarified.

2. *Ocean Pollutions Study* - In the coastal and oceanic environment pollutions study, we are trying to analyze and investigate the in-situ measurement data of the sewage ocean outfall. The in-situ physical measuerment parameters are the temperature and salinity, and the bio-optical measurement parameters are light beam attenuation coefficient and chlorophyll-a fluorescence. By analyzing these physical and bio-optical data, we try to identify different constituents of the sewage effluent at the ocean outfall site. The Los Angeles ocean outfall in-situ measurement data collected on August, 1988 was used as our sample data. The analysis procedures and results are helpful for monitoring coastal and ocean environments.

3. *Particle Velocimetry* - In a separate project, we are trying to develop particle imaging techniques for measuring the flow field in unsteady flows and slow-motion flows. An automatic analysis system is under development to extract the flow field from pictures containing light scattering seed particles within the flow. The accuracy and the performance of this technique will be investigated in various unsteady situations.

C. ATMOSPHERIC PHYSICS

In the area of atmospheric studies, we tried to determine the sufrace albedo in Taiwan area from satellite data. The atmospheric masking effects are unavoidable for satellite data. Using a radiative transfer model in a scattering atmosphere developed in the previous years, we constructed a linear relationship between the surface albedo and the planetary albedo observed by the NOAA satellites. We are able to determine the surface albedo and to get a more clear imagery than before. In this way, the atmosptheric masking effects and the energy budget of the earth-atmosphere system can be understood more easily.

D. PHYSICS OF FLUID INTERFACES AND FILMS

1. *Critical Phenomena in Liquid-Liquid Interface* - Phase separated binary liquid mixture is one of the complex fluids investigated in our group. The interface between the two phases was observed using a laser scanning reflectometer developed by one of our group member. With this technique, convection driven deformation of the interface has been observed with high angular magnification. By keeping the binary mixture closed to its critical point at which both the density difference and the surface tension are vanishingly small, new phenomena at the interface have been observed. Furthermore, we have also performed phase separation in this liquid-liquid interface.

2. *Growth of Dark Films in Soap Film* - Experiments are performed on freely standing surfactant (soap) liquid films to study the formation and growth of common dark film using an optical microscope. We find that althought there is no interface between the dark film and the bulk of the film, there seems to be a well defined line tension (surface tension) between them. The growth law of the dark film which is in the form of a disk is found to be linear in time. Also, during the growth of the dark film, patterns similar to a sun-flower can be observed at the rim of the growing dark film. At present, we are setting up models to understand the linear time dependence in terms of the hydrodynamics, intermolecular forces and the electrostatic forces of the bilayer formed at either interface of the liquid films. It would be most interesting if one can define a line tension between the dark film and the thick film.

3. *Bursting of Liquid Films* - Bursting of a freely standing liquid film (soap film) is a very fast process (of the order of millisecond) and provides very useful information on the dynamic properties of the film and surfactants. In this project, we carry out experiments to study the hydrodynamics of the bursting of liquid films by using a video lines-canning cammera which can provide information of the bursting process every 40 microsecond. This is a big improvement over past published experiments where still pictures of the bursting process of different liquid films were taken at preset time to give the dynamical information. Preliminary results of our experiments show that we are able to measure the time dependence of the shock wave procduced by the bursting process. Futhermore, different types of liquid films are being used including, simple fluid, binary mixtures and polymer solutions.

E. FLOW IN POROUS MEDIA

1. *Slip-Stick Dynamics* - Two phase flow within porous medium has been studied for a long time due to its importance in industrial processes. Usually the porous medium are three dimensional (such as glass beads packing) and observation within the medium is difficult. By filling water in the gap between two parallel ground glasses, we can study the effects of the randomly oriented glass surface on the dynamics of a driven air-water interface. A semi-automatic video imaging system has been developed to acquire and analysis the recorded images of the air-water interface when it moves within the glass plates. The experimental results are interpreted in the framework of self-organized criticality.

2. *Phase Separation in Prous Medium* - Understanding of the behaviour of binary liquid mixture in porous medium is very important in oil extraction industry. When super heated water is pumped into the well to push the crude oil out, mixing and phase separation of these two fluids will take place. It is the purpose of this study to investigate the phase separation behaviour of binary liquid mixture inside a porous medium. To observe the dynamics of the fluid within the opague medium, we employ the technique of diffusive wave spectroscopy in which the autocorrelation of the scattered light is extracted and analysed. Our preliminary results shows that the phase

separation temperature of the binary mixture within the glass bead packing is shifted away from that of the bulk if the size of the glass bead is small enough. To confirm our findings we plan to measure the conductivity of the binary liquid mixture in the porous medium at the same time.

F. PATTERN FORMATIONS

1. *Electroconvection in Liquid Crystals* - Experiments are performed to study the pattern formations in the electroconvections of nematic (MBBA) and smectic (8CB) liquid crystals. In the case of nematic liquid crystals, the convection is a three dimensional (3D) flow while that in a smetic film is two dimensional (2D). In the case of the 3D convection we find that a brain-like structure can be observed during the relaxation of the liquid crystal after the voltage applied is suddenly removed. Very little is known about this brain-like structure. Presumably, this is due the ordering of the nematics by the boundary conditions of the wall. For the 2D convection in a smectic film, we discovered a new type of flow pattern in which the the direction of convection is reversed every cycle when the separation between the electrodes is small. However, when the separation between the electrodes is large, a fingering-like instability is observed. Model simulations are being carried out to explain the above observations. The 3D convection experiments are works of the collaboration with Prof. W. I. Goldburg of University of Pittsburg, USA.

2. *Instability of a Suspension* - It is well known that Taylor vortices can be observed in the annulus of rotating cyliners with different rotational speeds. In this experiments, a similar situation is produced by the sudden deceleration of the rotational speed of a cylinder filled with a suspension of small particles. During the deceleration, the fluid at the rim of the cylinder will be slowed down first because of the effect of the boundary and therefore creating a situation similar to a Taylor-Couette instability. In fact, we find that, for decelerations exceeding some critical values, variations of suspension concentrations in the form of a periodic structure along the axis of the rotating cylinder similar to the Taylor vortices can be observed. Theoretical model is now being developed to explain our exerimental observations. This project is carried in collaboration with Prof. J. R. Chu of the National Central University.

II. FACILITIES

A. ENVIRONMENTAL WIND TUNNEL LABORATORY

In the environmental wind tunnel laboratory, studies of turbulent flow are carried out in an open suction type wind tunnel with a $3 \times 2.2 \times 18.5\ m^3$ test section. Flow field information within the test section are collected by hot wire and hot film anemometer systems. However, this laboratory will be out service for a period of two to three years because of the construction of a new building of the Institute at the same location.

B. WATER CHANNEL LABORATORY

The water channel is used to study the hydrodynamic phenomena of flow with wind on the free surface. The channel has a cross section of 60cm × 60cm and 8m long. Flow can be realised by a towing track mounted on the channel or by a wave generator which circulates the fluid using a closed loop type pumping system. Currently, the channel is used to study the effect of surface wind on the stratified flow in the channel. Important measurement means include hot wire, hot film and salinity gauge. Recently a particle imaging velocimetry system is developed to study the flow in a qualitative manner.

C. OPTICAL HYDRODYNAMIC LABORATORY

In the optical hydrodynamic laboratory, the physical scale of the apparatus is much smaller that those in the other two laboratories. Most of the experiments in this laboratory are related to the studies of basic phenomena in complex fluids and nonlinear phenomena in hydrodynamic systems. Instrumentations in this laboratory are mainly designed and built by our researchers. A partial list of these setups includes: programmable temperature controlled water and air baths, video image acquisition and processing systems, static and dynamic light scattering systems and liquid-liquid interface shape reflectometer. Recently, the laboratory has finished setting a laser doppler velocimetry system and a fast photon counting system for the future work on scaling properties of turbulence and complex fluids.

D. COMPUTATION FACILITIES

The group originally maintained a computational room consisting of PCs and SUN4 workstations for performing numerical works. In 1992, this room and its facilities had become part of the computing facilities of the Institute. Now, numerical works in computational fluid dynamics and simulations, are performed by the computers maintained in our institute. The machines used most frequently are the IBM RISC/6000 and the SUN SPARC workstations.

III. FUTURE OUTLOOK

In the future our group would like to recruit new members to enhance the ongoing researches. At the same time, the members are encouraged to response to stimulus from other research communities to keep pace with new developments occuring in other parts of the world. On the other hand, we notice that the academic research environment in Taiwan has come to a stage in which team efforts can be more fruitful than individual works. Based on this idea, we are planning to initiate close collaborations among the members of our group as well as those outside. We hope that by gathering expertise from different fields (or even different disciplines) we can attack specific problems in different perspectives so that a complete understanding of the problems can be condensed.

NUCLEAR PHYSICS GROUP

Presently our group consists of nine staff members (five research fellows, two associate research fellows and two assistant research fellows), conducting research works covering certain fields of both experimental and theoretical nuclear physics. In recent years one of our group members has spent a great deal of time in developing the experimental high-energy physics program for the Institute. The size of the group in 1993-94 is the same as in 1992-93.

Among our research staffs six are experimentalists and three theoreticians. The experimental nuclear physics programs are focused on the accelerator- based physics and are conducted at the accelerator laboratory of the Institute. The accelerator laboratory is equipped with a 3 MV 9SDH-2 pelletron accelerator installed in the middle of 1989, it is capable of producing light and heavy ion beams in the MeV range for a variety of research purposes. During the calendar year 1993 the accelerator has run 2900 hours. A fraction of the machine time was allocated to users from local universities such as National Tsinghua University and National Taiwan University.

The accelerator system is now equipped with six beamlines used for experiments, including the one which was set up in 1993 in a position 45° from the switching magnet with a scattering chamber and detection system designed for off-beam gamma-spectroscopy and radiative capture experiment. Other facilities of the laboratory include a micro Vax II computer and networks, including a fast electronic system for data acquisition (with fast NIM modules and CAMAC modules). In addition to the micro Vax II computer, our computing facilities for experiments also include two work stations, a VaxStation 3100/76 and a VaxStation 3100/34. These two stations are mainly used for the data relay and off-line analyses. For theoretical calculations, we have access to the SUN4 and IBM/RISC/6000 work stations located in the computer room of the Institute.

The efforts of the theoretical nuclear physics research members were devoted to the investigations of the medium energy physics and nuclear properties. Some specific topics are: nuclear many-body problems, neutrino and double beta decays, dark matter and its scattering from nuclei, quark models and heavy quark symmetry.

The following overview is not intended as a summary of all the work done in the period of 1993-94; instead it describes briefly some selected research projects completed in this time period.

I. EXPERIMENTAL NUCLEAR PHYSICS AND ACCELERATOR-BASED PHYSICS

These works were performed in the accelerator laboratory here, concentrating mainly on low energy nuclear reactions, light-and heavy-ion impact ionization, and particle induced x-ray emission (PIXE).

1. Investigation of low-lying excited states of ^{63,65}Cu using ^{7}Li-ion induced Coulomb excitation

An experiment of ^{7}Li-ion and thick Cu target collisions has been performed in the incident energy range 4.9 to 11.9 MeV. Gamma rays following the collisions have been measured. The results showed that the first excited state of ^{7}Li (478 keV, $1/2^-$) and several low-lying states of ^{63}Cu and ^{65}Cu were populated. Analysis of the energy dependence of the yields of these states indicates that the 478 keV state of ^{7}Li and most of the Cu low-lying states were populated via Coulomb excitation. By using the well known B(E2; g.s. $3/2^-$ to 478 keV, $1/2^-$) of ^{7}Li nucleus and the Coulomb excitation cross sections, we obtained the transition probabilities for several low-lying states of ^{63,65}Cu.

2. Light and heavy ion impact ionization

Inelastic collisions of charged projectiles with atoms produce inner-shell vacancies through the process of Coulomb ionization to the continuum of the target atoms or by electron capture into unoccupied projectile state. In recent years, there has been a great deal of interest in the ionization of inner-shell atoms by charged particles bombardment. To test the various theoretical predictions and to examine the dependence of ionization processes on energy and target, there is a continuing need for accurate measurements of cross section induced by many different ions. We made a detailed measurement of the K and L x-rays production cross sections induced by light-ions at certain energy range for a wide range of elements, and compared the results with the predictions of the current theories.

(a) Lithium-7 ion induced K x-ray production cross sections of Ti, Cu, Se and Ag in the energy range 3.0-10.0 MeV

Emission of characteristic K x-rays and elastic scattering particles induced by ^{7}Li ions impacted on Ti, Cu, Se and Ag (Z=22-47) were measured at energies 3.0-10.0 MeV in steps of 0.7 MeV. Experimental K x-ray production cross sections and the K_β/K_α intensity ratios were obtained. The measured cross sections for these four elements show a rapid decrease as the atomic number Z increases from 22 to 47. The results are compared with the predictions of the first-order Born approximation, the ECPSSR theory and the $1s\sigma$ molecular-orbital theory (MO). It was found that the ECPSSR and MO theories give better predictions to the data in the energy range involved. Agreement between the ECPSSR and MO theories and the experiment is reasonably good, except that for Ag the ECPSSR and MO theories seem to mildly underestimates the data at lower energies.

(b) Atomic K shell ionization by 3.0-15 MeV oxygen ions for selected elements between Ti and In

The K-shell x-ray elastic particles induced by 3.0-15 MeV oxygen ions were measured simultaneously for selected elements between Ti and In (in the atomic number range Z=22-49). Experimental K x-ray production cross sections as a function of projectile energy in this energy interval in steps of 0.6 MeV are reported. Results of the measurement are compared with the predictions of the first Born, the ECPSSR and the MO ionization theories. The first Born and the ECPSSR theories give about the same trends for the energy dependence of cross sections. However, the first Born approximation overestimates the experimental data by about a factor of 20 throughout the investigated energy range. The ECPSSR prediction shows a better agreement with the experiment, except at lower energies, where the MO theory matches the data slightly closer.

(c) L-subshell x-ray production cross sections of selected elements between Z=57 and Z=71 for 1-5 MeV proton impact

L-subshell x-rays of the elements La, Nd, Gd, Er and Lu were measured for proton bombardment in the energy range 1-5 MeV. From observed data we extracted the individual L-subshell production cross section σ_{Lx} and their ratios. The measurements are compared to the prediction of the first Born and the ECPSSR (energy-loss and Coulomb deflection effects, perturbed stationary state approximation with relativistic correction) theories. In general, the measured cross sections σ_{Lx} compare favorably to the ECPSSR theroy.

(d) Light-ion-impact ionization for atoms

Light-ion-impact ionizations were investigated for the atomic K-shell on target elements with Z=27-29 for incident protons, deuterons, ^{3}He- and ^{4}He- ions. X-ray production cross sections σ_x were measured as a function of incident energies 0.7-1.5 MeV/amu in steps of 0.1 MeV/amu. Systematic behavior of excitation functions and cross-section ratios $\sigma_x(1)/\sigma_x(2)$ measured with two types of projectiles of z=1-2 ions at same MeV/amu were observed. Current theories for direct Coulomb ionization and electron capture are discussed. Two theoretical calculations of the first Born approximation (PWBA+OBKN) and the ECPSSR theories were performed. The results obtained from the experimental data and the theoretical calculations are compared and discussed.

(e) Shape studies of ELC and ECC cusps

The velocity spectrum of electrons ejected in the forward direction in energetic ion-atom collisions exhibits a cusp-shaped peak when the emerging electron velocity matches that of the outgoing projectile ion velocity in both speed and direction. The three well known mechanisms giving rise to this phenomena are (1) the target-electron capture to the continuum states of projectiles (ECC); (2) the electron of projectile's loss to its own continuum state (ELC); and (3) the capture of one target electron into a bound state and capture of another target electron into the continuum states of the

projectile which is known as transfer ionization (TI). For the first two cases, we made a review of recent experimental results for the shape of cusp electron peaks, which reflect the dynamics of the collision processes. In the most recent experiments, we found that the ECC peak is symmetric, while the ELC is asymmetric. This seems to be consistent with the previous results of Knudsen et al. and Hsu et al. when the projectile energy dependence of their multipole parameters β_1 and β_2 is taken into account.

3. Particle induced X-ray emission (PIXE)

Proton induced x-ray emission is well known to be a powerful tool for multi-element and non-destructive elemental analysis for a variety of samples. We have successfully developed the external-beam PIXE technique and applied it to the determination of the elemental composition of ancient Chinese bronze artifacts, including a series of Ching Dynasty coins (AD 1644-1911). The x-ray emission measurements for the samples bombarded with 3 MeV protons from the 9SDH-2 pelletron accelerator were carried out with use of a 30 mm × 5 mm Ge(Li) detector. The data are analyzed with use of GUPIX software package. Variations of composition for more of 25 samples covering a time period of about three hundred years were examined. The contents of major and minor elements (Cu, Zn, Pb, Sn, Sb, Fe, Ni and As) were determined.

4. A CAMAC based event-by-event data acquisition system for low energy nuclear studies

An event-by-event nuclear data acquisition system has been setup at the Institute and used for low-energy nuclear experimental studies. This system includes Fast NIM modules, CAMAC modules, a Microprogramable Branch Driver (MBD), a LAMPF Trigger module and a microVax II computer with magnetic tape unit. As for the software, the LAMPF developed Q-system was used for acquisition and replay. An application on ^{110}Cd gamma-spectroscopy studies was made and results on the level structure were obtained.

5. International research collaboration

(a) With the Cyclotron and Radioisotope Center(CYRIC) at Tohoku University, Sendai, Japan

For years members of our group have performed experiments at CYRIC using their 35 MeV cyclotron to study the charge exchange (p,n) reactions and single-proton transfer (d,n) reactions. In 1993, we continued the collaboration and a study of the proton single-particle states was made through the (d,n) reaction on ^{20,22}Ne at E_d=25 MeV. Angular distributions of the emitted neutrons leading to final states of up to E_x=15 MeV were measured. Spectroscopic informatiion has been obtained from an analysis using the adiabatic deuteron breakup approximation, where s-wave deuteron breakup effects are included. Proton unbound transitions were analyzed by means of Vincent and Fortune's method. It was found that the observed proton single-particle states

in ^{21,23}Na exhausted almost all the strength for the 2s1d shell model calculations. The distributions of the 2s1d strength were reasonably reproduced by recent 2s1d shell model calculations. The occupation probabilities and single-particle energies of the proton orbits near Fermi levels in the ground states of ^{20,22}Ne were deduced in a framework of combined analysis of the stripping and pickup data on the same target nucleus.

(b) With Fermi National Accelerator Laboratory, USA, for high-energy physics experiments

We joined the Fermilab E789 experiment in 1989. This was a three-year collaborative project supported by the National Science Council. The objective of E789 is to study the rare two-body decay modes of B- and D-mesons. Observation of such decays could provide the first definitive experimental evidence on the coupling between bottom-quark and top-quark as well as the possibility of observing CP-violation in B meson decays.

E789 received its first allotment of beam time in May, 1990. This was a low-intensity test run at low-mass spectrometer setting optimized for charm study. Several hundreds $D \to K\pi$ decay has been measured. No $D \to \mu^+\mu^-$ was observed. The upper limit of $BR(D \to \mu^+\mu^-)7.2 \times 10^{-6}$ at 90% confidence is obtained. E789 began its second run in August, 1991. The run ended in January, 1992. Two different settings of the spectrometer, which separately optimize the acceptance for charm or beauty decays, were used in this run. Over 4000 $D \to K\pi$ events were observed from the charm data. The integrated cross section for neutral D-meson production by extrapolating the measured differential cross section to all x_F is $21.7 \pm 4.4 \mu b$ per nucleon. No nuclear dependence is found.

Beauty sensitivity is provided in the modes $B \to J/\Psi + X$ and B$\to$ dihadrons. More than 6000 $J/\Psi \to e^+e^-$ events were reconstructed. The prompt J/Ψ production cross section measured in 800 GeV pN collision is $410 \pm 133nb$ which is consistent with the previous measurement. Out of the 6000 J/Ψ events, four of them survived the vertex cut. It is believed that they originated from the $B \to J/\Psi + X$ decay. The preliminary result of the B meson production cross section obtained in this measurement is $11 \pm 6nb$.

II. THEORETICAL NUCLEAR PHYSICS

1. Two-neutrino double beta decay of ^{48}Ca

We have performed quasiparticle random phase approximation (QRPA) calculations for the $2\nu\beta\beta$ decay matrix element $M^{2\nu}_{GT}$ of ^{48}Ca using realistic effective interactions derived form the Paris, Bonn, and Reid potentials. Unlike earlier QRPA calculations where the BCS self-energies were suppressed, we have retained these self-energies together with the use of the single-particle levels provided by a ^{40}Ca core. Different choices for the single-particle levels are employed, and their effects on $M^{2\nu}_{GT}$ are compared. A majority of our calculated $M^{2\nu}_{GT}$ matrix elements are in good agreement with the experimental bounds of $\mid M^{2\nu}_{GT} \mid < 0.05$ MeV $^{-1}$, and exhibit good stability with respect to the variation of the particle-particle interaction strength g_{pp}.

2. Proton-antiproton scattering and quark-diquark structure

An unsymmetrized nucleon wave function obtained by adding the possible quark-diquark structure to the usual spatially symmetric wave function is used to calculate the elastic proton-antiproton multiple scattering amplitudes. Numerical computation is made on the double scattering term. Results show that the amplitude from the unsymmetrized wave function is larger in absolute magnitude than that from the symmetric one. The difference becomes more visible as the momentum transfer increases. This feature is briefly discussed.

3. Green's function methods in nuclear many-body problems

We present an elementary and fairly detailed review of several Green's function methods for treating nuclear and other many-body systems. We first treat the single-patricle Green's function, by way of which some details concerning linked diagram expansion, rules for evaluating Green's function diagrams and solution of the Dyson's integral equation for Green's function are exhibited. The particle-particle hole-hole(pphh) Green's function is then considered, and a specific time-blocking technique is discussed. This technique enables us to have a one-frequency Dyson's equation for the pphh and other Green's functions, thus considerably facilitating their calculation. A third type of Green's function considered is the particle-hole Green's function. RPA and high order RPA are treated, along with examples for setting up particle-hole RPA equations. A general method for deriving a model-space Dyson's equation for Green's functions is discussed. We also discuss a method for determining the Green's function transition amplitudes based on its vertex function. Some applications of Green's function methods to nuclear structure and recent deep inelastic lepton-nucleus scatterings are addressed.

4. Heavy quark symmetry

In the limit of infinite heavy quark mass, the strong interactions of a heavy quark become much simplified. Namely, the heavy quark sector of the effective QCD Lagrangian becomes independent of the flavors and spins of the heavy quarks. For N_f heavy quark flavors, the new spin and flavor symmetries combine to form a $SU(2N_f)$ symmetry group (heavy quark symmetry) which has been applied extensively to the study of heavy quark physics in recent years.

On the other hand, it is well known that the light quark sector of the QCD Lagrangian obeys an approximate $SU(3)_L \times SU(3)_R$ chiral symmetry, which is spontaneously broken, resulting in the existence of the eight "massless" pseudoscalar Goldstone bosons (π, K, and η). Consequently, to study the interactions of heavy hadrons

with low energy Goldstone bosons requires a synthesis of the heavy quark and chiral symmetries.

Earlier, we have developed a framework which describs low energy interactions of heavy hadrons with Goldstone bosons. In the past year, we systematically studied the $1/M_Q$ and SU(3) symmetry breaking corrections to the chiral dynamics of heavy hadrons. Such studies are necessary for a more complete understanding of low energy heavy quark dynamics.

Furthermore, we also studied the radiative weak decays of heavy hadrons. We took the effective Lagrangian approach, and carefully calculated the QCD corrections involved. Among other things, it was found that the decay asymmetry for SU(3) antitriplet to antitriplet baryons is fixed by heavy quark symmetry. This project is still in progress.

5. Correlated finite temperature mean field approximations

A correlated finite temperature mean field approximation is compared with the exact canonical, the conventional finite temperature Hartree-Fock and canonical finite temperature Hartree-Fock approximations in ^{20}Ne. The thermal behavior obtained in the correlated approach with a realistic effective interaction differs substantially from that given by mean field calculations. There are no sharp transitions and the system remains deformed at temperatures above the critical temperature of the deformed-to-spherical shape transition observed in the mean field calculations in agreement with the exact canonical results. This suggests rather strongly that using collective deformation parameters obtained from finite temperature mean field calculations as order parameters to descride the universal features of the nuclear shape transition may be misleading.

6. Evidence for nuclear halos

The radius of ^{11}Li determined semi-classically from an optical model analysis or from Glauber theory disagree with that obtained from a microscopic calculation of the rms radius even when the microscopically determined densities are used in the determination of the elastic scattering or reaction cross sections. The extracted interaction radii are consistently larger than the calculated rms radius.

7. An estimate of center of mass effects in quark potential medels

The correction to the mass for the spurious center of mass motion in a 3-quark system is calculated exactly in the non-relativistic constituent quark model for the Cornell potential. The result is somewhat higher than MIT bag model estimates but similar to that of a soliton bag model and a relativistic oscillator model.

SOLID STATE AND BIOPHYSICS GROUP

The main research areas of our research activities are surface physics, superconductivity, Raman and infrared spectra physics, magnetism, magnetism, thermodynamic and biophysics etc. During the last few years, a significant progress has been made. Current research projects focus on some of the fundamental problems of surface physics, solid state physics, as well as material sciences. The following summary is not intended to cover all the work done in this group; instead it describes briefly only some of our recent researches in this area.

SOLID STATE PHYSICS:

1. Surface physics:

Our research efforts focus on basic physics of solid surfaces and thin films. The surface physics laboratory is currently equipped with general surface science analytical instruments having the following spectroscopic techniques: ESCA, UPS, LEED, AES, HREELS etc., and microscopic techniques: STM, AFM, FIM and Atom-Probe FIM. The thin film laboratory has a microwave plasma chemical vapor deposition system and a mini MBE system. In addition, we have an active theoretical program in surface physics. Recent works accomplished and research projects in progress are summarized below.

a. Diffusion behaviors Ni and Re on the Ir(100) surface

The temperature-dependent diffusion behavior of thermally evaporated Ni atoms on the Ir(100) surface has been studied by low energy ion scattering spectrometry (LEIS). Ni adatoms are observed to exchange with the surface Ir atoms in the nonreconstructed (1×1) phase upon heating the sample to 200K whereas no exchanges are observed for the Ir surface in the reconstructed (5×1) phase. This atomic exchange phenomenon is also found for Re atoms on the Ir(100) surface by high resolution electron energy loss spectroscopy (HREELS). The results for these studies are in preparation for publication.

b. Surface diffusion of Re-Ir dimer/vacancy complex

When Re atoms are deposited on the Ir(100) surface and the surface is heated to 240K, Re-Ir dimer/vacancy complexes are formed. These complexes can diffuse on the surface with two different modes, or two different mechanisms. As this is the first time surface diffusion of a complex system has been studied, the result has been published in Phys. Rev. Lett.

c. Kinetic behavior of the artificially roughened Ir(100) surface

The kinetic behavior of the roughened Ir(100) surface has been studied by LEIS in

the temperature range of 110-1000K. The rough surface is created either by ion bombardement or by submonolayer deposition of Ir atoms on clean (5×1) Ir(100) surfaces. The initial healing of the roughened surface starts at ~120K. At ~200K, ledge atoms start to diffuse along the steps. The clusters can start to migrate on the terraces of the surface until the temperature reaches 400K. In addition, we also find that the rearrangement of the atoms in the step edge region of surface patches transforms the (1×1) structure to the (5×1) above ~480K.

d. Basic principle of atomic manipulation

We have studied the effects of the polarity and the height of applied voltage pulses as well as the atmospheric environments on the process of atom transfer between the tip and the sample of STM. In vacuum, mounds of gold atoms of size less than 200 $\AA$ in diameter and pits of width less than 50 $\AA$ can be produced on a gold surface with nearly equal probabilities by applying negative voltage pulses to a gold tip. In air, most frequently created features for the gold system are mounds, independent of the polarity of applied field. This study has been published in Phys. Rev. Lett.

When gold atoms are deposited onto a gold surface, the deposited clusters can induce a large strain on the substrate around them. Clusters may spread by diffusion to relieve the strain. For a surface which has not yet reached the thermal equilibrium state, the tip scanning can occasionally induce large scale morphological changes of the surface. This work has been published in Surf. Sci. Lett.

For the platinum system in air, the transfer direction of atoms is uniquely from the positive electrode to the negative. Our results are in accordance with the model calculations extended from a theoretical model of field evaporation for the FIM. The study of the Pt system in vacuum is currently under way and a new approach is employed in trying to clarify the mechanism of the atom transfer process under high field.

e. The growth mechanism studies of thin films

(1) Diamond thin films:

Polycrystalline diamond thin films are synthesized by microwave and hot-wired plasma enhanced chemical vapor deposition techniques. Catalytic behaviors of metals (Fe, Co, Ni) and gases(O_2, CO_2) are emphasized. Plasma diagnostic by optical emission spectroscopy are used to investigate the gas phase reactions. Epitaxial textured diamond growth on different substrates is also studied. The increase of the nucleation density by substrate biasing enhances the textured diamond growth.

(2) Single crystal metal thin films and superlattices:

Single crystal metal films and superlattices are grown in ultra-high vacuum environment by molecular beam epitaxy method. The molecular beams are generated from

c. Excitation spectra study:

Recently, the Institute of Physics of Academia Sinica has added a high resolution Fourier Transform infrared spectrometer. We propose to measure the electronic excitation spectra of various donor and acceptor impurities in silicon and germanium. The measurements will be made mostly with the sample cooled to liquid helium temperature. Due to the very high resolution of the spectrometer, the positions of the peaks of the absorption lines could be determined precisely. Weak lines could also be resolved and observed. Besides, the shape and the width of the absorption lines from the high resolution measurements are also going to be used to study the possible reasons for the line broadening phenomenon.

The purpose of the present researh is mainly to study the spin-orbit splitting of the valence band of silicon. We are going to use the high-temperature diffusion technique to introduce beryllium, a group II element, into silicon. Beryllium is a substitutional acceptor and has several impurity centers in silicon. Due to the spin orbit splitting of the valence band, each impurity center of beryllium will have two series of energy levels. From the infrared spectrum obtained from the optical transitions from the ground state to excited states, we plan to identify the existence of the splitting of the valence band as well as to calculate the magnitude of the splitting.

d. Single Crystal growth and their optical properties:

Crystal growth is a science of high application. The various crystals can be used in manufacturing electronic, semiconductor as well as solid state laser devices and also are important meterials for optical and instrument industry. Lithium Niobate single crystal was first successfully grown using the Czochralski technique in 1965 and its possible applications include optical storage, second harmonic generator, SAW, OPO, phase conjugation and integrated optics devices. Due to its important scientific and business potential, it is suitable to choose $LiNb0_3$ crystal as the starting meterial for studying the growth of nonlinear optical crystals. We hope the success of this research can provide crystals to other research institutes for academic and technical research.

The aim of this researeh is to grow large diameter $LiNb0_3$ single crystals using Czochralski pulling method. X-ray diffraction and laser Raman scattering techniques are employed to identify its structure and to inspect the quality of $LiNb0_3$ crystal. 1.06 um light of Nd:YAG laser is also used to study the second harmonic generation effect. It is hoped that the experience obtained from this recearch could be used for further nonlinear crystals study, such as SBN, LBO, BBO and other new crystals.

4. Magnetism:

a. Magnetic property of binary alloys:

Binary alloys, besides the single crystal and amorphous materials, belong to the

three electron beam evaporators. The structure of epitaxial films grown on different substrates, such as metal oxides and semiconductors, are varied but with good lattice matching. Single crystal Co thin films can be grown with different crystal structures (hcp, fcc, bcc) and orientations on MgO, Al_2O_3, $GaAs$ with or without buffer layers. Co films with different orientations, such as hcp (1120), (1010) et al. can be grown on top of bcc Cr films. The structure variations of single crystal metal films and alloys on different substrates, including the different buffer layers, are studied. Difference in ferromagnetic anisotropy magnetoresistance of these films are going to be measured. Single crystal metal superlattices, such as Co/Cr superlattices with different periods and layer thickness, have been grown. Giant magnetoresistance of these films and superlattices have been measured. The relationship between the structure and magnetic property are going to be investigated.

2. Superconductivity:

A number of significant researches concerning high temperature superconductivity in various systems have been reported during recent years. We have obtained a lot of experience in the fabrication and the physical properties of various high Tc oxides. It is evidently that the high Tc superconductors have much better potential for the future applications. Therefore, it is worthwhile for us to study the details and to find the mechanism and to improve the quality of high Tc superconductors.

3. Raman and infrared spectra physics:

a. Enhanced Raman scattering studies:

In this study, we have found that the enhancement of sulfite ions adsorbed on an Ag island film could reach as high as 10^{10}-10^{12} times, far more exceeding the well-known 10^6 value. The aim of this research, is to investigate the enhancement more accurately by use of the XPS measurement of sulfur content on the Ag thin film. In addition, in order to understand the underlying physics and therefore to determine appropriate model for the enhancement mechanism, we propose to measure the relation among the enhancement factor and the energy of incident photons as well as the thickness of thin Ag film.

b. Raman and Infrared Spectra Study

Applying the laser Raman and infrared spectroscopic techniques, we can obtain the complete temperature dependent Raman and infrared spectra of the crystal from 10K to 400K. A detailed study of the spectra of the mode frequency, line width, line shape and intensity versus temperatures, together with the group correlation table, give us accurate information of the crystal structures of different phases and also the identification of the vibration modes. These assignments propose a useful optical data in lattice dynamics calculations.

polycrystalline structures. There are at least two kinds of structures which exist in the polycrystalline alloys. That is the grain and grain boundary. Usually, the chemical compositions are quite different between the grain and the grain boundary. The grain boundary segregation means that some elements are in favor of the grain boundary. Therefore, the physical properties of these polycrystalline alloys will depend on the situations of the grain and the grain boundary. Much works concerning the morphology and growth kinetics of the grain boundary precipitation and segregation have been studied through optical microscopy. Comparatively, little effort has been devoted to the relation between the physical properties and the grain boundary precipitation and segregation.

Under this research topic, we will prepare a systematic alloys or compounds by means of the are meter. Their electrical resistivity, magnetization and thermal properties etc. will be studied.

b. Magnetic, optical and electric properties of magnetic alloy films:

The main goal in this is to study the magnetic, optical and the electric properties of magnetic alloy films. Especially, we shall pay attentions to those physical properties at various temperatures. As to the magnetic properties, the measured quantities include magnetization, magnetoresistance, and magnetostriction etc. As to the electric properties, electrical resistivity and heat capacity of these specimens will be measured. For optical properties, the measured quantities include absorption, transmittance and reflectance etc.

c. Magneto-Kerr effect:

First, we shall set up a Magneto-Kerr effect apparatus, which works only at room temperature. This apparatus employs the longitudinal Kerr effect. For a given material, we try to study the Kerr rotation and Kerr ellipticity as a function of photon energy. The incident light can be either s-wave or p-wave. The angle of incidence is fixed and smaller than 90°. At present, our lab. has equipped with the following optical items:those include mercury arc lamp, monochromator, Glan-Thompson prism, and etc. The samples will be made from our thin film coater. In order to build up the complete MOKE device, we need (a) an electromagnet, which can provide field strong enough to saturate the sample, (b) a high precision rotator, which is resolvable to a one minute range (usually, the Kerr rotation of ferromagnetic materials is in the range 1-10 min.) and (c) a gaussmeter, which is used to read the field strength. Our preliminary objective is to make a reliable MOKE device. The data obtained will also be analyzed. Here, because of the complications from the surface effect, which can only be distinguished from a in-situ measurement, we deliberately make our film much thicker (thicker than 2000A°) so that the measured properties are close to the bulk value.

5. Thermodynamic physics:

a. Two Dimensional Thermodynamic and Magnetic Properties in Copper Nanocrystals

Due to the megligible amount of surface mass in bulk materials, it is almost not feasible to directly measure the surface macroscopic properties such as specific heat and magnetic susceptibility. Whereas if materials are fabricated in the form of ultra fine particles with the size in the order of a few tens of angstroms to a couple of hundreds of angstroms, their surfaces can be considerably increased and their physical properties can be seen. In this work we performed the measurements of low temperature specific heat and magnetic susceptibility of copper and Cu nanocrystals with particle size around 5oo $\mathring{A}$, it is found that the specific heat and magnetic susceptibility of Cu nanocrystals exhibit the characteristics of two dimensional conduction electrons and lattice phonons which are associated with the surface area, electron density of states and probably with the defects, disorders and inter-grain boundaries in Cu nanocrystals.

b. Magnetic Susceptibility and Low Temperature Specific Heats of Palladium Nanocrystals

In this work we performed the measurements of low temperature specific heat for T=0.3K-20K and magnetic susceptibility for T=1.8K-300K of Pd nanocrystals with particle size around 75$\mathring{A}$. It is found that the specific heat of Pd nanocrystals can be fitted into formula $C(T)=\gamma T+\delta T^2+\beta T^3$, in which γT is the specific heat of the conduction electrons and βT^3 is the specific heat of bulk lattice phonons. The δT^2 term which is not seen in bulk Pd is attributed to the contribution of two-dimensional surface phonons by the proof of a simple algebraic calculation. In Pd nanocrystals the temperature coefficient of specific heat γ= ~7.8+0.3 mJ/mol K^2 and Debye temperature as derived Θ_D=240+5 K, both are smaller than those of bulk Pd, 9.42 mJ/mol K^2 and 274 K respectively. It is found that in the measurements of magnetic susceptibility, the magnitude of magnetic susceptibility of Pd nanocrystals is also smaller than that of bulk Pd for $1.8 < T < 300$K and the maximum seen in Pd bulk at ~80K no longer exists. It is concluded that the density of state D (ε_F) and elastic constant of Pd are decreased as it is fabricated in the form of nanocrystals.

c. Magnetic Ordering and Coherence in Heavy Fermion Compound $(Ce,La)_3Al$

We have studied the temperature dependent resistivity, magnetic susceptibility and specific heat in $(Ce_{1-x}La_x)_3Al$ for $0 \leq x \leq 1$. It was found that to increase amount of La substitution x will decrease the structural phase transition temperature T_{Ph} and anti-ferromagnetic ordering temperature T_N, T_{Ph}= 150K and T_N= 2.9K for Ce_3Al (X=0). Although the effect also occurred on the coherence onset temperature T_{Max} in $\rho(T)$, but it shows different behavior for x >0.3, for instance no anti-ferromagnetic ordering can be seen by the peak at T_N in $\chi(T)$ as $x \geq 0.3$ whereas the onset of coherence still exist for x up to 0.7 evidenced by the low temperature resistivity drop

in $\rho(T)$, its quadratic temperature coefficient A and the peak temperature in $C(T)$. The distinction also seen in the drastic change in low temperature Curie constant C, Curie-Weiss temperature Θ and temperature coefficient γ in $C(T)$. Different x dependent of magnetic ordering and coherence in $\chi(T)$, $C(T)$ and $\rho(T)$ were reported. It is concluded that below a critical amount of La alloying magnetic ordering and coherence develop might be dependent on same parameter and have close relation whereas for higher La concentration above a critical amount coherence still exists and moves to higher temperature as anti-ferromagnetic ordering disappears already. To understand this interrelation further study is needed.

d. Thermoelectic effect:

This is a low-temperature measurement. Temperature variations are from 2 to 10K. At present, our lab. has the following equipments:(a)two calibrated semiconductor type diode sensors, and (b)a He-4 insertable cryostat. We plan to attach a heater to one end of the sample so that there is a temperature gradient dT/dx along the sample length. Because it is essential to keep dT/dx as steady as possible, we need a constant current source, which has a low ripple, to control the heater power. Finally, the analyzing work will be put in two perspectives:(a)Two-current model for thermoelectricity, and (b)Thermoelectric power S=dlnσ/dE, where σ is the electrical conductivity and E is the electronic energy.

6. Physical poperty of Nanocrystalline particles:

For the researches of nanocrystalline particles, many investigations of the properties and the industrial applications such as new materials for catalysts sensors, and magnets etc. have been reported, in addition to the study of the growth technique. During the past several years, we have studied the physical properties of Fe nanocrystalline particles. Recently we are interested to study the electrical, magnetic, and thermal properties of nanocrystalline particles. From our experimental data, we will get new results for both academia and industrical contributions.

BIOPHYSICS:

Organs influence on the blood pressure wave propagation:

Rats will be used as the experimental animal to study the effect of organ on the blood pressure wave and flow.

Energy in the circulatory system is mainly in the form of pressure. Kinetic energy is only a few percent. The pressure wave is the main energy source to push the blood flow. This project will study the relation between blood pressure wave and blood flow especially the blood pressure wave and the blood flow into organs. The main organ is kidney.

We will study the change of its elasticity and resistance effect on the blood pressure wave as well as the blood flow.

Besides, We will derive the transverse wave propagation equation in the artery and study the wave propagation property at the branch point. Organ or vascular bed will be included in this equation. Studies of the flow in the renal artery aorta and microcirculation in the kidney will be performed to evaluate the accuracy of the equation. In clinical application, because the swelling of an organ, blocking of the small artery, changing of elasticity of the arterial wall.... all will be shown in the resonant frequency of this organ. the resonance model will be evaluated about the possibility of using resonance frequencies to studies the cardiac artery disease.

THEORETICAL AND HIGH ENERGY PHYSICS GROUP

THEORY:

Theory

1. Study of some fundamental issues in electroweak standard model and scale invariant theories
2. Scaling of Aharonov-Bohm couplings and the dynamical vacuum of gauge theories
3. Finite temperature chiral phase transition
4. World line representation of euclidean quantum field theory
5. Superfluidity and vorticity
6. Sandpiles models

Particle Phenomenology

1. SU(3)-breaking effects in charmed meson decays
2. Corrections to chiral dynamics of heavy hadrons: SU(3) breaking
3. Corrections to chiral dynamics of heavy hadrons: 1/M corrections
4. Weak radiative decays of heavy hadrons
5. Radiative kaon decays $K \to \pi\pi\gamma$ and direct CP violation
6. Parity-violating effects in high-energy hadron-hadron collisions
7. Polarization density matrix of $WW \to \gamma\gamma$
8. Sudakov suppression and the proton form factor
9. The phenomenology of models involving gauged family-lepton-number differences
10. Top, gauge bosons, hyperons, Gottfried sum rule

Gravitation and Cosmology

1. Anisotropy and polarization of cosmic microwave background
2. Graviton spectrum in inflationary cosmology
3. Cosmological bound on the decay $\pi^0 \to \gamma X$
4. Motion of dark matter in galactic halo

Statistical Physics

1. Statistical physics
2. Nonequilibrium phase transitions in sandpiles and interfaces

Theory

1. Study of some fundamental issues in electroweak standard model and scale invariant theories

In recent years, there are a few issues within the standard model that are bothering people. One of them is that the Higgs particle has not yet been seen and the mass of its lower bound keeps increasing. Another thing worth studying is that there are several theoretical groups giving arguments that the physical quantities calculated by people are actually gauge dependent. With all these in mind, we here want to investigate the issues of gauge invariance and renormalizability of scale invariant and electroweak standard model when one actually computes physical quantities and uses them to compare with experimental result.

2. Scaling of Aharonov-Bohm couplings and the dynamical vacuum of gauge theories

We have shown that electrons (and hence electron vacuum currents) in the vicinity of an arbitrarily thin tube of magnetic flux (F) are sensitive not only to the fractional part of F, *à la* Aharonov and Bohm, but also to the sign of F. We discuss why these facts are an inevitable corollary of helicity conservation, and go on to describe the relation of induced vacuum currents to the beta function for coupling of charge to flux. This contruct introduces an interesting non-perturbative vacuum structure of gauge field theories, a spaghetti of fluxons.

3. Finite temperature chiral phase transition

We are studying the some of the properties of the finite temperature chiral phase transition in $3+1$ dimensions. In particular, we have clarify certain subtleties that were believed to be present in the phase diagram. We have also carefully analyzed the dimensional reduction process of finite temperature, $3+1$ dimensional thoery to the $d=3$ theory in order to fully understand why the scalar Ising critical exponents are obtained instead of the chiral critical exponents.

4. World line representation of euclidean quantum field theory

We are studying the world line representation of Euclidean Quantum Field Theory (QFT). The hope is to be able to use this formalism to analyse the properties of a system consisting of both electrons and magnetic monopoles. Because of the Dirac quantization condition the monopole coupling is very large and perturbation theory is not applicable to its analysis. We have shown, however, that in the low energy limit the world line representation of QFT can be represented as a dilute gas of dipoles in the fluid. When the density of these dipoles is low, which is expected at low energies, the usual Debye-Hückel theory can be used to analyse the system. As the Debye-Hückel theory is an expansion in the density of dipoles and not on the coupling constant, this method is applicable to the electron-monopole system whereas perturbation theory

is not. Ultimately, we hope to be able to provide a non-perturbative proof that the Dirac quantization condition will not change under charge renormalization. In three dimensions, where confinement due to monopoles are present, we are interested in how the electron-electron interaction is affected by this confinement. We are also interested in any possible phase transition the system may undergo.

5. Superfluidity and vorticity

The symmetry breaking properties of the superfluid phase transition in two dimensions was analyzed and contrasted with the situation in three dimensions. It was shown that like the superfluid transition in three dimensions the superfluid transition breaks a $U(1)$ gauge symmetry. The method in which the symmetry was broken bears more resemblence to the Bogoluibov's theory of the condensation of the ideal bose gas, however, than the superfluid transition in three diemnsions.

In order to establish further links between the theory of superfluidity in two dimensions with that in three dimensions we have attempted to demenstrate the existence of an order parameter for the phase transition. Doing so requires the presence of vortices in the fluid and involves the use of Sheaf Theory from the theory of Reimann Surfaces to construct a $U(1)$ fibre bundle above the configuration space of the fluid. A section of this line bundle will then serve as an order parameter for the system.

We are also currently working on establishing an algebraic framework which will allow for the creation and annihilation of vortex states in the two dimensional film. The technique utilizes the observation that the rotation operator in two dimensions has a very simple form and essentially factorizes into two pieces. These two pieces can then be used to form creation and annihilation operators which will increment and decrement the vorticity of an eigenstate of this operator by the ammount $\hbar/m$. The Hamiltonian for the vortices was then proposed and the Hilbert space and wavefunctions were constructed. The Many Vortex system was then constructed and the statistical properties of a system of free, non-interacting vortices was studied.

6. Sandpiles models

We made an thorough investigation of the deterministic sandpile on a circle. For arbitary size L, we obtained an explicit expression for the number of stead states, the number of limit cycles and characterized completely the steady states for the case N=2 (N is the critical slope). We also obtained an exact characterization of each limit cycle. This is the first example of models associated with self-organized criticality that has been shown to have multiple limit cycles. In fact, we can prove that for any odd numer C, we can always find a suitable size L such that the model has a limit cycle of size C. We also calculated the exact one-point and two-point functions over the steady states. It would be interesting to know if the correlation functions is the same for all the limit cycles. Despite our efforts, we have not been able to get an exact expression for the correlation function for each limit cycle. We compared our results with the case

of sandpile on a line. As expected, they differ only by terms of 1/L. This 1/L term characterizes the different boundary conditions. We also investigated the multi-fractal structure in the spatial-temporal domain. Exact expressions were obtained and we are in the process of comparing it to the line case. Part of the work is being written up and submitted.

Particle Phenomenology

1. SU(3)-breaking effects in charmed meson decays

The decay rates of $D^+ \to \pi^+\pi^0$ and $D^0 \to K^+\pi^-$ recently measured by CLEO give the ratios $R_1 = 2|V_{cs}/V_{cd}|^2\Gamma(D^+ \to \pi^+\pi^0)/\Gamma(D^+ \to \bar{K}^0\pi^+) = 3.29 \pm 1.16$ and $R_2 = |V_{cs}^* V_{ud}/(V_{cd}^* V_{us})|^2\Gamma(D^0 \to K^+\pi^-)/\Gamma(D^0 \to K^-\pi^+) = 2.92 \pm 1.34$. Both are about three times of those expected from SU(3) symmetry. We show that, in the large-N_c factorization approach, such large SU(3) violations can be accounted for by the accumulations of several small SU(3)-breaking effects. An important requirement is the relative magnitude of the form factors, $f_+^{D\pi}(0) > f_+^{DK}(0)$.

2. Corrections to chiral dynamics of heavy hadrons: SU(3) breaking

The dominant decay modes of many heavy hadrons, which contain a heavy quark, are strong decays with one soft pion emission and/or electromagnetic decays. This is a consequence of the heavy quark symmetry of QCD: mass differences among the different spin multiplets of the ground-state heavy mesons and heavy baryons are generally small. An ideal framework for studying the low-energy dynamics of heavy hadrons is provided by the formalism in which the heavy quark symmetry and the chiral symmetry are synthesized. However, symmetry considerations alone in general do not give any quantitative predictions unless further assumptions are made. Fortunately, all the unknown parameters in the Lagrangian depend only on the light quarks and are calculable from the nonrelativistic quark model.

We examine various symmetry-breaking corrections to the strong and radiative decays of heavy mesons and baryons. There are two different kinds of symmetry-breaking effects on the chiral dynamics of heavy hadrons: the finite-mass effects from the light quarks and the $1/m_Q$ corrections from the heavy quarks. We have already incorporated one of the $1/m_Q$ effects, namely the magnetic moment of the heavy quark, into the formalism for describing the electromagnetic (M1) decay of heavy hadrons. This is because the charmed quark is not particularly heavy, and hence the contribution due to its magnetic moment cannot be safely neglected.

Since both symmetry breaking effects require a careful and thorough study, we focus on the SU(3) symmetry breaking in this paper. A detailed investigation of $1/m_Q$ corrections has been carried out in a preceding paper. Schematically, the general effective chiral Lagrangian in chiral perturbation theory (ChPT) involving heavy hadrons has the chiral expansion $\mathcal{L} = \mathcal{L}_1 + \mathcal{L}_2 + \mathcal{L}_3 + \cdots$, where the subscript denotes the sum of the

number of derivativess acting on the Goldstone fields and the velocity-dependent heavy hadron fields, and the power of Goldstone-boson mass squared in the Lagrangian. The higher-order chiral Lagrangians are suppressed by powers of p/Λ_χ or m^2/Λ_χ^2, where p (m) is the momentum (mass) of the Goldstone bosons, and Λ_χ is a chiral symmetry breaking scale $\sim$ 1 GeV. Therefore, perturbation theory makes sense if p and m are not too large compared to Λ_χ. Chiral corrections of interest usually receive two contributions: one from the chiral loops generated by $\mathcal{L}_1$, and the other from the higher order tree Lagrangian term $\mathcal{L}_2$. Loop contributions can be either finite or divergent. In ChPT, all divergences from chiral loops induced by $\mathcal{L}_1$ will be absorbed into the counterterms which have the same structure as that of $\mathcal{L}_2$. We see that although the lowest-order chiral Lagrangian $\mathcal{L}_1$ is scale independent, renormalized higher-order effective Lagrangians do depend on the choice of Λ, reflecting the non-renormalizability nature of ChPT. Of course, physical amplitudes should be independent of the renormalization scale; that is, the Λ dependence from chiral-loop is exactly compensated by the Λ dependence of local counterterms in $\mathcal{L}_2$. As the renormalized parameters f_i^r are unknown and must be determined from experiment, we will thus concentrate in the present paper the chiral corrections due to meson loops. Furthermore, we will choose $\Lambda \sim \Lambda_\chi$ to get numerical estimates of chiral-loop effects.

Chiral loop corrections to some heavy meson processes have been discussed by other authors. We attempt to make a systematic and complete investigation of chiral-loop corrections to the strong and electromagnetic decays of heavy hadrons. They arise from the chiral-symmetry-breaking terms and hence vanish in chiral limit. The leading chiral-loop effects we found are nonanalytic in the forms of m/Λ_χ and $(m^2/\Lambda_\chi^2)\ln(\Lambda^2/m^2)$ (or $m_q^{\frac{1}{2}}$ and $m_q \ln m_q$, with m_q being the light quark mass). Furthermore, they amount to finite-light-quark-mass corrections to the coupling constant, say g, in $\mathcal{L}_1$.

3. Corrections to chiral dynamics of heavy hadrons: 1/M corrections

We examine various symmetry breaking corrections to the strong and electromagnectic decays of heavy hadrons. There are two different kinds of symmetry breaking effects on the chiral dynamics of heavy hadrons: the $1/m_Q$ corrections from the heavy quarks and the finite-mass effects from the light quarks.

As is well known, the QCD dynamics in the limit of infinite quark mass exhibits a new spin-flavor symmetry which is known as the heavy quark symmetry (HQS). Corrections to this symmetry limit can be systematically incorporated into the heavy quark effective theory (HQET) of QCD where symmetry breaking effects are summarized by higher-dimensional operators suppressed by powers of $1/m_Q$. Such an effective theory has been a powerful tool to analyze weak-transition form factors of heavy hadrons containing one single heavy quark. We have recently, among others, initiated a study of strong and radiative decays of heavy hadrons by deriving a heavy-hadron chiral Lagrangian which obeys constraints from the heavy quark symmetry. As the idea of synthesizing the heavy-quark and chiral symmetries receives growing attention, there

remain important issues to be explored. Especially, implications of the aforementioned $1/m_Q$ corrections to the structure of the heavy-hadron chiral Lagrangian have not been systematically studied. Since the charmed quark is not particularly heavy compared to the QCD scale, such corrections can be important in the chiral Lagrangian for charmed hadrons.

As is well-known, there are two energy scales in the chiral perturbation theory involving a heavy hadron: the mass of the heavy hadron M_H and the the chiral symmetry breaking scale Λ_χ. In principle, one may expand the theory in inverse powers of these two scales. However, because the heavy hadrons have large masses, the derivatives acting on the heavy hadron fields will produce large momentum factors. This complicates the power counting procedure. This difficulty is overcome by a simple observation. Strong and electromagnetic interactions at low energies of a heavy hadron with other light hadrons are governed by the energy scale $\Lambda_{\rm QCD}$ which is much smaller than M_H. Consequently, the four momentum of a heavy hadron has only fluctuations of the order of $\Lambda_{\rm QCD}$ throughtout its history. In terms of $H_v(x)$, derivatives acting on the heavy hadron and Goldstone boson fields are treated on equal footing, and a consistent $1/M_H$ and $1/\Lambda_\chi$ expansion can be developed for the heavy hadron chiral Lagrangian.

4. Weak radiative decays of heavy hadrons

The recent observation of the weak radiative decay $\bar{B} \to \bar{K}^*\gamma$ by CLEO with the branching ratio $(4.5 \pm 1.5 \pm 0.9) \times 10^{-5}$ confirms the standard-model expectation that this decay mode is dominated by the short-distance electromagnetic penguin transition $b \to s\gamma$. Naively, it is tempted to think that $\bar{B} \to D^*\gamma$ will be the dominant weak radiative decay of the $\bar{B}$ meson as it is not suppressed by quark mixing angles. However, owing to the large top quark mass, the amplitude of $b \to s\gamma$ is neither quark mixing nor loop suppressed. Moreover, it is largely enhanced by QCD corrections. As a consequence, the short-distance contribution due to the electromagnetic penguin diagram dominates over the long-distance one. This phenomenon is quite unique to the bottom hadrons which contain a heavy b quark; such a magic short-distance enhancement does not occur in the systems of charmed and strange hadrons. For example, it is known that the mechanism $s \to d\gamma$ plays only a minor role in the radiative decays of kaons and hyperons.

We have systematically studied the flavor-conserving electromagnetic decays of heavy mesons and heavy baryons. Various photon coupling constants are related through the usage of heavy quark symmetry. For example, the $\bar{B}^*\bar{B}^*\gamma$ coupling, which is very difficult to measure in practice, is related to the $\bar{B}^*\bar{B}\gamma$ coupling via heavy-quark spin symmetry. The coupling constants appearing in the Lagrangians depend only on the light quarks and can be calculated in the nonrelativistic quark model. Consequently, the dynamics of the electromagnetic transitions for emissions of soft photons and pions is completely determined by heavy quark and chiral symmetry, supplemented by the quark model.

At the quark level, there are three different types of processes which can contribute to the weak radiative decays of heavy hadrons, namely, single-, two- and three-quark transitions. The single-quark transition mechanism comes from the so-called electromagnetic penguin diagram. Since the penguin process $c \to u\gamma$ is very suppressed, it plays no role in charmed hadron radiative decays. We will thus focus on the two-body radiative decays of bottom hadrons proceeding through the electromagnetic penguin mechanism $b \to s\gamma$: $\bar{B} \to \bar{K}^*\gamma$, $\bar{B}_s \to \phi\gamma, \Lambda_b^0 \to \Sigma^0\gamma,\ \Lambda^0\gamma$, $\Xi_b^0 \to \Xi^0\gamma$, $\Xi_b^- \to \Xi^-\gamma$, $\Omega_b^- \to \Omega^-\gamma$. There are two contributions from the two-quark transitions: one from the W-exchange diagram accompanied by a photon emission from the external quark and the other from the same W-exchange diagram but with a photon radiated from the W boson. The latter is typically suppressed by a factor of $m_q k/M_W^2$ (k being the photon energy) as compared to the former bremsstrahlung process. For bottom hadrons, the dominant decays which occur through the quark-quark bremsstrahlung $bu \to cd\gamma$ or $b\bar{d} \to c\bar{u}\gamma$ are: $\bar{B}^0 \to D^{*0}\gamma, \Lambda_b^0 \to \Sigma_c^0\gamma$, $\Xi_b^0 \to \Xi_c^0\gamma$, $\Xi'^0_c\gamma$, where we have followed the convention that a $\bar{B}$ meson contains a b quark and that Ξ_Q (Ξ'_Q) denote antitriplet (sextet) heavy baryons. For charmed hadrons, the Cabibbo-allowed decay modes via $cd \to us\gamma$ or $c\bar{u} \to s\bar{d}\gamma$ are $D^0 \to \bar{K}^{*0}\gamma, \Lambda_c^+ \to \Sigma^+\gamma$, $\Xi_c^0 \to \Xi^0\gamma$. Finally, the three-quark transition involving W-exchange between two quarks and a photon emission by the third quark is quite suppressed because of very small probability of finding three quarks in adequate kinematic matching with the baryons.

A different but more powerful approach to the W -exchange bremsstrahlung processes will be presented. The fact that the intermediate quark state in these processes is sufficiently off-shell, which is regarded as a disadvantage for the quark model calculation, turns out to be an advantage from a different point of view. By sort of short-distance expansion, the quark-quark bremsstrahlung reaction can be described by an effective five-point local interaction which is gauge invariant. To derive the effective Lagrangian, we have applied the idea of heavy quark symmetry to parametrize the quark momenta in terms of velocities: In the heavy quark limit, the velocity of the heavy quark, which is subject to a small fluctuation of order $\Lambda_{\rm QCD}/m_Q$ due to the interaction with the light quark(s), remains a constant and is the velocity of the heavy hadron containing a single heavy quark. This momentum parametrization has the advantage that the effective local interaction and gauge invariance are manifest during the course of derivation.

Armed with the effective Lagrangian for the W-exchange bremsstrahlung, we are able to study various radiative decay modes of bottom and charmed hadrons listed before, bearing in mind that this approach presumably works better when both the initial and final hadrons contain a heavy quark. We will use the factorization method, which is known to work well for nonleptonic weak decays of heavy mesons, to evaluate the mesonic matrix elements. As to the baryon radiative decays, we will demonstrate that heavy quark symmetry leads to a nontrivial prediction for antitriplet to antitriplet heavy baryon transitions: the ratio of parity-conserving and parity-violating amplitudes

is uniquely predicted. Baryonic matrix elements will be calculated using the MIT bag model.

5. Radiative kaon decays $K \to \pi\pi\gamma$ and direct CP violation

It is stressed that a measurement of the electric dipole amplitude for direct photon emission in $K^{\pm} \to \pi^{\pm}\pi^0\gamma$ decays through its interference with inner bremsstrahlung is important for differentiating among various models. Effects of amplitude CP violation in the radiative decays of the charged kaon are analyzed in the Standard Model in conjunction with the large-N_c approach. We point out that gluon and electromagnetic penguin contributions to the CP-violating asymmetry between the Dalitz plots of $K^{\pm} \to \pi^{\pm}\pi^0\gamma$ are of equal weight. The magnitude of CP asymmetry ranges from 2×10^{-6} to 1×10^{-5} when the photon energy in the kaon rest frame varies from 50 MeV to 170 MeV.

We have studied CP violation in the radiative kaon decay $K_L \to \pi^+\pi^-\gamma$. We conclude that the direct CP-violating effect originating from the electromagnetic penguin diagram is only of order $(10^{-3} - 10^{-4})\epsilon$, depending on the region of the Dalitz plot under consideration. On the contrary, arising from the same electromagnetic penguin mechanism can be large enough for experimental interest; explicitly, $\Delta\Gamma \leq 9 \times 10^{-4}$ is obtained. If this estimate is correct, it will be on the verge of the capability of the ϕ factory DAΦNE, and could be detected at future high-statistics facilities. The purpose of our work is to re-examine this CP-violating effect in the Standard Model in conjunction with the $1/N_c$ approach.

6. Parity-violating effects in high-energy hadron-hadron collisions

Hadron colliders with high-energy polarized proton beams are conceivably available in the future at RHIC, SSC and LHC. Depending on whether the proton beams are polarized longitudinally or transversely, parton spin densities of the proton can be probed via the studies of helicity or transverse spin asymmetries. With longitudinal polarization, the double helicity asymmetry defined by $\mathcal{A}_{LL} = \frac{d\sigma^{++} - d\sigma^{+-}}{d\sigma^{++} + d\sigma^{+-}}$ is the observable most commonly discussed in the literature, where $d\sigma^{++}$ ($d\sigma^{+-}$) denotes the inclusive cross section for the configuration where the incoming hadron's longitudinal polarizations are parallel (antiparallel). Double asymmetries at high energies have been investigated for various processes, such as single-jet, two-jet, two-jet plus photon and three-jet productions, double-photon production, direct photon production at large transverse momentum, and the Drell-Yan process. Most recent works were motivated by the European Muon Collaboration (EMC) measurement of the polarized proton structure function $g_1^p(x)$. The central issue of much theoretical controversy is whether or not gluons contribute to the first moment of $g_1^p(x)$. Two extreme possibilities for the explanation of the EMC experiment have been explored in the past: large (negative) sea polarization or large (positive) gluon polarization [10]. Measurements of aforementioned processes will help determine the spin dependent parton distributions and shed

light on the interpretation of the EMC results.

Contrary to the previous works, the purpose of the present paper is to analyze the single helicity asymmetry $\mathcal{A}_L$ defined in high energy proton-proton collisions. Experimentally, it should be easier to measure $\mathcal{A}_L$ than the double helicity asymmetry. However, theoretically a nonzero $\mathcal{A}_L$ can occur only if some of the parton-parton scatterings involve parity-violating weak interactions. Therefore, single helicity asymmetry can be used to probe parity violation in parton-parton subprocesses. Another party-violating (pv) effect of interest is the longitudinal polarization $\mathcal{P}_L$ of a high-energy baryon produced from unpolarized incident proton beams. Owing to the small size of weak effects, pv parameters $\mathcal{A}_L$ and $\mathcal{P}_L$ arise from the coherent interference between the strong-QCD and weak amplitudes.

7. Polarization density matrix of $WW \to \gamma\gamma$

We finished the calculation of the polarization density matrix of $WW \to \gamma\gamma$. This is needed for testing the trivector-boson and guad-vector boson coupling in order to establish the non-abelian character of the gauge bosons. We had started the investigation of the process of $t\bar{t} \to WWb\bar{b}$ folllowed by the fusion of the two Ws' into two photons. We shall be able to obtain similar polarization density matrix of $WW \to Z\gamma$ and $WW \to ZZ$. Preliminary investigation indicates that the WW fusion from $t\bar{t}$ decay process could be non-negligible. This has important implication for the collider experiments at Fermilab.

8. Sudakov suppression and the proton form factor

We have computed proton form factor based on the modified perturbative formalism proposed by Li and Sterman, which considers Sudakov effects in elastic scatttering of quarks. We gave a full renormalization group analysis in the resummation of Sudakov logarithms. It is found that the self-consistency of perturbative QCD was justified for energy scale down to 10 GeV^2, not 100 GeV^2 as argued from standard perturbative approach. It is also found that our predictions were in good agreement with experimental data.

9. The phenomenology of models involving gauged family-lepton-number differences was investigated

Gauge symmetry is one of the central concepts of modern particle physics. Its role in nature appears to be fundamental. Global continuous and discrete symmetries also appear in nature but their status is not so clear. For example, the experimental indications are that baryon and lepton numbers are conserved. In the context of the Minimal Standard Model (MSM) they are global symmetries. What is their real nature? Motivated by these considerations we study the consequences of having one or some combination of them gauged.

Possible extensions of the MSM can be defined by gauging the global baryon and/or lepton number $U(1)$ symmetries. It should be noted that the gauging of baryon or lepton numbers usually requires the fermion sector of the MSM to be extended. However, it was found that the differences in family-lepton numbers are anomaly-free in the MSM and can therefore be gauged. For three generations of quarks and leptons, three models emerge depending on whether (i) $L_e - L_\mu$, (ii) $L_e - L_\tau$, or (iii) $L_\mu - L_\tau$ is gauged. These are the simplest models to feature a Z' boson because no fermions beyond those already present in the MSM are required to cancel the gauge anomalies.

The phenomenology of two subsets of these models was analyzed. The two subsets are distinguished by how the extra $U(1)$ gauge symmetry is broken. The first subset uses a Higgs scalar which is a standard model gauge singlet to break the extra $U(1)$ symmetry. In this case it was found that the Z' bosons in these models could have relatively low masses and yet still evade present experimental bounds, while remaining detectable in current accelerators. The second subset uses a Higgs doublet for breaking the extra $U(1)$ symmetry. As a result, the Z' boson is constrained to be light because the vacuum expectation values which generate its mass also break the electroweak gauge group. It was found that nearly all but a small window of parameter space of this model was ruled out by experiment. There is, however, an interesting aspect to this model if the Z' boson is sufficiently light. In this case there exists the possibility of the two-body decay $\tau \to \mu Z'$ occuring. This will provide a striking signature to test the model. The point is that $\tau \to \mu Z'$ decay is essentially the only important new piece of low energy physics that the model predicts, provided that the Higgs bosons are heavier than a few tens of a GeV.

10. Top, gauge bosons, hyperons, Gottfried sum rule

We intend to study several physics issues which are closely related to the experiments our experimental group is participating and may therefore be tested immediately by analysing the experimental data. In close collaboration with the experimental group, we shall also investigate some interesting physics issues and ideas which may eventually result in a proposal submitted by our group to a high energy hysics laboratory to carry out he relevant experiment. Specifically, we shall investigate the following:

a. Complete calculation of the production and decay of the top-antitop pair through the di-lepton and lepton-jet channels to understand the effects of top polarization during production and its relevance to the top-search as well as the determination of the parameters related to top (such as the top mass).

b. Complete calculation of the WW fusion channels (such as di-lepton or di-lepton final states) through the $t\bar{t}$ production and decay.

c. Study other processes of di-vector boson production so as to test the non-abelian couplings of the vector bosons and to see what kind of information the experimental data can provide for the Higgs.

d. Detailed analysis of single-top production processes so as to work with the experimental group to search for top through the single-top production channel.

e. Study the possible mechanisms for the breaking of Gottfried sum rule. Simple models to account for the relevant non-perturbative effects will be presented and tested by analysing experimental data.

f. Review the various unresolved issues in the hyperon physics and study the possible ways of resolution as well as the potential of being tested experimentally at the existing facilities.

g. Investigate other interesting heavy quark physics (mainly top and bottom) as well as physics of strong interaction (small-x, higher twists etc.) which may be tested at the existing or coming accelerators.

Gravitation and Cosmology

1. Anisotropy and polarization of cosmic microwave background

The discovery of the cosmic microwave background radiation (CMBR) in 1964 provides the most strong evidence that the Universe began from a hot big bang. In subsequent studies, the CMBR has been found to possess a very high degree of uniformity. However, the Universe we observed have a variety of structures, such as galaxies and clusters of galaxy. It is generally believed that the density inhomogeneities in the Universe can account for the CMBR anisotropy, which is regarded as evidence for the seeds of galaxies formation.

Recent detection of large-angular-scale temperature quadrupole anisotropy in the CMBR by the DMR aboard the COBE satellite opens a window to our understanding of physics associated with the initial conditions of the early Universe. There are two sources of CMBR anisotropy, namely, the density perturbations (scalar mode) and the primordial gravitational waves (tensor mode). Using the existing COBE-DMR data, we propose to search for large-scale polarization of CMBR to separate the scalar from tensor mode contribution to CMBR anisotropy. Particular interest will be given to examine the polarization component of the Galactic synchrotron radiation. After subtracting the radiation, one can set a limit on the intrinsic polarization measurement of CMBR. This limit is particularly useful to place constraint on the recombination dynamics and the re-ionization history of the universe.

2. Graviton spectrum in inflationary cosmology

We calculate in detail the spectrum of gravitons produced during the de Sitter phase in an inflationary cosmology. By using the physically sensible method of Vilenkin to regularize the theory, and requiring continuity of the wave function and its first derivative at each epoch of change in the equation of state, we determine the full spectrum of the primordial gravitons. We discuss how the results depend on the initial

state at the onset of the inflationary epoch, the dynamics of inflation and the subsequent evolution of the Universe. In particular, the wave forms of primordial gravitational waves which are relevant for astrophysical measurements are given.

3. Cosmological bound on the decay $\pi^0 \to \gamma X$

Using the upper bound on the effective number of light neutrino species during primordial nucleosynthesis and the cosmological pion-pole mechanism $\gamma\gamma \to \pi^0 \to \gamma X$, we obtain an upper limit on the branching ratio for the decay $\mathrm{BR}(\pi^0 \to \gamma X) < 3 \times 10^{-13}$, where X is any long-lived weakly interacting neutral vector particle with mass smaller than the neutral pion mass.

4. Motion of dark matter in galactic halo

Using the Einstein's equations for a static, spherically symmetric spacetime we have developed certain constraints on the properties of dark matter in the galactic halo. In particular, if the spacetime in the halo is to be approximately flat, then the particles making up the halo must be very "cold", meaning that their kinetic energies must be very much less than their rest mass. A more general analysis was done for a general energy density in the same geometry and it was shown that a $1/r^2$ energy density can only arise from a very weakly interacting gas of particles.

Statistical Physics

1. Statistical physics

   a. We explained in some detail about how to combine the histogram Monte Carlo simulation method and important sampling Monte Carlo method.

   b. The histogram Monte Carlo simulation method was used to calculate the scaling functions for the Potts model and the bond percolation model on two and three dimensional lattices.

   c. We presented a thermodynamic formulation for nonlinear dynamics and used it to study anomalous diffusion.

   d. We presented a review on Monte Carlo studies of phase transition models based on the connection between percolation and phase transitions.

   e. We applied the histogram Monte Carlo simulation method to calculate the scaling function and thermodynamic order parameter for the site random percolation model on the square and the simple cubic lattices. We found that the scaling functions are different for the free and periodic boundary conditions.

2. Nonequilibrium phase transitions in sandpiles and interfaces

Phase transition of many-body systems in non-equilibrium states are, unlike its

equilibrium counterparts, relatively unexplored. However, many natural phenomena of interest are intrinsically non-equilibrium. They often escape the conventional Gibbs formalism of equilibrium statistical mechanics. Specifically, we have considered 1D sandpile cellular automata. These models are paradigms of a novel concept termed self-organized criticality, which attempts to relate the ubiquity of power-law correlations in space (e.g. fractals) and in time (e.g. $1/f$ noise). Under open boundary conditions, sandpiles naturally evolve into scale-invariant critical states without fine tuning. Despite their apparent simplicity, such models defy most analytical attacks. We have elucidated the issue of universality for the simplified two-state models, and derived for the general multi-state cases scaling properties of local-state distributions. The results establish the hierarchical structure of the various local states.

In another example of non-equilibrium steady states, we found that the otherwise rough interfaces between two coexisting phases in Ising model at low temperature become smooth, when an external drive is applied. The mechanism of smoothening was explored with computer simulations. We found that it is distinct from the equilibrium kind in which typically the associated Goldstone mode acquires a mass. While the non-equilibrium propagator remains singular at small momemta, its divergence is sufficiently weak to give rise to finite interface width, i.e., a smooth interface.

HIGH ENERGY PHYSICS GROUP:

The objective of the High Energy Physics Group is to actively participate and make important contribution to the current and future high energy physics experiment. Our present research involvements inculde Fermi National Accelerator Laboratory (Fermilab) CDF collider and fixed-target experiments.

1. Fermilab CDF experiment

The main purpose of the CDF experiment is to search for Top quark. Since the discovery of the Bottom quark, the search for the top quark had become one of the most important goals in physics. According to the present data and theoretical prediction, the Top quark mass is bounded between 92 GeV and 200 GeV which is in the reach of Tevatron at FNAL. In the RUN Ia experiment(between 1992 and 1993), CDF has accumulated data with integrated luminosity of 21.4 pb^{-1}. From the preliminary analysis, there are couple candidate events pass all the selection cuts. At present, RUN Ib data taking is under way and is expected to take 3 times more data in order to confirm these candidates.

The other goal of the CDF experiment is to study the B physics. It is expected that CDF will collect enough data at the end of this decade to study B cross section, CP violation, BB correlation, B meson spectrum, rare decay, and life time measurements. In order to identify B meson, the silicon microstrip detector(SVX') has been used at CDF to measure the distance between the decay vertex and the primary vertex.

The second stage experiment at Tevatron(Run II) is expected to run in the end of the 1997. The number of bunch in the accelerator will be increased from 6 to 36 and will be 99 when the main injector in service. The time interval between bunches will be 396 ns and 132 ns instead of 2.3 μs. According to these changes, CDF has been designing new silicon microstrip detector(SVXII). Its characteristics are:

1. double-sided detector with additional z direction information.

2. there are 3 barrels with the total length of about 100 cm in order to cover larger acceptance.

3. pipe-line readout in order to account for the shorter bunch interval.

4. using optical fiber to transfer data to the data acquisition system.

After the participation to the CDF experiment, we have been actively helping the assembly of SVX' detector and testing. The SVX' detector was installed to the CDF main detector at the end of 1993 and is presently used to take data for RUN Ib. Because of the assembly work, we have been one of the main members in the SVX' project to take charge of the SVX' alignment and simulation. In addition, we also participate the development of the interactive fitting using the display package and the data production. The RUN 1b data acquisition started from the December of 93 and is expected to run till the end of 94 in order to collect data of 100 pb-1 integrated luminosity. Meanwhile, the RUN 1b data analysis is presently under way.

As for the SVXII R&D project, our group involve in the data transfer and control of the data acquisition system. Due to the Tevatron upgrade plan, we need to have a data transfer and control system with large band width in order to accommodate the higher luminosity environment. Since the optical fiber has (1)large band width (2) less material (3) long-distance-transport capability, it is the ideal candidate for our need. However, due to the finite space around the SVXII detector, the present commercial electrical-optical modules can not be adapted for transferring between electrical and optical signals. Therefore, it is important to develop high density electrical-optical-interface module to account for this situation. At present, our group has been cooperating with the Tele-Communication Research Laboratory in order to develop this high density package in which 10-12 connectors will be sealed inside a dimension of 15mm x 10 mm x 5 mm. The first prototype had been completed in January of 94 and is under test. Its associated circuit is under design. Once this prototype and our capability been approved by the CDF group, we expect to establish a test station to assembly and test the electrical-optical readout system.

2. Fermillab E789 experiment:

E789 received its first allotment of beam time during May-August, 1990. This was low-intensity test run at a low-mass spectrometer setting optimized for charm decays.

With a total of 8 Silicon Microstrip Detector, several hundreds $D \to K\pi$ decay have been observed.

No $D^0 \to \mu^+\mu-$, a Flavour Changing Neutral Current process, has been observed. The upper limit obtained from this experiment is $BR(D^0 \to \mu^+\mu^-) < 8.0 \times 10^{-6}$ at 90% confidence level.

E789 began its second run in Aug. 1991 and ended the run in Jan. 1992. With an upgraded silicon vertex detector which contains sixteen Silicon Microstrip Detector, over 4000 $D^0 \to K\pi$ events were observed with both beryllium and gold target. The measured differential cross section, $d\sigma/dx_F$, for neutral D-meson production at $< x_F > = 0.031$ is 71 $\pm$ 10 μb per nucleon. The integrated cross section by extrapolation of the measured cross section to all x_F is 21.7 $\pm$ 4.4 μb per nucleon which is consistent with previous measurement. No nuclear dependence is found, with a measured α = 1.02 $\pm$ 0.04. The life time of neutral D-meson is measured to be 0.405 $\pm$ 0.018 ps.

More than 20,000 $J/\Psi \to \mu^+\mu^-$ events and 6,000 $J/\Psi \to e^+e^-$ events were reconstructed. The number of $J/\Psi \to e^+e^-$ events is about 5 times smaller than $J/\Psi \to \mu^+\mu^-$ events due to the Bremsstrahlung radiation energy loss in the 3mm think gold target, in silicon detector and in all the materials in the down stream spectrometer. The J/Ψ production cross section is measured to be 385.7 $\pm$ 6.0 $\pm$ 84.7 nb and 410 $\pm$ 133 nb for $J/\Psi \to \mu^+\mu^-$ and $J/\Psi \to e^+e^-$ respectively.

Through the tracking in the silicon vertex detector, more than 20 $J/\Psi \to \mu^+\mu^-$ events and 4 $J/\Psi \to e^+e^-$ events are originated in the down-stream of the target, which are taken as the decay product of B meson decay. Normalizing to the J/Ψ cross section, the B meson production cross section is measured to be 4.6 $\pm$ 1.8 nb and 11 $\pm$ 6 nb from $\mu^+\mu^-$ and e^+e^- study respectively.

3. Other Research Activities:

A small laboratory has been setup in our institute for detector design, manufacture and test. Prototype proptube and multi-wire proportional chamber have been successfully constructed. Investigation to understand the detector performance under various running conditions, such as gas gain versus gas mixture and high voltage setting, ... etc. has been done.

The design and construction of a gas microstrip detector is in progress. Gas microstrip detector is particularly interesting because of its high rate capability and potential usage in future experiment.

III

List of Ongoing Research

中央研究院物理所八十三年度計劃清單一覽表

主持人	計畫名稱	執行期間	計畫編號
曾忠一	NOAA衛星可見光資料的大氣修正	82.7.1－83.6.30	八三一遙測－01－20
王唯工	靈芝對人體脈波及穴道微循環之影響	82.7.1－83.6.30	NRICM-83107
何侗民	矽中鋰鈹複合雜質紅外線吸收光譜之研究	82.8.1－83.7.31	NSC83-0208-M-001-021
余海禮	強耦合規範場論(III)	82.8.1－83.7.31	NSC83-0208-M-001-015
鄭海揚	粒子現象學之研究(II)	82.8.1－83.7.31	NSC83-0208-M-001-014
任盛源	鐵－鎳磁膜的製作與其磁域研究	82.8.1－83.7.31	NSC83-0208-M-001-061
張志義	重夸克對稱	82.8.1－83.7.31	NSC83-0208-M-001-012
陳志強	非平衡液面現象之研究	82.8.1－83.7.31	NSC83-0208-M-001-046
李世炳	尺度不變理論的重整化問題	82.8.1－83.7.31	NSC83-0208-M-001-033
梁鈞泰	統計力學中開放系統的臨界性	82.8.1－83.7.31	NSC83-0208-M-001-052
楊維邦	協變性微分算子,可積分系統 W-代數之研究(II)	82.8.1－83.7.31	NSC83-0208-M-001-053
林爾康	質子激發X－射線放射及鋰離子激發原子游離之研究	82.8.1－83.7.31	NSC83-0208-M-001-045
謝雲生	二甲基氨六氯化錫晶體之拉曼光譜與長晶研究	82.8.1－83.7.31	NSC83-0208-M-001-018
曾忠一	散射大氣中輻射傳遞模式的發展與應用(III)	82.8.1－83.7.31	NSC83-0202-M-001-038
江紀成	pf層原子核受激態生命期(IV) ^{51}Sc核構造之研究	82.8.1－83.7.31	NSC83-0208-M-001-054
劉鏞	鑽石薄膜的生長及其表面反應之研究	82.8.1－83.7.31	NSC83-0208-M-001-023
鄧炳坤	輕離子誘發金原子L殼層游離截面研究	82.8.1－83.7.31	NSC83-0208-M-001-055
陳洋元	鈰基重費米子化合物磁性與低溫比熱研究	82.8.1－83.7.31	NSC83-0208-M-001-080
姚永德	鈦鈷合金及其薄膜之物性研究	82.8.1－83.7.31	NSC83-0208-M-001-082
王建萬	低能量鋰－7誘發核反應研究	82.8.1－83.7.31	NSC83-0208-M-001-013
曾詣涵	暗物質與夸克及原子核(I)	82.8.1－83.7.31	NSC83-0208-M-001-048

主持人	計畫名稱	執行期間	計畫編號
胡進錕	臨界現象新算法及其應用	82.8.1－83.7.31	NSC83-0208-M-001-0
李世昌	強作用及強相關性系統之研究(III)	82.8.1－83.7.31	NSC83-0208-M-001-0
梁乃崇	薄膜生長之研究	82.8.1－83.7.31	NSC83-0212-M-001-0
徐則林	脈波、血流與生理功能間之關係	82.8.1－83.7.31	NSC83-0412-B-001-002-M
余岳仲	輕離子束撞擊原子之游離研究	82.8.1－83.7.31	NSC83-0208-M-001-0
王唯工	主動脈與腎動脈血流波之測量及分析	82.8.1－83.7.31	NSC83-0420-E-001-0
黃榮鑑	電廠熱排水之混合擴散與模擬研究(Ⅰ)	82.8.1－83.7.31	NSC83-0209-E-001-0
黃榮鑑	複雜紊流場之有效預測法研究	82.8.1－83.7.31	NSC83-0209-E-001-0
鄭天佐 江紀成	精密車床	82.8.1－83.7.31	NSC83-0618-M-001-0
鄭天佐	固體表面原子擴散機制及能量學研究	82.9.1－83.8.31	NSC83-0208-M-001-0
王明哲 李世昌	頂夸克,B物理及粒子偵測器研製(一)	82.9.1－83.7.31	NSC83-0208-M-001-0
Baruch Rosenstein 余海禮	夸克之拓樸禁閉(II)	82.9.16－83.9.15	NSC83-0208-M-001-0
張嘉升	原子操縱術基本原理之研究	82.12.1－83.11.30	NSC83-0208-M-001-0
杜其永	二元混合液在多孔體內之相變實驗	82.2.1.－83.3.31	NSC82-0208-M-001-1
簡來成	建立「固體火箭裙焰分析」作業程式	83.2.1.－84.1.31	NSC83-0208-D-001-0

IV

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PUBLICATIONS OF LAST TWO YEARS

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2. I. Bartos and B. Rosenstein, "Edge States in Strong Magetic Field." *J. Phys.* **A27**, L53 (1994).

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V

Supporting Facilities

Computer Room
電腦室工作概況

㈠電腦室目前共有兩位工作人員，負責執行由資訊設備委員會議決議的各項事務；電腦室所有工作及支援行政室自動化系統之建立。主要工作項目為：

1. 管理及維護電腦室所有設備及資源之使用及使用者諮詢服務。
2. 提供研究人員大量資料處理及數值分析運算所需之軟，硬體設備。
3. 網路通訊服務。由於本所網路屬 TANET 上的一節點，因此可由本所網路直接對 Internet 上各節點進行通訊連結，傳遞訊息，檔案及分享資源等。
4. 行政室自動化方面，目前可透過專屬的 NetWare 網路進行資源共享及 micom 連接院內行政系統。另會計方面之專題計劃系統程式，由電腦室人員撰寫，亦已進入最後測試階段。
5. 為公共資料保存，製作備份。對全所共用系統上的所有資料及軟體等作維護及保存。
6. 提供技術支援。對所內各組別或個人提供技術、採購及網路連線之諮詢或支援服務。

㈡以目前本所擁有之軟、硬體設備及使用狀況而言：

1. 網路現況：

目前所內的網路採乙太網路（Ethernet）型態，二、三樓部份網路線是連接至一 hub 上，而行政室網路線亦是透過 hub 連接上所內網路主幹線（backbone）。

各樓層的實驗室及研究室亦透過 bridge 連接至主幹線上。整體網路的邏輯架構請參考附圖。

對外網路共可分 3 個部份，分別為本院院區光纖網路，院內 micom 系統及本所提供的兩組 modem 電話號碼。

本院院區光纖網路自八十二年五月啓用，提供院內傳輸速率達 10 MB／S。而本所與院內光纖網路之連接，乃透過計算中心之光纖中繼站所設的路由器（router）與所內網路主幹線相連。藉由光纖網路的連繫，不但在所內即可分享本院計算中心所提供的各項線上服務及各種資源，並可連上教育部的 TANET，進而與國際學術網路（BITNET）及網際網路（Internet）等大型網路相連。

而 micom 乃是經由多工器以 9600 baud 速度專線和院內計算中心的 Terminal Server 相連，提供專線的網路系統服務。

modem 系統，為時勢所趨，原二只 2400 baud 之 modem 已無法提供 user 便捷的服務，故更換為二台 14400 baud 的高速 modem，並具有傳輸即時壓縮之功能，更加快透過 modem 進入操作的 user 速度上的服務。

2. 計算機系統及其它週邊設備：

電腦室目前所有計算機設備包括四部 IBM RISC / 6000 工作站，十一部 SUN Sparc 工作站，一部 VAX 3100 工作站，七部 PC 及三部麥金塔電腦。並且連接多種週邊設備以期多方面充分利用資源。八十三年度

所採購的工作站共計三部，其型號及規格分別如下：

(1) IBM RS/6000 model 375 工作站一部，含 64MB RAM，1GB H.D .17" color monitor，graphic card，Ethernet card，IBM AIX V 3.2.5 O.S，xlf compiler 及 xlc compiler 等。目前命名為 hal3。

(2) DTK SUN Sparc 10/51 工作站一部，含 128MB RAM，1GB H.D，19" color monitor，Sun OS 4.1.3。其主機名為 phys10。

(3) DTK SUN Sparc 10/51 工作站一部，含 64MB RAM，525MB H.D，19" color monitor，Sun OS 4.1.3，SUN F77 V2.0.1 網路版路一套等。主機名稱為 phys11。

而針對各類型計算機目前使用狀況分別如下：

IBM RISC/6000 工作站，主機名稱分別為 hal，hal1，hal2 及 hal3，為專供本所研究人員數值運算，資料分析處理使用。採用 IBM AIX V3.2 OS，並安裝 fortran 及 C compiler 及一套 ESSL 工程科學程式軟體。這四部工作站皆已連上所內網路，以一部 model 550 工作站為專用檔案伺服器，並可和 SUN 工作站群共用二部網路雷射印表機、磁帶機及光碟機等週邊。目前皆放置於 420 室。

SUN 工作站群屬於全所共用的計算機系統，提供計算；網路；資料儲存；備份等多方面服務功能。凡本所人員或以學術，非商業用途為目的者皆可申請使用。其主機名稱分別為 physerv；physms；phys3 ～ phys11 等。而其分置於 420 室及 317 室及其它研究室及

實驗室。所有 SUN 工作站亦連上網路，有一部專用檔案伺服器，二部印表伺服器（ 置於 420 室及 317 室）及一部共用的電子郵遞（e-mail）及譯名服務（domain name）伺服器。其餘週邊設備有一部 2.3GB 8mm 磁帶機，二部 150MB 1／4" 磁帶機，一部容量涵蓋 600MB 至 1GB 可讀寫光碟機及一部唯讀光碟機。

SUN 工作站群除了有多種週邊設備外，軟體部份採用 SUN OS 4.1.x OS，其提供 Open Windows 及 Sun View 兩種視窗軟體，e-mail、ftp、telnet 等網路服務及 C compiler。此外，另有一套 SUN F77 V2.01 compiler，mathematica V2.0 ； V2.2 ，公共軟體如 TeX、WWW、Xmosaic 等等。

透過網路的使用，user 可利用 SUN 工作站之軟碟機、磁帶機及光碟機來備份自己的資料。而電腦室除了定期製作資料備份於磁帶及光碟片上，並於網路上提供一線上的 getmir 程式幫助 user 取回前一天所有的資料，以防止 user 資料意外的流失。

在個人電腦方面，共提供七部 PC，三部麥金塔電腦。另有 4 部 PC 供訪問學人借用。在 PC 使用上提供中英文 MS-Window 及 DOS、倚天中文。文書軟體有 pe2、3，中英文 Tex，OA-mate，MS-Word，C，C++，Clipper 等。系統軟體有 OS／2，NetWare，Linux 等。另外，也有其它諸如 mathematica 等數學軟體及影像處理軟體等多項應用軟體。

麥金塔上提供 System 7 英文 OS 及 System 6 中文，其有 MS-Word 文書軟體等。並有週邊：CD-ROM 及抽取式硬碟機。

在 PC 及麥金塔輸出方面，有一 HP PJ／XL 300 彩色噴墨印表機和 HP LJ4m 600dpi 雷射印表機與之搭配。

3. 影像處理系統，電腦室於八十三年度新增一套影像處理設備，目前連接至 SUN 工作站，可透網路來使用。其提供類比和數位訊號雙重接收功能，並附有影像格式轉碼程式，可使 PC 或 Mac 上的一般影像檔透過此程式轉為 SUN 工作站上的影像格式檔輸出至此設備，藉由其照相機拍於軟片上。加強了電腦室現有的彩色輸出。

㈢其它服務支援：

在行政室自動化於八十三年度添購一部穩定性極高的 Compaq Prosignia 檔案伺服器及一部可列印 A3 大尺寸的噴墨黑白印表機，並在另一部 Xerox XP-11 雷射印表機提供華康向量字型的輸出。另外，亦有新翰藝排版系統等文書排版軟體。

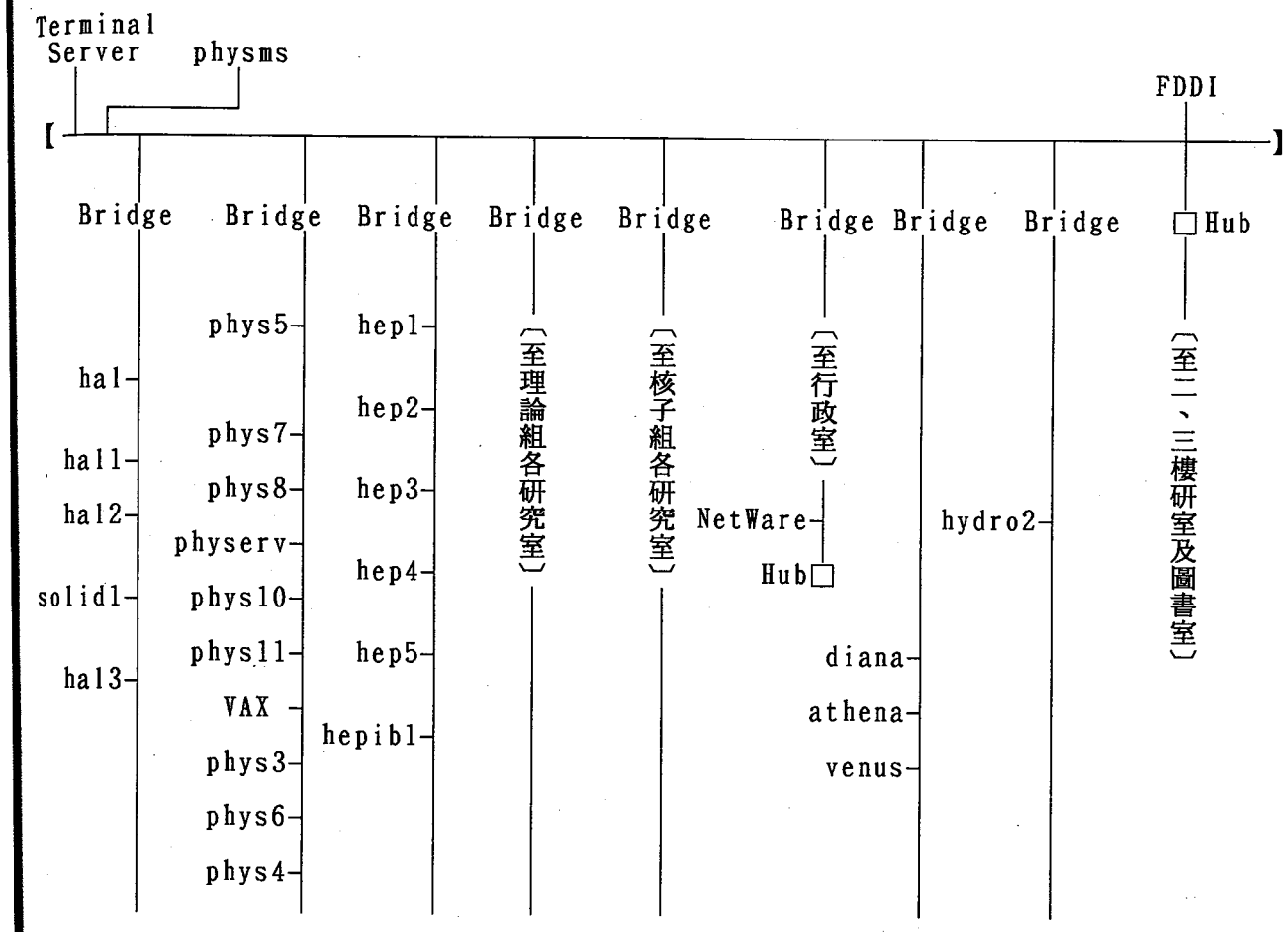
此外電腦室不但負責全所共用的電腦、網路及行政室自動化，並支援圖書室及各實驗、研究人員對網路連接、技術、採購等諮詢服務。而如本所新大樓之網路佈線及電腦室部份，亦提供管線、空間規劃等設計參考。

㈣結　論：

電腦室除維護現有設備，擴充及加強更新的設備外，也不斷加強技術及對使用者的服務。而預計編寫的簡

易使用手冊已近完成，屆時將使新 user 以最少的時間了解電腦室現有設備及如何有效操作之。而今年（八十三年）電腦室亦將各個樓層的網路線有效的連接起來，更促使所內人員不管在行政事務上，訊息傳遞上又向自動化邁進了一大步。

物理所電腦網路邏輯圖



Library
圖書室概況

壹、沿　革：

中央研究院物理研究所圖書室成立於民國51年（1962），為一學術性專門圖書館。成立的目的,在為本所研究人員,國內物理學界人士提供完善的物理學研究的環境。

貳、組　織：

隸屬於中央研究院物理研究所，所長為負責人，設有圖書委員會。委員由所內研究人員組成，協助所長掌理館藏規劃及圖書室政策之審議，並設有專業館員一名，及助理一名處理圖書資料的採訪、編目、典藏、閱覽、流通與參考服務等工作。

參、面　積：

位於物理所大樓三樓，共有170坪，內設圖書、期刊閱覽室，研究人員著作陳列室，及閱讀座位21席。

肆、經　費：

近二年來（82-83），每年購書經費約台幣650萬，其中85％訂購期刊，15％購買圖書。

伍、館　藏：

一、印刷品資料

中、西文圖書26,000餘冊（含期刊合訂本10,000餘冊）

期刊近300種（包括國際重要理期刊如Physical Review，Review of Modern Physics，Physical Review Letters等）。類別涵蓋物理、數學，及應用科學，大陸出版的科技期刊亦收藏有18種。每年購進的圖書約700種，裝訂成冊的期刊約1500冊。目前持續訂閱的期刊約200餘種。

二、非印刷品資料

㈠縮影資料（32種期刊的Back Issues）

㈡光碟系統4套

1. SCI（Science Citation Index）
2. INSPEC（Physics Abstract的光碟版）
3. PDF-2 Database（查材料屬性的資料庫）
4. OCLC（OCLC Online Computer Library Center，查西文書目的資料庫）

這些館藏除提供本所同仁使用外，並開放給外界物理研究者使用。

陸、圖書館作業內容：

圖書館作業內容分下列三點說明：

一、技術服務

僅針對資料徵集及資料處理兩方面而言。

㈠資料徵集：

1. 由研究人員推薦，經圖書委員會議審議後，提報所長視經費情況採購。
2. 資訊的掌握，為研究工作者的重要課題，本館針對此，時時注意及加強相關資料的收集，收集的途徑

如下：

(1)有學術價值的集叢，例如 Lecture notes in physics 等30餘種，委託國外書商以standing order的方式訂購，以加速資料到館的時效。

(2)單本圖書，委托國內外書商，以一般訂購方式購買。自81年度起，為改善到館時效，改以空運方式寄送。

(3)研究人員的興趣主題，凡能索贈者，即以索贈方式徵集，例如HTc Update等資料。

(4)有計劃的補購具有研究參考價值的期刊的 Back issues。

(5)陳列出版商的出版資料，做為新書介購的參考。

(6)CD-ROM在資訊檢索上較印刷資料快速，除可節省時間外，還可得到較完整的檢索，對資料的收集，助益頗大，本館為支援研究工作，購有CD-ROM產品（參考上列光碟系統），以提高服務品質。

㈡資料的處理：

徵集到館的書刊資料，為了方便管理和使用，將它作系統化的組織是必要的，本館資料處理方式如下：

1.編目：

中文採用中國編目規則（CCR），西文採用英美編目規則（AACR II）著錄該資料的題名，作者，出版資料等項目。方便館員或讀者就已知的作者，書名或主題查到所需要的資料。

2.分類：

中、西文資料分別採用中國圖書分類法，美國國會圖書館分法分類。經過分類的處理，可讓館員及讀者了解整個館藏資料的類別與性質，各類別資料間的比重及將來館藏發展的方向。資料的組織與整理是一項思考性與判斷性的工作，同時也是一項〝勞力密集〞的工作。所幸近年來電腦發展快速，利用電腦協助圖書館作業自動化可解決部份勞力的工作。

二、參考服務項目

服務項目分下列六項說明：

㈠閱覽服務：

1.本館資料採開架陳列，本院同仁可憑借書證借閱，院外人士以館內閱覽為原則。

2.每月有二次新書展示，在展示期間接受預約借閱。

㈡參考諮詢服務：

讀者可利用面洽，電話，傳眞或書信向本館查詢資料。

㈢館際合作服務：

本館是〝中華民國科技館際合作協會〞的會員，除協助本所同仁蒐訪其他圖書館收藏之科技資料外，並供應各合作單位及對物理研究有興趣者所需之資料。最近二年來，每年處理外界向本館申請的館際合作約500件，本館向外館申請的約250件。

㈣資料複印服務：

1.備有影印機二部，閱讀影印機（Reader/Printer）一部，以方便讀者在不侵害著作權益之原則下，影印本館資料。

2.備有傳眞機一部，提供資訊傳眞服務，縮短資料傳送的時間。

㈤其他：

1.購有PC，CD-ROM　Driver及Laser Printer一套，放在圖書室供研究人員檢索資料用。

2.CD-ROM網路系統的建立，是將來服務的項目，目前限於經費，尚未進行。

3.設立讀者意見箱，廣徵各方意見，做為圖書館館務推行的參考。

三、圖書館自動化

為有效處理本院館藏資料及發揮資訊交流的功能，中央研究院於民國80年引進INNOPAC圖書館自動化作業系統。本館為聯線圖書館之一，並於80年9月展開自動化作業。目前進行的工作有：

㈠書目與館藏資料的建檔：

為自動化作業第一階段的重點工作。為節省人力及加速建檔工作，利用書目光碟片做為館藏資料回溯的依據及新書編目的參考。目前已完成21,000餘筆館藏資料的建檔。

㈡期刊線上處理：

自81年底起，到館的期刊改由線上及人工雙向處理。期刊的登錄，催缺，裝訂清單的列印均可在線上

作業，使用者也可經由INNOPAC系統得知期刊到館的狀況。

㈢圖書流通：

已建有讀者檔100餘筆，借書記錄均已建入系統，陸續要完成的工作是將借書，借閱可直接在線上查看自己的借書記錄。

柒、總　結：

提供完善的資訊服務，協助研究工作的進行是本館經營的目標也是本館的任務。為了發揮此項功能，圖書館需要大家的督導，也需要大家的鼓勵。

Technical Group
技術組工作概況

本所技術組成立已屆兩年，成立的構想在集中本所目前的技術資源，作全所性的技術支援工作。其中包括：(1)電子儀器之維修與製作；(2)儀器配件之製作與組裝；(3)各種試料之裝備；(4)眞空技術之支援；(5)研究實驗用各種氣體、液體之供應與管理；(6)大型複雜性儀器設備之操作與保養；(7)放射性物料管理及輻射安全等；(8)各種電力供應通訊設施以及其它技術性之支援等等。目前技術組大約分為：(1)電子工作室(2)機械工作室(3)眞空服務(4)一般支援等四方面，茲將工作分述如下：

一、電子工作室

電子工作室對全所電子儀器設備提供服務，由於全所電子設備包羅萬 象，精密儀器種類繁多，因此在維修時，常因資料不完全，稀少性零件不 易覓得，在維護上造成困擾及耗費不少時間，我們已在加強：

1. 蒐集儀器資料：包括儀器的操作，維修手冊，以及廠商的資料等等。去年增加的資料手冊有 Analog Devices 及 National Semiconductor.
2. 加強電子零件的庫存：去年我們已開始建立一個完備而常用的電子庫存房，對於一般性的耗材能迅速提供各研究實驗室。希望能減少因耗材的欠缺而浪費時間，今年已增加 BNC， SHV 及 MHV 等訊號接頭料件庫存，亦提供各類訊號線之組裝。

3. 精密測試儀器：目前電子工作室的測試檢查儀器仍尚未完備，我們將在近期內增購邏輯分析儀、類比示波器、曲線追蹤儀、低電阻測試儀等。電子工作室去年所提供的服務如附表一：

二、機械室

機械室成立迄今已兩年餘，除了原有之設備外，又陸續添購了氬焊機、空氣離子切割機及自行修復一部木鋸床。另外在八十二年度國科會補助下，添購一部瑞士SCHAUBLIN精密車床。此部車床除了可車、削外，亦可作銑削及研磨；功能齊全，且精密度高，精密工件加工可不求外人。這部車床預計在本年六月中旬可加入運作。機械室目前正積極的建立各類耗材的庫存，以供全所同仁使用。以建立耗材庫存有：鋁材、銅材、不銹鋼材、壓克力、螺絲及Swagelok管接頭等，並且依各實驗之發展及需求，再陸續添購各類耗材。

兩年多以來，機械室的技術及工作經驗正逐步提升，將嚐試與其他較先進之機械工廠作技術交流，盼能藉此提高機械室之技術水準，以符合各實驗室之要求。機械室目前現有之設備如表二：

三、真空服務部：

眞空服務部除了繼續維持原有對原子核組加速器及固態組X光繞射各型眞空設備之操作與維修外，推廣並加強對各實驗室作眞空技術服務；另外並積極建立各項眞空零

組件與耗材的庫存，以方便同仁使用。目前已建立之庫存眞空零組件如表三：

希望在八十四年度能有一套自己的維修專用眞空泵，及一測漏儀便於維修與測試眞空設備，另一方面加強與各眞空泵製造商聯繫，能迅速取得最新的眞空泵、各類眞空系統的附件等技術資訊。

四、一般性支援

除了經常性維護本所研究大樓一般水電、消防、空調、通訊設備(包括電話、FAX、超短波、無線電等)聲光、影設備外，同時協助各實驗室改善電力品質及接地裝置，同時進行全所照明設備評估，改善目前以長條型日光燈為主的照明設備以節省燈管更換的人力及節省能源。已規劃完成液態氮供應系統工程，並於八十三年一月份試車啓用，此一系統完成後不但使各實驗室取得液態氮更為便利，在費用上，更較原先購買散裝之費用節省，預估每年可節省公帑25萬元。為了節省資源，更積極計劃將大樓各實驗室的冷卻以回收循環再利用，此計劃亦即將陸續完工。

負責全所輻射偵防，管理輻射廢料及人員輻射劑量佩章也是技術組工作之一，技術支援本所多項研討會錄音、錄影等工作；此外積極參與本所研究大樓擴建計劃，協助多項技術性及行政作業，在大樓工程進行時，將會同建築師事物所協助監工業務。

綜上所述技術組的工作繁多，除了一般性的技術支援外，也涉及到高科技的層面，怎樣使技術組茁壯成長，使

之眞正能發展配合尖端性的研究工作則還有大段路要走。而人力不足，人才難覓以及現階段的人事法令下發展出一強力技術支援群則有賴於大家的努力。好在目前各院方正積極進行“改善技術人力方案”，設法提升技術人員待遇及建立技術人員晉升管道。我們自己也在推動培訓人才的工作，設法送技術人員赴國外有名實驗室以汲取經驗，希望藉此以提昇其技術能力。

表一：電子工作室設計製作及維護項目

設計及製作方面：

工　作　項　目	使 用 人	備　註
High Speed Preamp	陳 悅 來	
High Speed Preamp	劉　鏞	Counter之前用
High Speed Preamp	鄭 天 佐	Laster Trig用
Power Supply	劉　鏞	3~617VDC,1/4A
高壓電位器製作	鄭 天 佐	6KV
高壓選擇器	鄭 天 佐	6KV
High Speed Buf 製作	何 其 力	3ns Rise Time
AMPTEC CSP 203 製作	江 紀 成	16 ch
CANBERRA 16ch Silicon Det. 測試	江 紀 成	16 ch
地線配置	陳 悅 來	
地線配置	江 紀 成	
信號線配置	林 鶴 南	RG 59
信號線配置	江 紀 成	RG 58、RG 62 RG 174
電腦網路連接	余 岳 仲	RG 58
LPF	江 紀 成	
阻抗匹配器	仲 國 慶	

修護方面

工　作　項　目	使 用 人
加速器SNIC SOURCE HV POWER SUPPLY 60KV	原子核組
EG&G Model P301 Preamp	劉　鏞
VG Gauge Controler	陳悅來
TP 520 Turbo Pump Power Supply	原子核組
加速器 TPS 調整	原子核組
Power Supply Switching Transistor更換	謝雲生
Power Supply CARD	陳悅來
Berton HV Power (10KV)	鄭天佐

表二：機械室現有設備

設備名稱	數量	設備名稱	數量
車床(楊鐵)	一部	手提砂輪研磨機	二部
鋸床(臥式)	一部	手提電鑽	二部
線鋸床(立式)	一部	手提電鋸	一部
鑽床(小型)	二部	花岩石精密平台	一部
鑽、銑兩用複合機(中型)	一部	精密高度規	一部
電焊機	一部	精密比測台	一部
砂輪機	一部	486電腦	一部
砂輪切斷機	一部	2#精密銑床(大型)	一部
氬焊機	一部	高速電鑽(小型)	一部
空氣離子切割機	一部	木鋸床(中型)	一部

表三：眞空服務部之庫存

Gasket	Blank		Bellow	UriNg	VentValve	Four way	Three way	90 ELBOW
16 CF	NW16	16CF	NW25	U.S.A.	NW-16	NW-50	35CF	NW25
35 CF	NW25	35CF	NW50	Parker	NW-40	35CF	NW25	
63 CF	NW40	63CF		Viton				
100CF	NW50	100CF		系列				
160CF		160CF						

VI

Academic Activities

Attendances in International Conferences
中研院物理所八十三年度出席國際會議表

會　議　名　稱	會　期	舉辦地點	出席人員	經費來源
第二屆國際光譜研討會議	6.27.82-7.7.82	英國約克布	何侗民	中研院
第十三屆粒子及核子國際會議	6.28.82-7.2.82	義大利 Perugia	張志義	國科會
第十三屆粒子及核子國際會議	6.28.82-7.2.82	義大利 Perugia	曾詣涵	中研院
第十一屆離子束分析國際會議	7.3.82-7.12.82	匈牙利 布達佩斯	林爾康	中研院
第五屆國際重Flavour物理研討會	7.5.82-7.11.82	加拿大 蒙特利爾	鄭海揚	物理所
第十八屆國際電子原子碰撞物理會議	7.19.82-7.27.82	丹麥奧休斯市	余岳仲	物理所
歐洲國際高能物理會議	7.20.82-7.28.82	法國馬賽	林貴林	中研院
國際純料及應用生物物理聯合會第十三屆會員大會	7.22.82-8.4.82	匈牙利 布達佩斯	王唯工	中研院
第九屆國際數值及計算機模擬會議	7.25.82-7.31.82	美國舊金山	黃榮鑑	物理所
第十三屆國際離子原子碰撞研討會	7.27.82-8.1.82	瑞典 斯德哥爾摩	余岳仲	國科會
會後作短期訪問	7.28.82-8.5.82	德國 法蘭克福	林貴林	物理所
第四十屆國際場發射研討會	8.1.82-8.7.82	日本名古屋	鄭天佐	物理所
第四十屆國際場發射研討會	8.1.82-8.7.82	日本名古屋	鄭天佐	中研院
第十六屆國際輕子光子作用研討會	8.1.82-8.17.82	美國紐約	李世昌	中研院
第十六屆國際輕子光子作用研討會	8.6.82-8.15.82	美國紐約	余海禮	中研院
第十六屆國際輕子光子研討會	8.9.82-8.15.82	美國紐約	王明哲	物理所
第十六屆國際輕子光子作用研討會	8.10.82-8.15.82	美國Ithaca	鄭海揚	中研院
第四屆國際表面結構會議	8.11.82-8.20.82	中國上海	鄭天佐	中研院

會　議　名　稱	會　期	舉辦地點	出席人員	經費來源
香港研究講習會--表面繞射及影像目睹的新領域	8.11.82-8.15.82	香　港	魏金明	國科會
表面結構新技術香港研討會	8.11.82-8.13.82	香　港	鄭天佐	物理所
赴香港及大陸進行學術交流及訪問中國科學院	8.12.82-8.25.82	香港及上海、北京	謝雲生	中研院
第二屆遠東醫工研討會	8.14.82-8.20.82	中國北平	王唯工	物理所
第四屆國際表面結構會議	8.15.82-8.20.82	中國上海	鄭天佐	中研院
碎形九三:在自然及應用科學碎形會議	8.19.82-9.12.82	英國倫敦	胡進錕	國科會
第三屆歐洲加速器應用研究及技術會議及短期訪問	8.20.82-9.6.82	法國巴黎	林爾康	物理所
第九屆國際傅立葉轉換光譜會議	8.21.82-8.30.82	加拿大卡加立	何侗民	國科會
第三屆天津宇宙學夏季課程	8.31.82-9.11.82	中國天津	吳家樂	物理所
第四屆歐洲鑽石、類鑽及相關材料會議	9.18.82-9.26.82	葡萄牙 Algarve	劉　鏞	中研院
第廿一屆國際純粹及應用物理聯盟大會年會	9.19.82-9.25.82	日本奈良	鄭天佐	中研院
第廿一屆國際純粹及應用物理聯盟大會年會	9.20.82-9.26.82	日本奈良	李世昌	中研院
手徵微擾理論及其他有效理論研討會	9.28.82-10.3.82	丹麥 Karrebaksmined	鄭海揚	中研院
兩岸港口及海岸工程開發研討會	10.15.82-10.28.82	中國南京及杭州	黃榮鑑	物理所
第四十四屆國際太空聯盟年會	10.16.82-10.22.82	奧地利 Graz	簡來成	物理所
第七屆全國光散射學術會議	10.17.82-11.2.82	中國武漢	謝雲生	物理所
第卅八屆磁學及磁性材料年會	11.12.82-11.20.82	美國明尼亞波利斯	姚永德	國科會
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會　議　名　稱	會　期	舉辦地點	出席人員	經費來源
第四十六屆美國物理學會流體動力學年會	11.19.82-11.25.82	美國墨西哥州亞巴克基市	杜其永	國科會
第三屆亞洲太平洋風工程研討會	12.12.82-12.18.82	香　港	蕭葆義	物理所
表面物理研討會--STM Workshop	2.20.83-2.24.83	日本千代	鄭天佐	物理所
1994年美國物理學會三月會議	3.20.82-3.25.83	美國匹茲堡	魏金明	物理所
美國物理學會年會並於2.24-3.19及3.26-4.1短期訪問	3.21.83-3.25.83	美　國	胡進錕	物理所
世界華人物理學會議籌備會議	3.21.82-3.23.83	大陸汕頭市	謝雲生	物理所
第十四屆國際拉曼光譜會議之衛星會議	3.25.83-3.28.83	大陸廣州	謝雲生	物理所
第三屆「沒有邊界物理」會議	4.18.83-4.19.83	美國華盛頓特區	鄭海揚	國科會
第一屆東亞生物物理研討會	5.16.83-5.20.83	日　本	王唯工	中研院

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Kratky, K. W.	Viena, Austria
Nishimori, H.	Tokyo, Japan
Parisi, G.	D Rome, Italy

Shih, W.-H.	Philadelphia, USA
Stanley, H. E.	Boston, USA
Suzuki, M.	Tokyo, Japan
Szeto, K. Y.	Hong Kong
Wu, F. Y.	Boston, USA

ORGANIZING COMMITTEE

Chan, C.-K.	Academia Sinica, Taipei
Chen, H. H.	Tsing Hua Univ., Hsinchu
Chen, L. J.	Taiwan Univ., Taipei
Chen, Y.-Y.	D Taiwan Univ., Taipei
Fung, M.-K.	Taiwan Normal Univ., Taipei
Hu, B.	Univ. of Houston, Houston
Hu, C.-K.,Chairman	Academia Sinica, Taipei
Lai, P.-Y.	Central Univ., Chungli
Leung, K.-t.	Academia Sinica, Taipei
Lin, S. C.	Academia Sinica, Taipei
Li, S. P.	Academia Sinica, Taipei
To, K.	Academia Sinica, Taipei
Tzeng, H. C.	Chung Hsin Univ., Taichung

Monday morning, 2 August 1993 Chairman: C. K. Hu

09:10-09:50 Opening and Welcome Addresses
C.-K. Hu Symposium Chairman
T.-B. Lo Vice President, Academia Sinica
A. Aharony Chairman, IUPAP Comm. on Stst. Phys.
Y. D. Yao Councillor, Phys. Soc. of ROC

09:50-10:40 Applications of Statistical Physics and Fractal Concepts to Biology
H. E. Stanley Boston Univ.

11:00-11:50 Computer Simulation Studies of Critical Phenomena (I): Statics
D. P. Landau Univ. of Georgia

Monday afternoon, 2 August 1993 Chairman: K. T. Leung

13:30-14:20 Recent Developments in Quantum Monte Carlo Methods
M. Suzuki Univ. of Tokyo

14:30-15:10 Biased Diffusion of Two Species
B. Schmittmann Virginia Poly. Inst.

15:10-15:50 Statistical Mechanics of Flux Lines in Oxide Superconductors
C. Dasgupta Indian Inst. of Science

16:00-18:15 Contributed Talks : C1-C9

Tuesday morning, 3 August 1993 Chairman: C. K. Chan

09:10-10:00 Computer Simulation Studies of Critical Phenomena (II): Dynamics
D.P. Landau Univ. of Georgia

10:00-10:40 Order-disorder Behaviors in Weakly Ionized Magneto-plasmas
Lin I National Central Univ.

11:00-11:50 Nonlinear Dynamics near Critical Points
A. Onuki Kyoto Univ.

11:50-12:30 Self-Organized Criticality
Per Bak Brookhaven National Lab.

12:30-13:30 Lunch Break

Tuesday afternoon, 3 August 1993 Chairman: P. Y. Lai

13:30-14:20 Multifractals, Multiscaling \& DLA: Theory \& Applications
H. E. Stanley Boston Univ.

14:30-15:10 What Landau Theory Tells Us about the Structure of Fullerenes
A. B. Harris Univ. of Pennsylvania

15:10-15:50 New Results on Solvable A--D--E Lattice Models
P. A. Pearce Univ. of Melbourne

16:00-18:15 Contributed Talks : F1-F9

Wednesday morning, 4 August 1993 Chairman: S. P. Lee

09:10-10:50 Frenkel-Kontorova Model of Modulated Phases
R. B. Griffiths Carnegie-Mellon Univ.

11:10-11:50 Universality in Generalized Frenkel-Kontorova Models
B. Hu Univ. of Houston

Wednesday afternoon, 4 August 1993

01:00-05:30 Visit to Palace Museum
06:30-09:00 Banquet

Thursday morning, 5 August 1993 Chairman: K. W. To

09:10-10:00 Universality, pattern selection and Scaling in the evolution of froth
E. Domany Weizmann Inst. of Science

10:00-10:40 Critical Phenomena in Interface Motion through Random Media
M. O. Robbins Johns Hopkins Univ.

11:00-11:50 Renormalization Group Methods for Flow in Oil Reservoirs
A. Aharony Tel Aviv Univ.

11:50-12:30 Exact Solution of a Model of Flux Lines in Type II Superconductors
F. Y. Wu Northeastern Univ.

12:30-13:30 Lunch Break

Thursday afternoon, 5 August 1993 Chairman: C. S. Lin

13:30-14:20 Avalanches and Catastrophes
P. Bak Brookhaven National Lab.

14:30-15:10 Dynamics of Surface Roughening in a Model Experiment on Geomorphological Evolution
T. Vicsek Eotvos Univ.

15:10-15:50 Renormalization-Group Analysis and Simulational Studies of Groove Instability in Surface Growth
F. Family Emory Univ.

16:00-18:15 Contributed Talks : J1-J9

Friday morning, 6 August 1993 Chairman: B. Hu

09:10-10:00 Superlocalization of Wave Functions on Fractal Networks
A. Aharony Tel Aviv Univ.

10:00-10:40 Periodic Orbit Theory of Deterministic Diffusion
R. Artuso Sezione Fisica Teorica

11:00-11:50 Novel Results of Extremely Thin Substrate-Free Liquid Crystal films Obtained From Calorimetric and Computer Simulation Studies: New Universality Class (?)
C. C. Huang Univ. of Minnesota

11:50-12:30 Gauge Glasses - Exact Results
H. Nishimori Tokyo Inst. of Tech.

12:30-14:00 Lunch Break

Friday afternoon, 6 August 1993 Chairman: M. K. Fung

14:00-14:50 Coherent-Anomaly Method - Recent Developments
M. Suzuki Univ. of Tokyo

15:00-15:20 Coffee Break

15:20-16:00 Finite Size Scaling Renormalization Group
P. M. C. de Oliveira U.Federal Fluminense

16:00-16:15 Coffee Break

16:15-18:30 Contributed Talks : M1-M9

List of Contributed Talks

Monday, 2 August 1993 Chairman Choon-Lin Ho

4:00-4:15 Scaling in the Collapsed Polymer Phase: Exact Results
A. L. Owczarek Univ. of Melbourne

4:15-4:30 Interaction Partially Directed Self-Avoiding Wlaks: An Exact Solution
T. Prellberg Univ. of Melbourne

4:30-4:45 Self-Avoiding Walks on a Two-Layer Square Lattice
K. Y. Lin and Y. C. Shaw Tsing-Hua Univ.

4:45-5:00 Interacting Domain Walls and the Five--Vertex Model
J. D. Noh and D. Kim Seoul National Univ.

5:00-5:15 (When) Can One Define Renormalization Group Transormations?
A.C.D. van Enter, R. Fernandez and A.D. Sokal Inst. Theo. Phys., Groningen

5:15-5:30 Critical Depinning in Disordered Media: Mean Field Theory and Functional Renormalization
L.-H. Tang Universitat zu Koln

5:30-5:45 Two-Dimensional Ising Model in External Field on a Hierarchical Lattice
F.-T. Lee and M. C. Huang Chung Yuan Christian Univ.

5:45-6:00 Almost Integrable Mappings
S. Boukraa, J-M. Maillard and G. Rollet Univ. de Paris

6:00-6:15 Kinetic Theory and Irreversible Thermodynamics
M. ChenVanier College

Tuesday, 3 August 1993 Chairman L.-J. Chen

4:00-4:15 Surface Critical Exponents of SAWs on a Square Lattice Wth an Adsorbing Linear Boundary: A Computer Simulation study
I. Chang and H. Meirovitch Florida State Univ.

4:15-4:30 Computer Simulations of Polymer Chains End-Grafted on a Surface
P.-Y. Lai Central Univ.

4:30-4:45 Anomalous Interfacial Correlations and Dispersion in Nonequilibrium Anisotropic Systems
K.-t. Leung and R. K. P. Zia Academia Sinica

4:45-5:00 Histogram Monte Carlo Renormalization Group Method and its applications
C.-K. Hu Academia Sinica

5:00-5:15 A New Methodology of Simulated Annealing for the Optimisation Problems
S. C. Lin and J. H. C. Hsueh Academia Sinica

5:15-5:30 Fractal Behavior of the Shortest Path Aggregation
X. R. Wang Hong Kong Univ. of Sci. and Tech.

5:30-5:45 The Transfer Matrix Approach to the Self-Avioding Walk and the Trail in Fractal Spaces
X. R. Wang Hong Kong Univ. of Sci. and Tech.

5:45-6:00 Quantum Monte Carlo Study of the Exchange Interaction Model
Y. C. Chen Tsing-Hua Univ.

6:00-6:15 In a Stellar Disk of Flattened Galaxies
E. Griv, Tzihong Chiueh and W. Peter Central Univ.

Thursday, 5 August 1993 Chairman H.-K. Leung

4:00-4:15 Generalized Abelian Sandpile Model
H. F. Chau Univ. of Illinois

4:15-4:30 Freezing Transitions in Neural Networks
K. Y. M. Wong Hong Kong Univ. of Sci. and Tech.

4:30-4:45 Chaotic Scattering in Three-Body Coulomb Systems: Fracal, Symbolic Dynamics, and Scaling
X. Tang, Y. Gu, and J. M. Yuan Drexel Univ.

4:45-5:00 Stochastic Excitation and Dissociation of Adsorbate in a Laser Field
W.-K. Liu Univ. of Waterloo

5:00-5:15 Long-Range Anti-Correlations and Non-Gaussian Behavior of the Heartbeat
C.-K. Peng

5:15-5:30 Fractal Diagrams for a Relativistic Standard Map
H.-C. Tseng Chung-Hsing Univ.

5:30-5:45 Coulomb Lattice in a Weakly Ionized Colloidal Plasma
J. H. Chu and Lin I Central Univ.

5:45-6:00 Phase Separation of a Diffuse Liquid-Liquid Interface
C.-K. Chan Academia Sinica

6:00-6:15 Separation of Immiscible Binary Liquid Mixture under Gravity
K. To and C.-K. Chan Academia Sinica

Friday, 6 August 1993 Chairman H.-C. Tseng

4:00-4:15 Phase Transition of Hopping Frustrated Spin Systems
K. Y. Szeto Hong Kong Univ.of Sci. and Tech.

4:15-4:30 Anomalous Crossover Behaviors in the Two-Component Random Resistor Network
K. W. Yu and P. Y. Tong Chinese Univ. of Hong Kong

4:30-4:45 Linked Cluster Series Expansion of Spin-One Heisenberg Ferromagnet with Arbitrary Crystal-Field Potential
K.-K. Pan and Y.-L. Wang Tsing Hua Univ.

4:45-5:00 Isomeric Transitions in Fullerenic and non-Fullerenic Carbon Aggregates
Z. Slanina Chung-Cheng Univ.

5:00-5:15 Critical Exponents of Chiral Universality Classes
H.-L. Yu and A. Kovner Academia Sinica

5:15-5:30 Generalized Equations for Domain Wall Dynamics
V. L. Sobolev, S. C. Chen and H. L. Huang Taiwan Univ.

5:30-5:45 AC Field Effects in Thermomagnetism
J. J. Lu, H. L. Huang, I. Klik Taiwan Univ.

5:45-6:00 A Closed Form Approximation of the Entropy of Site-Site Mixture and Site-Bond Mixture
G.-J. Lin Taiwan Univ.

6:00-6:15 Multifractal for a Polynomial Circle Map
T.-C. Yu, C.-K. Hu and B. Hu Academia Sinica

International Symposium on Surfaces and Thin Films

March 28 -April 1, 1993

March 28 (Monday)

08:00-09:20 Registration

09:20-09:30 Openning Remarks

Session I.

Chairman: Prof. M.K. Wu

09:30-10:20 M.A. van Hove
Surface Structure Determination: Details vs. the Big Picture

10:20-11:10 C.T. Chan and K.M. Ho
Investigations of Surface Structures First Principles Total Energy Caculations

11:10-12:00 T. Sakurai
FI-STM Study of Fullerenes

12:00-13:30 Lunch

Session II.

Chairman: Prof. Y.S. Gou

13:30-14:20 T.E. Madey
The Growth and Morphological Stability of Ultrathin Metal Films on Metal and Oxide Surfaces

14:20-14:40 W.S. Fann
Near Field Optical Microscope: Principles and Applications

14:40-15:30 A.M. Bradshaw
The Structure of Molecules and Molecular Fragments Adsorbed on Metal Surfaces

15:30-15:50 Coffee Break

Session III.

Chairman: Prof. C.S. Shern

15:50-16:40 R.F. Willis
Magnetism in the Monolayer Thickness Limit

16:40-17:10 A.A. Villaeys, M. Hayaski and S.H. Lin
Theoretical Description of Steady State Sum-Frequency Generation

17:10-17:30 T.S. Gau and S.L. Chang
Exact Calculation of Surface Rod-Scan Using X-Ray Dynamical Theory

17:30-17:50 W.H. Tsai, Y.H. Lian and J.G. Newman
Characterization of H_2O-Plasma Treated Polystyrene Films

March 29 (Tuesday)

Session I.

Chairman: Prof. J.T. Lue

09:30-10:20 P. Avouris
Probing the Wave Properties and Confined State of ELectrons at Surfaces with the STM

10:20-11:10 Y.M. Mo
Scanning Tunneling Microscopy Study and Control of Surface Kinetics at the Atomic Level

11:10-12:00 T.T. Tsong
An Atomic Level Study of the Dynamical Behavior and Energetics of Solid Surfaces

12:00-13:30 Lunch

Session II.

Chairman: Prof. Y.F. Chen

13:30-14:20 I.S. Hwang, S.K. Theiss and J. A. Golovchenko
Mobile Point Defects and the Atomic Basis for the Structural Transfor -mations of a Germanium Surface

14:20-14:40 C.S. Chang, H.N. Lin, W.B. Su and T.T. Tsong
Field-Induced Atom Transfer of Gold and Platinum Systems in the Scanning Tunneling Microscope Configuration

14:40-15:30 Y. Murata
Desorption Mechanism on Laser-Induced Desorption of NO and CO from Pt Surfaces

15:30-15:50 Coffee Break

Session III.

Chairman: Prof. C.Y. Huang

15:50-16:40 C.C. Chang
Molecular Dynamics Simulations of Ion Irradiation Effects on Single -Crystal Surfaces

16:40-17:30 J.E. Butler
Diamond Chemical Vapor Deposition Growth Mechanisms

17:30-17:50 K.D. Shiang, T.T. Tsong
A Molecular Dynamic Study of Self-Diffusion and Surface Reconstruction

March 30 (Wednesday)

Session I.

Chairman: Prof. Y.C. Liu

09:30-10:20 J. Kirz
Soft X-ray Microscopy

10:20-11:10 G.D.W. Smith
Three Dimensional Atom Probe Analysis

11:10-12:00 C.M. Wei, I.H. Hong and Y.C. Chou
A New Direct Surface Structure Probe by Invertion Measured Kikuchi ELectron Patterns

12:00-13:30 Lunch

Session II.

Chairman: Prof. H.L. Huang

13:30-14:20 Y. Sato
Recent Topics in Diamond CVD

14:20-14:40 Y. Liou
Emission Spectroscopy Study of Diamond Formation

14:40-15:30 H.C. Shih, S.L. Sung, L.K. Lin and W.P. Chang
Synthesis, Characterization and Application of CVD Diamiond Films

15:30-15:50 Coffee Break

Session III.

Chairman: Porf. W.S. Tse

15:50-16:40 T.J. Chuang
Surface Chemical Processes Induced and Probed by Lasers

16:40-17:30 Y.L. Wang
Diffusion and Aggregation of Oxige on Liquid Gallium Surface: Non-Qquilibrium Growth Kinetics in 2+1 Dimensions

17:30-17:50 黃蒨芸
蜂巢狀陶瓷纖維基材塗佈砂膠作爲除濕材料的應用

18:00-22:00 Banquet for Review Lecturers and Session Chairmen at Asiaworld Plaza and Chairmen

March 31 (Thursday)

09:30-11:00 Lab Tour of Institute of Physics
11:00-16:00 Lab Tour of Institute of Atomic and Molecular Sciences
16:00- Free to See Taipei

April 1 (Friday)

09:00-14:00 Tour to Palace Museum, or Synchrotron Radiation Center in Hsin-Tsu, for Foreign Visitors

1993 流體及非線性物理研習會演講時刻表

MAR 4, 1994

13:00-14:00 報到
14:10-16:30 伊林
非線性力學簡介 對稱破壞的概念 Bifurcation theory 1
17:00-18:00 陳志强
液晶中的電驅動對流

MAR 5, 1994

09:10-10:00 陳志强
流體中之熱對流及Taylor-Couette flow
10:10-12:00 陳義裕
熱對流之理論分析及自發圖案形成
12:00-13:00 午餐
13:10-14:00 陳志强
Hele-Shaw cell中的指狀結構
14:10-15:30 伊林
Bifurcation theory 2 表面成長之自發性結構
16:00-17:30 陳義裕
Lorenz方程式及振幅方程式

MAY 6, 1994

09:00-10:00 陳義裕
生物及流體中之自發圖案形成比較
10:10-11:00 陳志强
Faraday instability
11:00-12:00 綜合討論

五月十七日「吳大猷院長榮退物理研討會」時刻表

主席：謝雲生先生

14:00-14:10 李院長致辭
14:10-14:40 楊振寧
"吳大猷與我"
14:40-15:05 劉遠中
"同步輻射的建造與應用科技發展"
15:05-15:30 鄭天佐
"物理與科技發展"
15:30-15:55 吳茂昆
"The Resistive Behavior in the Superconducting state of $YBa_2 Cu_3 O_7$ System"
15:55-16:20 Coffee Break
16:20-17:00 李政道
"Bosonization of Fermions and High Tc Superconductivity"
17:00-17:25 黃偉彥
"中、高能核物理的一些迫切問題"
17:25-17:50 李世昌
"高能物理組發展近況"
17:50-18:00 吳大猷院長致辭
18:00 晚宴

The Second Workshop on Particle Physics Phenomenology

May 21-23, 1994, Taiwan, ROC
at
Kenting National Park

Organizing Institution

Institute of Physics, Academia Sinica

Sponsors:

National Science Council (ROC)
Ministry of Education (ROC)
Physical Society of ROC

The Scientific Program

All invited talks will have 5-10 minutes for questions and discussions.
This schedule is subject to possible last-minute adjustments.

May 21, 1994

08:40-09:00 Registration
09:00-09:10 Symposium Opening

Morning Session Chairman: Hoi-Lai Yu, Academia Sinica

09:10-10:40 M. Neubert, CERN
"Heavy Quark Effective Theory: Introduction"
10:40-11:00 Coffee Break
11:00-12:20 M. Neubert, CERN
"Heavy Quark Effective Theory: Applications"
12:20-13:00 Lunch
13:00-17:45 Free Activity
17:45-18:30 Dinner

Evening Session Chairman: Ling-Fong Li, Carnegie-Mellon University

18:50-20:00 Chi-Yee Cheung, Academia Sinica
"Chiral Dynamics of Heavy Hadrons"
20:00-20:15 Coffee Break
20:15-21:30 Wit Busza, M.I.T.
"Physics of Heavy Ion Collision and the Status of the RICH Project"

May 22, 1994

Morning Session Chairman: Wei-Shu Hou, National Taiwan University

09:00-10:30 Wei-Min Zhang, Academia Sinica
"Light-front Dynamics"
10:30-10:50 Coffee Break
10:50-12:10 Wei-Min Zhang, Academia Sinica
"Light-front QCD"
12:10-13:00 Lunch

13:00-17:45 Free Activity
17:45-18:30 Dinner

Evening Session Chairman: Shih-Chang Lee, Academia Sinica

18:50-20:00 Ling-Fong Li, Carnegie-Mellon University
"Spin Structure Functions in Deep Inelastic Scattering"
20:00-20:15 Coffee Break
20:15-21:30 Hsiang-Nan Li, National Chung Cheng University
"Perturbative QCD Analysis of B Decays"

May 23, 1994

Morning Session Chairman: Darwin Chang, National Tsing Hua University

09:00-10:30 Chao-Qiang Geng, National Tsing Hua University
"Search for Time-reversal Violating Effects"
10:30-10:45 Coffee Break
10:45-11:45 S. Pakvasa, University of Hawaii
"CP Violation in Hyperon Decay"
11:45-12:00 Symposium Closing

Seminars
中央研究院物理所八十三年度演講一覽表

演講題目	演講者姓名	所屬機構	日期
Covariant Nonlocal Effective Action	V.V. Zhytnikov	中央大學物理所	82/07/01
Effect of Spin-Orbit Scattering on the Transport in Narrow Constrictions	朱仲夏	交通大學電子物理系	82/07/01
Baryogenesis	Bengt-Ake Lindholm	Center for Theoretical Phys. Seoul National University	82/07/02
Positrons From Supernova	陳啓榮	中央大學天文研究所	82/07/02
近代科學進入中國的歷史	楊振寧	國科會邀請講席	82/07/14
Search for Top at Collider Detector at Fermilab	J. Antos	中研院物理所	82/07/23
Knots and Statistical Mechanics	伍法岳	美國東北大學物理系	82/07/26
Knots and Statistical Mechanies	伍法岳	美國東北大學物理系	82/07/27
Nucleaire et De Physique Des Particules EPR:Theory, Experimental	C. Schwab	Institute National De Physique	82/08/03
Hamiltonian & non-Hamiltonian Fixed Points in Driven Diffusive Systems	B. Schmittmann	Virginia Polytechnic Institute & State University	82/08/11
Heavy Particle Effects in Rare Decays and High Order Radiative Correction	李靈峰	Carnegie Mellon University	82/08/11
Infinite Discrete Symmetries of Phase Diagrams of Two-Dimensional and Three-Dimensional Spin and Verten Lattice Models	Millard Jean-Marie	LPTHE, Univ. Pavel M. CURIE, CNRS	82/08/13
Fractal Landscape of DNA Sequences	彭仲康	Harvard Medical School	82/08/16
Chaotic Electronic Scattering: Fractal, Symbolic Dynamics, and Scaling	袁建民	Drexel Univ., U.S.A.	82/08/16
Chaotic Atomic Scattering: Stimulated Molecular Recombination as a Simplest Possible Chemical Reaction	袁建民	Drexel Univ., U.S.A.	82/08/17
Cross-Sectional Scanning Tunneling Spectroscopy of Semiconductor Heterostructures	C.K. Shih	Univ. of Texas at Austin	82/08/23
Soft Condensed Matter Journal Club Organization Meeting	陳志強	中研院物理所	82/08/30
Transition between Craek Patterns in Quenched Glass Plates	劉文祺	中研院物理所	82/09/06
Quantum Field Theories of Group-Valued Local Fields: Exchange Algebras and Local-Quantum-Group Symmetry	Ling-Lie Chau	University of California, Davis	82/09/07

演講題目	演講者姓名	所屬機構	日期
1P1 States of Heavy Quarkonia	San Fu Tuan	University of Hawaii	82/09/10
Synchronizing Chaotic System	陳義裕	台灣大學物理所	82/09/13
Graviton Production in Inflationary Cosmology	吳建宏	中研院物理所	82/09/17
Now Advances in Spectromicroscopy and Free Elcctron Laser Spectroscopy in Physics and Biophysics	Giorgio Margariton do	Ecole Polytechnique Federale de Lausanne, SWISS	82/09/18
Alternating Morphology Transition in Electrochemical Desposition	徐茂傑	中研院物理所	82/09/20
What Is New Inside the Proton?	余海禮	中研院物理所	82/09/20
When Order Is Disordored:Entropy-Driven Formation of a Superlattil in a Hard-Sphere Binary Mixture	謝定國	中研院物理所	82/09/27
Quark-Lepton Symmetry	Henry Lew	中研院物理所	82/10/01
Probing Surfaces with Theoretical Calculations	陳子亭	Ames. Lab.	82/10/04
The Physics and Mathematics of Fullerences	陳子亭	Ames. Lab.	82/10/04
高溫超導磁浮軸承之物性研究	張培仁	台灣大學應力所	82/10/05
Times Arrow and Boltzmann's Entropy	Joel Lebowitz	Rutgers University	82/10/06
Stationary Nonequilibrium States	Joel Lebowitz	Rutgers University	82/10/06
Two Body Problems for Maxwell-Chern-Simons Anyons	G.M. Zinovjev	Division of High Energy Physics, ITP Kiev	82/10/08
Photon-Photon Interactions at LEP 200 with the L3 Detector	Maurice Bourquin	University of Geneva, Switzerland	82/10/08
A Talk on Discrete Vortex Method	張建成	台灣大學應力所	82/10/13
Eigenstates of the Rotation Opcrator: The Creation and Destruction of Vortex States in 2-Dimensions	Achilles Speliotopoulos	中研院物理所	82/10/15
Singular Dynamical Renormalization Group and Biased Diffusion on Fractals	陳企寧	中研院物理所	82/10/18
熵α面積的物理解釋	吳錦鉉	Dept. of Phys. and Astr. University of Maryland	82/10/22

演講題目	演講者姓名	所屬機構	日期
Marangoni Instability in a Liquid Layer with Two Free Surfaces	杜鎮球	Nasa Lewis Research Center	82/10/27
Hints of the Top Quark?	葉恭平	美國費米國家加速器實驗室	82/10/29
Theory of Special Relativity and a Generalized Transformation	劉前覺	Marquette University	82/11/04
Theory of Special Relativity and a Generalized Transformation-Application in Quantum Field Theory	劉前覺	Marquette University	82/11/05
CP Violation in Hyperon Decays	張達文	清華大學物理所	82/11/05
Monte Carlo Method	陳昭安	中央大學物理所	82/11/08
Soft Condensed Matter Journal Club: Spatial & Temporal Chaotic Patterns	杜其永	中研院物理所	82/11/15
Deep Inelastic Scattering as a Probe of Nucleon Structure	A.W. Thomas	Univ. of Adelaide Australia	82/11/17
Recent Surprises in Deep Inelastic Scattering	A.W. Thomas	Univ. of Adelaide Australia	82/11/17
Fermions from Photons: Bosonization in Three Dimensions	Alex Kovner	Los Alamos National Lab.	82/11/19
我國第三代同步輻射加速器之建造與試俥	劉遠中	清華大學物理系 同步輻射研究中心	82/11/19
Turbulence in the atmospheric boundary layer:wavelet approa	朱佳仁	中央大學土木系	82/11/24
從多體微觀理論與藍道費米液態現象理論看電子自旋感應	賴山強	中央大學物理系	82/11/25
Recent in teresting development in large Nc QCD (I)	鄭海揚	中研院物理所	82/11/26
Soft Condensed Mtter Journal Club: Adsorption Transition in Polymer System	黎璧賢	中央大學物理系	82/11/29
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中央研究院物理研究所年報

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中央研究院
物理研究所年報
第二十二卷

發行人：鄭 天 佐
編輯者：中央研究院物理研究所（出版小組）
出版者：中央研究院物理研究所　臺北市南港區
印刷者：英杰企業有限公司
電　話：七三二一二三四

中華民國八十三年七月出版