ANNUAL REPORT

of

THE INSTITUTE OF PHYSICS ACADEMIA SINICA

VOLUME 20

APRIL 1992

THE INSTITUTE OF PHYSICS, ACADEMIA SINICA
TAIPEI, TAIWAN, REPUBLIC OF CHINA

中央研究院物理研究所集刊

第二十卷

中央研究院物理研究所印行

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說明：

本刊主要是物理研究所從七十九年八月到八十年七月間學術活動之紀錄。今年所刊和以往不同的地方在於我們這次把內容分爲五部份。第一部份是本所四組之研究發展和設備的介紹。其內容都是各組負責人撰寫的。第二部份則是各研究人員正在進行研究之摘要。這部份之內容主要是從各研究人員之國科會研究計劃中找到。在自由投稿的第三部份，我們收集了一些研究題目的介紹文章和本所電腦室之發展和設備簡介。我們把各研究人員研究成果之摘要收錄於第四部份。由於這部份之資料皆由研究人員自己提供，所以並非代表本所所有之研究成果。最後之第五部份是本所所舉辦之學術演講和各研究人員所參加會議之名稱。

The Annual Report is published annually by the Institute of
Physics, Academia Sinica, Taipei, Taiwan, 115, Republic of China

I

Review of Research Projects

Nuclear Physics Group

Experimental Nuclear Physics

The focus of our research activities is accelerator-based physics, where the new 3 MV 9SDH-2 pelletron accelerator is a new experimental facility for research. We branched into some areas of research including low-energy nuclear physics, atomic physics, and applied technology. During the year 1990-1991 progress in research has been made by the accelerator laboratory. The following overview is not intended as a summary of the work done in this period; instead it describes briefly some experimental results obtained for the research projects last year.

1. Nuclear reaction induced by alpha-particles at low energies

Charged-particle reactions have provided considerable information on level schemes. From the study of alpha-particle capture reactions at low energies, information on the high excitation levels can be obtained. with alpha-particle beam from our new 3 MV Pelletron tandem accelerator, we are able to measure precisely the excitation function of reaction products with a small step of energy (6 KeV). In a project we carried out measurements of the gamma-radiation following the reactions $^{27}Al(\alpha,\gamma)^{31}P$, $^{27}Al(\alpha,p\gamma)^{30}Si$, $^{27}Al(\alpha,\alpha\gamma)^{27}Al$ and $^{27}Al(\alpha, n\gamma)^{30}P$ in the energy range E_α =3.4-6.4 MeV. Many new resonances were found and the corresponding excitation energies (12-15 MeV) were determined. The results provide an useful information for further studies of the higher excitation(>12.6 MeV) and high spin states in ^{31}P.

2. Nuclear reaction induced by protons at low energies

A research is directed towards detailed investigation of statistical properties of nuclear levels measured with high-energy-resolution proton beams at low energies. We carried out a ^{27}Al + p experiment for E_p =3.58-4.06 MeV and measured excitation functions of various decay modes with $\triangle$ E=2 KeV. Considerable

information on the resonances and decay modes of the compound system $^{27}Al + p$ at 15.03 - 15.50 MeV excitation have been obtained. The fine structure of resonances was observed, and energies together with widths of resonances were determined. Also, the spin and parity of several resonances were suggested.

3. Atomic ionization induced by ion-atom collision

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 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 continuing need for accurate measurements of cross section induced by many different ions. In a project we made a detailed measurement of the K x-ray production cross sections for Co induced by protons, deuterons, ^{3}He and ^{4}He particles with high precision at 0.5-3.0 MeV/amu, and compared the results with the predictions of the ECPSSR theory and first Born approximation. The target Co was selected for the investigation since few experimental data for x-ray procduction cross sections exist for the Z=27 element.

4. Proton induced x-ray emission

The proton induced x-ray emission is an useful tool for a variety of application over a broad range of sample types and specimens. We have established the beamline system and experimental setup for elemental analysis using PIXE method with an external beam. An external beam nozzle probe was designed specially for the PIXE measurement. The proton beam was led to air passing through slits and graphite collimator with a circular aperature inside the nozzle probe. In January, 1991, we successfully obtained the 3 MeV proton beam with 25 nA of a size 1 mm in diameter at exit of the nozzle probe travelling in the air for a distance of 13 cm. Experiments for the elemental analysis of the ancient Chinese porcelains using PIXE method are in progress.

5. Off-beam and in-beam gamma spectroscopy

The off-beam γ - Spectroscopy or radioactivity measurements have been performed in this laboratory. The radioactive samples were prepared by thermal neutron irradiation in Tsing-Hua University reactor. The singles, coincidence spectra and the $\gamma - \gamma$ directional correlation functions for the selected cascades are being measured for studying the nuclear structure parameters, the results are compared with IBA and collective calculations. ^{82}Kr, ^{110}Cd and ^{124}Te nuclei have been studied in the last year.

The in-beam γ - spectroscopy studies is another one of our research projects. The light ion or light -heavy ion capture radiative reactions and the short lifetime measurements for the nuclear excited states with Doppler Shift Attenuation Method (DSAM) is proposed to measure the (d, p γ) or other (particle, particle γ) reactions at low energies. At the first stage, the sd shell nuclei such as ^{54}Cr, ^{50}Ti and ^{48}Ca etc. are focused. A series study on the odd-odd nuclei are succeeding. In these studies, the outgoing particle -, particle - γ , and $\gamma - \gamma$ spectra are expected to be obtained to extract the structure informations for the specific nuclei. Two special scattering chambers for this purposes have been designed and produced. An integrated multichannel detector system of multi-strip Si detector is adopted for the outgoing particle measurement. A new beam transportation line, includes a quadruple-doublet lens, a double slit assembly and an ion pump also will be installed in the position of 45^{0} from the switching magnet for the purpose. And a new electronic system for event-by-event data acquisition has been built-up. This fast logic system includes the Fast MIN modules, CAMAC modules and a μ -VAX II computer. For the data acquisition and replay, the software Q of LAMPF is used. The whole system has been tested and works well.

A low energy (p, γ) reactions are also proposed to study the meson exchange current effect in the D (p, γ) ^{3}He reaction.

6. International collaborative research

(a) with the Cyclotron and Radioisotope Center (CYRIC) at Tohoku University,

Japan

For years our group members have performed experiments at Cyric using their 35 MeV cyclotron to study the charge exchange (p,n) reactions. In 1990-91 nuclear charge exchange reactions continue to be of our interest, particularly the 6 J=1 stretched states and isobaric-analog transition in sd-shell nuclei. By mean of high resolution time-of-flight technique, (p, n) reactions on many sd-shell nuclei (^{17}O, ^{18}O, ^{22}Ne, ^{25}Mg, ^{26}Mg, ^{27}Al, ^{30}Si, ^{34}S, ^{38}Ar, and ^{40}Ar) have been studied to investigate systematically the isovector potential parameters in the nucleon-nucleon channel.

(b) with Fermi National Accelerator Laboratory (FNAL), USA, for high energy physics experiment

Two group members joined the E789 project of Fermi Laboratory in 1989 initiated by Dr. J. C. Peng of Los Alamos National Laboratory for a long-term collaborative work on the experimental investigation of the rare two-body decay modes of B-mesons and D-mesons. Observation of such decays could provide the first definitive experimental evidence on the coupling between beauty-quark and up-quark as well as the possibility of observing CP-violation in B -meson decays. Such measurements will give vital information on the origin of CP-violation, so far only observed in neutral kaon system. To accomplish this task E789 have developed the world's most powerful particle-antiparticle spectrometer. It combines a very high-rate microvertex detector and a magnetic spectromenter with excellent invariant mass resolution. A state-of-the-art Ring Imaging Cerenkov detector provides particle identification over the full range of accepted momentum.

E789 received its first allotment of beam time during May -August, 1990. This was a low-intensity test run at a low-mass spectrometer setting optimized for charm decays. With a total of 8 Silicon Micro-strip Detector (SMD), the two-body decay modes of D mesons had been observed successfully. Sufficient data were taken to see D→K pi at the few-hundred-event level and to search for dileptonic D decays at the 10E-5 level.

The upgrade of the E789 apparatus took place from Sept. 1990 to May 1991. First, all 16 SMD, together with their readout electronics, were implemented and

tested. This will greatly improve the overall efficiency and accuracy of the vertex measurement. Second, the vertex processor is operational. That will efficiently reject background events and allow much high interaction rates. Third, the data acquisition system was upgraded to accept up to 64 megabytes of data during one beam spill, a factor of 16 improvement over the previous system.

Visits to Fermi Laboratory to do E789 experiments were supported by the National Science Council. In the year 1990-91 the collaborative work procceed smoothly.

Experimental and Computing Facilities

Nuclear Physics

In 1989, a 3 MV Pelletron tandem accelerator was installed in the Institute of Physics, Academia Sinica, for basic research in atomic and nuclear physics and for a wide range of ion beam technique applications. It is an ion accelerator of model 9SDH-2, rated at terminal voltage 3 MV, manufcatured by the National Electrostatics Corporation (NEC), Wisconsin, USA. The Pelletron is now one of important facilities for experimental research in the Institute of Physics.

The accelerator project for the Institute of Physics was initiated in early 1985. After taking about two years for preparation, the project has set into operation in late 1986. The contract was signed with NEC to purchase their new model 9SDH-2 Pelletron accelerator in 1987. The installation of entire systems in the basement of the Physics Building was completed in April 1989, and later the ion-beams of H through Zr were run with a satisfactory performance for the acceptance tests. The following Table shows the specifications of the 9SDH- 2 accelerator:

Insulating Column Voltage Rating	3.00 Megavolts
Voltage Stability	Better than 1KV
Voltage Ripple	500V peak-to-peak
Singly Charged Ion Energy Range	0.5-6.0 MeV
Doubly Charged Ion Energy Range	0.75-9.0 MeV
Triply Charged Ion Energy Range	1.0-12.0 MeV
Charging Current Rating	300 microamps (60Hz power)
	250 microamps (50Hz power)

Beam Current (in acceptance test):

H^{+}	2.0 microamps at 3.0 MeV
$^{4}He^{2+}$	1.0 microamps at 3.0 MeV
B^{2+}	10.0 microamps at 9.0 MeV
B^{3+}	6.0 microamps at 9.0 MeV
Si^{2+}	25.0 microamps at 9.0 MeV
Base Vacuum (no beam)	$1\times10^{-8}-5\times10^{-8}$ Torr

The installed accelerator system has two negative ion sources, SNICS for solid source material and Alphatross for noble gases ^{3}He and ^{4}He, capable of producing a wide range of ion beam species. The ion-beams for a given charged (Z) state with a maximium energy E=3(Z+1) MeV can be analyzed and selected by a analyzing magnet to meet experimental need.

Since the accelerator started to operate, establishment of beamlines, design and construction of scattering chambers, instrumentation and development of facilities have required much of our conscientious efforts in the past two years. At present, four beamlines at 0^{0}, 15^{0}, and $\pm 30^{0}$ from the switching magnet have been set up. Three scattering chambers have been designed and built and installed at the end of the 0^{0} and 15^{0} beamlines, respectivity, for studies of nuclear radiative transition reaction, for investigations of atomic inner-shell ionizations induced by light ions, and for gas jet target to study the charge exchange transfer mechanism and molecular effect in the ion-atom collision induced by light ions from the new pelletron. In addition, a NEC RC43 RBS end-station with a 17 in. chamber assembly was installed at the end of the 30^{0} beamline for measurements using RBS and channeling techniques, and one beamline at -30^{0} was established for elemental analysis with external beam PIXE, and for other technological applications. Under the support and help of the laboratory staffs, a fifth beamline (-15^{0}) has been recently set up by the users from the Institute of Nuclear Science of National Tsinghua University for a collaborative research project of charged particles bombardment-induced radiation damage in materials.

The accelerator has been operated reliably over a period of two years since

operation. The member staffs have continuously devoted much of their time to the laboratory works for the successful operation of the accelerator and to the necessary works for getting experiments started. Several experiments have been performed in the second year. Although the accelerator will be used primarily for institute staffs, it is opened to users throughout universities. International colaborative programs can be arranged for users from abroad.

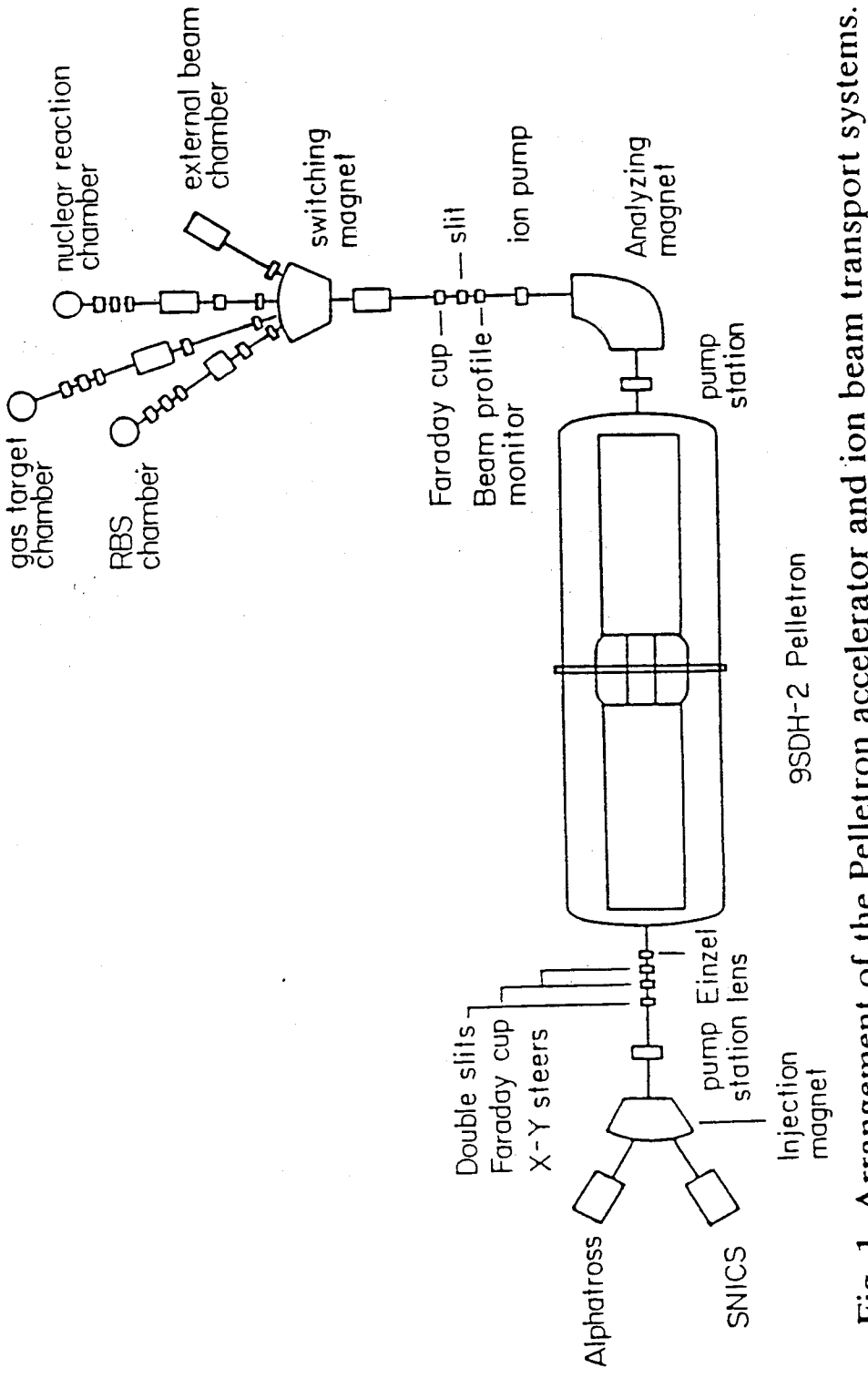


Fig. 1. Arrangement of the Pelletron accelerator and ion beam transport systems.

Hydrodynamic and Atmospheric Physics Group

Review of Research Activities

1. Turbulent Flow

The turbulent flow study is one of our research activities focus. The flow encountered in nature is almost turbulent flow. Our experimental researches on turbulent flow were conducted in wind tunnel. The study topics include :

(a) turbulent wake behind the cylinder and flat plate

(b) artificial disturbances in the wall region of the turbulent boundary layer,

(c) detection of bursts events in the turbulent boundary layer.

From the experimental investigations, we obtain some valuable results which can provide more understanding in the turbulent wake flows and turbulent boundary layer flows.

2. Hydrodynamics of complex fluids

The term "complex fluid" refers to fluids with internal structure such as polymer solutions, liquid crystals and fluid mixtures close to their critical point. One important characteristic of complex fluids is that the hydrodynamics of these fluids are not governed simply by the Navier-Stokes equations. For example, it is well known that a small amount of polymer can drastically reduce the turbulent drag in a pipe flow. Our interest in complex fluid is mainly on its non-linear behavior and rich hydrodynamic phenomena not observable in other systems.

Currently, both numerical and experimental works are being undertaken to understand the nature of complex fluid flow. On the experimental side, we are working on :

(a) Convection Pattern in Phase-separated Binary Mixture

(b) Demixing of Binary Mixture Under Gravity

(c) Viscosity of Phase-Separating Fluid

(d) Surface Roughness of a Growing air-liquid interface inside a porous medium.

As for the numerical studies, we are developing simulation models to study the effect of flow on a binary mixture close to the critical point. Specific works include :

(a) simulation of shear in an Ising model

(b) simulation of critical phenomena in cellular automata

3. Computational Fluid Dynamics (CFD)

Using computational technique and physical models, one can simulate the fluid phenomena numerically. Recently, Academia Sinica equipped a super computer with performance of parallel/vector processor. It is encouraged to utilize the parallel/vector technology to enhance the computation capability. Not only the program technology but also the numerical algorithm are investigated by the improved facilities to meet the recent development of computational hydrodynamics.

Both theoretical and applied aspects of the fluid dynamics are performed in our group:

(a) Classical fluid dynamics: laminar and turbulent boundary layer phenomena are investigated. Flow over circular, elliptic and various shapes are studied to examine the boundary layer structure and the mechanism of effect on the flow. Stratified flow is interested to simulate the buoyancy diffusion, and diffusion phenomena of the pollutant in the atmosphere and ocean.

(b) computational technology: grid generation, adaptive grid, multi-level grid technology are developed and applied in research in classical atmospheric and ocean problem. Monte Carlo method are practiced to research the suspensive particle flow and solidification problems.

(c) flow stabilities: stabilities of flow transition from laminar to turbulent phase change, porous flow and phase change occurrence are also the main research field in the group.

(d) atmospheric physics: cloud physics, remote sensing and atmospheric dispersion are investigated for basic theory and application.

Research Facilities

1. Environmental Wind Tunnel Laboratory

Most of the works on turbulence are done in a wind tunel. The environmental wind tunnel is an open suction type. The cross section is 3m wide, 2.2m high and the test section is 18.5m long. The fan is an 16-blade axial type and is driven by a 200 HP DC servomotor. The contraction ratio is 4:1. In the wind tunnel laboratory, there are also data acquisition system and hot wire anemometer system. Besides these, there is also computer system which is used to process the experimental date.

2. Optical Hydrodynamic Laboratory

This is still currently a developing laboratory intended to facilitate the studies of complex fluids. Optical means are used to measure and study flow phenomena in complex fluid systems. Important equipments are:

(a) Temperature Control System: since temperature is usually a very important parameter for complex fluids, temperature controls are used extensively in this laboratory. We have developed and built temperature controlling air and water bath with the stability of $\pm$ 2mk and $\pm$ 0.5mk respectively.

(b) Video Image Processing System: For slow and steady state flow phenomena, a video image processing system is developed to record and analysize the video data. The system is comprised of a CCD camera, image frame grabber, an Umatic video recorder, a frame code generator and a PC/AT. Because of the limited processing power of the PC/AT, the system is also networked to the work stations of the group. The resolution of the system is now 512x512 pixels with 256 gray levels for every 1/30 sec.

(c) Laser Doppler Velocemetry: For non-contact measurement of flow velocity in sealed samples, a laser Doppler velocimeter is acquired recently. This velocimeter has a 2D probe which can measure the x and y component of the flow up to 5m/s. This equipment is still under testing and development. Future applications include flow in porous media, polymer solutions, liquid

crystals and other basic fluid flow researches which preclude the use of hot wire.

(d) Liquid-Liquid Interface Shape Reflectometer: This equipment is totally built by our members in the laboratory. By using a scanning laser beam reflected from the liquid-liquid interface and the above mentioned image processing system, we have developed a reflectometer which can measure the shape of the interface up to a 5 micron resolution in a 5 cm range. Currently, this reflectometer is used to study the convection pattern in a phase-separated binary mixture. We are planning to use the system to study the contact angle of liquid systems.

3. 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 x 60 cm and 8 m long. Flow can be realized by a towing track mounted on the channel or by a wave generator which circulates the fluid by 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 systim is developed to study the flow in a qualitative manner.

4. Computation Room

The group has a computation room which housed two SUN4 Sparc workstations for numerical calculation and data analysis of experimental data. The image processing system and particle velocimetry system mentioned above are in fact connected with these two workstation to form a small network of the group. One advantage of such a configuration is that one can use the mass-storage of the work stations with a PC. At present the two work stations deliver a total of 25 MIPS computation power which is quite adequate for experimental data analysis but not too comfortable in performing CFD tasks. However, as the computation facilities of the Institute and Academia Sinica is improving every year, these public facilities should be able to fulfil most of the CFD needs.

Future Outlook

The group is actively seeking new members to join the group to enhance the ongoing researches and at the same time develop researches in area such as non-linear hydrodynamic phenomena and fundamental flow physics. In the next five years, it is the plan of the group to enhance the following new research area to meet the latest developments of physical hydrodynamics:

(a) Fundamental fluid flow phenomena: although the subject of hydrodynamics has been studied for a long time, there are still many fundamental problems which one has only very little or even no understanding. Good examples are those of transition to turbulence, intermittency and flow in porous media. In fact, these problems have been very popular among the physics communities in the last ten years as our understanding of nonlinear dynamics improvs. It is now recognized that nonlinear dynamics might have universal behaviours. The understanding of these fundamental flow problems might have impact on other fields of physics. Because of the importance of these problems, the group wants to maintain an active participation in this area.

(b) Non-linear phenomena in complex fluid: with the advances of material science and technologies, there now exist many new materials in the form of fluid such as liquid crystal, surfactant and polymer solution. It is well known that these systems have very interesting physical properties and important technological applications. However, the hydrodynamic behaviors of such systems can be very different from those of the traditional fluids like water and air. Interesting nonlinear behavior in these systems such as drag reduction have been observed but their physical origin is not well understood. Since this is a new and important area of research, the group sees very good research opportunities in this area.

Solid State and Biological Physics Group

Experimental Solid State Physics

The main research areas of our research activities are surface physics, superconductivity, Raman and infrared spectra physics, magnetism, thermal dynamic physics and bio-physics etc., During recent years, progress in research has been made. Research projects have been performed on current topics related to the fundamental problems of solid state physics, as well as problems in material sciences. The following statement is not intended as a summary of all the work done in this group; instead it describes briefly some of our recent researches only:

1. Surface physics:

Our research efforts focus on basic physics of solid surfaces and thin film. The surface physics laboratory is currently equipped with general surface science analytical instruments with the following capabilities: ESCA, UPS, LEED, AES, HREELS etc., and a microscopic surface technique, the Scanning Tunneling Microscope. A Microwave plasma chemical vapor deposition system is under construction. We also plan to add the following instruments to our laboratory in the very near future: an Atomic Force Microscope, a Field Ion Microscope, and an Atom-probe field Ion Microscope. In addition we have an active theoretical program in surface physics. Recent works accomplished and research projects in progress are summarized below.

a. Mechanism of Surface Diffusion

This project is under the direction of Tien T. Tsong, In cooperation with his students at the Pennsylvania State University. The mechanisms of surface diffusion have been studied with the FIM. They found that surface diffusion of Ir atoms on Ir surfaces can occur via atomic hopping as well as atomic replacement. On already reconstructed {110} surface, atomic hopping occurs. On the nonreconstructed {001} and {110} surfaces, self-diffusion occurs by atomic

replacement. For Re adatoms on the Ir {001} surface, the atomic replacement takes two distinctive steps. First a Re-Ir dimer -vacancy is formed around 240 K. Upon further heating to above 280 K, the dimer dissociates and the Re atom is incorporated into the substrate lattice. The atomic steps are revealed in detail and the activation energies of these steps are derived. This reserach results in a publication in Letter to Nature and in Physical Review Letter. The finding of the atomic replacement mechanism was also selected as "News of theWeek" of Science News of USA.

b. Binding Energy of Surface Atoms

Atomic site specific binding energy of surface atoms has been determined by a kinetic energy analysis of low temperature field evaporated ions and by thermal dissociation of surface layers. This work is also carried out under the direction of Tien T. Tsong in corporation with his students at the Pennsylvania State University.

c. Effects of Electric in atomic Manipulations

Field evaporation and a field gradient induced directional walk of surface atoms have been invoked by Tien T. Tsong to explain recent STM works on atomic manipulations. Under the direction of Tien T. Tsong, atomic replacements and surface layer alloy formation are being investigated with various surface analytical techniques. He and his assistants also intend to study various surface atomic processes and surface atomic structures with the STM.

d. Surface reaction Mechanisms and applications to diamond thin film growth

This project is under the direction of Yung Liou. Its goal is to use surface analysis tool such as low energy electron diffraction, electron energy loss spectroscopy, Auger electron spectroscopy etc. to study the physical and chemical reactions of hydrocarbon radicals interaction with the surface of diamond or substrate.

Two topics are now under study:

a. The growth of diamond thin films : this research includes design and construction of a microwave plasma chemical vapor deposition system which has three major parts : microwave system, gas flow control system and vacuum chamber plus a pumping system.

b. The analysis of diamond thin films : an electron energy loss spectrometer (EELS) plus an Auger electron spectrometer are constructed, tested and will be calibrated for this study. Other surface analysis tools such as ESCA will also be employed.

e. Surface lattice dynamics by high resolution electron energy loss spectroscopy (HREELS).

A newly constructed LK-2000 high resolution (~2 mev electron energy loss spectrometer system equiped with a quadrupole mass analyzer and Auger electron spectrometer is being checked for its electronics and vacuum by Yung Liou and his assistants. Tests of silver and copper samples are being carried out. Once the sysrem is renovated two topics are going to be emphasized :

a. High Tc superconductor surface phonon study by HREELS.

b. Diamond this film growth mechanism will be studied by HREELS.

f. Surface Structure by Diffraction Techniques

This projest is under the direction of C.M. Wei. In this project theoretical methods for the study of the ordered surfaces, including dynamical low-energy electron diffraction, angle-resolved X-ray photoelectron and Auger-electron diffraction, energy-dependent photoelectron spectroscopy and high-resolution electron energy loss spectroscopy, have been developed. Research areas can be covered include : (1) the study of surface structure of metals, semiconductors, gas -covered metals and metal-adsorbed semiconductors by low-energy electron diffraction. (2) the study of surface structure of small molecules adsorbed on metal and semiconductor surfaces by angle-resolved X-ray photoelectron and Auger electron spectroscopy, and energy-dependent photoelectron spectroscopy. (3) the study of surface vibration modes of clean metal surface and small molecules adsorbed on metal surfaces by high-resolution electron energy loss spectroscopy.

The result derived from these three techniques are complementary and interrelated. Close collaboration between theory and experiment is essential. Our objective is to formulate quantum mechanical theories to analyze and explain experimental data measured by other research group. A cooperative project "The adsorption of Hydrogen on Nb(001)' with Prof. B.S.Fang's group of National Tsing Hua University has been established.

Another research subject which has collaborated with Prof. S.Y. Tong of University of Wisconsin-Milwaukee, is to develop a "direct-imaging" method of multi-energy angle-resolved photoelectron diffraction. The advantage of this method is that, with a simple three dimensional Fourier transformation, one can reconstruct the surface structures without and dynamical calculations. Two systems, 'c(2x2) S on Ni(001)' and '(2x1) Na on Si(001)', have been studied and achieved a complete reconstruction of three-dimensional images of the surface structures with a good resolution smaller than 1 A, thus qualifying this technique as a direct structural tool. Such studies of holographic reconstruction of diffraction patterns offer the possibility of rapid processing of the diffraction patterns to yield real-time atomic-resolution images.

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 T_c oxides. It is evidently that the high T_c 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 T_c superconductors.

3. Raman and infrared spectra physics:

a. Enchanced 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. Infrared and Raman study of crystalline Li Cs SO_4 :

Li Cs SO_4 (Lithium-Cesium double sulfate) is a typical molecular crystals in which the molecular vibrations are divided into two groups. The high frequency modes correspond to internal molecular stretching while the low frequency group belongs to their lattice vibrational modes. This information can give a help to the lattice dynamics calculation in molecular crystals. An X-ray diffraction measurement has shown that the crystal undergo several phases from 80 K to their melting point.

Applying the laser Raman and infrared spectroscopic techniques, in this work, we can obtain the complete temperature dependent Raman and infrared spectra of this crystal from 80 K to 480 K. A detailed study of the spectra of the mode frequency, linewidth, lineshape 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 vibrational modes. These analysis propose a useful optical data in lattice dynamics calculations.

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 donors and acceptors 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 position of the peak of each absorption line could be determined more precisely and some weaker lines could be resolved. 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.

4. Magnetism

a. Magnetic property of binary alloys:

Binary alloys, besides the single crystal and amorphous materials, belong to the 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 binary alloys or compounds by means of the arc melter. Their electrical resistivity, magnetization and thermal properties etc. will be studied.

b. Magnetic and electric properties of Co-Pd-Ni alloys.

The main goals in this is to study the magnetic and the electric properties of Co-Pd-Ni alloy. Especially, we shall pay attentions to those physical properties at T = 4.2K. As to the magnetic properties, the measured quantities include magnetization magnetoresistance, and magnetostriction. As to the electric properties, electrical resistivity and heat capacity of these specimens will be measured.

c. Noise and electrical conducticity in metal oxide-glass thick film:

Metal oxide-glass thick film resistors (TFR), such as Bi_2 Ru_2 O_7-glass and RuO_2- glass, are the cermat made by conductive metal-oxide particles and insulative glass particles. Thick film resistors have been widely used in hybrid

circuites due to its easy, low cost fabrication and small size. The disadvantage of this material is its ac noise induced by dc voltage bias. After the failure in explanation by conductive path model and its statistical calculation, R.W. West. G. E. Pike and C. H. Segar in 1975 based on "metal-insulator-metal tunneling" model successfully constructed noise and electrical conductivity mechanism of TFR. The noise-frequency relation can be described by Hooge's law as follows

$S_v = K \cdot V_{dc} \cdot \triangle f/f^{\alpha}$

S_v : noise power specturm. V_{dc} : DC Voltage bias across TFR, f and $\triangle$ f : frequecy and its band width, α : the exponent index, ranged approximately from 0.8 to 1.2 .

So far we have completed the noise and resistivity measurements for temperature range from 77K to 300K. Our experimental results are in good agreement with those of G. E. Pike et al. using Island model. We plan to complete our noise study in rest temperature ranges, i.e., from 1.5K to 77K and 300K to 800K. In these temperature ranges, we will have the chance to study the electronic excited states in barrier and voltage-current relation. Based on the theory of quantum tunneling effect we believe that the barrier thickness and its magnitude (which are related to particle size and its properties) are involved in mechanism of noise and electrical conductivity.

5. Thermaldynamic Physics :

a. Specific Heat of rase-earth compounds :

Valence Fluctions compound $CePd_3$ is a typical example in which the valence of Ce is dependent on time, temperature and pressure. In Heavy Fermion compound $CeAl_3$., the effective mass of f electron of Ce is about 1000 times of the rest mass of free electron. This result is shown by the specific heat coefficient measurement. Superconductivity in Heavy Fermion compounds, which is seldom to occur in the appearance of magnetic moment, have been commonly observed in these rare-earth alloys and compounds in the past two decades. These interesting physical phenomena made the study on these material more important.

We believe to perform heat capacity measurements and Hall effect

measurements on these compounds will give us more clear picture in explanation the mechanism of coherence occured in these rare-earth material.

b. Coherence effeets in Kondo lattice Studied by specific heat.

The coherence of 4f magnetic moments among rare earth ions (for example Ce ions) in Kondo lattice system is an important and difficult problem. C. D. Bredl et. al. had found anomaly in low temperature specific heat of $CeCu_2Si_2$ and $CeAl_3$ Kondo lattice systems. This anomaly which has never been observed in Kondo ion system is believed to be relevant to the coherence in Kondo lattice system. C. D. Breel et al had proposed the existence of pseudogap near Fermi energy to explain the specific heat anomaly.

The Kondo temperature values of $CeCu_2Si_2$ and $CeAl_3$ are 3K and 5K respectively. Because of the small values, the mensurements had to be performed in very low temperatures (about 1-2K). The Kondo temperatures of Ce_3X (X = Al, In, Sn) are around 10-20K. If we perform same experiments for the system, then we will have better chance to observe how the coherence is affected by magnetic field. No exact answer has been reported in this yet. We hope through the specific heat measurement of Ce_3X in applied magnetic field the answer of mechanism of coherence can be found.

6. 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 pressuse wave.

Energy in the circulatory system is mainly in the form of pressure. Kinetic energy is only a few percent. The pressrure wave is the maim 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.

We will study the external pressure on the organ to change its elasticity and measure the effect of this short time pressure change, its effect on the flood pressure wave as well as the flood flow.

Theoretical Physics Group

Review of Research Project

1. Neutrino Physics
2. Proton spin, ploarized structure functions
3. Rare decays of D and B mesons
4. Radiative corrections induced by internal top quark in the standard model
5. A cosmology with conformally coupled scalar field
6. Application of nonlocal string operator in QCD
7. Quantization of gauge theories
8. θ -vacuum of (1+1) chiral Schwinger model on torus
9. Topological field theories
10. Vilkovisky-De Witt effective action
11. A new perturbative approximation: δ - expansion
12. Phase transitions, precolation, nonlinear phenomena, self-organized criticality, quantum systems

1. Neutrino Physics

The research on neutrino physics has been focused on several areas: quantum mechanics of neutrino oscillations, properties of neutrinos in dense matter, as well as neutrino interactions in astrophysical and cosmological environments. The phenomenon of neutrino oscillation is being studied in detail while taking into consideration the correlation of the neutrino with other particles present in the production and detection processes. In the case of neutrinos in dense matter, exact second-quantized wavefunctions for a neutrino in a matter background has been obtained and the result has been used to calculate the decay of neutrinos into Nambu-Goldstone bosons in such an environment. In astrophysics, we have calculated in some detail the production of righ-handed Dirac neutrinos in supernovae via helicity-flipping neutrino scattering. We have also considered the production of these particles in the early Universe via a different mechanism, namely through pion-pole enhanced photon-photon annihilation into neutrinos. At present, we are studying the flipping of the helicity of neutrinos in intense gravitational fields.

Within the framework of the N = 1 mininal supergravity model (SUSY), we investigated the SUSY effects on neutrino-lepton elastic scattering process. The charge radius of a neutrino is given by extracting the electromagnetic form factor of the neutrino-lepton scattering process. The SUSY contribution to the neutrino charge radius (NCR) of a neutrino was performed within the Sirlin's on-shell renormalization scheme. We show that the SUSY contribution is a finite and gauge independent quantity. The effects of the extended Higgs sector, the gaugino-higgsino sector, and the squark-slepton sector are studied. We throughly study the dependence of NCR on SUSY parameters.

The gravitational coupling of spin 1/2 Dirac and Majorana particles are studied in general terms. By imposing Lorentz, CPT and CP invariance on the energy-momentum tensor matrix element, certain conditions on the form factors can be obtained. Thus, the question of whether a particle is a Dirac or Majorana type particle acquires a physical meaning.

2. Proton Spin and Polarized Structure Functions

EMC data enhanced the problem of the proton spin, which does not fully come from the valence quarks inside the proton. Its surprising conclusion attracts many physicists to address some questions of the naive parton model. With numerous suggestions and controversies over the past three years, this problem still has no definite result and what we have only known is a relation of polarizations of sea and gluon. Further studies of the spin effect inside the proton at high energies should help us to further understand its nature. This problem in fact is worth tackling. We now have firstly tried to find whether only the polarized sea or gluon distribution function can explain the EMC data.

What we have firstly done are that we assume the polarized gluon distribution is fully polarized. By a method of Operator Product Expansion (OPE), the polarized proton structure function can be directly related to the polarized up, down and strange quark distribution functions. The polarized strange quark distribution function is assumed to be equal to the polarized sea distribution function. With the assumption of the fully polarized sea and the recalculated value of g^p_1, we find out that it is possible to explain the EMC data, only considering the polarized sea distribution function.

A case of no sea polarization will also be considered, and we try to obtain the polarized gluon distribution function. Finally, we shall study a possible case of both of polarized sea and gluon distribution functions to be finite.

In spite of EMC data had stimulated the proton spin problem, we now only had one set of DIS measured data. It is difficult for physicists to adjust how large of sea polarization, gluon polarization and even for what the sign of $\triangle G$ is. Of course there are actually many questions, which are still to stay there particularly, U(1) problem which is involved in strong CP violation.

After completing the above studies, we will study spin effects with polarized protons at the Relativistic Heavy Ion Collider (RHIC). It has been pointed out that vector gauge boson productions, such as W^+, W^- and photon from pp collision, should give a better insight for u and d quarks polarization and help to pin down the gluon polarization. At now the values of polarizations of u and d quarks are

obtained from the measurements of β -decay of hyperon and neutron. And an asymmetry of direct photon production is very sensible to the polarization of gluons. For the W^+ and W^- production, their momenta should be totally reconstructed, if we let W^- and W^+ decay in leptons, it will be easy to directly measure. For further consideration of Z^0 production, we definitely have more information of u and d. And W's decay into two jets can also be studied.

3. Rare decays of D and B mesons

Measurement of the rare decay modes of charmed and bottom mesons is one of the main activities of current experiments. With the expectation that more data will become available in the near future and that this data will provide a new arena in which to test the standard model, we begin a study of the branching ratios of rare decays through the use of heavy-meson wave functions. Our goal is to learn the dynamics of weak decays.

One of the rare decays of particluar interest is the process of $B_s \to \gamma\ \gamma$. First, this process is greatly influenced by the top quark mass in its partial decay width as well as the CP properties of the two-photon final state. A heavy top quark invalidates the GIM suppression because of the contributions from one-particle-reducible diagrams. Consequently, the two-photon final state becomes a mixture of the CP even (FF) and CP odd (FF) states. The relative strength of FF and FF terms are rather sensitive to the top quark mass. Second, we found that gauge invariance dictates a strong cancellation between the contributions from the one-particle-irreducible diagrams and the reducible ones. We showed that this is a direct consequence of a non-soft extension of the low energy theorem, and it can be applied to all theoretical models. Third, the branching ratio of the decay $B_s \to \gamma\ \gamma$ was estimated to be 10^{-7} and also sensitive to the top quark mass.

4. Radiative corrections induced by internal top quark in the standard model

We are interested in constructing a low energy effective theory in which all radiative corrections induced by the heavy top quark are embedded. In the standard model, it is a well known fact that the decoupling theorem no longer

holds in general and the theory becomes non-renormalizable once heavy fermions are "integrated out" from the theory. We proceed to integrate out the top quark degree of freedom by setting its source term to zero in the generating functional. The resultant effective action after the Legendre transformation would not be gauge invariant due to the following reasons: (1) In a gauge theory, the gauge invariance could be lost by the gauge fixing; (2) By switching off the source terms for the top quark in the generating functional, one could end up with $SU(2)_L \times U(1)_Y$ non-invariant Green's functions. Furthermore, in removing any fermion degree of freedom, which participates in the anomaly-cancellation mechanism, the celebrated Wess-Zumino terms are induced. The first problem is circumvented by choosing a suitable background field gauge such that the effective action which contains only external gauge bosons and Higgs scalars is gauge invariant modulo the Wess- Zumino terms caused by the axial anomalies. The second difficulty only arises in that part of the effective action which contains external fermions as well. However, we have shown that, by putting all the external fermions on mass shell, the Green's functions so obtained are still gauge invariant. Meanwhile, except for the Wess-Zumino terms, the pure bosonic effective action has been completely determined. In the heavy top quark limit, the power counting arguments place an upper limit on the number of derivatives which could possibly appear in the gauge invariant operators. The external field method and the derivative expansion technique then permit us to obtain the effective action in the symmetrical phase of the theory. We have found agreements between our effective theory and direct calculations regarding the top quark effects on the ρ parameters and the decay of $H \to \gamma\gamma$. Further applications can be directed to the studies of vector boson scattering, Higgs productions due to gluon fusions or virtually any physical process involving top quarks in internal loops.

In the future we would like to start on new subjects in addition to expanding our current efforts on realms of the effective field theory. The immediate steps for completing the effective theory are to obtain the Wess-Zumino effective action, which is induced as one removes the top quark from the fundamental theory, as well as a parallel investigation on the effective action with external

fermions. The latter work is rather involved as the gauge non-invariant structures arises and the number of operators increases considerably.

5. A Cosmological Model with Scale Invariance

The main idea of Einstein's theory of general relativity is based on the assumption that the physical laws are invariant under the general transformations of space-time coordinates. The theory was generalized by Weyl, for whom it includes the symmetry of scale invariance. As is well-known, Weyl's gravity is not physically acceptable. However, the problems in his theory can be circumvented by the introduction of a Brans-Dicke (BD)-like scalar field. As a consequence, the gravitational "constant" is no longer a physical constant. It is given by the vacuum expectation value of the scalar field which may change with time.

On the other hand, the unrenormalizability of the quantum theory of gravity, due to the dimensional constant of gravitation, and the renormalization group arguments lead us to conjecture that the theory of gravity is locally scale invariant at distance shorter than the planck length. Thus, the theory of Einstein's gravity appears at low energies to be the broken phase via the Higgs mechanism. Meanwhile, the planck scale is generated dynamically as a vacuum expectation value of a Higgs field.

Since then, much work has been done in the studies of the cosmological models with a varying gravitational constant. Recently, extended inflation has been suggested as a new approach to the inflationary cosmology based on models closely related to the BD theory. However, most of the BD-like models not only incorporate a mysterious coupling of the BD scalar field to the trace of the energy-momentum tensor of the classical matter, but also disregard the conformal invariance from the onset, thus making them unnatural and against the original motivation.

Here, we shall discuss a scalar field theory conformally coupled to gravity. As in the BD theory, the scalar field will be associated with the gravitational constant. We shall include classical matter and a nontrivial potential for the scalar field. As in the theory of induced gravity, the potential should be dynamically

generated by quantum effects. The nontriviality of the potential can be attributed to the existence of the conformal anomaly of the scalar field in curved space-time. Hence, we shall obtain a set of equations of motion which are basically different from those obtained in most BD-like models. Although we shall not work out explicitly the form of the potential, we shall be able to discuss some specific solutions of the equations.

6. The Problems of Quantization of Gauge Theory

Quantum chromodynamics (QCD) is a very successful gauge theory for strong interactions, but its applications have been limited to problems to which QCD quantized in the covariant gauges is applicable. Therefore, consistent quantization of QCD in other gauges suited for formulating various interesting physical problems is theoretically very important.

The problems of quantizing QCD are studied in the temporal gauge, which is useful for studying the physics of quark-gluon plasma. We introduced a so-called "second-order" formalism to study the renormalization structures of the theory in two approaches. One approach is based on the requirement that the gluon propagator satisfy the temporal gauge strongly in the sense of distribution thoery and the other, on the equivalence theorem of Cheng and Tsai. The two approaches lead to different renormalization structures and, in particular, the gluon self-energies calculated to one-loop order in these approaches are non-transverse. This indicates that the Ward identity is violated, and the usefulness of these approaches in the present formalism are questionable. A "first-order" formalism can be suggested to study this problem, and is worthy of further investigation.

7. θ -Vacuum of (1+1) Chiral Schwinger Model on Torus

The vacuum is the most important structure of a quantum field theory. For chiral Schwinger model on torus, we are interested in its θ -vacuum. This model serves as a useful toy theory for a new type of non-Goldstonian symmetry breaking. The quantization of this model on non-trivial spaces is also interesting because there present non-integrable phase factors.

The quantization of the model on torus requires boundary conditions that are

periodic. Periodic boundary conditions play an important role in the formulation of lattice gauge theories. In our study, we should like to investigate the model in two steps. Quantization of the vector Schwinger model on torus is considered first. We use the canonical quantization procedure for the gauge fields in the Lorentz gauge condition, which allows us to put the fields on torus. The physical Hilbert space is defined such that it is annihilated by the gauge condition. The θ -vacuum of the model can then be obtained. The chiral model will be investigated subsequently.

8. Application of nonlocal string operators in QCD

High-energy scattering processes of hadrons with large momentum transfer can be analyzed with the help of local operator product expansion (OPE). However, it is more effective to use nonlocal light-cone expansion (LCE) as shown by earlier calculations.

From a mathematical viewpoint, nonlocal LCE is a true identity in the Fock space, but local LCE is valid only on a dense subset of the Fock space. From a physical viewpoint, the use of nonlocal LCE that makes use of nonlocal string operators is very appealing, beacuse hadrons, whose dynamics can be very well described by quantum chromodynamics (QCD), are extended objects and should be more naturally described by appropriate nonlocal operators. Therefore, nonlocal operators play an important role both in our understanding of QCD and in practical computations.

These operators are useful for calculating various high -energy cross sections or hadron wave functions. The cross sections are given by hadron time-ordered product of currents. In the context of OPE, the product is expanded as a series of nonlocal operators of different twists, whose evolutions are closely related to the moments of hadron struture functions. We recall that the method of OPE is analogous to the usual multipole expansion in electromagnetism. The multipoles for the potential of a distributive charged object characterize the moments of the charge distribution.

The hadron wave functions are defined by the time-ordered expectation of operator sandwiched in between the hadron states and the vacuum, and their

moments can also be analyzed by the nonlocal OPE method. Meson and baryon wave functions of nonleading twists have been investigated.

Presently we are calculating the string operators for lepton-hadron deep-inelastic scattering processes. We should like to obtain the evolutions of the hadron structure functions which are related to those of the operators. For the calculations, we use the background field method or external field method. Massless quarks are considered, so that the spinor calculus and conformal algebra can facilitate our analysis. The evolutions of the operators are described by the renormalization group equation.

9. Topological Field Theories

After the seminal work of E. Witten on topological quantum field theories, there has been a lot of interest on this subject. In (2+1)-dimensions there are two categories of topological theories: the Chern-Simons and the B-F theories. It has been shown that the Chern-Simons theories are related to quantum groups, conformal field theories and integrable models in (1+1)-dimensions, while the B-F theories are related to (2+1)-dimensional gravity. We have examined the perturbative properties of these theories by calculating their one-loop effective actions using the so-called eta-function regularization with some surprising results.

We hope to extend these considerations to general curved spacetimes and higher dimensions, with potential applications to Kaluza-Klein theories. Another direction that we would like to pursue is the perturbative calculations on the observables, for example, the Wilson-loop expectation values, of these theories. This will lead us to a better understanding of these theories, especially (2+1)-dimensional gravity, which is believed to be a finite theory in this formalism.

10. Vilkovisky-DeWitt Effective Action

The conventional definition of the effective action depends on the gauge choice one makes, even when the background field method is used. This problem has been solved recently by Vikovisky and DeWitt by introducing a new definition of the effective action, now known as the Vilkovisky-DeWitt effective

action. This effective action, being independent of the gauge choice, provides an unambiguous way to consider, for example, symmetry breaking through the Coleman-Weinberg mechanism. We have applied this approach to Einstein an higher-derivative gravities coupled to scalar fields to investigate the possibility of inducing Einstein gravity dynamically. At the same time the relevance of these models to the primordial inflationary scenario is also examined.

Currently, we are working on the calculation of the Vilkovisky-DeWitt effective action for Einstein gravity in six dimensions, which will have several applications in Kaluza-Klein cosmologies, notably the self-consistent compactification by Casimir effects. further applications of the Vilkovisky-DeWitt which we are interested in are the Higgs potential in the Weinberg-Salam model, finite temperature QCD, and the extension to supersymmetric theories.

11. δ -Expansion: A New Perturbative Approximation

The δ expansion is a new perturbation scheme in which an artificial expansion parameter δ is introduced through the replacement of a carefully chosen exponent by δ, inserted in such a way that at $\delta=0$ the problem is exactly soluble. For example, instead of $\lambda\phi^4$ one considers a $\lambda(\phi^2)^{1+\delta}$ theory, and expresses the relevant quantities in a power series of δ. This approach has been applied to problems both quantum mechanics and quantum field theory, to the calculation of vacuum energy in a supersymmetric Wess-Zumino model, and even to solving non-linear differential equations. We concern mainly the renormalization of the $\lambda(\phi^2)^{1+\delta}$ theory. We have shown that the theory is renormalizable and the δ expansion degenerates to the renormalized weak-coupling expansion of $\lambda\phi^4$, in the limit that the momentum cutoff is taken to infinity.

The question of renormalizability of this scheme in curved spacetime is now under investigation. On the other hand, attemps to define this type of expansion for gauge theories are also underway. This will provide a new tool to explore the strong-coupling, non-perturbative regime of gauge theories.

12. Phase transitions, percolation, nonlinear phenomena,

self-organized criticality, quantum systems

There are five research projects we are working on:

(1) Monte Carlo Study of Percolation Transitions and Phase Transitions of Interacting Systems

Many physical systems may be represented by the Potts model or the hard-cord particle model. We want to use the Swendsen and Wang's Monte Carlo simulation method to simulate clusters of a q-state bond-correlated percolation model (QBCPM) corresponding to the q-state Potts model (QPM). From such simulations we can obtain accurate physical quantities for the QPM. We can also use the Monte Carlo simulation method to study the hard-core particles on lattices with the pure excluded volume interactions. The phase transitions of the studied systems will be compared to the percolation transitions.

(2) Percolation Theory of Phase Transitions and Critical Phenomena

One of the objectives of theoretical physics is to find appropriate few concepts and mathematical framework so that many apparent different natural phenomena may be understood and described. Percolation is a mathematical concept of much current interest. We will study the usefulness of percolation in our understanding and description of phase transitions and critical phenomena of interacting many particle systems. The topics under study will include percolation theory of phase transitions of Ising-type models, geometrical meanings of scaling powers for critical exponents, percloation Monte Carlo calculations of the thermodynamic free energy and critical properties for the Potts model, percolation and phase transitions of hard-core particles with pair interactions or in external driving field, etc.

(3) Calculations of the Free Energy for a Potts Model by a Static Monte Carlo Simulation Method

The calculation of the free energy for interacting systems by the Monte Carlo simulation method is not a trivial problem. Based on the subgraph expansion for the q-state Potts model (QPM), we can get the partition function for the QPM as a sum over products of an interacting factor I and the geometrical factor G(B,n), where G(B,n), is the number of subgraphs with b occupied bonds and n clusters. In this study, a static Monte Carlo simulation method will be used to calculate G(b,n) and the free energy for the QPM. The calculated results should then be compared with exact results.

(4) Critical phenomena of quantum systems:

We will use exact diagonalization method and the concept of off-diagonal long-range order to study the connection between phase trasitions and percolation and then develop new simulation method based on the connection between quantum and classical systems, using linked-cluster expansion method to study Hubbard model and quantum spin models.

(5) Nonlinear phenomena:

In this research topic we will carry out the following three categories of researches:

1. The more connections between various phase transition problems and geometrical concepts such as percolation, fractals, multifractals etc.
2. The applications of various calculation methods developed in our series of researches to understand experimental results such as nonlinear current(I) and voltage(V) relation in inhomogeneous material, I-V relation in high T_c super-conductior, Phase diagrams of molecular solids and atoms on surfaces, etc.
3. The study of critical behavior of circle map and high dimensional nonlinear systems, mechanism of self-organized criticality, nonlinear phenomena related to the theory of earthquakes, etc.

Ⅱ

Ongoing Research Abstracts.

主持人：鄧炳坤（副研究員）
協同主持人：江紀成（研究員）
協同主持人：王竹方（副教授）
執行期限：
本年度計畫：自79年4月1日起至80年3月31日止
全程計畫：自79年4月1日起至82年3月31日止
計畫名稱：
中文：重夸克稀有衰變之探討
英文：STUDY OF RARE DECAY MODES OF HEAVY QUARKS

Keywords:STUDY OF RARE DECAY OF HEAVY QUARKS

We propose to participate in a new high energy physics experiment at Fermilab. The main goal of this experiment (E789) is to study two-body decay modes of B mesons. Such decays allow a determination of the coupling between the b and u quarks, an important parameter in the standard model. These two-body decays are also among the most promising channels to study CP-violation in B decays. Furth more, E789 provides a sensitive search for the rare dilepton decay modes of D and B mesons.

E789 uses several state-of-the-art technologies in high energy physics experiments including Silicon Microstrip Detectors (SMD), vertex processor, and Ring Imaging Cherenkov detector. The size of the E789 collaboration is rather small, making it relatively easy for us to make significant contributions. E789 will take data during May 1990-March 1991. Additional running is also expected during 1992/ 1993. Timely physics results and publications are expexted for E789. The physics being pursued in E789 is of interest not only to us, but also to many theoretical physicists here and abroad. Three experimentalists from E789 have agreed to be guest coordinators on this proposal.

We propose to focus our effort on three areas in E789. These are the Silicon Microstrip Detector, vertex processor, and data analysis. It is expected that the

upgrade of E789 during 1991 will require improving the Silicon Microstrip Detector and vertex processor. This would give us an opportunity to make substantial contribution to E789 in one or two years from now. The task of data analysis is crucial for extracting the physics results, and has the advantage that it can be accomplished in Taiwan.

Our proposed participation in E789 can be roughly divided into three phases. During the first phase, April 1990 to march 1991, we will participate in the E789 experiment at Fermilab to gain expertise on the operation of SMD and vertex processor and to initiate a concrete plan for future upgrade. Meanwhile, we will install a VAX Station in Taiwan for data analysis and other related calculations. During the second phase, April 1991 to March 1992, we will concentrate on the E789 upgrade by fabricating the electronics needed in Taiwan. Meanwhile, the data analysis will continue to progress. During the third phase, April 1992 to March 1993, we will travel to Fermilab to install our equipment and participate in the E789 data taking.

主持人：蕭先雄（副研究員）

執行期限：

本年度計畫：自79年8月1日起至80年7月31日止

計畫名稱：

中文：研究在質子—質子碰撞反應裡超異子與核成子間的作用及K—介子的產生

英文：Hyperon-Nucleon Iuteraction and Kaon Production in The p-p Collision.

(Keywords: Hyperon-Nucleon interaction, Strange Dibaryon, Coupled Channel Calculation.)

An enhencement of the missing mass spectrum at 2.13 Gev just below the Σ -N threshold in the reaction K d$\rightarrow \pi \Omega$ p is probably a signature of a strange dibaryon. Dibaryon was oringinal'ly thought of as a deuteron-like hyperon-nucleon as predicted by Oakes in 1936. And the interaction involved can be well represented by a phenomenogical one-boson-exhange potential.

However, dibaryons which could also be a six quark bag state of strangeness-1 and mass around 2.23 GeV have been predictecd by Jaffe in 1977. This is in the context of quark-gluon mode in contrast with baryon-meson mode in Oakes' theory. Experiments are prepared in looking for both possibilities in various reactions which would provide hyperon and nucleon in the final state.

In this project we propose to use proton-proton collision as the cleanest way of studying hyperon- nucleon intraction. The basic ingredients are

1. A baryon-baryon potential model to treat the initial state and final state interaction; here we use de Swart's potential model D. Also a coupled channel calculation is required to include threshold effect properly.
2. A dynamic model for the kaon production; we will use a nonrelativistic impulse approximation which is similar to the treatment of the reaction n p$\rightarrow$ γ d.
3. Isobar contributions; experimentally found the following isobars

areimportant: N(1238), N(1420), N(1518), N(1688), N(1920) and N(2360).

This project is timely in the sense that new experimental data are becoming available and a clearer picture of hyperon -nucleon interaction is most useful to both nuclear physicists and particle physicists.

主持人：張志義（研究員）

執行期限：

本年度計畫：自80年8月1日起至81年7月31日止

全程計畫：自80年8月1日起至81年7月31日止

計畫名稱：

中文：相對論性量子二體問題

英文：Relativistic Qusntum Two - Body Problem

（關鍵詞：量子二體問題，相對論性，費米子—波色子）

二體問題的相對論性的描述，是量子力學的一個重要及基本的課題。過去我們對於兩個費米子（Fermion）的系統作過研究，並得到一些嶄新及非常有用的結果。本計劃旨在擴展我們過去的工作，研究一個含有費米子及波色子（Boson）的二體系統。我們知道，費米子（自旋爲1/2)所遵守的是一階微分的Dirac方程，而被色子所遵守的則是二階微分的Klein-Gordon方程，二者的耦合，在文獻裡找不到一個好的解決方法。但是，我們注意到其實波色子所符合的方程，也可寫成一階微分的形式，這就是Dnffin - Kemmer - Petiau方程。在DKP的架構裡，波色子的波函數是五維的，所以也有其復雜性。我們計畫用Dirac及DKP方程的耦合，來研究費米子及波色子的相對運動；這是相對論性量子二體問題研究的一個新方向。

主持人：曾詣涵（研究員）

計畫名稱：

中文：夸克效應與核成子—反核成子作用反應

英文：Quark Effects and the Nucleon-antinucleon Interaction

Because the particle identities of the nucleon- antinucleon (NN) system often undergo dramatic changes after interactions, the NN system can be a nice test ground for quark dynamics. Though rich of physics information, this system is much more difficult and complicated to deal with than the NN system. To avoid unnecessary complications in the beginning, attention will first be drawn on the elastic scattering $N\bar{N} \rightarrow N\bar{N}$ and the charge exchange reaction $P\bar{P} \rightarrow n\bar{n}$ with the possible extention to $N\bar{N} \rightarrow Y\bar{Y}$ or other related interactions. Through the investigations of different quark reaction diagrams, we wish that better understanding of qq, $q\bar{q}$ interactions can be reached. This project is chosen here as a continuation of the series for studying the strong interaction.

主持人：林爾康（研究員）

協同主持人：王建萬（研究員）

協同主持人：鄧炳坤（研究員）

執行期限：

本年度計畫：自79年8月1日起至80年7月31日止

計畫名稱：

中文：近庫侖碍輕離子引導核反應之核共振態研究

英文：Nuclear resonmces in the light HI reaction at energies near Coulomb barrier

In this project, we propose to carry out an experiment to study the mechamism of the light heavy-ion reaction at energies near Coulomb barrier. The light ion beams are extracted frow a 3 MV Pelletron tandem accclerator at Acadanin Sinica. With this new accelerator we are able to accelerate ^{12}C and ^{14}N ion beans of energies$\sim$15 Mev. A new scattering chamber will be designed and constructed for the experinent on which a movable S.S.D is mounted for the measurement of charged particles from the reatction, and a Hp Ge detector is used for the γ - ray measurement. We shall obtain the reaction cross section and energy excitation function and search for the possible nuclear quisimolecular state in the light heavy -ion reactions at energies near Coulomb barrier.

主持人：王建萬（研究員）
協同主持人：林爾康（研究員）
協同主持人：鄧炳坤（副研究員）
執行期限：
本年度計畫：自79年8月1日起至80年7月31日止
計畫名稱：
中文：輕重離子誘發原子內層游離研究
英文：Light Heavg Ion Induced Atomic Inner Shell Ionization

(Keywords:Light heavy ion induced inner shell ionization; Ok. Pk(6))

Ion induced atomic inner shell ionization has long been studied. Considerable experimental results have been accumulatid. However, most of these results are light ion (e. g., P, α)induced reactions (Ref. 1). The early theoretical colculations on this subject were mainly pased on plane wave Born approximation (PWBA), semiclassical approximation (SCA). and molecular orbital (MO) excitation model. Crucial success had been acheived(Ref.2). Brandt and Lapicki (Ref.3), took into account the relativistic effect of inner shell electron motion and the effect of binding energy increasing during the ion impact, proposed a more delicate theory ESPSSR. and explained most of the experimenty results successfully. However, at low bombarding velocities, the ECPSSR theory overpredicts substancially the experimental results. Recently, Benka et al. (Ref.4) Present a modified ECPSSR theory by Considering the target K electron velocity increasing due to ion bombardment and the effect of Coulomb deflection upon the relativistic correction. Some significant results have been obtained (Ref.5).

Besides, PWBA, ECPSSR.and MECPSSR theories Predict total ionization cross section, but SCA theory Preclict both total and differential cross section. At higher incident energy, the SCA Prediction Coincide with that of PWBA.

Thus Coincidence measurement of the scattered ion with x -ray (or Auger electron) can give a further inside of the ionization mechanism(Ref.6).

The project of this research study is to meanure the x- ray (or Auger electron) produced by atoms Z=15 to 40. (e. g. S, Ar, co, Zn, Kr etc.) following inner shell ionization by light heavy ion (e g. Li^{g+} B^{g+}, C^{g+} O^{g+} etc.) bombordment. Light heavy ion beams will be produced by our newly established 9SDH-2 tandem accelerator. Beam energies will range about 0.5 to 2 MeV/amu. Some ion-x-ray coincident measurement will also be made. Experimental result will compare with the mentioned theories.

References:

1. H. Paul and J. Muhr, Phys Rept. 135(1986)47
2. J. D. Garcia et al., Rev. Mod. Phys. 45(1973)111
3. W. Brandt and G. Lapicki, Phyo. Rev. A23(1981)1717
4. O. Benka et al., J. Phys. (Paris) Colloq, C9- 251(1987)
5. M. Geretschlager et al., Phys. Rev., A41(1990)123
6. J. F. Chemin et al., Phys. Rev., All(1975)549

主持人：陳志強（副研究員）

執行期限：

本年度計畫：自79年4月1日起至80年7月31日止

計畫名稱：

中文：用二元混合液作擴展的研究（II）

英文：Experimental Studies of Spreading with Binarr Mirtures（II）

鍵詞：擴展，動態觸角，潤濕，二元混合液，臨界點

我們將利用二元混合液之表面張力在臨界點附近隨溫度變化之特性來進行液體在固體表面擴展的實驗。這個實驗將爲擴展過程的動力學提供新和有系統的數據。這些數據對工程應用，擴展的流力和潤濕物理的理解將是有用的。與此同時，這個計劃所採用的技巧和設施將爲以後研究在臨界點附近流體力學現象提供服務。

主持人：蕭葆義（Shiau, Bao-Shi）

計畫名稱：

英文：Study on the Simulation of oil Pollutants Transport and Diffusion by a Lagrangian Discrete Parcel Algorithm.

二、(2)計畫摘要：英文部分

(Koywords:Lagrangian discrete-parcel algortihm, mechanical spreading)

Owing to oil pollutants which discharge from vessels or leak out through crakes of oil pipe-line, the aquatic environments were polluted. Oil pollutants affect the marine life seriously.

The present sutdy utilizes the Lagrangian discrete- parcel algorithm to simulate the transport and diffusion of oil pollutants on the water. In this algorithm. the oil pollutant is viewed as a large ensemble of small parcels. The movement of each parcel on the water is affected by the mean and turbulent motion of water and the concentration of surrounding parcels. The tansport and diffusion of the oil pollutant include advection and mechanical spreading. The spreading of the oil pollutant is determined by the balance between gravitional, viscous, and surface-tension forces. The path and mass of each discrete-parcel are followed and recorded as functions of time relative to a reference grid system in space. The density distribution of the ensemble can be interpreted as the concentration of the oil.

The simulation results of this study can offer the aoquatic environment impact assesment for the oil pollutant.

主持人：蕭葆義（Shiau, Bao-Shi）

計畫名稱：

英文：Study on Wind Tunnel Test of Aerodynamics for Windbreak in a Harbor.

二、(2)計畫摘要：英文部分

(Kcywords: Windbreak, Wind Tunnel, Turbulent Boundary Layer)

The wind is very strong during the period of northeastern monsoon in the western coast area of Taiwan. The strong wind will reduce the cargoes operation efficiency in the wharf. In order to enhance the operation efficiency, it is necessary to construct the windbreak to prevent the strong wind.

Owing to the complex aerodynamics…… boundary layer, it is effective and practical to utilize the atmospheric environment wind tunnel to investigate the wind environment and wind force characteristics of the windbreak.

In present study, we use the wind tunnel to simulate a neutral atmosphheric turbulent boundary layer and investigate the aerodynamics of the windbreak in a turbulent boundary layer. The test section of atmospheric environment wind tunnel is 18.5 m long, 3.1 m wide, and 2.2 m high. The simulation of neutral atmospheric turbulent boundary layer is obtained by an appropriate arrangement of spires and roughness elements which are placed at the upstream of the test section. The wind tunnel model measurements include wind environment and wind force characterstics of the windbreak, such as wind speed profiles, turbulence intensity profiles, Reynolds stress distributions, turbulence power spectrum, wind reduction, wind pressure coefficient, etc. In addition, effects of the aspect ratio and permeability of the windbreak on the wind reduction are also analyzed, The above measurements and analysis of the aerodynamics of the windbreak in a turbulent boundary can provide references for wind prevention structures design and evaluation in a harbor.

主持人：梁文傑（教授）

執行期限：

本年度計畫：自798月1日起至80年7月31日止

計畫名稱：

中文：紊流擴散模擬對靜電集塵效率估算之影響

英文：The effects of Turbulent Dlffusion Modelling on the Estimation of Collection Efficiency for Electrostatic precipitator.

關鍵詞：靜電集塵器、紊流擴散、紊流模式、集塵效率

許多實驗資料顯示，紊流擴散效應對靜電集塵器的性能有重大影響。然而現有的除塵效率模式中對紊流擴散之處理方式不一，本研究擬將現行之各種主要紊流擴散模擬方法代入除塵效率模式中求取除塵效率，並與工業技術研究院能源與資源研究所合作，在該單位之靜電集塵實驗室（E.S.P. pilotplant）中模擬常見之集塵情況，以所得之實驗數據與各不同之紊流擴散模擬結果相比較，評估其優劣。

本研究擬探討之紊流擴散模擬方法包括層流模式、德氏模式、庫克曼模式、雷歐米契模式及二階封合模式。實驗數據之比較則包括多粒徑之實驗結果。

主持人：曾忠一

執行期限：自80年7月起至81年6月止

計畫名稱：

中文：海溫遙測業務化研究

英文：An Operational Research of the Satellite Sensing of Sea Surface Temperature

現在使用中的多頻道海溫計算公式是國外發展出來的。多頻道海溫計算公式其實隨大氣平均狀態和天氣形勢不同，故國外建立的計算公式不一定適用於我國附近海域。爲了改進衛星海溫的準確度，本計畫將使用我國附近九個氣象測站的探空資料來建立迴歸模式，並將多頻道海溫計算公式加以更新，以提高衛星海溫的準確度。

前人研究概況：

國內過去國立中央大學和中央氣象局曾做過這方面的研究，本機構在過去幾年間也一直在做。國外許多衛星資料接收站都曾發展自己的多頻道海溫計算模式，尤其是北美國家大氣與海洋總署（NOAA），不在這裡贅言。

計畫目標：

建立可以隨時更新的多頻道海溫計算模式，改進衛星海溫的準確度，以供學術研究的依據，或爲漁業的參考。

1.根據以前的研究結果，建立多頻道海溫計算模式，以供隨時更新計算公式之用。

2.由NOAA衛星AVHRR觀測到的資料計算海面溫度，並與船測資料比較，決定其準確度。

3.最主要的目標是將這個多頻道海溫計算模式由水產試驗所繼續測試，以便改進衛星海溫的準確度。

重要工作項目及實施方法：

現在多頻道水汽訂正法的技術已相當成熟，本機構在過去五年間也一直在做（見曾與朱，1988），其詳細原理可參考一些專書（如曾，1988）。

本計畫的工作步驟如下：

1.利用九個氣象測站的探空資料和LOWTRAN-7程式集建立多頻道海溫計算模式，接著用衛星資料計算海面溫度，並與船測資料互相比較。

2.然後在水產試驗所使用計算機與衛星資料接收系統繼續測試更多的個案。

3.研究結果和技術自然而然轉移到水產試驗所。

另外，本計畫將使用到下面資料：

1.九個氣象測站的探空資料，用來建立多頻道海溫計算模式。

2.AVHRR第3、4、5頻道的資料，用來計算海面溫度。這些資料將由水產試驗所提供。

3.船測的定點海溫資料，用來校驗衛星海溫的準確度，這些資料將由水產試驗所提供。

主持人：曾忠一

執行期限：

自80年8月起至81年7月止

計畫名稱：

中文：散射大氣中輻射傳遞模式的發展與應用

許多氣象學和遙測問題需要求解散射大氣中的輻射傳遞方程。本計畫將發展輻射傳遞模式，以便模擬衛星輻射計在3.7微米窗區頻道觀測到的輻射強度。垂直非均勻的散射大氣中的輻射傳遞模式將用離散縱標法求解。海面上的雙向反射函數將用蒙地卡羅法模擬出來。計算出來的大氣層頂處的向上輻射強度將和衛星資料比較。這個模式可用來決定海溫遙測中的反射陽光訂正。

主持人：曾忠一

執行期限：

本年度計畫：自79年8月1日起至80年7月30日止

全程計畫：自78年8月1日起至80年7月30日止

計畫名稱：

英文：Numerical Simulation of Cloud Seeding Experiment II

(Keywords: Cloud seeding, cloud model)

The two-dimensional time-dependent cloud model developed previously will be modified to simulate the effects of dry ice cloud seeding experiment. The original model contains five classes of water substance : water vapor, cloud water, rainwater, cloud ice and graupel. All the microphysical processes are represented by the parameterization technique to simplify the computational work. This model includes a set of conservative equations of momentum, energy and mass (air and water substances). In order to simulate dry ice seeding, an additional conservative equation to trace the seeding agent and a snow content equation will be added to the basic set of equations. This modified cloud model will be used to investigate the cloud seeding experiment in an attempt to study how to augment precipitation by dry ice seeding.

主持人：黃榮鑑（研究員）

執行期限：

本年度計畫：自79年8月1日起至80年7月31日止

全程計畫：自79年8月1日起至82年7月31日止

計畫名稱：

中文：波浪對於海洋放流影響研究

英文：Effect of Surface Wave on the Waste Disposat

Keywords: surface discharge, buoyant jet, plume, diffusion, wave, interaction.

On studying the problem of ocean outfall, it is conventionally based on the theorem of the jet. The model is always developed and established to solving the outfall mechanism for the planing reference of the outfall system. While the wave motion is exactly existed in the broad ocean ambient. And there must be some influence to the effects of outfall. Therefore taking account of wave motion advancedly is the interest research about the outfall.

This study is desired to research the effects under the interaction of outfall flow and surface wave. The typical withdraw include both the surface and submerged discharges. The effects of mixing, spreading and diffusion under the process of development between teh discharged and ambient water body will be discussed. From the mechanic theorem of outfall, the governing equations are derived. The near- field mixing integral model is established by modifing the characteristic of turbulent and wave. The turbulent closure mechanism is applied in the diffusion at far field. It is noted that the free surface mathematic model is finished through the transformation of the vertical coordinate. The experimentatl datas are used to modify the coefficients of these models.

主持人：楊緒濃（資深博士後研究員）

協同主持人：楊維邦（研究員）

執行期限：自79年9月1日起至80年8月31日止

計畫名稱：

中文：規範場量子化等問題之探討

英文：Studies in Quantization of Gauge Theory in Noncovariant Gauges and Other Problems.

1. Quantization of Gauge Theory in Noncovariant Gauges

Quantization of gauge theory in noncovariant gauges has been studied for many a decade [1]. Special attention is being focused on how the noncovariant-gauge (unphysical) singularities should be defined, thereby giving a set of useful Feynman rules for perturbative calculations.

The commonly-used noncovariant gauges are the Coulomb gauge and algebraic gauges, such as the temporal, the spatial-axial, and the light-cone gauge. For perturbative calculations, one has to choose a gauge and the choice of a noncovariant gauge can be useful for studying a certain process, allowing one to extract the dominant properties of the process in the theory. For example, it is advantageous to study bound-state problems by using the Coulomb gauge. However, the Feynman rules in a noncovariant gauge are plagued by unphysical singularities appearing in the polarization sum in the gauge field propagator. Unlike the physical singularities, which are given by Feynman iE-prescription, the unphysical ones have been freated by a variety of different prescriptions, corresponding to imposing different boundary conditions on the gauge field propagator. It should, however, be mentioned that the use of a certain prescription can lead to erroneous results. For example, the use of the principal-value prescription for the temporal gauge leads to erroneous results for the Wilson loop calculations.

In 1987 I proposed a unified formalism to study the gauge singularity problem

[2]. I introduced a special linear gauge that unifies covariant gauge and noncovariant gauges by a tunable parameter, and treated the unphysical singularities as regularized by the parameter. I calculated the one-loop gauge field self-energy in this gauge and obtained the self-energy in the Coulomb gauge and also that in the Landau gauge. To study the renormalization of this unified formalism, I employed the approach of Becchi, Roret, and Stora. (This formalism was independently introduced by Burnel [3].) Although this formalism has been further studied, the feasibility of higher-loop calculations remains open and thereby constitutes an essential part of my research interests.

Recently I proposed a regularization scheme for defining the Feynman rules in the noncovariant gauges [4]. This work was presented at the workshop held in Vienna in September 1989. But how one should apply the gauge theory in this scheme to physical processes remains to be established and requires first the understanding of the renormalization of the gauge theory in this scheme.

References

[1] G. Leibbrandt, Rev. Mod. Phys. 59 (1987) 1067, and references cited therein.

[2] S.-L. Nyeo, Phys, Rev. D36 (1987) 2512.

[3] A. Burnel, Phys. Rev. D36 (1987) 1852.

[4] S-L. Nyeo, talk given at the Workshop on Physical and Nonstandard Gauges, Tech. Univ. Vienna, Sept. 19-23, 1989.

2. Radiative Calculations for Multijet Cross- Sections for Drell-Yan Process.

We are interested in the leading and next-to- leading radiative corrections based on Quantum Chromodynamics (QCD) to the inclusive cross sections: parton + parton→ V + Multi-partonic jets, where V is an on-shell electroweak boson $W^{\pm}$ or Z^{O}, or a massive virtual photon γ^{*}. These calculations provide crucial tests of the standard model for the strong and electroweak interactions. Especially, the new generation of hadron colliders will provide decisive tests of the model and eventually give evidence for new physics only if QCD radiative corrections are under reasonable control.

Presently, we are studying the one-jet and two- jet processes to $O(\alpha_s^2)$, Where α_s

主持人：胡進錕（研究員）

執行期限：

本年度計畫：自79年8月1日起至80年7月31日止

全程計畫：自78年8月1日起至80年7月31日止

計畫名稱：

中文：相變幾何理論及其應用（II）

英文：Geometrical Theory of Phase Transitions and Its Applications（II）

Keywords: Percolation, Phase transitions, renormalization Super conductivity

This is the second year project of a two-year research project. In this year. we will carry out the following researches.

1. Percolation renornalization group studies of phase transition models.
2. Percolation Monte carlo renormalization group studies of spin and hard core particle models.
3. Connection between percolation and singular behavior in transport diffusion, and dynamic problems.
4. Numerical studies of quantum systems related to the theory of super conductivity.

主持人：李世昌（研究員）

協同主持人：鄭海揚（研究員）

協同主持人：楊維邦（研究員）

協同主持人：余海禮（副研究員）

協同主持人：李世炳（副研究員）

執行期限：

本年度計畫：自79年9月1日起至80年8月31日止

計畫名稱：

中文：粒子、場論與弦論之研究（III）

英文：STUDIES IN PARTICLE PHYSICS, FIELD THEORIES AND STRINGS（III）

ABSTRACT

This is the research proposal of the high energy theory group of Institute of Physics, Academia Sinica to seek financial support from NSC for five postdoctors and two research assistants. It is the continuation of the proposal "Studies in particle physics, field theories and strings (II)" previously approved by NSC under the contract number NSC-79-0208-M001-63. The appointment of the five postdoctors are for the second year. A new appointment will be made from a pool of eight qualified candidates.

We propose to study the following subjects:

1. D− and B− particle decay and their wave functions.
2. Possible relation between the masses of Higgs and the top quark following from the constraints of $K^O - K^O$ and $B^O - B^O$ mixing as well as CP violation data.
3. New phenomenological constraints on the parameters of the extended electroweak models.
4. Investigation of two dimensional gravity theories.
5. Surface functional theory of p-brane and supersymmetry.
6. Investigation of anyion superconductivity.
7. A cosmology with conformally coupled scalar field.

主持人：楊維邦（研究員）

執行期限：

本年度計畫：自79年8月1日起至80年7月30日止

全程計畫：自79年8月1日起至80年7月31日止

計畫名稱：

中文：具有時空超對稱的四維弦模型的研究

英文：Studies on 4-dimensional string models With Spacetime Supersymmetrices

(Keywords: String theories)

In this project we shall study the known four- dimensional space-time supersymmetric models. We Shall concentrate on the calculation of the corresponding String amplitudes, and at the same time enguire into the structural relations between the Space-time supersymmetries and the exact R-G equations for the models.

主持人：鄭海揚（研究員）

執行期限：

本年度計畫：自79年8月1日起至80年7月31日止

計畫名稱：

中文：弱作用的有效手徵Lagrangians

英文：Effective chiral Lagrangians for weak interactions

(Keywords: effective chiral Lagrangian, weak interaction)

In the large Nc limit, higher-derivative effective chiral Lagrangians for weak intevactions were derived very recently and have been applied successfully to various low-energy hadronic weak decays. I plan to study:

1. the applications of the new weak chiral Lagrangians to other nonleptonic decuys, radiative decays and rare decays whick have not been explored previously,
2. the incorporation of CP violation,
3. the calculation of chiral-loop effects in weak decays, and
4. the gluonic effects on the coupling constants.

主持人：李世炳（副研究員）

執行期限：

本年度計畫：自79年8月1日起

全程計畫：至80年7月31日止

計畫名稱：

中文：原子核模型計算與相變理論（II）

英文：NUCLEAR MODEL CALCULATION AND THEORY OF PHASE TRANSITION（II）

(1)Nuclear model calculation:

We will use the formalism that we developed last year for solving a phenomenological two-body Dirac equation to compute the quark-antiquark bound state meson mass spectrum, nucleon-nucleon scattering and similar nuclear problems.

(2)Theory of phase Transition:

We will use the algorithms that we developed on various computers during the last year to study some statistical systems in order to understand the phenomena of non- equilibrium phase transition.

主持人：胡進錕（研究員）

協同主持人：陳立仁（台大副教授）

執行期限：

本年度計畫：自79年9月1日起至80年8月31日止

計畫名稱：

中文：表面活化齊與油水混合齊之熱力統計性質

英文：Statistical thermodynamic propertics of surfactant, waten and Oil mixture

(Keywords:Surfactant, Phase diagram, Mean field Method Monte Carlo)

In this research proposal, we will use the mean field method and Monte Carlo Simulation method to study the statistical thermodynamic properties of surfactant, water and oil mixtures, such as phase diagrams, wetting behavior, etc.

主持人：李世昌（研究員）

執行期限：

本年度計畫：自79年8月1日起至80年7月31日止

計畫名稱：

中文：規範不變非限域算子之重整

英文：Renormalization of Gauge Invariant Nonlocal Operators in QCD

Renormalization of Gauge Invariant Nonlocal Operators in QCD

Abstract

We propose to study the renormalization of gauge invariant nonlocal operators in QCD by background field method. In order to familiarize ourselves with the details of the background field method, we shall first apply the method to the computaton of two-loop DeWitt- Vilkovisky effective action in the three dimensional Yang -Mills theory with Chern-Simons term. We shall also apply the method to various one-loop and twoloop calculations in the Standard Model. We have in mind processes such as the gluon fusion into multi- vector bosons; gluonic radiative corrections to the flavor -changing neutral current vertices and the gluonic radiative corrections to the low energy effective chiral Lagrangian. These will be done in collaboration with assistant and student.

Then we shall apply the background field method to calculate the evolution equation for a single string operator under renormalization. Terms up to twist-4 shall be kept to obtain the amplitude for the splitting of a string into two strings. Then we shall compute the renormalization of two string operators to obtain the amplitude for the joining of two strings into a single string. With the complete twist-4 calculation, we shall try to solve the evolution equation either analytically or numerically. Other gauge invariant nonlocal operators such as those with baryon number one will be considered.

主持人：鄭天佐（教授）

協同主持人：方建雄（副研究員）

執行期限：

本年度計畫：自79年8月1日起至82年7月31日止

計畫名稱：

中文：原子尺度材料表面及界面動態之研究

英文：Dynamical Behavior of Surfaces and Interfaces on Atomic Scale

關鍵詞：原子結構，表面及界面，超微型材料，構造及化學穩定性，偏析現象，掃描穿隧顯微鏡，場離子顯微鏡，原子探針。

本計畫長遠目標是要在中央研究物理研究所建立一個具有微觀表面分析儀器的表面科學實驗室。現在物理研究所及其他大學及研究機構已有相當有基礎的宏觀表面科學及超微型結構材料研究，微觀表面科學可以和這些已有相當基礎的研究互相配合，一起擠進世界上基礎性及應用性表面科學及材料科學研究的前鋒。近期的目標是要在物理研究所利用掃描穿隧顯微鏡，場離子顯微鏡，及原子探針研究超微型結構材料表面及界面的原子結構，化學偏析現象及在原子尺度的動態及變化。

固體表面多薄膜並不是靜態的，只要高到某一個溫度，原子和小原子團在表面上就會隨時隨地作無序運動。很多材料在室溫中，其結構及化學成份分佈隨時在作毫微米尺度的變化，這些變化會慢慢地改變超微型結構材料的物理及化學性質，也會影響超微電子元件，光學薄膜及催化用合金粒子等等高科技超微型材料的性能及可用壽命。從基礎科學來看，原子分子物

理，統計力學和熱動力學在超微型材料中匯合在一起，所以瞭解超微型材料表面及界面原子尺度動態乃是基礎表面科學上的一個重要課題，它對於瞭解高科技材料的性能及穩定性也是很重要的。

本專題研究計畫擬利用上面所說三種具有原子分辨率的顯微鏡來研究超微型高科技材料的表面和界面的原子結構，在不同物理及化學環境下在毫微米尺度的物理及化學變化，以及單原子和原子團在這些表面上的作用及動態，原子在表面上各種不同行爲所需能量也將加以測量。

如果本專題研究計畫獲得支持，本計畫主持人鄭天佐教授將回到計畫執行單位中央研究院物理研究所三年以上主持此項研究，並與在台灣正在做表面科學及超微型材料研究人員互相合作，共同促進台灣在這方面的研究成果，並擠進世界此項研究的前鋒，也希望對台灣高科技材料工業發展有所助益。

主持人：Prof.S.Y.Tong（教授）
協同主持人：方建雄（副研究員）
協同主持人：鄭伯昆（教授）
協同主持人：謝雲生（教授）
協同主持人：蔡尚芳（教授）
執行期限：
本年度計畫：自79年4月1日起至80年3月31日止
全程計畫：自79年4月1日起至82年3月31日止
計畫名稱：
中文：以低能電子繞射研究III族金屬在Ge表面之原子結構
英文：LEED STUDIES OF SURFACE ATOMIC STRUCTURES OF GROUPIII METALLIC OVERLAYERS ON GE.

(Keywords: LEED, Sub - monolayer, Auger Electron Spectroscopy (AES))

This proposal is a part of R.O.C-U.S. joint project. The counter part U.S. Proposal is sponsored by the U.S. National Science Foundation (NSF) under the grant DMR: 8805938. The principle investigator of the U.S. counterport project is Prof. Darid S.Y. Tong, a distinguished professor of physics and the Director of the Laboratory for Surface Studies at the University of Wisconsin-Milwaukee. The proposal is to apply the funding of the part of joint project which will be carried out in the Institute of physics, Academia Sinica, Republic of China.

The joint project consists of two main parts of experimental and theoretical studies. Theoretical studies will be performed by Prof. Tong in U.S., and experimental studies are the essence of this proposal. It is expected that this collaboration between the two research groups in R.O.C and U.S.A. can not only study the topic thoroughly but also strengthen the R.O.C.-U.S. cooperative research program. Low energy electron diffraction (LEED) I -V measurement,

spot profile analysis and dynamical calculations will be used to investigate surface atomic structures of group III metals on Ge surface from the corerages of Sub-monolayer to a few monlayers.

The proposal is to perform experimental studies. Atomic beam evaporator will be used to evaporate group III metals on Ge single crystal surface. Surface analysis technique such as Auger electron spectroscopy (AES) and x-ray photoelectron spectroscopy (xps) are used to determine the overlayer coverage. Data of LEED I-V and SPA- LEED measurements will be used to fit the results of dynamical calculations obtained from the U.S. counter part.

主持人：謝雲生（研究員）

執行期限：

本年度計畫：自79年8月1日起至80年7月31日止

計畫名稱：

中文：硫酸鋰銫之紅外光及拉曼光譜研究

英文：INFRARED AND RAMAN STUDY OF CRYSTALLINE LiCsSO4

(Keywords: RAMAN AND INFRARED SPECTRA, MOLECULAR CRYSTALS)

LiCsCO4 (LITHIUM-CESIUM DOUBLE SULFATE) IS A TYPICAL MOLECULAR CRYSTALS IN WHICH THE MOLECULAR VIBRATIONS ARE DIVIDED INTO TWO GROUPS. THE HIGH FREQUENCY MOOES CORRESPONDS TO INTERNAL MOLECULAR STRETCHING WHILE THE LOW FREQUENCY GROUP BELONGS TO THEIR LATTICE VIBRATIONAL MODES. THIS INFORMATION CAN GIVES A HELP TO THE LATTICE DYNAMICS CALCULATION IN MOLECULAR CRYSTALS. AN X -RAY DIFFRACTION MEASUREMENT HAVE SHOWN THAT THE CRYSTAL UNDERGO SEVERAL PHASES FROM 80 K TO THEIR MELTING POINT.

APPLYING THE LASER RAMAN AND INFRARED SPECTROSCOPIC TECHNIQUES, IN THIS WORK, WE CAN OBTAIN THE COMPLETE TEMPERATURE DEPENDENT RAMAN AND INFRARED SPECTRA OF THIS CRYSTAL FROM 80 K TO 480 K. A DETAILED STUDY OF THE SPECTRA OF THE MODE FREQUENCY, LINEWIDTH, LINESHAPE AND INTENSITY VERSUS TEMPERATURES, TOGETHER WITH THE GROUP CORRELATION TABLE, GIVE US ACCURATE INFORMATION OF THE CRYSTAL STRUCTURES OF DIFFERENT PHASFS AND ALSO THE IDENTIFICATION OF THE VIBRATIONAL MODES. THESE ANALYSIS PROPOSE A USEFUL OPTICAL DATA IN LATTICE DYNAMICS CALCULATIONS.

主持人：陳洋元（副研究員）

執行期限：

本年度計畫：自80年2月1日起至81年1月31日止

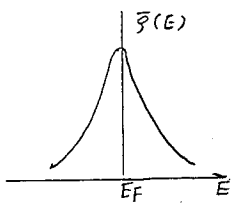
計畫名稱：

中文：以變化磁場之比熱研究康斗晶格之同調性

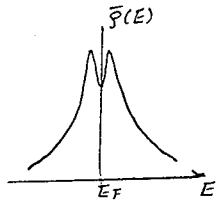
英文：Coherence Effects in Kondo Lattice Studied by Specific Heat Measurement in Magnetic Field

(Keywords: Kondo lattice, Coherence, Pseudogap)

The Coherence of 4f magnetic moment among rare earth ions (for example Ce ions) in Kondo lattice system is an important and difficult problem. C. D. Bredl et. al. have found anomaly in low temperature specific heat of $CeCu_2Si_2$ and $CeAl_3$ Kondo lattice system. This anomaly which is never been observed in Kondo ion system is believed to be relevant to the Coherence in Kondo lattice system. C.D. Bredl et al have proposed the existence of pseudogao near Fermi energy to explain the specific heat anomaly. The picture of the pseudogap is as follows.



Kondo Ion



Kondo Lattice

The Kondo temperature values of $CeCu_2Si_2$ and $CeAl_3$ are 3° K and 5° K respectively. Because of the small values, the measurements had to be performed in very low temperatures (about 1-2° K). The Kondo temperatures of Ce_3X (X=Al, In, Sn) are around 10-20K. If we perform the same experiment in the system, then we will have better chance to observe how the Coherence is affected by magnetic field, No exact answer has been reported in this aspect yet. We hope through the specfic heat measurement of Ce_3X in applied magnetic field can find the answer. of the mechanism of coherence.

主持人：陳洋元（副研究員）

執行期限：

本年度計畫：自79年3月1日起至81年2月8日止

計畫名稱：

中文：稀土化合物比熱及霍爾效應之研究

英文：Specific Heat and Hall Effect of Rare - Earth Compounds

(Keywords: Cherence, Valence Fluctuations, Specific Heat)

Valence Fluctuations ($CePd_3$ Compounds is a typical example in which the valevce of Ce is dependent on time, temperature and pressure), Heavy Fermion (In $CeAl_3$, the effective mass of 4f elecctron of Ce is about 1000 times of the rest mass of free electrom, this result is shown by the specific heat coefficient measurement) and Supercondvctivity in Heavy Fermion compounds, which is not supposed to occur in the appearance of magnetic moment, have been commonly observed in these rare-earth alloys and compounds in the past two decades. These interesting physical phenomena made the study on these material more important.

In our latest study in Ce_3Al, Ce_3In and $Capd_3$, We found that the substitution of Ce by La has dramatically affected the correlation among Ce magnetic moments in these compounds. For instance, as the amount of La substitution increases, the iso-structural phase transition temperature ($T_C \sim 100°$ K for Ce_3 Al) decreases. The antiferromagnetic transition temperature T_N is also decreased by the amount of La substitution. In C_3In, the resistivity results show the onset of coherence of Ce moments is disappear as La substitution is up to 9% of Ce.

We believe to perform heat capacity measurements and Hall effect measurements on these compounds will give us more clear picture in explanation the mechanism of coherence in these rare-earth materials.

主持人：陳洋元（副研究員）

執行期限：

本年度計畫：自79年8月1日起

全程計畫：至80年7月31日止

計畫名稱：

中文：金屬氧化物厚膜反頻率雜訊與電導率研究

英文：1/f Noise and electrical condutivity in metal oxide - glass thick film

(Keywords: Metal oxide-glass thick film, 1/f nose, Tunneling model)

Metal oxide-glass thick film resistors (TFR), such as $Bi_2Ru_2O_7$-glass and RuO_2-glass, are cermet made by conductive metal-oxide particales and insulative glass particles. Thick film resistors have been widely used in hybride circuites due to its easy, low cost fabrication and small size. The disadvatage of this material is its ac noise induced by dc voltage bias. After the failure in explanation by conductive path model and its statistical calculation, R.W.West, G.E Pike and C. H. Segar in 1975 using on "metal-insulator-metal tunneling" model successfully constructed noise and electrical conductivity mechanism of TFR. The noise-frequency relation can be described by Hooge's law as follws.

$$S_V = K \cdot V^2_{dc} \triangle f/f^{\gamma}$$

Sv: noise power spectrum.

V_{dc}: DC Voltage bias across TFR.

f and $\triangle$f: frequecy and its band width.

γ :the exponent index, ranged approximately from 0.8 to 1.2

So far we have completed the noise and resistivity measurements for temperature range from 77° K to 300° K. Our experimental results are in good agreement with those of G. E. Pike et al. We plan to complete our noise study in

rest temperature ranges, i.e., from 15° K to 77° K and 300° K to 800° K. In these temperature ranges, we will have the chance to study the electronic states in barrier and voltage -current relation. Based on the theory of quantum tunneling effect we believe that the barrier thickness and its magnitude (which are related to particls size and its properties) are involved in mechanism of noise and electrical conductivity. These relation can be seen by the formula of de jeu et al.

$C=C_r/[mp^2(lbd)]$ and C ($Sv = C.V^2\, dc.\triangle f/f^{\gamma}$)

l, b and d are the length, width and thickness of TFR. P is the number of conductive paths and m is the number of barriers in a a conductive path. The relation of dielectric constant and noise is formulated by T. M. Chen as follows

$$S_j(f) = D^2 \cdot V^2 \cdot f_t \quad f_{tp} \frac{e^2}{S K E_o} \int_o^s \frac{N_t(x) \cdot x^4 \cdot \tau_o \cdot \exp(\tau x)}{1+(w\tau_o)^2 \cdot \exp(2\tau x)}$$

when E_o is substituted by E

Recently we had discovered an interesting feature which is never reported in literatures, i.e., a peak around 80K in noise vs. temperature plot. This phenomena is not understood and worthy to further study. Our ultimate goal of the project is to build a complete connection between theory and experiment by which new and low-noise TFR'S can be fabricated.

主持人：姚永德（研究員）

執行期限：

本年度計畫：自79年8月1日起至80年7月31日止

計畫名稱：

中文：銅與希土二元合金之物性研究

英文：Physical properties of binany alloys of copper and rare earth elements

(Keywords: Binany alloy, Coppen and Rare earth elements, Electric, Msgnetic, Thermal.

The physical properties of many binary alloys have been studied extensively during the past years. However up to now, there are still quite a lot of anomalous phenomena in many binary alloy systems which have not been studied both theoretically and experimentally. We have many experiences to analyzing the physixal phenomena of binary alloy systems; and many results and conclusions have been reported before [Ref. 1-21]. In recent years, many oxides of Cu and rare earth elements have leen found to have the property of high Tc superconductivity. This motivated us to study the physical properties of binary alloys of copper and rare earth elements. Besides, we found that only a few compounds and alloys of Cu and rare earth elements which have been investigated [Kef. 22-25]; therefore, it is worthwhile to write this proposal to study them extensively.

Under this research proposal, we will prepare a systematic binary alloys or compounds of Cu and some rare earth elements by means of the arc melter. Their electrical resistivity, magnetization and thermal properties etc. will be studed. There are many very interesting phenomena in the binary alloys of Cu and rare earth elements. For example; the transformation of the structure from cubic CsCl- type to orthorhombic FeB type etc.; in some compounds which crystallize in the cubic CsCl-type structure, there may exist three types of simple collinear antiferroma gnetic structures. Besides these physical variations due to the

composition of Cu and are earth elements, we are also very interested to study the relation between the physical properties and the variations of the grain bourdany precipitation in these binary alloys. The emperature range for this study will cover from 4K to above 1000K. We believe that, stanting from this proposal and after several years of work-hard, we will achieve many new results and conclusions; and finally, we hope to discover some new phenomena and some breakthrough.

主持人：姚永德（研究員）

執行期限：

本年度計畫：自80年2月1日起至81年1月31日止

計畫名稱：

中文：N型及線型超導體之物性研究

英文：Physical properties of N-typs and Wire-Type Superconductors

(Keywords: High-Tc Superconductor, N-type Superconductor, rire-type Superconductivity

A number of significant developments concerning high temperature superconductivity in various system are reported recently [1 — 4]. prof Chu at Huston announced that they can continuously fabricate bulk high temperature superconductors with large critical current density at high magnetie fields. One research group at Australia reported that the critical current density of Ag-clad Bi-Pb-Sr-Ca-Cu-O wire with optimal heat treatment has been measured to be 11900A cm^{-2} at 77K in a zero field. If we take the Jc, Tc and Hc_2 as three coordinates and compare the properties of the high-Tc Superconductors with that of the conventional superconductors as shown in Fig. 1. 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 bigh-Tc superconductors.

Recently, the electron-doped copper oxide superconductor has been discovered by Tokura et al [5]. The various physical properties of the hole-doped copper oxide superconductors have been studied extensively, However, relatively little effort has been devoted to the various effect in the electron-doped superconductors. Tc is arunnd 24k for ghe T'-phase superconductors. It is quite low, if we compare it with the Tc=125K for the hole-doped superconductors, In this research project, (1) we will carefally study the mechamism of the T'phese superconductors and (2) we try to find some new system of the election-doped superconductors and try to improve the Tc up to 125K on higher. Wthin 4 years. we try to get some significant developments for the high Tc superconductors under the supports under the supports of Nationel Scince Council.

Daring the last one year. there have been significantly progress in the reseanch area of wire type hiph-Tc superconductors. We have obtain a lot of experience in the fabrication of wirestype matirals. Unden this reserch projest, we will discuss closely with many other researches; for example, profs Wu and Lin at Tsing Hua Ulniv, MRL and Metenial R & D center of Chung Shan Institute of Science and Technology etc., and try to get wire stype high tamperature superconductors with high critical current density.

主持人：姚永德（研究員）
協同主持人：陳洋元（副研究員）
協同主持人：徐新光（副研究員）
執行期限：
本年度計畫：自79年9月1日起至80年8月31日止
全程計畫：自79年9月1日起至83年8月31日止
計畫名稱：
中文：高溫超導機制及特性改進研究（一）
英文：Mechamism and Improvement of High-Tc. Superconductors(一)

關鍵詞：高溫超導，機制，特性改進

自高溫超導被發現後超導應用的可能性大爲增加，極可能導致下次之工業革命。國科會有鑑於此，乃積極推動及規劃我國之高溫超導研究。

今年國科會推動的大型整合性高溫超導研究計劃以三個人以上組合起來共同研究而提出計劃爲原則。

合作研究計劃之基礎建立在共同意願以個人之專長，相互配合，從個人的觀點出發，最後能相互交換意見，融合而成整體性之結果，此外，在不同研究單位的人員，固有空間之隔開，較不易溝通，所以今年我們以中央研究院，本身爲單位，並以目前積極正在從事高溫超導的人爲核心，亦即以化學所之徐新光博士，物理所之姚永德及陳洋元大家主持推動高溫超導之大型計劃。但其他有興超者均屬於長期合作研究的對象。
所以今年我們提出之大型計劃包括三個子題：

1.姚永德負責之：N型及線型超導體之物性研究(一)。

2.陳洋元負責之：以三靶濺鍍方法進行高溫超導薄膜與元件之研究應用。

3.徐新光負責之：processing of Y $Ba_2Cu_3O_{7-8}$ - Transport Current Density Enhancement of Polycrystalline Bulk Superconducting Ceramies.

上述三研究子題均需用到SQUID Magnetometer來仔細研究高溫超導性與磁性之關係，而SQUID Magnetometer之測量頗費時間。目前去台大或清大SQUID中心測量均需排隊等待，許多實驗結果也不易立刻知道結果後判斷下一步應如何測量。所以中央究研院之諸同仁們討論後，認爲物理，化學兩所實應有一SQU ID Mapnetometer來作深入而廣範的研究各類製出之高溫超導體，我們過去針對高溫超導性及各類磁性均有廣泛之研究經驗，並發表多篇論文。相信在國科會之大力支持下，定能達成我們所期望之目標。

主持人：何侗民（研究員）

執行期限：

本年度計畫：自79年8月1日起至80年7月31日止

計畫名稱：

中文：矽與鍺中施者與受者高鑑別率激發光譜之研究

英文：High Resolution studies of the Excitation spectra of Donors and Accptors in Silicon and Germaninm.

(Keywords: FT-IR Spectrometer, Excitation Spectrum, Impurity, Si Ge)

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 donors and acceptors in silicon and germanium. The measurements will be made mostly with sample cooled to liquid helium temperature. Due to the very high resolution of the spectrometer, the position of the peak of each absorption line could be determined more precisely and some weaker lines could be resolved. 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.

主持人：梁乃崇（研究員）

執行期限：

本年度計畫：自79年8月1日起至80年7月31日止

計畫名稱：

中文：ATP和H_2O的增強拉曼散射

英文：Enchamced Ramam Scattering of ATP and H_2 O Molecules

(Keywords: SERS, ATP, interfacial water molecule)

With the aid of the Characteristics of the SERS.

We will study the relation between the biological molecule ATP and water molecules. We plan to observe the SERS from thie interfacial water molecules surrounding the triphosphate of ATP. We also do the same using adenosine instead of ATP. Comparison of the two SERS results could yield the SERS signal from the interfacial water molecules surrounding the triphosphate of ATP. Further, We would change the Cations and perform more observation of the SERS from ATP and the water.

主持人：王唯工（研究員）

執行期限：

本年度計畫：自79年8月1日起至80年7月31日止

計畫名稱：

中文：臟器對血液波之影響

英文：Organs influence on the blood presure wave propagation

(Keywords: Blood Pressune Wave, Organ

Rats will be used as the expeimental animal. to study the effect of organ on the flood pressure wave.

ENergy in the circulatory system is mainly in the form of pressuree. 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 bet blood pressure wave and blood flow. especially the blood pressure wave and the blood flow into organs.

This year, We will study the external pressune on the organ to change ts elasticity and measnne the effect of this short time pressure change, its effect on the blood pressure wave as well as the blood flow.

主持人：任盛源（研究員）

執行期限：

本年度計畫：自80年4月1日起至81年3月31日止

計畫名稱：

中文：鐵釩合金之磁性與電性研究

英文：Magnetic and Electrical Properties of FeV alloys.

(Keywords: Fe-V alloys, Magnetic and electrical properties)

First, I (Dr. S. U. Jen) shall take a subbatical leave (supported by NSC and Academia Sinica) next year. However, I still submit this project, because my students are interested in the project, and they wish to take it as part of their MS theses I think although I'll be out of the country, I can manage to take good care of this project, and communicate frequently with my students.

Vanadium is listed on the left hand side of iron on the periodic table. Hence, when the Fe-V alloys are formed, their magnetic moments are increased with the increasing number of 3d electrons per atom. The reason is because that by adding more electrons, they mostly go into the spin-down band, while, on the other hand, the Fermi energy is pinned in the gap of the spin-up Fe and V bands. In order to keep this condition, Fe-V alloys must have the BCC structure. However, from the phase diagram, it is well known that under equilibrium, σ - pase will appear when the concentration of V reaches 25 at.%. Therefore, we should be fully aware of this property.

Experimentally speaking, we shall measure the follwing quantities: saturation magnetic moment, high field magnetic susceptibility, heat capacity, electrical resistivity, and magnetoresistance. The emphasis will be laid on their changes with the vanadium concentrations. Theoretically speaking, in the past, Dr. Berger has proposed a split- band model, which is supposed to work in the system with the valence difference being larger that 2. Hence, Fe- V should be a good system to study.

主持人：任盛源（研究員）
協同主持人：姚永德（研究員）
協同主持人：陳洋元（副研究員）
執行期限：
本年度計畫：自79年8月1日起至80年7月31日止
計畫名稱：
中文：鐵鋁錳鋼之低溫比熱工程研究
英文：Low temperature Specific Heat Study of FeALMnC steels

Keywords: Specific heat, Low temperature, and FeAlMnC steels)

In the past few years, we (S. U. Jen and Y. D. Yao) have joined the Fe-Al-Mn steels research Projects, and have studied their low temperature properties: such as electric, magnteic, thermal expansion, and thermal conducitivity studies. At the present stage, there is yet another important property, which needs to be measured. That is the low temperature specific heat. At first, we plan to measure the specific heat in the temperature range between 77-300K, adn then, we shall plan to extend low temperature limit to 4K.

As to preparation of sample speciments and subsequent heat treatments, we shall collaborate with National Chiao Tung and National Tsing Hwa Universities as usual.

We believe in this project we should lay emphasis on consumptive items: such as liquid helium, vacuum parts, and electronics.

Because we already knew that T_N of Fe-Al -Mn steels are in the temperature range of- 30 to-50° C, it is expected that there may exist anomalies in specific heat around T_N too.

In addition, we are also planing to measure the lattice constant of these steels at low temperatures.

主持人：任盛源（研究員）
執行期限：
本年度計畫：自79年4月1日起至80年3月31日止
計畫名稱：
中文：鈷—鈀—鎳合金之磁性與電性研究
英文：Magnetic and electric properties of CO-Pd-Ni alloys

(Keywords: Alloy Magnetic properties, Electric Properties)

In recent years, one of the main projects of our solid state research in physics Institute is to develope a low temperature physics laboratory. To join in this research, the present project is proposed.

The main goals in this project are to study the magnetic and the electric properties of Co-Pd-Ni alloy. Especially, we shall pay attentions to those physical properties at T=4. 2K. As to the magnetic properties, the measured quantities includes magnetization, magnetoresistance, and magnetostriction. As to the electric properties, electrical resistivity and heat capacity of these specimens wil be measured.

Various facilities in our group are sufficient to make specimens and to allow us for making all the measurements stated above. However, one drawback in present equipments is that the lowest temperature reached is around 10- 15K. Hence, a 4.2K cryostat is needed for this project. In this way, some of the most important properties can be measured and analyzed.

In this study, the compositions of Co-Pd-Ni alloy is changed according to the following rule: x(Co at.%)+z(Pd at.%)=constant, as shown in the figure. In fact, part of the specimens have been made, and they are currently being analyzed for compositions by AES, and for structures by x-ray. The purpose to fill in Pd is to study its effect on the magnetic and electric properties of Co-Ni based alloy. In the past, similar studies on the Co-Ni-Pd system have been reported in the literatures. Among all d-elements, what is left with a higher magnetic property is

palladium (enhanced paramagnetic susceptibility). Therefore, we do not exclude the possibility of its potential usefulness.

Theoretical speaking, analyzing work is a little difficult, for the current theories for magnetoresistance and magnetostriction are rather incomplete. Among all models, what we will try on for magnetoresistance is the one called the two current model proposed by Smit, and Campbell et al., and for magnetostriction is the one called the one- ion or two-ion model.

主持人：簡來成（研究員）

執行期限：

本年度計畫：自80年1月1日起至80年12月31日止

計畫名稱：

中文：地型對中氣層重力波的動力效應

英文：The Dynamic Effects OF Geography on Mesosphere Gravity Wave

（關鍵詞：波動，動波，數值方法）

鑑於未來國內太空科學研究的發展，明年將發射太空火箭。對台灣及其附近地區高層大氣現象有進一步瞭解的必要。本計畫擬就台灣地型所激發重力波在中氣層的動力特性做初步的探討。

台灣的地型用數據儀讀等高度的經緯度，換算成座標選取一剖面代表台灣地型的剖面。用Bacmeister和Schoeberl（1989）考慮地型效應，探討受地型影響重力波在大氣中的傳遞現象。

解統御方程式，用ADI方法求解，因考慮地型效應與波動的特性鄉力我們將統御方程式轉成 curvilinear 座標，採取 adaptive grid（可調式格點）以提高計算波動性質的正確性。

研究成果的表示方法，在申請單位的支援下，已有彩色繪圖終端機及其介面卡，希望開發印圖的啓動程式，將研究成果能用彩色圖像表示之。

Ⅲ

Articles

表面物理發展新趨向

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在這個世界上到底有誰有能力來預測任何一行業或學門發展的新趨向呢？一個學門的新發展往往會由一兩個沒有預料到的新發現或新發明來左右，不知有多少人做過這種嘗試，到後來也只能成爲無稽之談而已，所以當編者提議我寫這篇文章時，我有點猶豫。好在很少人會把這種文章看得很認眞，大則把它作爲參考，小則把它拿來消遣消遣而已，所以寫一篇文章來讓大家來開開心也是一件好事。

表面物理的觀念及研究到底從什麼時候開始呢？這問題已無從查考，有人把它追溯到巴比倫楔形文字中所描寫的把油倒進盆水時狀況作爲表面科學的起源，這未免太勉強。在十八世紀美國聞名政治家及學者Benjamin Franklin就曾描述過一個非常有趣的表面現象，他有一天發覺如果在一個小池塘裡，倒進半茶匙的油，風在池塘表面上激起的波紋就會變得平滑多了，小池塘也就會顯得特別寧靜。如果你靜坐下來花幾分鐘給這個問題作一個簡單的思考及計算，你就會驚奇的發現，水面上油膜的厚度也只不過是約十A° 而已。那薄薄的幾個原子層厚度的油膜竟能有這種可觀的作用，大概也不是一般人所能預料得到的吧。

從理論上來說，早在1877年Gibbs就詳細考慮到熱力學上可能引起的表面現象，他的理論已預言在熱平衡時，合金表面上應該會有偏析現象（Surface Segregation）。此一現象得等近百年表面分析技術已開始發展成熟後才有人在實驗本加以證實。表面物理眞正萌芽時期應該算是在一九三十年代，當時晶體原子結構由於 X- 光繞射技術的發展已趨完善，晶體表面原子排列情形也開始有了清楚的概念。Stranski等人開始研究晶體從其表面上成長的理論。Muller 發明了場發射顯微鏡及其在表面擴散現象的研究，以及Langmuir在化學吸附現象的傑出研究等等，都使我們對表面的物理及化學觀念逐漸的明朗化。在一九五十年代有 Muller 場離子顯微鏡的發明，表面原子排列的情形第一次能清楚的看到，多少也使我們對表面的了解更進了一層。眞正進入規模比較大的表面科學研究是在一九六〇年代開始，當時應半導體電子工業及觸媒化學石油工業需要，以及眞空和其它表面技術的進步，表面概念的趨於成熟等等相互推動，使表面科學成爲跨越固態物理、材料科學及觸媒化學等行業的一門新科學，及科學研究上的一個新熱門。在一九六〇及一九七〇年代最主要表面技術應該算是低能電子繞射，Auger 電子表面分析、光電現象及場發射等等。很值得我們注意的是這些技術都是根據二十世紀初期所發現的物理現象所發展出來，這些現象也是當時促進量子力學發展的原動力，量子力學對於二十世紀科學的進步是無法計量的。在半世紀後這些現象及量子力學才又被廣泛的應用於表面科學的研究。

到了一九八〇年代有人用過的表面技術已超過了一百種，研究課題也多得無法計數，但到現在爲止，很多人還是認爲表面物理發展並未達到成熟階段，它缺乏一個比較嚴謹，應用廣

泛，有預測能力的理論。例如現有的表面電子結構只是把固態理中的Band Theory稍爲維廣一下到表面而已，金屬表面理論也只發展到非常不切實際的 Jellium Model. 一到需要解釋與表面原子結構或行爲有關係的現象時，總是離不開 Lennare-Jone 或 Morse 類型的勢能程式。半導體表面原子間作用計算雖說比較完全，多數也只根據現象學理論（Phenomenological Theory），而非從基本原理爲出發點的理論（First Principle Theory），也因爲表面物理缺乏有預測能力的一般性理論，表面物理實驗研究課題就顯得很零亂，所謂重要理論或實驗多半也只反映做的人多，叫的聲音大而已，不一定對表面物理的通盤了解做了基礎性的貢獻，也許這就是表面物理的特色，因爲表面的低對稱性，我們研究高對稱性物理系統所獲得的經驗，不一定能完全適用於表面物理，或許因此在表面物理研究中，往往是實驗在引導理論，而實驗又往往由新技術的發展來引導。所以把表面物理的發展當做一個無秩序的行走（Random Walk）也不過言。

我們現在來考慮一下表面物理及科學可能發展之新方向。這是一個很難回答的問題，一門學問的發展往往只要有一兩位特別有天份的理論家，或因時機已成熟，或因機運好創出有一般性，並有預測性的理論來，整個行業的研究方向可能爲之改變，一九二六年de Broglie物質波理論就是一個例子。表面物理也不例外，除了這種無法預料的特殊情況之外，表面物理多半會受現有技術及高科技工業發展之需要的影響。預測它的發展也比較可能性，也不至於變成完完全全的無稽之談。

今年七月中旬美國“科學”（Science）雜誌就根據了與超過一百名美國權威科學家們的會談結果登了一篇長達四十頁的文章，對將來二十年內科學各行業中的工作機會、可能熱門科

技部門、熱門科學技術等等問題作了一個預測。在此文中，掃描電子穿隧顯微鏡（Scanning Tunneling Microscope）與相關技術及應用這些技術的原子控馭術或操縱術（ Atomic Manipulations ）及超微結構（ Nanostructures ）的製造與研究等被列爲所有熱門研究課題及技術發展之冠。其次與表面物理有關的熱門研究課題有蒸渡固體外延成長（Vapor-Soild Epitaxy）、超導薄膜、表面光電現象、 超短脈衝雷射及 X- 光同步輻射線在表面物理上的應用等等。根據這篇文章及我個人的體驗，我認爲有下面幾個課題很有可能在不久的將來會被更積極的追求。

一、原子控馭術或操縱術的研究：

凝態及表面物理學者及材料學者們一個莫大的理想是能自己自由自在的來操縱每一個原子的動向。利用STM及相關技術，這個理想已初步做到了，美國IBM科學家成功的利用STM的針尖來移動吸附在金屬表面上的氙原子，把它們排成IBM的字樣，最近更進一步的能移動吸付的金屬原子及CO等分子，也可以在矽表面上取出一個原子，其後又把它放回原來的位置，原子控馭術發展的目的在於希望能用此技術製造新分子，或在表面上製造原子尺寸的人造結構，如果這個技術發展成功，將來對科學及工業上的貢獻將是無可限量。

二、表面原子動態的研究：

要高度發展原子控馭術及利用各種不同蒸鍍方法來成長有不同物性的薄膜，我們必需了解不同原子在各種材料表面上的互作用、動態、各種原子程序的機制和所需能量，以及受電場及化學作用之影響等等，表面原子動態本來就是表面物理上的

一個基礎課題它關連到各種表面現象，現在由於發展原子控馭術及蒸鍍固體外延成長術的需要，此項研究也就更有迫切性了。

三、原子位置特有的物理及化學性質（Atomic Site Specific Physical and Chemical Properties）：

很多表面現象及表面促成的化學反應都與表面原子結構及每一個原子位置特有的電子結構及化學性質有密切關係。今後表面物理研究將會逐漸注重闡明材料表面每個原子位置特有的物理及化學性質。舉幾個例子：在用蒸鍍方法成長薄膜時，原子從表面的那些位置開始一個一個結合，繼而成長爲單原子層膜或小晶體，在化學吸附（原子吸附）時，起先在表面上吸附的分子在表面那些原子位置被分解成爲原子，不同原子又擴散到那些原子位置才會結合成新分子，而新分子又從那些位置退附等等， 研究這些原子步驟（ Atomic Steps ）及原動力（Dynamics）是了解基本表面物理及化學所必需的課題。

四、表面現象之動力及原動力學：

由於極短暫的脈衝性雷射的發展，很多表面現象之原動力（Dynamics）及進展速率（Kinetics）已有充分的時間分析力（Time Resolution）來加以研究，很多表面的電子及原子程序如何發展及其發展速率都將可以加以量測，其機制也可以加以闡明。

五、表面材料的選擇：

除了半導體及金屬表面會繼續受到重視外，大家也可能逐漸重視絕緣體、聚合體（Polymer）以及有機和生物體表面的研

究。表面只是另一種Solid-Vacuum Interface（固體—眞空介面）。介面種類很多，比較簡單的、有實用價值的、及可複性的（Reporducible）介面會慢慢的受到重視，由於此需要，不同的新研究技術也會被逐漸發展出來。

六、技術發展：

大家會往具有時（Time）、空（Space）、質量（Mass）與能量（Energy）的高分析技術方面發展，具有顯微鏡性能又能有其它分析能力的儀器將是將來表面物理研究最可貴最有用的設備。

七、理論：

除了繼續嘗試發展具有一般性的理論，以及繼續發展以往比較有限度的、解釋個別現象的理論外，利用高性能及速度計算機的理論計算將會逐漸受到重視。最近First-principle計算已能得到一個原子在不同位置時整個系統的總能量的變化，料想隨著計算機的發展，這種計算將會繼續發展，成爲更可靠的方法。另一方面大家也會嘗試發展比較簡單，但有相當廣泛應用價值的勢能程式可以用來解釋很多表面現象。

八、分子動力模擬（Molecular Dynamic Simulations）：

它是一項新興的熱門研究，大多數的人認爲它是一種理論形式，有些人卻認爲它是一種新實驗，也有人認爲它是實驗與理論之外的另一種科學研究方法。不管你的想法如何，分子動力模擬可以根據一些實驗或理論所得勢能程式模擬各種實際上難以實施的實驗。將來發展方向應會更重視量子作用及考慮一個原子在運動路程中對於整個系統勢能所會引起的變化，但是

不管理論做得多美，分子動力模擬做得多完善，我認爲最終的判斷仍然要靠眞正的實驗結果。物理本來就是一門實驗科學，表面物理也不會例外，所以好實驗是不能忽視的。我們也不能完全依賴做實驗的人的直覺來摸索探討，好的表面物理實驗應該會促進表面理論的發展，好的理論應該也會促進我們對表面物理有一個通盤的了解，也能預測新的表面現象。所以將來表面物理不管是朝那一個方向發展，實驗與論與模擬相互推動將是不可缺少的，我希望表面科學研究會在台灣生根，不只會對基礎科學的進步作貢獻，對台灣高科技工業發展也會有直接或間接的促進作用。

（轉載自物理學會雙月刊）

MICROGAVITY EFFECT ON SOLIDIFICATION PROBLEM

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ABSTRACT

Material processing has been conducted in the earth orbit laboratory to take advantage of the reduced gravity environment in the space. In the microgravity environment, the products reveal significantly difference from those on the earth surface. In this paper, the solidification of binary alloys and of chloride solution in vessel under microgravity conditions are presented. The significant effects of the gravity effect on solidification are shown through the simulation.

1. INTRODUCTION

The use of the space environment for scientific and commericial purposes was limited in the past. However, the era of space exploration by man has led to the development of new knowledge through scientific research, and opened the utilization of space resource. Sounding rockets and satellites have launched successfully during the past decades. Not only have the special performance satellites found in the space, but also have commercial satellites provided opportunities to bring the benefits of space to all mankind.

Among the new development knowledge through space activities, the microgravity is the youngest field of space utilization. The physics of microgravity is the particular behavior of the matter under weak gravity.Thisfield was made accessible by manned low earth orbit flying space shuttle and some related system of SPACELAB. Microgravity environmentofspace holds interst for both scientific and commericial

processapplication. The physical Presented in 91' chinese Aerospace Technology Symposium, Hongkong, December 2. processes most affected by microgravity are those involiving fluid system where buoyance driven convection, sedimenttation and the resulting turbulence and disruption of quiescent conditions are absent.

Material processing in space consists in the production of materials under microgravity. These products can be used for research and development purposes or for industrial and commerical objectives. The interest in material processing in space has increased steadily during the past years.

Many investigation have sought to characterize the manufacture processes from both theoretical and experimental perspectives in a variety of geometric configurations boundary conditions. Due to the absorption or release of latent energe, phase change problems are nonlinear and exact solutions are limited to a small class of problems involving pure substances in one dimensional infinite domains. Therefore, scientists try to develop the numerial procedure to solve these problems (Ahmadian and Burmeister, 1990; Beckerman and Viskaanta, 1989; Dene and Baird, 1990; Ganesan and Poirier, 1990; Ravishanka, 1989; Saitou and Hirata, 1991).

Deere and Company investegated the phenomena of microstructure development during solidification because the microstructure is so significant in the castability of iron, the machining of the castings and the properties of the finished components. It was suggested that it would be possible economically to manufacture castings in space. The company then conducted experiments on several cast iron onboard KC-135 and F-104 aircraft. These aircraft developed periods of low gravity for about 20 seconds on KC-135 and 52 seconds on F-104. The short periods of solidification in the low gravity revealed structural differences in these cast iron from those on the earth. However, the period of low gravity was too short for any quantitive studies (Graham, 1986).

In the space lab or shuttle environment, the existence of perturbative accelerations is well known. These perturbations are caused by mechanical vibrations, orbiter maneuvers, and crew activities, and can not be totally eliminated from space manufacturing environment. According to the reports, accelerations of 2.6 E-02 g due to crew activities are found. Such undersirable

perturbations during manufacturing processes affect heat and mass transfer and may have detrimental effects on the quality of material processed in space. This situation could be especially important in space-based crystal growth where the elimination or reduction of natural convection is essentially to the quality of crytstal.

During NASA-SPARIX flight, the structure of alloys solidified under microgravity is investigated (Potard 1982). The gravitational effects have immediately related to the buoyancy driving convective flows. And the presence of gravity will cause sedimentation and possibly phase sparation. Because of this two reasons, the investigation on gravity effects on the solidification alloys has been pald attention by the scientists. Roger (1986) studied the effect of gravity on the solidification of binary alloys by numerical simulation. Durachenko and Regel (1986) investigated the crystalization of metal alloys in microgravity.

At France, an automated apparatus for organic crystal growth from solution is designed. On April 1990, a flight duration of more that 15 days, the instrument was well adapted to crystal growth from solution and applied to space experiment on fluids (Gonzlez, Gunisse and Perigaud, 1990). At Center for Crystal Growth in Space, Clarkson University, Wilcox and his faculties (1990, 1991) developed computer codes for the computation of heat transfer in the furnace and thermal stress in the resulting crystal. The group applied theoretical and experimental methods for floation zone melting and Bridgman Stockbager growth of cadmium telluride crystal in thespace. Payload System Inc. has complete the first of a six-mission program to develop and exploit long duration space-based techniques to grow protein crystals of diffraction quality. The results show that the protein crystais grown on MIR Space Station met or exceeded the quality of the best earth -grown crystals in size, morphology, internal perfection and mosaicity (Arrot, et. al. 1990). Under the cooperation of USSR and Japanese scientists, the investigation on synthesis of diamond thin film under microgravity environment is initiated (Takagr, et. al, 1991). Aboard the space station MIR, solidification of silvergermanium alloy is investigated (Bewersdoff, 1991). Recently, crystal growth of GaAs in space (Zhong, et. al., 1991) and GaAs solution growth aboard TEXUS rocket (KOdama, et. al., 1991) are studied.

To sum up, the studies indicate that microgravity environment on space station is conductive to solidification and to manufacture process. The space stiation is a relatively stable environment for manufacture process, in term of temperature, vibration and radiation exposure (Arrot, et. al., 1990). It is necessary to obtain a fundamental understanding of some isolated aspects of fluid dynamics systems in microgravtational environment.

In this paper, we apply the simulation method to investigate the microgravity effect on solidification of binary alloy and aqueous solution. In Section 2, the study of the influence of gravity on the meltspinning process -rapid solidification by an imping molten metal jet on a cold moving wheel is present (Chien, et al., 1988). And in Section 3. the microgravity effects on solidification of binary aqueous ammonium chroride solution in rectangulay vessel is investigated (Chien and Hu, 1991). Both cases show the gravity effects on solidification manufacture process is significant.

2. SOLIDIFICATION OF BINARY ALLOYS

The physical model of the melt puddle is shown in Figure 1. The configuration involves the impingement of molten metal stream onto a cold rotating wheel of high thermal conductivity. A continuous ribbon is formed by solidification and extraction liquid metal from the pool of molten metal at the stagnation point on the wheel.

In order to describe the fluid flow and heat flow in the melpuddle, the model based on the following proposed by Katgerman (1983) is incoporated. Considering the gravity effect and using the Cartesian coordinate system, we have the governing equations for the liquid metal relative to the moving solidification front in the follwing form:

the contnuity equation,

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0,$$

perturbations during manufacturing processes affect heat and mass transfer and may have detrimental effects on the quality of material processed in space. This situation could be especially important in space-based crystal growth where the elimination or reduction of natural convection is essentially to the quality of crytstal.

During NASA-SPARIX flight, the structure of alloys solidified under microgravity is investigated (Potard 1982). The gravitational effects have immediately related to the buoyancy driving convective flows. And the presence of gravity will cause sedimentation and possibly phase sparation. Because of this two reasons, the investigation on gravity effects on the solidification alloys has been pald attention by the scientists. Roger (1986) studied the effect of gravity on the solidification of binary alloys by numerical simulation. Durachenko and Regel (1986) investigated the crystalization of metal alloys in microgravity.

At France, an automated apparatus for organic crystal growth from solution is designed. On April 1990, a flight duration of more that 15 days, the instrument was well adapted to crystal growth from solution and applied to space experiment on fluids (Gonzlez, Gunisse and Perigaud, 1990). At Center for Crystal Growth in Space, Clarkson University, Wilcox and his faculties (1990, 1991) developed computer codes for the computation of heat transfer in the furnace and thermal stress in the resulting crystal. The group applied theoretical and experimental methods for floation zone melting and Bridgman Stockbager growth of cadmium telluride crystal in thespace. Payload System Inc. has complete the first of a six-mission program to develop and exploit long duration space-based techniques to grow protein crystals of diffraction quality. The results show that the protein crystais grown on MIR Space Station met or exceeded the quality of the best earth -grown crystals in size, morphology, internal perfection and mosaicity (Arrot, et. al. 1990). Under the cooperation of USSR and Japanese scientists, the investigation on synthesis of diamond thin film under microgravity environment is initiated (Takagr, et. al, 1991). Aboard the space station MIR, solidification of silvergermanium alloy is investigated (Bewersdoff, 1991). Recently, crystal growth of GaAs in space (Zhong, et. al., 1991) and GaAs solution growth aboard TEXUS rocket (KOdama, et. al., 1991) are studied.

To sum up, the studies indicate that microgravity environment on space station is conductive to solidification and to manufacture process. The space stiation is a relatively stable environment for manufacture process, in term of temperature, vibration and radiation exposure (Arrot, et. al., 1990). It is necessary to obtain a fundamental understanding of some isolated aspects of fluid dynamics systems in microgravtational environment.

In this paper, we apply the simulation method to investigate the microgravity effect on solidification of binary alloy and aqueous solution. In Section 2, the study of the influence of gravity on the meltspinning process -rapid solidification by an imping molten metal jet on a cold moving wheel is present (Chien, et al., 1988). And in Section 3. the microgravity effects on solidification of binary aqueous ammonium chroride solution in rectangulay vessel is investigated (Chien and Hu, 1991). Both cases show the gravity effects on solidification manufacture process is significant.

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the contnuity equation,

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0,$$

the momentum equation

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=\mu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right),$$

$$\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}=\mu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}\right),\ +g\beta(T-To),$$

the energy equation

$$\frac{\partial T}{\partial t}+u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}=\mu_e\left(\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}\right),$$

for $>\delta$ T. For solid metal, y $<\delta$ T the energy equation is

$$\frac{\partial T}{\partial t}=a_s\left(\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}\right),$$

Boundary conditions are at the chill surface, y = 0, the temperature is equal to the substate temperature, T, = T_0. For the solid-liquid surface, y = δ T (x), u = U_0, v = O, the etmperature is equal to that of melting, T = T_L. And the conservation of heat at the intersurface is also specified,

$$K_s\frac{\partial T}{\partial y}+Kl\ \frac{\partial T}{\partial x}\ \frac{u}{y}=r_sL_f\ \frac{\partial T}{\partial t}.$$

At far field,y =∞, u = O and T = T_p.

Solving the above governing equations numerically, we obtain the phenomena for the case of aluminum. The data used in the computations are listed below. The solid and liquid density are $p_s = 2.7\times10^3$ kg/m^3, $\rho_1 = 2.36\times10^3$ kg/m^3. The laten heat of fusion is L_f=3.9×10^5 J/kg; specfic hat for liquid C_{pl}, 1.08×10^5 J/kg.k. solid C_{ps}, 1.04×10^3 J/kg.k. Thermal conductivity k_s for solid is 209 w/(m, k), 92 w/(m,k) for liquid k_1.

The melting casting and substrate temperature are 660° , 780° and 25℃ respectively. The heat transfer coefficient h is 8.25×10^5 w/(m^2.k), dynamicviscosty 1.3×10^{-3} Ns/m^2, thermal diffusivity 3.61×10^{-5} m^2/s and bulk modulus 1.1×10^{-4} /k.

In order to ensure the accuracy of the numerical algorithm applied, the case of no gravity is considered at first. By the results of the computation, it is easy to evaluate the solidification boundary layer δ (x) and viscous boundary layer δ_1 (x) and viscous boundary layer δ_1 (x). And the meltspun ribbon thickness is defined by d= δ_M (x)+ δ_T (x). where δ_M (x) is the momentum layer thickness. We have computed the case of U_0 equal to 25, 30 and 50 m/s and compared with the work of previous investigation (Van der Hoeven, et al., 1983). The results coincide with those of the existing solutions for low substrate velocity. The meltspun ribbon thicknesses agree with those of the experiments. Whilst for higher velocity U_0, the thicknesses predicted by the computation are under estimated.

In the case of increasing the velocity U_0, the puddle lenght becomes shorter, and the solidification boundary layer reduces. Contrarily, the displacement thickness become thicker. When the velocity U_0 increases, the total ribbon thickness does not increase.

In figure 2a and 2b, the Reynolds numbers are 9E + 04 and 1.12E + 05 respectively. The gravity force is not considered. The higher velocity U_0, the streamlines is more condensed on the upstream. The flow patterns are no much difference at the downstream near the solidification boundary. For the cases of gravity force considered, figures 3a and 3b, the same phenomena is also observed.

The isotherm patterns are shown in figures 4a and 4b. The isothermals are decrease in breadth for larger Reynolds number near the solidification boundary layer. The narrower the isotherms show the greater the Nusselt numbers.

When the gravity is considered, we could hardly discern the contribution of natural convection from the figures shown. By the numerical computation, it is easy to observe the effect of the gravity on the boundary layer. When the substrate velocity is less than 10^{-4} m/s, the natural convection dominates the boundary layer thickness. And thus the rapid solidfication is desirable.

3. SOLIDIFICATION OF CHLORIDE SOLUTION

A continuum model is used with a well-established finite-difference scheme to investigate solidification of a binary aqueous ammonium chloride solution in a rectangular cavity. In this model, single region contains solid, liquid and

solid-liquid phases. The formulations of this region combine each phase equations to be well suited treating the nonlinear properties of solidification. The development of governing equations from classical mixture-theorem and the phase equilibrium diagram are based on the control- volume. Solving the governing equations for solidification of binary eutectic systim, we can predict teh transient temperature, flow pattern, species and solid-liquid interface (Chien and Hu, 1991).

In this section, an aqueous solution of ammonium chloride (NH4CI-H2O) is investigated. This system was chosen because flow visualization results have been reported (Szekely 1978; Bennon 1987). Thermophysical property data are well established. Figures 5-7 illustrate velocity, streamline, isotherm and liquid isocomposition distributions at dimensionless time 0.0003, 0.003, 0.007 respectivey. Soulutal Rayleigh number is 5.5×10^5 and thermal Rayleigh number is 4.2×10^5.In velocity field we can see two circulation region. The circulating flow in buck liquid is due to the thermal buoyancy and the solutal in the mushy region. The circulating folw driven by thermal is opposite with the circulating flow by solutal. Within the mushy region, solutally riven flow of lighter water rich interdendritic fluid establishes a recircualtion pattern in which upflow occurs near the solidus. downflow develops just inside the liquids as shown in liquid isocomposition profiles a water rich fluid layer at the top of the cavity. The extent to which this layer can penetrate horizontally along the cavity top is limited by the strength of the opposing, thermally driven flow in the bulk fluid. The flow within the buck liquid and mushy regions are consistent with qualitative experimental observations made by previous investigators (Bennon 1987; Szekely 1978). Hot and cold wall heat flux rate is large during initial stages of solidification. Then. it approaches to quasisteady states.

In order to survey the microgravity and the surface tension effects on the solidification process, the same conditions are simulated except the microgravity and surface tension considered. Figure 8 illustrates velocity, streamline, isotherm and liquid isocomposition distributions at dimensionless times 0.007, solutal Rayleigh number 5.5×10^5 and thermal Rayleigh number 4.2×10^5 . Because the gravity is small, the circulation is not significant, and the natural convection can

be neglected. The only heat transformation effect is heat conduction. Therefore, isotherm lines are straight and ttemperature varies linear with distance of closed hot wall. Because of this phenomenon. we can control the temperature accurately. The solidification of alloy has focused attention on the strdying in microgravity.

The investigated micro-gravity and suface tension effects for the solidification process on transient flow properties such as flow patterns, thermal characteristics are studied and compared with the exist solutions. The micro -gravity effect on the surface tension convection is more effective than buoyancy-driven convective.

4. CONCLUSION AND RECOMMENDATION

Material processing and manufacturing in space under microgravity conditions promises possibilities of major improvement in the quality of the products for industrial an commerical utilization. However, a research or production facility designed and optimized for operation on the earth can not be applied directly or even with relatively major modifications, for space operations. The interrelation between different physical phenomena that control the material processing or manufacturing system are generally different for normal gravity conditions on the earth and for microgravity conditions in the space, must be considered. Design of prototype systems for space applications on the basis of extensive testing at earth installations are impractical.

The appropriate theoretical and ground based work should be carried out prior to the inflight experiment. Numerical simulation is one of the most effective and economic methods to investigation the material process in the space. In this study, the microgravity effect on the solidification of binary and alloy liquid in the vessel are presented. The simulated material showed that the physical properties are different from those in the normal gravitational showed that the physical properties are different from those in the normal gravitational condition. In industrial and commercial applications, the products in the space is improved in the space because of the microgravity environment.

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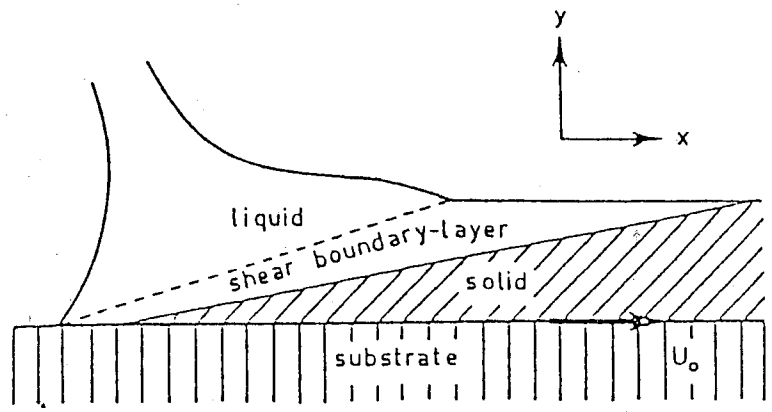


Figure 1. Schematic representation of melting prddle.

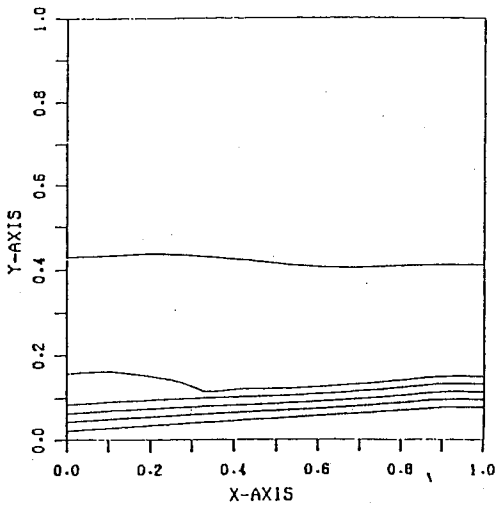


Figure 2a. Flow pattern at Re= 90 $\times 10^3$, Pr= 0.0015 and gravity acceleration= 0.

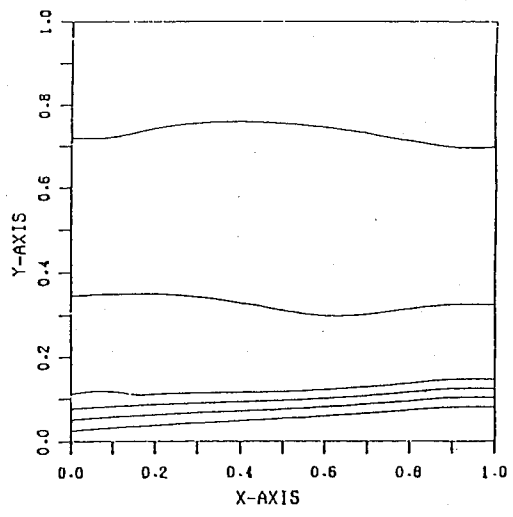


Figure 2b. Flow Pattern at Re= 112 $\times 10^3$, Pr= 0.0015 and gravity acceleration= 0.

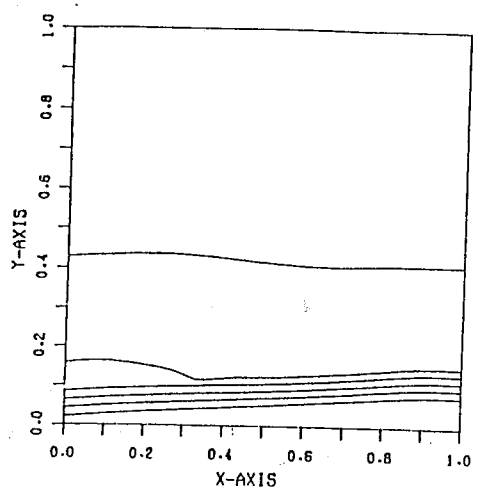


Figure 3a. Flow Pattern at Re= 90 $\times 10^3$, Pr= 0.015 and gravity acceleration= 9.8.

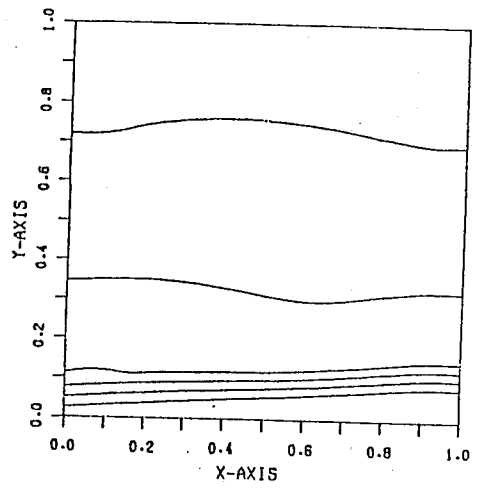


Figure 3b. Flow Pattern at Re= 112 $\times 10^3$, Pr= 0.015 and gravity acceleration= 9.8

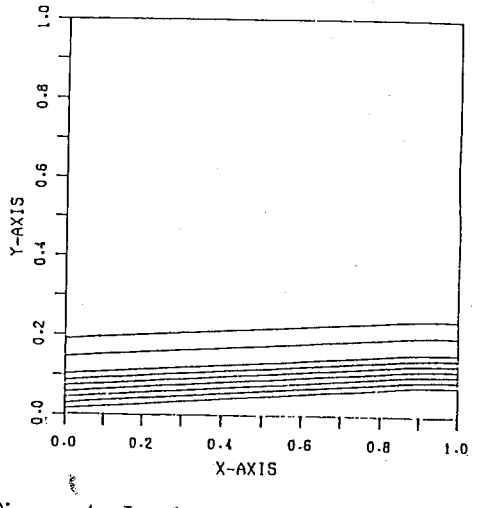


Figure 4a. Isotherm pattern at Re= 90 $\times 10^3$, Pr= 0.015 and gravity acceleration= 0.

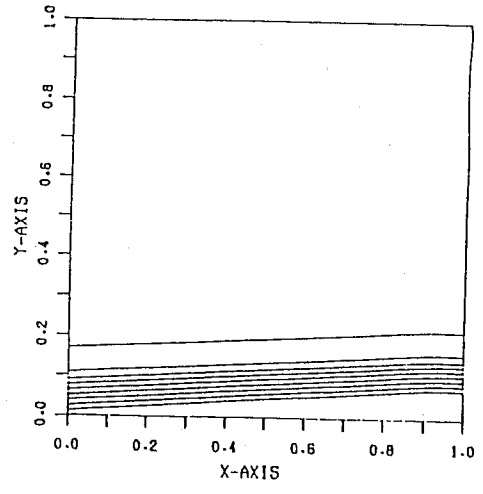


Figure 4b. Isotherm pattern at Re= 112$\times 10^3$, Pr= 0.015 and gravity acceleration= 0.

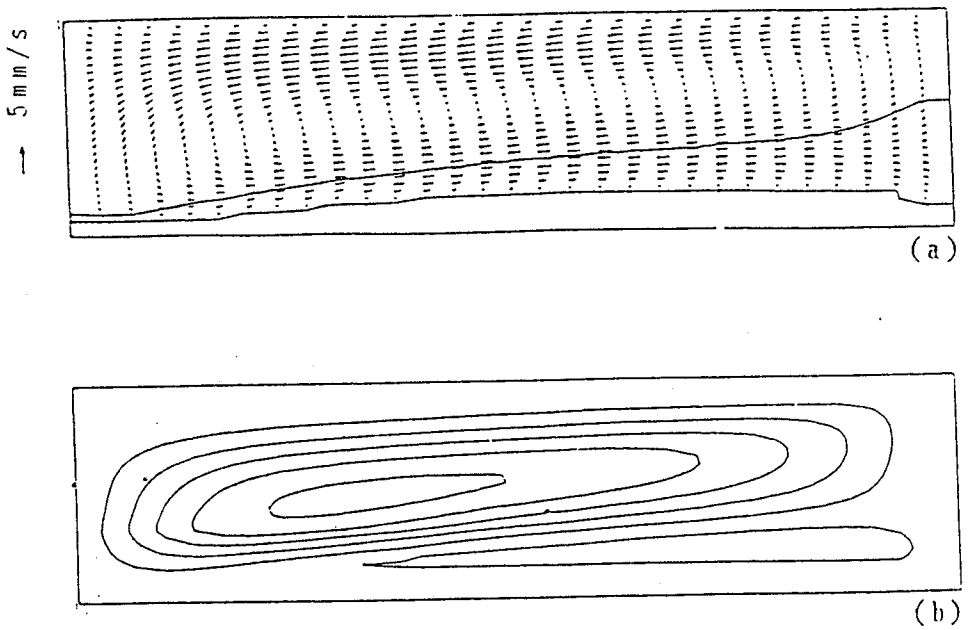


Fig. 5. (a) Velocity vectors (b) streamlines (c)isotherms (d)liquid isocomposition lines at dimensionless time 0.0003 and $RaT=4.2\times10^5 Ras=5.5\times10^5$.

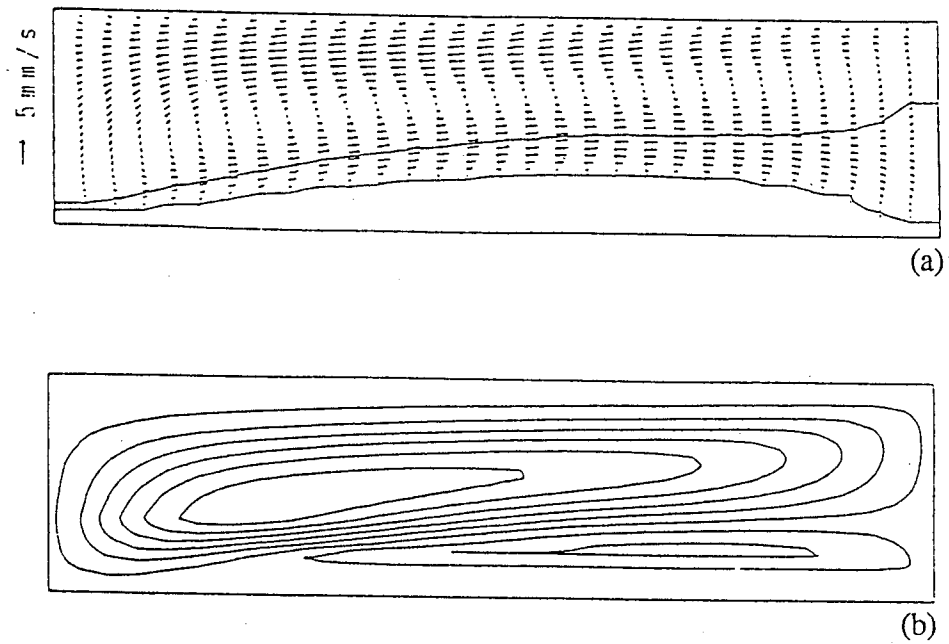
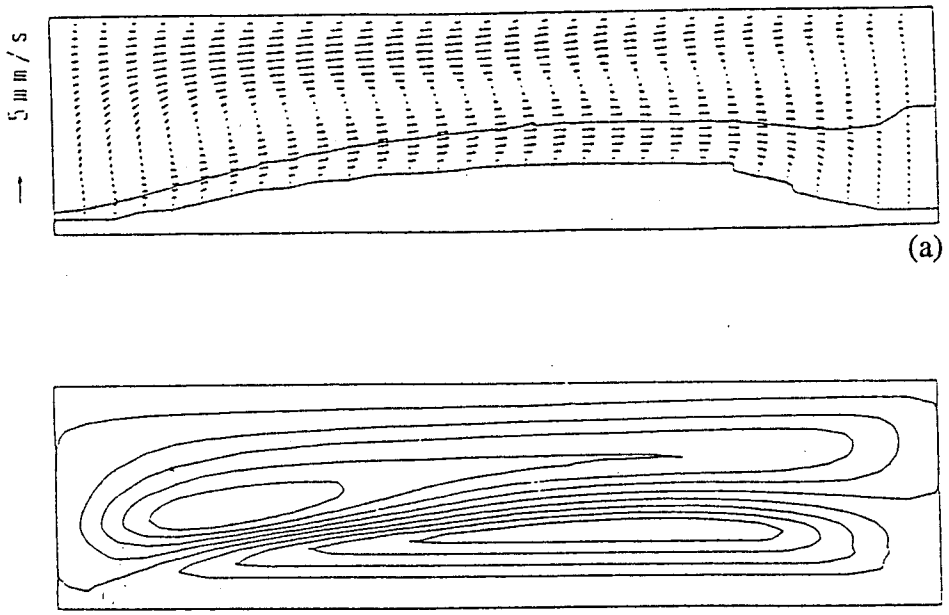


Fig. 6. (a) Velocity vectors (b) streamlines (c isotherms (d)liquid isocomposition lines at dimensionless time 0.003 and $RaT=4.2\times10^5 Ras=5.5\times10^5$.



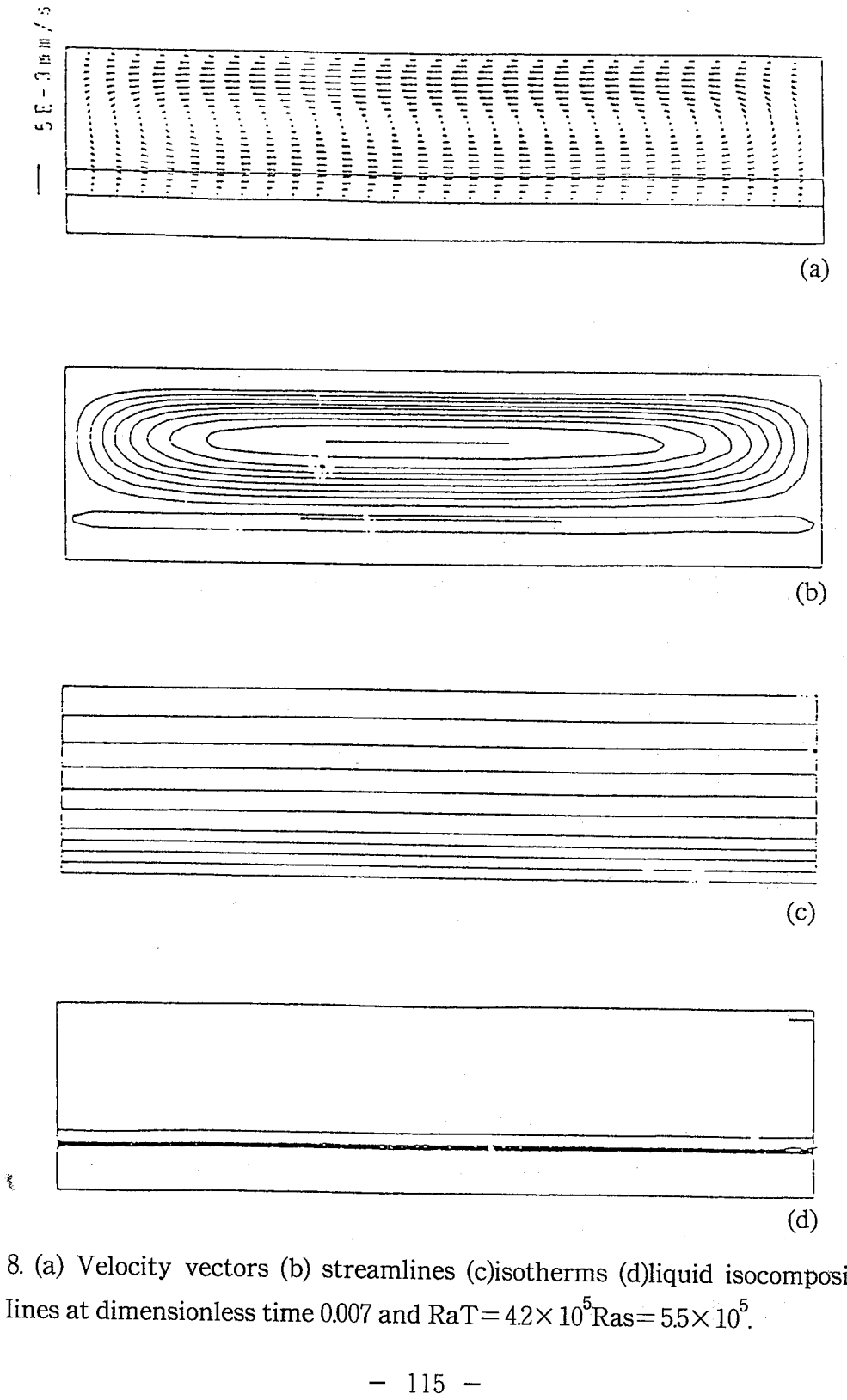
(a)

(b)

(c)

(d)

Fig. 7. (a) Velocity vectors (b) streamlines (c)isotherms (d)liquid isocomposition lines at dimensionless time 0.007 and $RaT = 4.2 \times 10^5$ $Ras = 5.5 \times 10^5$.



(a)

(b)

(c)

(d)

Fig. 8. (a) Velocity vectors (b) streamlines (c)isotherms (d)liquid isocomposition lines at dimensionless time 0.007 and $RaT = 4.2 \times 10^5$ $Ras = 5.5 \times 10^5$.

本 所 計 算 室 小 史

陳鴻裕

1.前言：

1-1.沿革：

本室設備原爲理論組與核子組共同管理（粒子物理計算室），進行數值分析，模擬運算以及實驗數據分析等研究工作，後來擴大爲全所共用，定名爲“計算機室”。由本所編列預算（資訊設備費）購置設備，提供研究人員研究用。

1-2.回顧：

1-2-1.粒子物理計算室時期：

利用個人電腦及終端機經由 M478 以電話線（ DDCMP ）與本院各單位連線，主要使用資訊所 VAX780 及教育部 IBM3080 進行各項數值運算的研究工作。

1-2-2.計算機室：

民國 77 年起，在前所長林爾康先生、代所長何侗民先生及現任所長鄭天佐先生、副所長李世昌先生的大力支持下，進行一系列逐年規劃案，詳細評估本所資訊設備的需求並編列預算，交由本所相關研究同仁負責執行及管理。

1-2-3.資訊設備管理委員會：（民國80年7月成立）

隨著資訊設備的日益增加，及本所乙太網路系統的建立，整個系統的管理成爲一個複雜而專業的工作，所內同仁乃建議成立“資訊設備管理委員會”。負責綜合各組的需求，共同管理資訊設備，編列預算以及採購資訊設備。

2.現有設備：

2-1.所內網路連線：

採用乙太網路（ Ethernet ）共連接十三部工作站，以及兩部終端機，數部個人電腦（以 Vterm, ST240, 或 NFS 連接網路），模擬終端機。主幹線（ backbone ）從四樓計算室，經三樓流力組計算機室，到一樓核子組計數室，再到流力實驗室。另外兩條副幹線，分別繞經四樓核子組及理論組各研究人員的研究室。

2-2.對外的連線：

以三部 M478 及 T1 多工器（共 88 埠(ports)），利用四對電話線連結本院計算中心的 MICOM 多工器，與計算中心各大型計算機連線，透過 MICOM，亦可與本所工作站連線。另外經由計算中心以 gateway 的方式亦能連上國際學術網路（ BITNET ）及台灣學術網路（ TANET ）。

2-3.計算機室簡介：

計算機室共放置八部工作站，兩部網路電射印表機，三部個人電腦，一部雷射印表機（供個人電腦用），以及一部繪圖機。

2-3-1. Phys1（SUN4/260）：

77年7月購置，爲本所第一部工作站。亦爲本所的網路伺服機（Server），除存放部份使用者的檔案外，並裝有六種套裝軟體，另外以M478與計算中心MICOM連線。

2-3-2. Phys2（SUN4/330）

78年11月購置，配置24MBytes的記憶體，負責本所大部份的計算工作。並接一部雷射印表機，提供網路印表使用。

2-3-3. Phys3（IBM RS6000/320）

80年3月購置，爲本所目前CPU最快的工作站，負責部份的計算，並安裝FORTRAN。

2-3-4. Phys4 Phys5（SUN4/20）

80年3月購置，Phys5爲第三個檔伺服機，配備700 MBytes的硬碟，僅用來存使用者的檔案，不負責計算。Phys4爲phys5的back up System，與其基本配備一致，每日定時從Phys5：／ypusr1備份到Phys4：／ypusr2保存，當Phys5有問題時，即可立刻取代Phys5。

2-4-5. Phys6.(Sun4/20)

80年3月購置。負責少部份的計算工作，以及作爲終端機使用。

2-4-6. Phys (VAXStotion3100)

79年12月購置，爲本所的E-mail Server,以DECnet透過計算中心的VAX8530，利用gateway的方式，連接國際學術網路。

3.軟體：

3-1. IMSL

以FORTRAN程式語言編寫的科學運算程式庫，提供研究人員撰寫程式使用，節省程式撰寫時間。

3-2 Tex：

爲排版系統軟體，供研究人員使捷的文書處理環境，出版論文等。

3-3 Interleaf：

在SUN工作站上具專業水準的出版系統軟體，可開到十六個視窗同時顯示檔案的各部份，進行編修的工作。圖形可以用掃描的方式輸入，與文字檔與圖形結爲一體，以進行一致性的修改。特殊符號及數學式可以用視窗的方式挑選。

3-4. MATLAB：

易用的交談式軟體，本所研究人員主要使用其處理矩陣數值運算及二、三維繪圖的強大功能。

3-5. MACSYMA：

交談式的軟體，可以數值式或無誤差的符號的運算來解決代數，微積分及矩陣等問題。

3-6. MATHEMATICA：

結合各主要軟體（MATLAB. MATHCAD. MACSYMA. Reduce SMP. POSTCRIPT. LISP. C及PASCL）的長處，其交談式

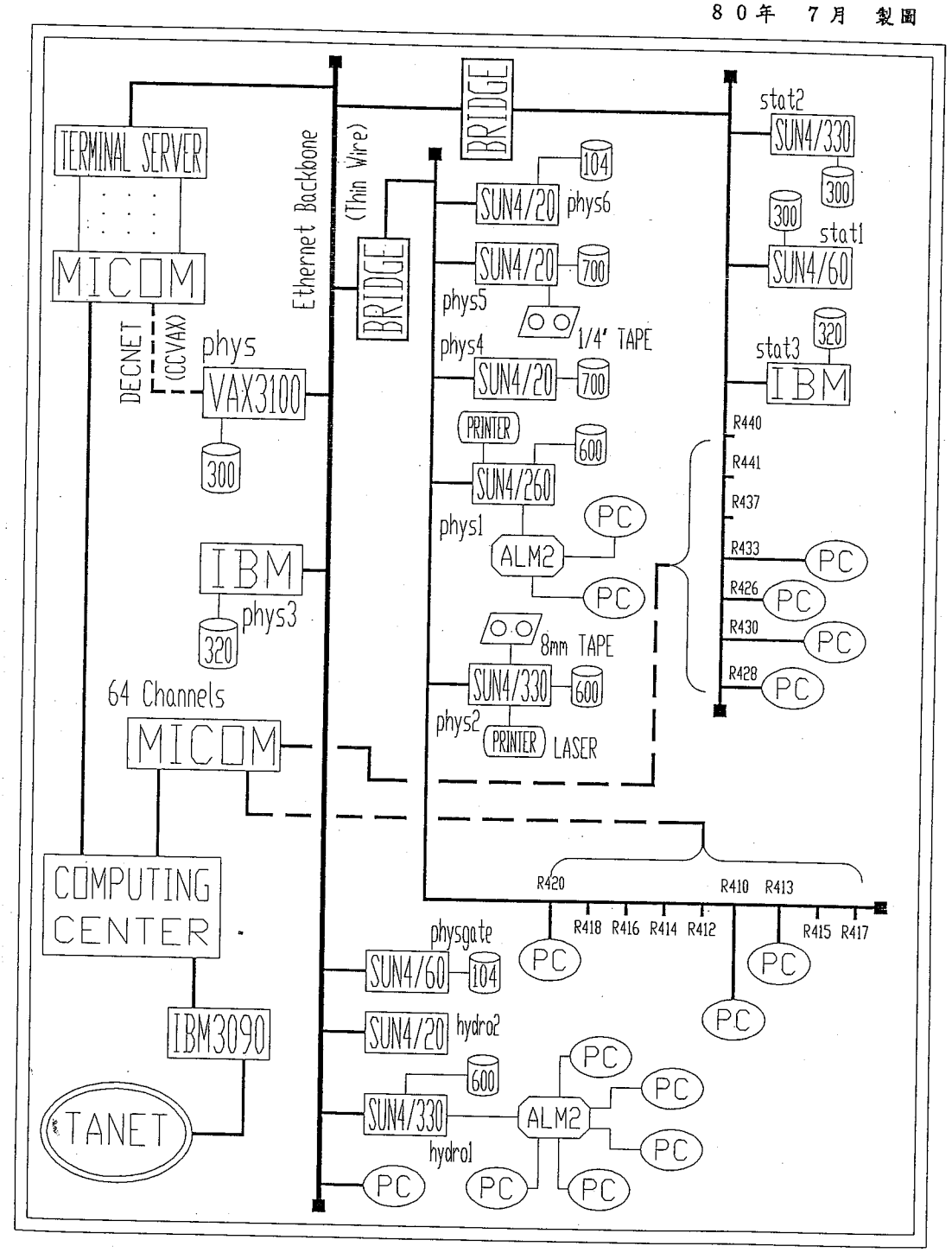
的輸人法更具彈性。本軟體主要提供給已經熟悉此軟體使用法的同仁做符號運算。

4.本來發展：

爲因應大量的計算，及進一步做爲其他超級電腦的前置機器，近期特再增購具有大容量硬碟（至少在2GBytes以上）的主機，並配合院區光纖網路的架設，透過TANET直接與國內外各大型計算連線使用，如此一來，研究人員不僅能在所內使用各型電腦；不在所內時，亦可透過網路使用，使研究工作不受時空的限制。

物理所乙太網路圖

80年 7月 製圖



目前本所乙太網路共連接十三部工作站，依使用情形細分三組：

（一）phys：

Hostname	Memory	Disk	MODLE	MFLOPS	MIPS
phys1	32MB	600MB	SUN4/260	1.1	10
phys2	24MB	600MB	SUN4/330	2.5	16
phys3	8MB	320MB	IBM RS 320	7.5	29.6
phys4	8MB	700MB	SUN4/20	1.2	12.5
phys5	8MB	700MB	SUN4/20	1.2	12.5
phys6	8MB	104MB	SUN4/20	1.2	12.5
phys	8MB	300MB	VAX3100		
physgate	8MB	104MB	SUN4/60	1.4	12.5

（二）stat：

Hostname	Memory	Disk	MODLE	MFLOPS	MIPS
stat1	8MB	300MB	SUN4/60	1.4	12.5
stat2	8MB	300MB	SUN4/330	2.5	16
stat3	8MB	320MB	IBM RS 320	7.5	29.6

（三）hydro：（流力組購置）

Hostname	Memory	Disk	MODLE	MFLOPS	MIPS
hydro1	24MB	600MB	SUN4/330	2.5	16
hydro2	8MB	NONE	SUN4/20	1.2	12.5

Ⅳ

Abstracts of Published Works

FABRICATION AND MAGNETIC PROPERTY OF MANGANESE - ALUMINIUM PERMANENT MAGNETS

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The magnetic properties of Mn-Al alloys are depend on its chemical compositions, grain size, sintering temperature and additivies, and are processing sensitive. Effects of the sintering temperature, and the carbon addition on the magnetic properties of sintering Mn-Al magnets have been investigated. The electrical resistivity and magnetization of Mn-Al alloys have been studied between 4 and 1200 K. Large differences have been observed between the Z-phase and other non-magnetic phases. The best magnetic properties for the isotropic sintered samples in this study are B_r = 2800 Gauss, ${}_bH_c$ = 1500 Oe, and $(BH)_{max}$ = 1.2 MGOe.

Electrical and Magnetic Studies of Co - Pt Alloys

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Electrical resistivity and magnetization measurements were made on a series of Co-Pt alloys to study the order-disorder effect. The specific alloys studied are $Co_{25}Pt_{75}$ and $Co_{50}Pt_{50}$. Curie temperature Tc and order-disorder transition temperature Tx are determined from electrical resistivity data in the temperature range of 4-1200 K. Magnetic hysteresis curve of each sample is measured by a vibrating sample magnetometer at different temperatures. It is found that both magnetic and electric properties are very dependent on the thermal history of the sample, because of the order-disorder effect.

Long Term Oxidation Behavior of Ni_3Al Alloys With and Without Chromium Additions

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The oxidation behavior of Ni_3Al alloys with and without chromium additions was studied after long term exposures in an air furnace over a wide temperature range from 560℃ to 1300℃. The chromium-containing alloy exhibited a better oxidation resistance below 1150℃. Above this temperature the penetration depth of oxides into and along the grain boundaries in the chromium containing alloy became larger than that in the alloy without chromium. Also the penetration depth increased drastically at 1150℃ for both alloys. Through Energy Dispersive X-Ray Spectro-scopy (EDS), X-Ray Diffraction (XRD) and X-Ray Photoelectron Spectroscopy (XPS) analyses, the compositions and structures of the oxide scales for both alloys were also identified.

CALOTIMETRIC STUDY OF $YBa_2Cu_3O_x$, $Bi_{1.6}Pb_{0.4}Sr_2Ca_2Cu_3O_y$, & $Nd_{1.85}Ce_{0.15}CuO_z$ BETWEEN 300 and 750 K

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The specific heat of the superconductors $YBa_2Cu_3O_x$, $Bi_{1.6}Pb_{0.4}Sr_2Ca_2Cu_3O_y$, & $Nd_{1.85}Ce_{0.15}CuO_z$ was studied as a function of temperature between 300 and 750 K by means of Differential Scanning Calorimetry technique. For Y-based system, it goes from endotherm for orthorhomic structure to exotherm for tetragonal structure in the temperature range roughly between 600 and 750 K. For Bi-and Nd-based systems, The DSC (or TG) data are linearly increased (or decreased) functions of temperature between 300 and 750 K; this suggests that the oxygen is gradually desorpted.

THE EFFECT OF Ag DOPING ON THE LOW TEMPERATURE SPECIFIC HEATS OF $Nd_{1.85}Ce_{0.15}CuAg_xO_{4-y}$

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The Specific heat measurements were performed in the temperature range $2K<T<25K$ for a series of $Nd_{1.85}Ce_{0.15}CuAg_xO_{4-y}$ where X=0, 0.1 and 0.2. The resistivity data showed that Ag doping in $Nd_{1.85}Ce_{0.15}CuO_{4-y}$ did not make marked change in superconducting transition temperature T_c. A couple of features in the specific heat data of these compounds were noticed. First Ag doping in $Nd_{1.85}Ce_{0.15}CuO_{4-y}$ slightly decreased the specific heat of Nd ions magnetic ordering for $T<8K$. Secondly the magnitudes of specific heat of $Nd_{1.85}Ce_{0.15}CuAg_xO_{4-y}$ were raised drastically by Ag doping. As the specific heats of electronic contributions and Debye lattice contributions were figured out, the coefficients of specific heat of $Nd_{1.85}Ce_{0.15}CuO_{4-y}$ and $Nd_{1.85}Ce_{0.15}CuAg_{0.2}O_{4-y}$ were then calculated as ~ 10 mJ/mole K^2 and ~ 18m J/mole K^2 respectively, and Debye temperatures for the former was 175K and 160K for the latter.

Electrical resistivity, magnetization, and grain-boundary precipitate in nickel-rich nickel-indium alloys

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The variations of the electrical resistivity, the magnetization, and the grain-boundary Precipitates of a Ni-rich Ni-In alloy system with In concentration up to 7.5 at. % have been investigated as functions of annealing time at 773 K. For samples homogenized at 1225 K, clear grain boundaries are observed. However, for these aged samples, we observed both grain-boundary precipitates and variations of the electrical resistivity and the magnetization; and the binary alloy with higher In concentration has the higher variation rate in the decrease of the electrical resistivity, the increase of the magnetization, and the growth of the grain- boundary precipitates.

Crystal structure, magnetic property and Mossbauer spectra of bis (pyridine-2, 6-dicarboxylato) iron (III) dihydrate

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(Received October 17, 1990)

Crystal structure, magnetic property and Mossbauer spectra studies of bis (pyridine-2, 6- dicarboxylato) iron (III) dihydrate indicate a structure consisting of $H_5O_2^+$ and $[Fe(dipic)_2]^-$ ions, and Fe (III) in the complexes in a high-spin state. Temperature-dependent magnetic susceptibitlity shows smooth curvature with Curie-Weiss behavior characteristic of appreciable weak ferromagnetic interaction.

Magnetic properties of ultra-fine iron particles

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Received 1 August 1990; in revised form 20 September 1990

Ultra-fine iron particles of sizes ranging from 75 to 300 Å were prepared by the gas-evaporation method in an argon atmosphere. By controlling the pressure of argon gas, various sizes of iron particles were made. From TEM micrographs, the mean particle size is determined. Magnetic properties of these particles were obtained by a vibrating sample magnetometer. It is considered that an oxidation layer may be formed on the surface of iron particles, when they are exposed to air. Based on this surface effect, most of the observed magnetic behavior, such as temperature dependences of magnetization and coercive force, can be explained. X-ray and differential scanning calorimetry measurements were also performed on these particles.

HYDROGEN AND DEUTERIUM IN PALLADIUM

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Electrochemical permeation technique has been used to measure the diffusivity and permeability of hydrogen and deuterium in palladium. A discharge technique was also used to measure the solubility of hydrogen and deuterium in palladium. The permeation results showed an Arrhenius temperature dependence of diffusivity and permeabillity between 298 and 340 K. The solubility values of hydrogen and deuterium in palladium from measurements show exothemic reaction. Cathodic charging on palladium electrodes was also observed, fusion spectra was not found in our results. The surface morphology and deuterium charged specimen was examined by scanning electron microscope.

EFFECTS OF Ag DOPING IN THE N-TYPE SUPERCONDUCTOR Nd-Ce-Cu-0

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C.C. Wu[b], C.H. Cheng[b] and J.Y. Chen[c]

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Changes in various physical properties due to both addition of Ag and substitution of Ag for Cu in the N-type superconductor system Nd-Ce-Cu-O were investigated by measurements of electrical resistivity, magnetization, X-ray powder diffraction, X- ray photoelectron spectroscopy (XPS) and UV photoelectron spectroscopy (UPS). There is only a small decrease in the superconducting transition temperature with Ag dopants up to 40% (compared with Cu). The normal-state resistivity decreases with the addition of Ag; however, it increases with the substitution of Ag for Cu. The M- H hysteresis loops at 5 K were enhanced for the 20% Ag- doped samples. The superconductivity in the Ag-doped Nd-Ce-Cu-O samples depends greatly on the reduction processing conditions.

MOSSBAUER SPECTRA AND MAGNETIC PROPERTIES OF POLYDIIMINE COMPLEXES OF IRON (II) SULFATE

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A new series of polynuclear iron complexes with polydiimine ligand have been prepared from the Schiff-base condensation of pyridine-2, 6-dialdehyde or 2, 6-diacetylpyridine with aliphatic diamines. The structures of the complexes are represented by $[- N{=}CR-Py-CR{=}N-(CH_2)_n-]_2 FeSO_4{\cdot}xH_2O$; Where R=H, CH_3; n=4 ~ 10, x=5 ~ 8. Mossbauer spectra and magnetic measurements show several complexes have unusual magnetic properties.

GRAIN BOUNDARY PRECIPITATE, ELECTRICAL RESISTIVITY AND MAGNTIZATION IN NICKEL INDIUM ALLOYS

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* Graduate Institute of Material Engineering, National Taiwan University, Taipei, Taiwan, ROC

The variations of the grain bourdary precipitates, the electrical tesistivity and the magnetization of nickel-rich nickel-indium alloys containing indium up to 6.2 at.% have been investigated as functions of annealing temperature and annealing time. For samples homogenized at 1225 K, clear grain boundary was obsarved by using SEM microscope, and single Curie temperature was observed by the electrical resistivity and magnetization measurements. However, for these aged samples, we observed both grain boundary precipitates and variations of the electrical and magnetic properties. The variations of the electrical resistivity and magnetization in these aged alloy samples can be expressed as monotonically varied functions of the growth of the grain boundary precipitates.

The Characteristic of Ionics Wind and its Effect on Electrostatics Precipitator

W.J. Liang* T.H. Lin

The ionic wind and turbulent flow field formed by nonconservative electrical force field have long been recognized to have significant effect on ESP (Electrostatic Precipitator). For acturally simulation of the flow field in ESP, the electrical force term is involved in momentum equations. Becauce turbulent flow as working condition is needed, three dimensional K-E-E as well as K -E-A modelsare applied to close turbulence. SIMPLE-C schemeis selected as the tackle of numerical solution to treat the characteristic of ionic wind and it's influence on ESP. The collecting efficiency of ESP. foreaach grade ofdiameter is calculated to understand Thus we can study how ion wind interfers with collecting efficiency.

Computed results indicated that under normal operating conditions, the phenonmena of ionic wind isn't distinct, and flow field and collecting efficiency are almost the same as that calculated from fully developed flow. When flow velocity becomes smaller, especially when the flow velocity is smaller than 02 m/s, the effects of ionic wind becomes more istinct. and the efficiency and the turbulent intensity will differ from what calculated from calculated from fully developed flow.

Isothermal crystallization of amorphous $Fe_{78}B_{13}Si_9$

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We have studied the high temperature ($T_a \geqq 500℃$) isothermal crystallization processes in amorphous $Fe_{78}B_{13}Si_9$ using a differential scanning calorimeter. X-ray diffraction, the etching technique and metallographic observation have been used to analyze specimens under different treatments. We have found the Avrami exponent n to be between 2 and 3. It is believed that the crystallization behavior of α - Fe at high T_a ($\geqq 500℃$) is different from that at low T_a ($\leqq 400℃$). The amount of α -Fe crystallization is closely related to the annealing temperature T_a.

衛星遙測資料的大氣效應訂正：反射陽光訂正

曾　忠　一

中央研究院　國立臺灣大學

摘要

白天時地球資源衛星或氣象衛星在3.7微米紅外窗區頻道內觀測到的輻射強度都會受到反射陽光的影響。本文通過求解平行平面散射大氣的輻射傳遞方程探討3.7微米頻道內的反射陽光。輻射傳遞方程使用離散縱標法求解，大氣在垂直方向都假設爲非均勻的，下邊界的反射函數使用蒙地卡羅法來模擬。這個輻射傳遞模式在物理特徵上和現有的其他模式都互相符合。研究結果表明，沿鏡面反射方向，反射陽光訂正值可高達40度以上，但隨海面風速減小。因此在白天時若使用3.7微米頻道的觀測，必須仔細進行反射陽光訂正。這個輻射傳遞模式可用於計算反射陽光訂正值隨天頂角和相對方位角的變化，以便決定更精確的海面溫度。（發表於1991遙測技術應用研討會論文集，1991年6月20日，21日，國立中央大學）

Scalings of Growing Self-organized Surfaces

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June 10, 1991

A self-organized mechanism is used as a growth model to study the scaling properties of the growth of a 1D surface. It is found that the surface width, w(t,L) at time t, for small system size L, obey the scaling ansatz: $w(t,L) \sim L^{\alpha} f(t/L^{z})$. Values of the exponents z and α show that the usual continuum description of growth is not applicable here. Moreover, it might be possible that the 1D surfaces grown by this model is not well defined for large L.

CRYSTALLIZATION IN AMORPHOUS $Fe_{78}B_{13}Si_9$

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Isothermal crystallization in amorphous $Fe_{78}B_{13}Si_9$ with annealing temperature $T_a \geqq 500$℃ has been measured by a differential scanning calorimeter in pure oxygen and nitrogen atmospheres. Our results showed that oxygen has more pronounced effect on the 2nd crystallization peak than on the 1st crystallization peak. The heat released from the 1st crystallization is enhanced, while that of the 2nd crystallization is reduced by oxygen. X-ray results indicates that the two crystallization peaks are mainly due to the formation of α-Fe crystallites. The Avrami exponent n_i for each peak of crystallization was examined and analyzed. Selective oxidation and out- diffusion of silicon have been observed. Although the phenomena were not very significant, due to shorter annealing time, they were more apparent for the oxygen case than for the corresponding nitrogen case.

Magnetization and transport properties of Co-Ni-Pd alloys

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A series of Co_{15} $(Ni_x$ $Pd_{1-x})_{85}$, Co_{25} $(Ni_xPd_{1-x})_{75}$, and $Co_{35}(Ni_xPd_{1-x})_{65}$ alloys was made. Different thermal treatments were performed on these alloys: (1) furnance cooling from 1000℃ with − 3 to − 5℃ /min, (2) annealing at 750℃ in high vacuum for 23 h, and (3) salt water quenching from 800 and 900℃, respectively. Properties measured include magnetization, electrical resistivity, magnetoresistance, and lattice constant, An order- disorder transformation is suggested indirectly in $CoNi_3$ by some changes in the measured properties for samples subjected to different thermal treatments. All the changes observed are explained from the viewponits of order -disorder transformation, textural structures, impurities, and other phenomena.The physical effect of replacing Ni by Pd is discussed briefly.

Temperature dependence of magnetoresistance of amorphous $Fe_{80-x}V_xB_{14}Si_6$

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Amorphous Fe_{80-x} $V_xB_{14}Si_6$ With $0 \leqq x \leqq 16$ have been made by the quench spinning method. We have measured the electrical resistivity ρ_0, ferromagnetic anisotropy resistivity (FAR), $\triangle \rho / \rho_0$, and transverse force magnetoresistance (TEM) $(\partial \rho / \partial \rho H)\perp$ from 300 K to 10 K. For $x \geqq 4$, T_{mim} is observed for each ρ_0 versus T plot. $\rho_0(T)$ is fitted to a $T^{1/2}$ dependence and to a ln T dependence respectively, to see which is better for $T<T_{mim}$ The anomalous behavior in resistivity does not seem to affect the temperature dependence of FAR. At 10 K, both magnetization and FAR are decreasing functions of x. As x is increased, TFM changes from a negative value to a positive value.

Self-Diffusion on the Reconstructed and Nonreconstructed Ir (110) Surfaces

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(Received 26 December 1990)

On the (1 × 1) Ir (110) surface the diffusion of single Ir adatoms is two dimensional; i.e., an adatom can diffuse along the $[1\bar{1}0]$ surface channel by atomic hopping as across the channel by atomic replacement. The energy needed for an Ir adatom to hop along the channel is 0.80 ± 0.04 eV, or 0.09 eV larger than needed to replace a lattice atom in the cross-channe jump. In contrast, Ir adatom diffusion on the (1 × 2)-reconstructed surface, with double-space $[1\bar{1}0]$ channels, is one dimensional; i.e., an adatom can only hop along these channels. The activation energy, 0.86 ± 0.03 eV, is higher than that for either cross-channel or along-the-channel diffusion on the nonreconstructed surface.

Meaurement of the binding energy of kink-site atoms of metals and alloys

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The binding energies of kink-site atoms of several metals and alloys have been measured from a kinetic- energy analysis of low-temperature field-evaporated ions using a high-resolution pulsed- laser time-of-flight atom-probe field ion microscope. Data are collected from atomically well-defind surfaces. The binding energies of metal atoms in kink sites obtained by this low- temperature and high-field method are found to agree with the cohesive energies of these metals, derived by thermodynamic methods, to -0.03 ± 0.19 eV. The binding energy of Co atoms in Pt_3Co alloys, either in ordered state or in disordered state, is 0.65 ± 0.17 eV higher than that in Co metal whereas the binding energy of Pt in the alloy is about 0.1 eV lower than that in Pt metal. We present details of the experimental method and indicate other problems which can be studied with this method.

Mechanisms and Energetics of Surface Atomic Processes

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The energies involved in various surface atomic processes such as surface diffusion, the binding of small atomic clusters on the surface, the interaction between two adsorbed atoms, the dissociation of an atom from a small cluster or from a surface layer, the binding of kink site atoms or atoms at different adsorption sites to the surfacet etc. can be derived from an analysis of field ion microscope images and a kinetic energy measurement of low temperature field desorbed ions using the time-of -flight atom-probe field ion microscope. These energies can be used to understand the transport of atoms on the surface in atomic reconstructions, epitaxial growth of surface layers and crystal growth, adaorption layer superstructure formation, and also why an atomic ordering or atomic reconstruction at the surface is energetically favored. Mechanisms of some of the surface atomic processes are also clarified from these studies.

A Quasi-Relativistic Equation for a Fermion-Boson System

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We propose a new quasi-relativistic two- body equation for a system consisting of a spin-1/2 fermion and a spinless boson. Our scheme involves coupling a Dirac equation to a Duffin-Kemmer-Petiau equation. A general method for solving this new relativistic two-body equation is presented.

INITIAL TEMPERATURE FIELD FOR UNSTEADY LAMINAR FORCED CONVECTION FROM AN IMPULSIVELY STARTED SPHERE

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Abstract-Analytic solution for forced convection heat transfer from an impulsively started heated sphere is investigated. Because of the impulsive start, there is a singularity at the very beginning of the motion. The accurate analytic solution for the initial temperature field is obtained by solving the nonlinear energy equation using the method of matched asymptotic expansion to the third order. The solution is in terms of exponential function and error function. The time development of the temperature field is plotted and investigated. The local Nusselt number over the sphere surface and the progress of minimum Nusselt number point with time are obtained.

Microscopic detection of spin-dependent long range interactions

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We propose several types of precision measurement experiments to detect the possible existence of spin- dependent gravitational or other types of long range interactions. These experiments are all based on the principle of magnetic resonance. We show that limits achievable in microscopic measurements are generally much more stringent than those obtainable by macroscopic means.

COMPTON SCATTERING BY THE PROTON AND NUCLEON POLARIZABILITIES

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Low-energy Compton scattering by proton is studied. We include the effects of the $\triangle$ (1232) excitation and also the π - and η -exchange contributions in this work. Issues concerning nucleon polarizabilities are discussed.

SOLVING A PHENOMENOLOGICAL TWO-BODY DIRAC EQUATION

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We present a general scheme of solving a relativistic two -body equation with phenomenological potentials. It is shown that, for a rather general class of local potentials, the problem can be reduced to that of solving a pair of coupled Schrodinger-type equations. A general discussion of the mixing of partial wave channels and the question of the Klein paradox is also presented.

MEASUREMENT OF DISTURBANCE EFFECT IN THE WALL REGION OF A TURBULENT BOUNDARY LAYER

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Results of the effects of controlled disturbance introduced artificially into the wall region of a turbulent boundary layer are reported. A thick turbulent boundary layer was produced by the flow over a smooth flat plate in the wind tunnel. The disturbance was generated by a small pin which was driven up and down cyclically through a minute hole into the wall region of the turbulent boundary layer. A feedback system controls the DC servomotor which drives an eccentric cam and the small pin follower. A hot wire anemometer was used to measure the turbulent velocity. The VITA (Variable Interval Time Average) scheme is applied to obtain the mean frequency of burstlike events. The measurement results indicate that the effect of disturbance on the local flow structure decays as it is convected downstream. From measurement of the mean frequency of burst -like event, it is found that there are exponential relations exist between the disturbance frequency and the mean burst frequency. And the mean burst frequency decreases exponentially with decreasing the disturbance frequency.

Model Test of Windbreaks With Half Circlular and Rectangular Section in Taichung Harbor

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In this paper, model tests of windbreaks with half circular and rectangular sections in Taichung Harbor were carried out in the wind tunnel. The neutral atmospheric turbulent boundary layer was simulated in the low speed wind tunnel in accordance with the geometric and dynamic similarities. The half circular and rectangular sections of windbreaks were tested for the wind attenuation in the Turning Basin region of Taichung Harbor. Results indicate that the windbreaks with half circular section provides better shelter than the windbreaks with rectangular section. The gradient of the wind speed is more smooth in the left hand lee side when the half circular section of windbreaks are used. For windbreaks with half circular section, the lines with equal wind attenuation factor are more parallel to the windbreaks, this is advantages for handling large vessels in the Turning Basin of Taichung Harbor.

WIND TUNNEL TEST OF TWO-DIMENSIONAL WINDBREAKS IN TAICHUNG HARBOR

Bao-Shi Shiau Robert R. Hwang

In this paper, the two-dimensional windbreak model tests of Taichung Harbor were carried out in the wind tunnel. The effects of windbreak height and porosity were studied. Model tests results reveal that windbreak with lower porosity has a better wind attenuation result, and a higher windbreak shelters a longer distance.

Magnetization study on grain-boundary precipitation in a Ni-8 at. % Sn alloy

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The variations of the grain-boundary precipitates, the electrical resistivity, and the magnetization of a Ni -8 at. % Sn alloy have been investigated as functions of annealing temperature and annealing time. For samples annealed at 773 K, the averaged growth rate of the size of the grain-boundary precipitates is roughly 0.42 μ m/h for the first 24 h; the electrical resistivity at T=10K and the magnetization at T=10K and H=5kG vary monotonically with respect to the annealing time for the first 2 weeks, changing from 22.5 to 7 μ Ω cm for the electrical resistivity and from 27 to 33 emu/g for the magnetization. A large tail section in the magnetization versus temperature curve was also observed in the aged samples. All these electrical and magnetic variations in the Ni-8 at. % Sn samples annealed at 773 K varied monotonically with respect to the growth of the grain- boundary precipitates.

OXYGEN CONTENT VARIATION IN CATION-DEFICIENT AND CHEMICALLY-DOPED HIGH-T_c Y-Ba-Cu AND Bi-Sr-Ca-Cu-O SUPERCONDUCTORS

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Oxygen content in high-T_c superconductors has been determined by using a charged particle activation method. Changes of oxygen content in Cu-deficient Y-Ba-Cu-O and Cu/Bi- deficient Bi-Sr-Ca-Cu-O compounds were obtained and used as a basis for discussing the variations in other cation-deficient materials.

Electrical Resistivity, Magnetization, and Grain Boundary Precipitates in Ni—Sn Alloys

Y.D. Yao (a), Y.Y. Chen (a), S.J. Tzeng (b), and T.H. Chuang (c)

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The variations of the electrical resistivity, the magnetization, and the grain boundary precipitates of a binary Ni-Sn alloy system with Sn content up to 8 at% are investigated as functions of the annealing time at 773 K. For samples homogenized at 1325 K, clear grain boundaries are observed; the residual electrical resistivity is increased roughly by 2.81 $\mu\ \Omega$ cm per at% of Sn and the Curie temperature is found to decrease roughly 32.5 K per at% of Sn. However, for these aged samples both, grain boundary precipitates and variations of the electrical resistivity and the magnetization, are observed, the binary alloy with higher Sn content has the higher variation rate in the decrease of the electrical resistivity, the increase of the magnetization, and the growth of the grain boundary precipitates.

Fur ein binares Ni-Sn-Legierungssystem mit Sn-Gehalt bis zu 8 At% werden die Anderungen des elektrischen Widerstands, der Magnetisierung und der Korngrenzenprazipitate als Funktionen der Temperungszeit bei 773 K untersucht. Fur bei 1325 K homogenisierte Proben werden deutlich Korngrenzen beobachtet, der elektrische Restwiderstand nimmt ungefahr um 2.81 $\mu\ \Omega$ cm pro At% Sn zu, und die Curietemperatur nimmt etwa um 32,5 K pro At% Sn ab. Jedoch werden fur diese gealterten Proben sowohl K orngrenzenprazipitate als auch Anderungen des elektrischen Widerstands und der Magnetisierung beobachtet, wobei die binare Legierung mit hoherem Sn-Gehalt die hohere Anderungsrate beim Abfall des elektrischen Widerstands, beim Anstieg der Magnetisierung und dem Wachstum der Korngrenzenprazipitate aufweist.

Effect of La Substitution on the Phase Transition in Ce_3Al Compound

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The compound Ce_3 Al has a hexagonal Ni_3 Sn structure. The resistivity measurements and thermal expansion measurements show around 100K there is a first order phase transition occurrence. Recently we have studied the effect of La substitution on the 100K phase transition in alloys $(Ce_{1-x}\ La_x)_3$ Al. The resistivity and magnetic susceptibility results show the phase-transition temperature T_c is decreased gradually from 105 K to about 75K as the amount of La substitution is increased to 9% of Ce. This result is similar to the result reported early in the pressure dependent resistivity measurements in which the transition temperature is decreased by the release of applied pressure. An existance of a critical value of the lattice constants of Ce_3 Al which is responsible for the phase transition is proposed. All the susceptibility of these alloys are of Curie-Weiss form $X(T)=C/(T+\theta)$, and the curie constants derived are approximately the same with $Ueff-2.52u_b$ for Ce_3 Al and its alloys $(Ce_{1-x}\ La_x)_3$ Al, this indicates the valence status of Ce in these alloys are trivalent. The XPS spectra of the alloys also show no distinction among Ce_3 Al and its alloys $(Ce_{1-x}\ L3_x)_3$ Al, this ruled out the possibility that Ce valence change is involved in the phase transition.

Electrical Resistivity of Metal Matrix Composites

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Introduction Recent theories for the resistivity of metal matrix and in-situ composites predict a resistivity minimum followed by a sharp upturn in resistivity with the lowering of sample temperature. The expected minimum arises from two competing mechanisms, viz., (1) the normal decrease of metallic resistivity with temperature due to a larger mean free path for electron -phonon collisions, and (2) the contribution to the resistivity from electron scattering at the matal- fiber interface, enhanced at low temperatures by the larger mean free path in the bulk. The latter is essentially the size effect first discussed by Dingie /1/ in connection with the resistivity of thin wires.

A detailed analysis of this size effect for unidirectional fiber reinforced metal matrix composites predicts resistivity enhancements of several thousand-fold in the temperature range from about 4 to 10 K /2,3/. The measurements reported here for boron-aluminum composites were gathered to test this prediction.

Resuits and discussion Our samples, containing 40 vol% and 80 vol% continuous boron fibers, were obtained from Commonwealth Scientific Corporation, Alexandria, Virginia, USA. Additional information on these materials and the experimental techniques for their study is given in /4/, where the electrical resistivity of the 40 vol% sample is reportad in the temperature range from 78 to 400 K.

Fig. 1 shows the longitudinal and transverse (with respect to the fiber axis) electrical resistivity of our boron- aluminum composites between 4.2 and 300 K. Neither the 40 vol% nor the 60 vol% sample shows and evidence of the dramatic enhancement suggested by the theory of /2/. In defense of this negative result, we offer the following argument for estimation the contribution from interface

scattering to the resistivity of metal matrix composites:

The scattering of electrons at the metal-fiber boundary can be seen as modifying the microscopic conductivity of the metal in the vicinity of the interface. This (spatially varying) conductivity, say σ (r), is smaller than the bulk value for the metal σ_o, but approaches the latter far from the interface. The smallest— —

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SOME PHYSICAL PROPERTIES OF SUSPENDABLE SUPERCONDUCTING 123-Ag COMPOSITES

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We have measured the M-H hysteresis loops of n $YBa_2Cu_3O_y$: Ag (n=3,5,and 7), and 3R$Ba_2Cu_3O_y$: Ag(R=rare earth) as a function of temperature. We have found that the residual magnetization and, hence, pinning, is strong and is independent of n and R, but dependent on the metallurgy. The giant creep rates have been measured and are greater than those of pure 123 samples. Scanning electron microscopy and polarized light microscopy have show that the presence of silver gives rise to the growth of large grains($\sim$1 mm) in the 123-Ag samples. The field dependence of the critical current density is not strong at high field. We have also measured the resistance in field up to 200 kOe. The resistance remains zero even at 80 K and 200 kOe. The field dependence of the superconducting transition is discussed in terms of phase slippage.

PHOTOEMISSION STUDIES OF THE EFFECTS OF SILVER IN THE ELECTRON-DOPED SUPERCONDUCTOR $Nd_{2-x}Ce_xCuO_{4-\delta}$

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The variation of physical properties as a result of silver addition and substitution of 10% and 20% Ag in the bulk $Nd_{1.85}Ce_{0.15}CuO_{4-\delta}$ electron -doped superconductor have been investigated. The T_c drops from -24 K to -22 K with 10% doping. It becomes nonsuperconducting when the Ag content is increased to 20%. Ag clusters were observed in the 20% Ag- doped samlpes. Ag impurities also behave as an effective oxygen stabilizer.

THERMAL ANNEALING STUDY OF HIGH-T_c YBaCuO AND BiSrCaCuO SUPERCONDUCTING WIRES

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High-T_C YBaCuO and BiSrCaCuO Superconducting wires have been fabricated by powder metallurgy technique. Copper and silver tubes were used as the external jackets. Thermal annealing treatments for all the wire-type samples were performed between 773 K and 1223 K. Both electrical and magnetization studies show that the superconducting proper ties can be improved after properly thermal annealing these samples with silver jacket. Our experimental results show that proper thermal annealing treatment can enhance the intragrain critical current density more than 100 times; however, the intergrain critical current density improves only a few times.

Magnetic properties of FeAlMnC steels

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A series of high yielding strength (90－180 ksi) and high -elongation (30%－45%) FeAlMnC steels have been made. The magnetic, microstructural, and thermal expansion properties of these steels have been studied. Basically, their magnetic transitions on cooling can be classified into three groups according to their microstructures: (i) For fully austenitic (γ) steels, the transition is from paramagnetic to antiferromagnetic. T_N is lowered with the addition of Al; (ii) for $\alpha + \gamma$ phase steel (volume fraction of $\alpha \leqq 0.3\%$), the transition is from superparamagnetic to antiferromagnetic, and (iii) for the mixed phase steel, whose α phase has percolated, it is ferromagnetic with $T_C \sim 200°C$. The susceptibility of austenitic steels is low. Their nonmagnetic properties are comparable to commercial 304 or 25/12 stainless steel. An Invar-like property in the thermal expansion was observed around T_N. Their volume magnetostriction values are in the range of $10^{-6}-10^{-5}$.

Superconducting Property and Structure Studies of $YBa_2Cu_3O_7-Ag_2O$ Composites

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We have studied the superconducting property and the structure of $YBa_2Cu_3O_7$ added with Ag_2O, with the weight ratios of $YBa_2Cu_3O_7$ to Ag equal to 4, 6, 8, and 10. Resistance and magnetization measurements show that the normalstate transport behavior and the superconducting transition temperature, T_c, are insensitive to the amount of Ag added. The normal-state resistance decreases linearly with temperature, reaching a large value of ~ 3 for the ratio R (300K) /R(100K). This value is evidently larger than that ($\leqq 2.5$) generally observed in polycrystalline $YBa_2Cu_3O_7$, and is ascribed to the improved grain growth behavior resulting from Ag addition. X-ray diffraction and scanning electron microscopy studies have also been performed. X-ray diffraction study indicates the Ag peaks appear as a separate phase. Scanning electron microscopy study reveals large $YBa_2Cu_3O_7$ grains ($\sim 20-6\,\mu$ m). Finally, we point out that the microstructures of the samples depend much on the subtle preparation conditions.

Electrical Resistivity of Nickel-Rich Nickel-Indium Alloys between 10 and 800 K

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Introduction The morphology of the grain boundary precipitation in the nickelrich nickel-indium alloy system has been extensively studied /1 to 4/. However, relatively little research work has been devoted to the electrical and magnetic properties /5 to 8/. It is well known that the electrical resistivity measurements on a magnetic binary alloy system provide useful information about their characteristic electronic, structural, compositional, and magnetic situations. The electrical resistivity depends not only on the electronic structure, but also on the mechanisms of the relaxation of the conduction electrons which are due to the scattering by structural defects of the lattice, phonons, magnons, and electron-electron interactions. According to theoretical studies /9, 10/, the derivative of the electrical resistivity with respect to temperature should vary like the magnetic specific heat near the Curie temperature T_C. This means that a monotonous temperature dependence of the electrical resistivity ρ near the Curie temperature will show a singularity in $d\rho/dT$ at T_C. Basing on these consideration, we are motivated to study the electrical and magnetic properties of this nickel-rich nickel- indium alloy system.

In this study, we report investiga- tions of the electrical resistivity of nickel-rich nickel- indium alloys as a function of function of temperature and discuss the significance of the results.

Experimental procedure The nickel-indium alloy samples containing 0.0, 1.5, 3.0, 5.0, and 7.5 at% of In, were prepared by melting. The melting ingots

withappropriate amounts of Ni and In were homogenized at 1325 K for three days to remove any microscopic segregation. From these ingots, samples in the form of rectangular parallelepipeds were cut by a low speed diamond saw. Typical sample dimensions were roughly 1x2x10 mm^3. Four Mo electrodes were lightly spot-welded to each sample. The width, thickness, and distance between the potential leads were determined by means of a very accurate Vernier caliper.

PREPARATION OF HIGH-PURITY $Tl_2 Ca_n Ba_2 Cu_{n+1} O_{6+2n}$ (n=1,2) POWDERS PROM STOICHIOMETRIC REACTANT MIXTURES.

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New powder synthesis methods have been developed for preparing the single-phase $Tl_2 CaBa_2 Cu_2 O_8$ (the 2122 compound) and $Tl_2 Ca_2 Ba_2 Cu_3 O_{10}$ (the 2223 compound) powders from stoichiometric reactant mixtures. The 2122 compound was prepared from a stoichiometric mixture of $Tl_2 O_3$, CuO, and $CaBa_2CuO_4$, while the 2223 compound was prepared from the same mixture but with additional Cao and CuO to setch the correct (Tl: Ca: Ba: Cu=2: 2: 2: 3) stoichiometry. The single-phase 2122 sampies with T_C above 110 K were obtained by using one-step calcination at 830℃, while the 2223 samples with T_C ranging between 115 and 120 K were obtained by employing a first calcination at 830℃ for 5 hrs and a second calcination at 870℃. Powder selting, which is strongly associated with the conventional methods, was significantly suppressed in the new methods.

Electrical and Magnetic Properties of $(Re_{1-x} Cd_x) Ba_2 Cu_3 O_{7-\delta}$ Systems (Re=Y and Rare Earth Ions)

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The electrical and magnetic properties of the pseudoquaternary systems $(Re_{1-x} Cd_x) Ba_2 Cu_3 O_{7-\delta}$ with Re=Y, Nd, Gd, Dy, Ho and $O \leqq x \leqq 1.0$ have been investigated by means of ac electrical resistance and dc magnetization measurements. A gradual change from metallic to semiconducting behavior in the normal state resistance was found as x increases for all Re elements. The superconducting transition temperature T_C was found to be essentially unchanged for $x \leqq 0.6$ for Re=Y, Gd and Ho. For Re=Nd and Dy, monotonic decreasing in T_C with increasing Cd concentration x was observed.

In addition, dc magnetization data reveal that the normal state susceptibility follows a Curie-Weiss behavior with μ_{eff} varying systematically with Cd concentration x for all Re ions.

Observation of cathodic charging on a palladium electrode in heavy water

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Electrochemically induced nuclear fusion in heavy water has been reported recently, with scientists around the world scrambling to reproduce the cold nuclear fusion of deuterium on a palladium surface [1,2]. Palladium metal has an fcc structure. A potential applied to the electrode reduces the water to deuterium and then dissolves into palladium to form PdD [3]. The considered reaction steps for the electrolyte evolution of deuterium from acid heavy water on palladium can be similar to the water system [4]. The reaction sequence can be summarized as follows:

$$D^+ + e + Pd \rightarrow PdD_{(ads)} \quad (1)$$

$$PdD_{(ads)} = PdD_{(abs)} \quad (2)$$

$$PdD_{(ads)} + PdD_{(abs)} \rightarrow D_2 + 2Pd \quad (3)$$

$PdD_{(ads)}$ refers to the deuterium adsorbed on the electrode surface. $PdD_{(abs)}$ means the deuterium absorbed into the electrode. In the Bockris-Thacker model [5], the absorbed step and chemical recombination step are competing. The absorption reaction is written as a "fast" step meaning that equilibrium is obtained rapidly, and the step proceeds with little activation energy. Deuterium first dissolves into palladium to form a solid solution. The diffusivity of hydrogen in α phase is rapid (10^{-11} m^2 s^{-1}) at room temperature. When the palladium becomes saturated with deuterium, a β phase is formed [6,7].

Certain compounds of Group VA, VIA elements of the Periodic Table have the effect of increasing the kinetics of the deuterium entry into metal,

i.e.theymake more monoatomic deuterium at the metal surface. Some cathodic promoters [8], such as thiourea and sodium sulphide were added to the solution to interfere with Reaction 3 in this study.

A Nichia Model G 1001 E Galvanostat was used for a constant cathodic charging current (625mA) on palladium in 0.1 M $KHSO_4 + D_2O$ solution. The recorded average anodic potential was approximately 9V (SHE). A baseline experiment run with 99.9% palladium sheet (0.5mm × 2.5cm × 2.5cm) was also performed in 0.1 M $KHSO_4 + H_2O$ solution. Meanwhile, a platnum sheet (0.1mm × 2.5cm × 2.5cm) was chosen to run the second baseline reaction in 0.1 M $KHSO_4 + D_2O$ and 0.1 M $KHSO_4$ aqueous solution. All electrolytes were prepared from reagent grade chemicals. A temperature rise of 100ml electrolyte in a teflon beaker during galvanostatical charging was recorded. The temperature of electrolytes in all test conditions rose from 6.7 to 6.8℃ for the first five minutes from room temperature (26℃), i.e. the generation heat from platinum sheet in 0.1 M $KHSO_4 + H_2O$ is the same as palladium in 0.1 M $KHSO_4$ D_2O solution. According to these baseline results, the excess heat in this work is not from a fusion process. Several scientists [9] have suggested that deuterium and oxygen combine to create the heat, or that the heat is coming from a Peltier junction effect.

Palladium sheets (0.5mm × 2.5cm × 2.5cm) were cathodic- charged in 0.1 M $LiOH + D_2O$, 0.1 M $KHSO_4 + D_2O$ with and without 5 gl^{-1} thiourea, and 0.1 M $KHSO_4 + D_2O + 5$ gl^{-1} thiourea + 0.2 gl^{-1} Na_2S solutions to examine the fusion products. The 24h specturm accumulation of γ rays (2.5 MeV) and neutrons (2.45 MeV) emitted from the test cell due to the fusion reactions was determined using a sodium iodide crystal scintillation detector, a 30 MeV spectrum analyser and a neutron dose equivalent rate monitor. In all of the experiments reported here all spectra can not be fitted to nuclear fusion reactions. The fusion spectra was not reproduced in our limited results.

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Effects of silver doping in the high-T_C superconductor system Y-Ba-Cu-O

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Changes in various superconducting properties as a function of silver substitution in the bulk granular high-T_c system Y-Ba-Cu-O have been investigated. In the low doping limit, Ag impurities behave as an excellent oxygen stabilizer and the critical current density is enhanced by an order of magnitude while the T_C remains practically unchanged. When the Ag contentis increased to above 20%, the T_C starts to drop and the effects of Ag clusters as well as impurity phases become more important. However, the compound is still a superconductor with a T_C around 20 K by full substitution of Ag for Cu. The problems concerning the location of Ag atoms and formation of Ag clusters are examined with measurements of x-ray absorption fine structure using synchrotron radiation. Our results indicate that at least some Ag atoms occupy the Cu(1) and Cu(2) sites in the material. Magnetic field dependence shows that the critical current density of a bulk sintered high- T_C superconductor below a characteristic value H'_C is mainly controlled by intergranular weak -link coupling. A shift of H'_C With the addition of Ag helps explain the variation variation of critical current density in this compound system.

SUPERCONDUCTING AND NORMAL STATE PROPERTIES OF THE $Y_{1-x}Cd_xBa_2Cu_3O_{7-\delta}$ SYSTEM

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The superconducting and normal state properties of the pseudoquaternary system $Y_{1-x}Cd_xBa_2Cu_3O_{7-\delta}$ with $0 \leqq x \leqq 1.0$ were investigated by means of the AC electrical resistance. DC magnetization and powder X-ray diffraction measurements. For Cd concentration $x \leqq 0.6$, X-ray diffraction pattern reveals that the majority phase of the samples is of the oxygen deficiency perovskite type with a gradual change from orthorhombic to tetragonal structure as x increases. The superconducting transition temperature T_C was observed to remain almost unchanged up to $x \sim 0.6$. This means the superconductivity occurs in orthorhombic structure as well as in the tetragonal structure. However. DC magnetization measurements taken at H=20 G indicate that the superconducting volume fraction in the sample decreases as x increases, although T_C remains unchanged, which shows that superconductivity in these samples is of granular characteristic.

V
Academic Activities

演　　講

題目：R & D Environment
日期：79年9月14日（星期五）
講員：陳韶賜建築師
時間：下午2時30分
地點：一樓演講室

題目：Phase Transition of Superconducting Networks.
日期：79年11月16日（星期五）
講員：齊正中博士（IBM Yorktown）
時間：下午2時30分
地點：一樓演講室

題目：Molecular Engineering for Sabucicron Polynceric Thin Film.
日期：79年11月17日（星期六）
講員：Dr. A.T. Lee（Univ. of Connecticut）
時間：79年11月17日上午10時
地點：一樓演講室

題目：洛斯阿拉莫斯實驗室簡介
日期：79年11月26日（星期一）
講員：徐小輝博士（Los Alamos Sci. Lab.）
時間：下午2時30分
地點：一樓演講室

題目：高溫超導體現況
日期：79年11月28日（星期三）
講員：吳茂昆教授（清華大學物理所）
時間：上午10時30分
地點：一樓演講室

題目：Thermodynamic Characterization of Hg-Cd-Te and Ph-Sn-Te System by Optical Absorbance of the Vapor phase.
日期：79年12月14日（星期五）
講員：黃瑜博士（清華大學材料中心）
時間：上午10時30分
地點：二樓演講室

題目：Resonance Excitation of Non-linen Density Wavec in Disk System
日期：79年12月20日（星期四）
講員：袁旂教授（Chi Yuan）City College of New York
時間：下午2時30分
地點：一樓演講室

題目：Thermoclynancic Characterization of Hg-Cd-Te and Ph-Sn-Te Syctems by Optical Absorbance of the Vapor phase
日期：79年12月21日（星期五）
講員：黃瑜博士（清華大學材料中心）
時間：上午10時30分
地點：二樓演講室

題目：Ultra Fast Optics and Application
日期：80年1月3日（星期四）
講員：李齊湘博士（美國馬利蘭大學電機系教授）
時間：下午2時0分
地點：一樓演講室

題目：表面物理簡介
日期：80年1月3日（星期四）
講員：何文程教授（美國康乃爾大學）(國科會短期訪問學人)
時間：下午3時30分
地點：一樓演講室

題目：Fabrication and Test of Silicon Wicrostrip Detector.
日期：80年1月5日（星期六）
講員：Dr. Takashi Ohsugi（日本廣島大學）
時間：上午10時0分
地點：一樓演講室

題目：Femtosecond Laser & Surface Analysis
日期：80年1月7日（星期一）
講員：高甫仁博士
時間：上午11時0分
地點：一樓演講室

題目：Photonic Band Structure
日期：80年1月8日（星期二）
講員：梁覺明教授
時間：下午2時30分
地點：一樓演講室

題目：Low Temperature Heat Capacity of Rare-earth-Copper Intermetallic Compounds.
日期：80年1月10日（星期四）
講員：何健民教授（Wichita Univ.）
時間：上午11時0分
地點：一樓演講室

題目：Computation of photonic Band Structure.
日期：80年1月10日（星期四）
講員：梁覺明教授（Pohytechnic Univ.）
時間：下午2時30分
地點：一樓演講室

題目：Microgravity Fluid Science and Applications.
日期：80年2月8日（星期五）
講員：洪儒珍教授（美國阿拉巴馬大學）
時間：下午2時30分
地點：一樓演講室

題目：Interaction of Gaces on Solia Surfaces-Description Kinefics Measurement.
日期：80年2月21日（星期四）
講員：伍光仁先生（Physics of Dept. Univ. of Oregon）
時間：下午2時30分
地點：一樓演講室

題目：Diamond Growth and Thin film.
日期：80年3月5日（星期二）
講員：劉鏞教授
時間：下午3時30分
地點：一樓演講室

題目：Spin-Isospin Excitation in Nuclei
日期：80年3月11日（星期一）
講員：Prof. H. ORIHARA（Director, Cyclotron and Radioisotope Center Tohoku Univ., Japan）
時間：下午3時30分
地點：一樓演講室

題目：Electrical and Magnetic Properties of High-Tc Superconductors.
日期：80年4月2日（星期二）
講員：陳國毓博士（工業材料研究所）
時間：上午10時30分
地點：一樓演講室

題目：Plasma Physics Problems In Astronomy
日期：80年4月16日（星期二）
講員：Dr. James Wai-Kee Mark（LBL）
時間：下午2時30分
地點：一樓演講室

題目：Anisotropic Optical Properties of YBCO Superconduct ors.
日期：80年5月7日（星期二）
講員：倪祖偉教授（清華大學物理系）
時間：下午2時0分
地點：一樓演講室

題目：鐵電薄膜材料之電光效應
日期：80年5月20日（星期一）
講員：吳瑜教授
時間：上午10時30分
地點：一樓演講室

題目：Hardronic matter under extreme coaditions.
日期：80年5月29日（星期三）
講員：Prof. C.M. Ko（柯治明教授）
時間：下午3時0分
地點：一樓演講室

題目：Quark-Gluon Plasma in Relativistic Heavy Ion Collisions
日期：80年6月5日（星期三）
講員：Prof. M. Gorenstein（Institute for Theoretic Physics, Kiev., USSR.,）
時間：下午3時0分
地點：一樓演講室

題目：Hypersonic Chmical Reacting Flow
日期：80年6月29日（星期六）
講員：Prof.C.P.hi（Univ. of Houston）
時間：上午9時30分
地點：一樓演講室

題目：Interfacial Tension of Phase-Separated Polymer Solutions
日期：80年8月14日（星期三）
講員：夏克青博士（Cornell University）
時間：上午10時10分
地點：一樓演講室

出席會議表

會議名稱	會期	地點	出席人員	備註
表面物理討論會	80.05.27～80.05.31	北京	鄭天佐	
第三屆高溫超導材料與機制研討會	80.07.22～80.07.26	日本	姚永德 陳洋元	
第六屆Marcel-Grossmann廣義相對論國際會議	80.06.23～80.06.29	日本 京都	吳建宏	
第八屆世界風力工程研討會	80.07.08～80.07.12	加拿大	蕭葆羲	
第七屆數值方法在熱學問題應用國際會議 第七屆數值方法在層流紊流應用國際會議	80.07.08～80.07.12 80.07.15～80.07.19	美國・史丹佛大學	簡來成	
	80.06.02～80.06.22		李弘謙	
	80.06.12～80.06.30		Dr.Jean-Marie Maillard	
	80.06.12～80.06.30	巴西	伍法岳	
	80.07.08～80.08.08	美國	鄭洪	
第十五屆國際紅外線及毫波會議	79.12.10～79.12.14	美國 佛州	何侗民	
Yoshio Nishina百年紀念討論會	79.12.05～79.12.07	東京	林誠謙	
第廿屆國際純粹暨應用物理聯合會	79.09.25～79.09.28	東德	胡進錕	
物理科學之發展趨勢研討會	79.12.05～79.12.07	東京	胡進錕	
金屬表面自行擴散研討會	80.04.29～80.05.01	丹麥 哥本哈根	鄭天佐	國科會
第七屆中韓凝體與統計物理研討會	80.01.20～80.01.26	漢城	鄭天佐	已交報告 國科會
美國物理學會1991年年會	80.03.18～80.03.22	美國 辛辛那堤	鄭天佐 李世炳	已交報告
金屬表面自行擴散研討會	80.04.29～80.05.01	丹麥	鄭天佐	
自發形成時空結構及臨界現象研討會	80.04.02～80.04.12	挪威	胡進錕	

（續前頁）

會議名稱	會期	地點	出席人員	備註
第三屆國際計算流體力學網格形成會議	80.06.03～80.06.07	西班牙 巴塞隆那	黃榮鑑	
第五屆磁學及國際磁性物理聯合會議	80.06.18～80.06.21	美國 匹茲堡	任盛源	已交報告
第七屆高級科學與技術國際會議	80.03.23～80.04.05	美國・阿岡實驗室	簡來成	
壓力容器及管路研討會	80.06.23～80.06.27	加州 聖地牙哥	蕭葆羲	已交報告
第十六屆國際醫學及生物工程第九屆國際醫學物理會議	80.07.07～80.07.12	日本 京都	王唯工	
第十五屆國際輕子－光子會議暨歐洲高能物理會議	80.07.25～80.08.01	瑞士 日內瓦	鄭海揚 李世昌	國科會
1991新加坡混沌及其應用夏季學校	80.06.03～80.06.14	新加坡	何俊麟	
第十三屆IMACS計算與應用數學國際會議	80.07.22～80.07.26	受爾蘭 都柏林	簡來成	國科會

Appendix : members

Theoretical Physics:

S.C. Lee（李世昌）
C.K. Hu（胡進錕）
W.B. Yeung（楊維邦）
C.Y. Cheung（張志義）
H.Y. Cheng（鄭海揚）
H.L. Yu（余海禮）
S.P. Li（李世炳）
S.C. Lin（林誠謙）

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C.W. Wang（王建萬）
C.C. Kiang（江紀成）
Y.H. Tzeng（曾詣涵）
P.K. Teng（鄧炳坤）
S.S. Hsiao（蕭先雄）
G.C. Jon（仲國慶）
D. Wang（王定）
Y.C. Yu（余岳仲）

Solid State Physics and Biophysics：

T.T. Tsong（鄭天佐）
L.T. Ho（何侗民）
W.K. Wang（王唯工）
Y.D. Yao（姚永德）

W.S. Tse（謝雲生）
N.T. Liang（梁乃崇）
S.U. Jen（任盛源）
Y.Y. Chen（陳洋元）
Y. Liou（劉鏞）
C.W. Wei（魏金明）
Y. Chiang（蔣宜）

Fluid Mechanics and Atmospheric Science

C.T. Wang（汪群從）
R.R. Hwang（黃榮鑑）
C.Y. Tseng（曾忠一）
W.J. Liang（梁文傑）
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中央研究院物理研究所集刊

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鄭天佐 (T.T. Tsong)
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中央研究院
物理研究所集刊
第二十卷

發行人：鄭　天　佐
編輯者：中央研究院物理研究所集刊編輯委員會
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

中華民國八十一年四月出版