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Summaries of Papers Published in Bulletin of Research Institute for Applied Mechanics (Japanese) No. 73, 1992

Long-Pulse Plasma Position Control with Hall-Effect Sensors in the TRIAM-1M Lower Hybrid Current Drive Experiments

By Hiroshi OKUBO, Shoji KAWASAKI, Eriko JOTAKI, Takaaki FUJITA, Shin-ichi MORIYAMA, Akihiro NAGAO, Kazuo NAKAMURA, Yukio NAKAMURA and Satoshi ITOH

Researches on steady-state operation by lower hybrid current drive are being made in the superconducting high-field tokamak TRIAM-1M. In the plasma position measuring system a hall-effect sensor has been adopted as a magnetic field detector. In the first step 4 hall-effect sensors to measure the poloidal field were set in the interior of the vertical port, and the change in the output signal due to the temperature increase was compensated. In the second step 8 hall-effect sensors to measure the poloidal and radial field were set in the exterior of the vacuum chamber. With this system a new world record of 1 hour 10 minute 10 second was made in the discharge duration time.

Numerical Analysis on Long-Duration Current Drive in TRIAM-1M

By Hiroyasu NAKAMURA, Shoji KAWASAKI, Eriko JOTAKI, Takaaki FUJITA, Shin-ichi MORIYAMA, Akihiro NAGAO, Kazuo NAKAMURA, Yukio NAKAMURA and Satoshi ITOH

Steady-state operation is one of important issues for the realization of nuclear fusion reactors. Experiments on long-duration tokamak discharge by LHCD have been proceeded in the superconducting tokamak TRIAM-1M and a steady-state tokamak discharge with the duration of more than one hour has been achieved. It is very important to study the properties of the long-duration discharges in obtaining the information on steady-state tokamak discharge. We report here the

numerical analysis on long-duration current drive in TRIAM-1M.

Spectroscopic Measurements in the TRIAM-1M Long-Pulse Current Drive Experiments

By Dai FUKAMI, Shoji KAWASAKI, Eriko JOTAKI, Takaaki FUJITA, Shin-ichi MORIYAMA, Akihiro NAGAO, Kazuo NAKAMURA, Yukio NAKAMURA and Satoshi ITOH

Radiation spectra were measured by visible and VUV spectrometers in the TRIAM-1M current drive experiments. The sensitivity of the VUV spectrometer was calibrated by branching method. The ratios of the impurities (O, Mo) to the electron density and the Z_{eff}-value were found to decrease with the electron density, though the oxygen influx increased. The ratios of the impurities to the electron density and the Z_{eff}-value were almost constant in the long-pulse plasma beyond 1 hour.

Summaries of Papers Published in Bulletin of Research Institute for Applied Mechanics (Japanese) No. 74, 1992

Convective Circulation in a Rotating Fluid

By Masaki TAKEMATSU, Tsugio KITA, Iwao YAMASHITA, Takesi TOYOTA

Thermal convection in a rotating cylindrical basin of uniform depth was investigated experimentally. The flow was produced by uniform cooling of the basin's vertical sidewall or by local cooling of the free surface of the working fluid. The experiments were conducted under the following four boundary conditions:
case-1 the upper surface is free and the bottom is bounded by a solid plate,
case-2 the upper surface is free and the bottom is bounded by a (dense) starch solution,

case-3 the upper surface is solid and the bottom is a starch solution, case-4 both the upper and lower boundories are solid.

In either case, the interior region was characterized by a horizontal circulation with a vertical shear consistent with the thermal-wind balance. However, it was found that the barotropic component of the horizontal circulation was greatly affeeted by the boundary conditions at the upper and lower surfaces. In the case-1, the convective circulation produced by cooling had an anti-cyclonic barotropic component, but in the case-2 and case-4 the net horizontal transport (=barotropic component) of the circulation was almost zero. In the case-3 the circulation had a net transport in the cyclonic direction opposite to the one in the case-1. A typical Ekman layer with a spiral structure was observed along the solid boundary, but not along the starch boundary. A numerical study of the laboratory model is now under way.

Simulated Drifter Tracks in the Pacific off Central America

By Shin-ichiro UMATANI

Water mass movements were studied with tracking drifters set in a numerical model by use of which we simulated oceanic variations off Central America in the eastern tropical Pacific. The northern part of the North Equatorial Countercurrent (NECC), an eastward current, flows into the Costa Rica Coastal Current (CRCC) through the southern and eastern edges of the Costa Rica Dome (CRD). In contrast, the southern part of the NECC flows into the Bay of Panama during summer and fall, bringing about convergence ; the converged water is forced into the lower layer by the induced downwelling. The water in the lower layer flows northward along the coast of Central America, gradually upwelling to the surface layer of the CRCC. The accumlated surface water in the Bay of Panama flows out in a southwestward direction when the NECC weakens during winter and spring. We hypothesize that the movements of the water are affected mainly by the convergence and deflection of the NECC along the western coast of Central America which causes the termination of the seasonally varying NECC.

On the abyssal circulation around isolated bottom features based on a reduced-gravity model incorporating vertical and horizontal difffusion of density

By Akira MASUDA and Genta MIZUTA

A reduced-gravity model of Masuda and Uehara incorporating the density diffusion in the vertical and horizontal directions is generalized to the ocean with variable bottom topography. The model is used in studying the deep circulation around a large-scale isolated bottom feature of a sea mount or a depression. Low pressure is induced above the botttom feature, irrespective of whether it is a sea mount or a depression. The low pressure extends westward at the poleward (equatorward) side of the sea mount (depression). This feature is explained well in terms of a perturbation theory to the second order. The results qualitatively apply to such steep botttom topography that a planetary island appears. For steep features, however, the circulation associated with the low pressure above the bottom feature is confined along the critical geostrophic contour; within the planetary island, upwelling is much reduced. The topographic beta which takes the opposite sign between a sea mount and a depression causes a noticeable pattern of upwelling that winds in colckwise and anticlockwise, respectively. These features are represented well by analytical expressions obtained through local approximation and simplificaition. Such solutions show that these newly found phenomena are interpreted by analogy with the northern (southern) boundayr layer for the flat basin or the boundary flow near the inlet or outlet.

Waves and Winds off the Coast of Tsuyazaki
——The Tsuyazaki Ocean Station 1990 (1)——

By Tadao KUSABA, Kenji MARUBAYASHI and Michiyoshi ISHIBASHI

The Research Institue for Applied Mechanics has been measuring waves and winds off the coast of Tsuyazaki by a ocean station sicne 1988. The data acquired every one hour by the station have been published as "Annual Report of Ocenographic Data at the Tsuyazaki

Station 1989, 1990 and 1991".

This paper describes the climat of waves and winds off the coast of Tsuyazaki obtained from investgating statistically the above annulal report 1990.

Direct solution for the system of steady linear shallow water equations used for the thermohaline circulation in the ocean.

By Katsuto UEHARA and Akira MASUDA

A procedure using direct method was introduced to solve steady linear shallow water equations, which turned out to provide a steady state solution with less computation time and better precision when compared with conventional time integration method. As shown by Masuda and Uehara (1992), three dimensional primitive equation expanded with vertical modes will result in the shallow water equations. As an application of the direct method, we carried out a preliminary calculation of the three dimensional equation. The direct method was applied to get the solution for each vertical mode. As this method is free of the CFL conditions or the time constants, it is especially effective when the high resolution is required for the boundary regions or when the time constant is very large.

Aero Dynamical Performance of Two Ultrasonic Anemometer

By Akira SASAKI, Tadao KUSABA,
Kenji MARUBAYASHI, Michiyoshi
ISHIBASHI and Hisashi MITSUYASU

Perfomance was tested of two kinds of sonic anemometers ; Anemometer A has 20 cm probe-span with right-angled axes, whereas Anemometer B has 5 cm probe-span with slightly obliqued axes (120°).

When the wind blows with a noticeable angle to the probe axis or the acoustic path, it was found that both types of anemometers measure the wind velocity of 1 to 15 m/s within the error of 1 %. When if the

wind is oriented nearly along the acoustic path, however, the anemometer underestimated the wind velocity by 10-15 %. This underestimation is larger for Anemometer A, and it is probably because the sound travels in the wake of the transducer for that angle of the wind.

Linear stability of point vortex streets affected by horizontal divergence

By Kuniko MIKI and Akira MASUDA

Stability of quasi-geostrophic divergent vortex streets is investigated in the way as von Kármán accomplished for two-dimensional non-divergent vortex streets: each point vortex is represented by concentrated potential vorticity rather than concentrated vorticity. Three types of vortex streets are examined: a single row, a symmetric double row, and a staggered double row. The single row and the symmetric double row are always unstable, though the growth rate of unstable modes is much reduced by the introduction of horizontal divergence.

As regards a staggered double row, however, horizontal divergence does not necessarily increase stability in a monotonic way; the growth rate increases at first and finally decreases, with the increase of horizontal divergence. The stability of the staggered double street depends on a non-dimensional divergence parameter F^* and the aspect ratio b^* of the vortex street. When $F^* < F_c^* = 3.04$, there is only one stable configuration b_s^*, which takes the Kármán ratio $b_K^* = 0.281$ at $F^* = 0$. Above the critical value of $F_c^* = 3.04$, the stability configuration widens to a finite segment of b^*. The appearance of a stable region with non-zero measure is explained in terms of a near-field approximation, which takes into account only the vortex force due to the neighboring point vortices. Where F^* is large, the stability diagram obtained through the near-field approximation agrees well with that obtained through the detailed computation. In particular, we find that a double staggered row with the aspect ratio $b^* > \frac{\sqrt{3}}{2}$ is unstable, however large F^* may be.

Radiation and Diffraction Waves of a Ship at High Froude Number

By Makoto OHKUSU, Makoto YASUNAGA
and Masaru INADA

Measurement and analysis of radiation and diffraction waves are proposed to test the validity of theories predicting the flow field and hydrodynamic forces of a ship running in waves at high speed. This is "flow visuarization" type of experiment which is more appropriate for scientific purpose than the measurement of the hydrodynamic forces. Complete wave patterns of radiation and diffraction waves are obtained and illustrated.

At the higher Froude number a ship runs, the narrower the angle of radiation and diffraction waves. A method to measure those waves along a line parallel to the ship's track (longicut method) is likely to give less accurate infomation of the wave field at higher speed. Measurement into the transverse direction (transcut method) is proposed.

The Kochin functions of the waves are derived with the Fourier transform of the measured data. It is confirmed that the results using data by the longicut method and the transcut method are almost identical except for the wave components propagating behind the ship. Reason is that the former method does not provide correct information on that part of the wave pattern.

Model Experiments on Floating Ocean Platform for the Study of Air-sea Interaction

By Wataru KOTERAYAMA, Tsutomu HORI
and Masahiko NAKAMURA

An experimental-study on the dynamics of floating ocean platform for the research on the air-sea interaction was carried out. The motions of a platform model in regular waves were measured by using the technic of image processing, which was newly, developed for the experiment on a very small model in this study. The experimental

study showed that the accuracy of the measuring system is very good and the motions of the model in regular waves are small.

A Study on High Speed Water Sampling System for Ocean Environment Research

By Masahiko NAKAMURA, Ryuji TOH
and Wataru KOTERAYAMA

The global environment is now facing a serious crisis caused by increasing production and large scale development. On the other hand, Japan owes most of its metallic resources to imports, and stable supply of these important resources is essential to the growth of her national economy. The development of ocean mineral resources is very important for her. We must, therefore, find some way to harmonize the global environment and ongoing ocean developments, and this is impossible to accomplish without a detailed knowledge of environment. Rescarch on the ocean environment is therefore very important both for protecting it and for the development of marine resources. From this point of view the Research Institute for Applied Mechanics of Kyushu University has continued a series of projccts on the developments of ocean measurement systems.

In this paper a fundamental study on the dynamics of towed vehicle for high speed water sampling in mid-ocean will be reported. Experimental results of hydrodynamic coefficients of the towed vehicle and results of numerical simulations to confirm the performances of towed vehicle designed here will be described.

Developing Process of the Boundary Layer Flow Passing over a Heat Source

By Masakazu TATSUNO, Takashi KARASUDANI,
Hajime AMAMOTO and Koji ISHI-I

The developing process of the boundary layer flow along a horizontal flat plate is experimentally studied when a part of the flat plate is heated isothermally from below.

The thermal instability occurs in the boundary layer flow over the heated section and the longitudinal vortices appear in the spanwise direction. As the longitudinal vortices move in the downstream direction, they become unstable and merge into large scale structures. Simultaneously, a streamwise periodic structure appears in the flow. The scales of these spanwise and streamwise periodic structures increase in the downstream direction and the boundary layer develops into a turbulent flow.

Stratified Flow over Two-Dimensional Obstacles in Fluid of Finite Depth

Stratified flows over a two-dimensional semi-circular cylinder placed on a horizontal plane are investigated both experimentally and numerically at Reynolds numbers of 2000-7500. Attention is focused on the effect of stratification on a separated and reattaching flow behind the body. Using a density-stratified wind tunnel, flow patterns around a body are visualized by means of the smoke-wire technique. Numerical analyses by a finite difference method are in good agreement with the experiments and afford detailed features of the stratified flows. The separation bubble is shortened owing to the stable stratification and strongly suppressed by the appearance of lee waves.

By Yuji OHYA, Shigehira OZONO, Koichiro MATSUO,

Akinori MAEDA and Kenichiro SUGITANI

The stratified flow over a surface-mounted semi-circular cylinder and a 2-dimensional triangular ridge were investigated both experimentally and numerically. Attention was focussed on the interaction between separation bubble and lee waves. Using a density-stratified wind tunnel, flow patterns were visualized with a smoke-wire technique. Wind tunnel tests are conducted at Reynolds numbers equal to 3400-9000, while the Reynolds number used in the numerical analysis was fixed at 2000, where the Navier-Stokes equations were solved by a finite difference method. The results of numerical analysis and experiment are in good agreement. The separation bubble is shortened with stratification intensified.

Critical Geometry and Galloping of a Rectangular Cylinder (With a Splitter Plate in the Wake)

By Katsuya HIRATA, Yasuharu NAKAMURA,
Tatsuya URABE, Kimihiko WATANABE
and Nobutaka FUKAMACHI

We conducted measurements of the time-mean and fluctuating pressures on rectangular cylinders with a very long splitter plate in the wake, with a flat front face normal to the flow. The ratio of depth (stream-wise dimension) to height (cross-stream dimension) of the cross section tested was less than 4.0. The tests on cylinders forced to oscillate transversely in the flow at an amplitude of 10 % of the height were examined along with those on stationary cylinders. It was shown that there is a critical geometry, for which base suction shows a peak value, for both stationary and oscillating cylinders. The relation between the critical geometry and the onset of galloping, and time-mean pressures on the side faces of cylinders are also discussed.

The Strength of Kevlar Rope Terminated by Metal Socket Joints

Hiromi HIYAMA, Yoji KOGA,
Wen-Xue WANG and Yoshihiro TAKAO

A terminal of Kevlar rope with a metal socket was loaded statically and repeatedly to assess the effect of high water pressure. The experimental results show that the water pressure increased both the static and fatigue strengths of the terminal. An analytical simulation of this terminal was also performed using the finite element method, where contact pressure, friction and slip process were taken into account. The detailed stress distribution and concentration were estimated along the interface between the rope and tapered socket. It was found that there are two stress concentrations on the Kevlar rod surface. One is at a concave being made in the forming process and another is at a contact point between the rod and socket. When the water pressure is low enough to keep the rod-slip out of the socket within a small quantity, two stress concentrations yield a single peak

near the socket edge. High water pressure decreases the stress concentration factor at a contact point, which explains the present experimental result.

Development of Low Pressure Wire Explosion Spraying

By Shigehisa FUKUDA and Terutake MATSUBARA

Experimental studies have been conducted on the optimum conditions for wire explosion spraying of metal and cermets under low air pressure.

Advantages of coatings produced by low pressure wire explosion spraying methods have been demonstrated. The main results are as follows:

(1) The optimum sectional area of wire is given by the following empirical equation:

$$S_0=K_1\{1+k[(P_0/P)-1]^{\beta}\}^{-1}CVf^{\alpha},$$

and the optimum distance between the wire and the substrate is determined by

$$R_0=K_3(P_0/P)^{v}r_w.$$

(2) Low pressure wire explosion spraying methods can give the coatings with low oxidation and porosity, which results in improvements of adhesive strength and hardness.

(3) Average thickness of interphase regions is increased under low pressure, which leads to excellent mechanical properties of coatings.

Failure of High-Strength Synthetic Yarns and Related AE Measurement

By Yasuhiro SAKURADA and Kiyoshi TAKAHASHI

Tensile strength was studied for yarns of high strength synthetic fibers, i.e. PE, Kevlar 29, PA6 and Polyester, as a function of twisting. AE measurement was performed to monitor sequential failure processes in the yarns. Effect of twisting was discernible for fibers of every polymer in the AE measurement. The PE and Kevlar 29 yarns exhibited a slight increase of strength when the number of twisting was

increased up to 80 T/m. No significant change, on the other hand, was observed for the strength of PA6 and polyester yarns.

Development of Dual Focus High Speed Photography Camera RIAM-DFC2

By Toshio MADA and Kiyoshi TAKAHASHI

A camera has been developed to take high speed pictures on different focal planes simultaneously. This camera, named RIAM-DFC2, is an advanced version of the former single-focus multiple spark camera RIAM-MC2. Spark gap lamps, totally 30 units, as well as the camera box have been renewed. Each unit of the lamps can contain spark energy six to seven times as much as the RIAM-MC2 unit. Photography examples are presented from fast fracture in PMMA and golf ball impact test. In the latter case, deformation of the ball as well as flow of air are visualized extremely well.

Mode I Interlaminar Fracture in Carbon Fiber Reinforced Composites

By Kazuo ARAKAWA, Masatsuka ISHIGUMA and Kiyoshi TAKAHASHI

Moiré interferometry was utilized to study mode I interlaminar fracture in double cantilever beam specimens of unidirectional carbon fiber/epoxy composites. The crack opening displacement was experimentally determined in the vicinity of the crack tip to evaluate the distortion at the beam root of the specimen. The beam root distortion was found to make an important contribution to increasing the value of crack opening displacement. The effect of the beam root distortion on the evaluation of fracture toughness value was also examined.

Fabrication of Ceramic Specimens by Slip Casting Method

By Tetsuo OGAWA, Kazuo ARAKAWA, Kiyoshi TAKAHASHI, Hiromichi TAKEBE and Kenji MORINAGA

Slip casting method was employed to make dumbell and CT type specimens of ceramic material. Aqueous slips with a ceramic powder volume fraction of 70 wt % were prepared from alumina powders and acetic acid based distilled water. The preparation process yielded that the relative density of the specimen reached to 98 % after sintering at 1600°C for 2 hours. The fracture surface of the specimens showed that they consisted of grains of less than 10 μm in diameter with few micro voids and defects.

Influence of Temperature and Loading Rate on Fracture Behavior of Short-Glass-Fiber Reinforced Poly(ethylene terephthalate)

By Takafumi HAYASHI, Nak-Sam CHOI and Kiyoshi TAKAHASHI

In a temperature range from 23°C to 53°C, tensile and shear mode failure was dominant on the surface and in the interior of SGFR-PET, respectively. On the other hand, at 70°C which is close to Tg, no cracking and shear banding were observed both on the surface and in the interior. Instead, a specific layer as well as debonding exhibited their growth around the fiber end even on the specimen surface.

Computer Simulation of Fundamental Process of Void Swelling

By Eiichi KURAMOTO and Tetsuo TSUTSUMI

In nucleation and growth processes of void swelling in high temper-

ature heavy irradiation there are many difficult problems unresolved. In the present study the analysis of void nucleation process and computer simulation on the bias factor which is the most important factor in void swelling are described. The nucleation rate of void swelling depends on various parameters, especially on surface energy. This was determined so that the experimentally obtained void number density may be reproduced at the end of the nucleation stage. The difference of void swelling in FCC and BCC metals was discussed from the point of bias factor.

Crystallographic Characterization of Carbon

By Noboru TSUKUDA, Eiichi KURAMOTO
and Tetsuo TANABE

Characterization of graphite has been performed from the development of the fusion reactor materials. Lattice parameters, graphitization factors and coherent length have been estimated by x-ray diffraction for isotropic graphite, HOPG, B-doped graphite, glassy carbon, carbon whisker and foil carbon. The correlation of these crystallographic properties with other physical and mechanical properties have been studied and the compatibility of the coating material for the plasma facing materials has been discussed.

ERD (elastic recoil detection) Study of Implanted Hydrogen Atoms in Tungsten

By Yoshikazu TANAKA, Minoru TAKENKA
and Eiichi KURAMOTO

In Tokamak type fusion reactors plasma facing materials such as limiters are usually exposed to heavy irradiation damage and then material selection is very important. In the present study tungsten was chosen for the limiter material and behaviour of hydrogen atoms in tungsten was investigated by the elastic recoil detection method. The methodology was established in the present study and the preliminamy result, such as depth distribution of implanted hydrogen atoms was

obtained.

Positron Annihilation Study of Electron-Irradiated Fe-Cu, Fe-Cu-C Alloys

By Fuminobu HORI, Minoru TAKENAKA, Yasuhisa AONO and Eiichi KURAMOTO

Recovery process of radiation-induced defects in Fe-Cu dilute alloys (0.02-0.22 wt%) and Fe-Cu-C ternary alloys electron-irradiated ($E = 28$ MeV, $T_{irr} = 77$ K) has been investigated by positron annihilation lifetime measurement. In Fe matrix the existence of Cu atoms shifts the stage III to higher temperature side and prevents vacancies from forming clusters. These phenomena depend on the concentration of Cu atoms. Coexistence of Cu atoms and carbon atoms suppresses diffusion of vacancies and then no vacancy clusters were formed.

Stacking Disorder in Orientated Pyrolitic Graphite

By Noboru TSUKUDA and Shinya YAMAZAKI

The intensity distribution of x-ray diffraction by orientated pyrolitic graphite containing stacking faults has been described. Intenty equations of (0 0.L) band and (h k.L) band have been represented by Hendix-Teller eq. and Wilson eq., respectively. The stacking fault probabilities of the samples prepared at 2200, 2500 and 2800 °C were evaluated. The problems in the convetional models has been pointed out.

Crystal Structural Charges in Austenitic 316 Stainless Steels by Cathodic Hydrogen Charging
——Depth Distribution and Ageing Effects——

By Takatoshi ARAI and Noboru TSUKUDA

316 austenitic stainless steel has been been cathodically hydrogen charged with the current of 100 mA and studied by means of x-ray diffraction. Martensitic ε and α' phases were formed in matrix γ phase by over-saturated hydrogen. The transformation is considered to be the stress-induced transormation. In the erly stage of ageing, the x-ray profiles of the martensitic phases, especially of ε phase were very broad. The profiles of ε phase became sharp and the peak positions shifted to the regular angle. They result from the decreasing and the spatial distribution of hydrogen atoms.

The Recovery Characteristics of 30MeV Electron Irradiation-Induced Defects

By Hironobu ABE and Eiichi KURAMOTO

The recovery characteristics of defects induced by 30Mev electron irradiation were examined by electrical resistivity measurements using high-purity iron and their isochronal annealing behaviors were compared with those of defects induced by 2.5MeV electron and neutron irradiation.

The results obtained for 30MeV electron irradiation were as follows: (1) the amount of the stage II recovery is intermediate between those for 2.5MeV electron and neutron irradiation (most notable for neutrons) and vice versa, the amount of stage I. (2) the recovery temperature of stage II approaches closely that of neutron irradiation and shows a slight shift to lower temperature with increasing dosage in striking contrast to low energy electron irradiation. These characteristic recovery behaviors of stage II were discussed in terms of annihilation of densely-distributed di-interstitials retained in stage I in cascades produced by high-energy primary knock-on atoms.

The Role of Ni and Zu in Defect Behavior and Microstructural Evolution of Copper under Electron Irradiation

By Eiichiro ISHIAMARU, Takeo MUROGA,
Yoshio MIYAMOTO and Naoaki YOSHIDA

The effects of nickel and/or zinc addition on microstructural evolution in copper under electron irradiation have been investigated to study possible effects of solid transmutants generated in copper and copper alloys by fusion neutrons. Radiation-induced dislocation density increased with increasing nickel content but was independent of zinc content during 1 MeV electron irradiation. An enrichment of nickel and a depletion of zinc at grain boundaries occurred during irradiation. Measurements of temperature and damage rate dependences of saturated dislocation loop density showed that the interstitials are deeply trapped by nickel clusters forming loop nuclei in alloys containing nickel. It was shown that clusters of nickel as a solid transmutation product can affect strongly the dislocation evolution and related properties of copper and copper alloys by trapping interstitials from relatively initial period of fusion reactor operation. On the other hand, the effects of zinc production seemed to be small, althogh possible interactions with vacancies were suggested.

On the Study of Langmuir Circulations

By Shinjiro MIZUNO

Department of Civil Engineering, Hiroshima Institute of Technology.

This is a short study note associated with the research of Langmuir circulations that was made in a laboratory wind-wave tank. In this study a pair of Langmuir circulation was found in a laboratory tank only by blowing a uniform wind, without any forcing other than wind. I wrote this note to stress how an important role this phenomenon played in the vertical mixing of water in the tank.

On Time Evolution of Solutions to a Modified Nonlinear Schrödinger Equation

By Masayuki OIKAWA

For a wave system in which the dispersion curve has an inflection point, time evolution of the solutions to a modified nonlinear Schrödinger equation (MNLS) describing nonlinear modulation of a plane wave near the inflection point is investigated numerically under the periodic boundary condition.

The MNLS includes a third-order dispersion term in addition to the nonlinear Schrödinger equation. Especially, our main concern is whether or not the third order term gives rise to an irregular behaviour in the solutions. The behaviour of the solutions is also investigated when the coefficient of the third-order term becomes small.

Wavy Mode of the Secondary Flow Induced by an Oscillating Cylinder in a Stratified Fluid at Rest

By Masakazu TATSUNO and Takashi KARASUDANI

When a circular cylinder is oscillated transversly in a linearly stratified fluid at rest, the streaked flow are generated alternately along the cylinder axis and each streaked flow follows a wavy path in the horizontal plane.

Nonlinear Evolution Equations with Forcing Terms Describing Waves in a Fluid

By Mitsuaki FUNAKOSHI and Susumu INOUE

A few nonlinear evolution equations with forcing terms, which describe waves in a fluid generated by a variety of forcings, are reviewed. Characteristics and stability of the important solutions to these equations are shown. The results of corresponding experiments

are also introduced.

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Low Dose Fission Neutron Irradiation on Fe-Cr-Ni Austenitic Alloys with Improved Temperature Control of JMTR

By Qiu XU, Hideo WATANABE, Yoshio MIYAMOTO, Takeo MUROGA and Naoaki YOSHIDA

The initial process of microstructure evolution in Fe-16Cr-17Ni and its P-and Ti-modified alloys was studied during irradiation in JMTR to 1.1×10^{24}n/m^2 (>1.0MeV) under improved and conventional temperature control conditions. Interstitial loop density showed strong temperature dependence; the nominal activation energy for the loop nucleation process in the ternary alloy was about 0.5eV. With addition of 0.024%P, the interstitial loop density increased very much, but void formation was suppressed considerably. In 0.1%P-alloy, Fe_2P was precipitated at 673K instead of interstitial loops. In conventional temperature control irradiation, loop density was two to three times higher than that of improved control irradiation. This suggests the need for improvement of temperature control of fission reactor irradiation for understanding essential processes of damage evolution at the set temperature.

Mixing and Chaos in the Flow Due to the Rotation of Eccentric Cylinders

By Mitsuaki FUNAKOSHI, Susumu INOUE and Takashi ATOBE

Chaotic motion of fluid particles (Lagrangian Chaos) in the Stokes flow due to alternate rotations of two eccentric cylinders is experimen-

tally studied. From the motion of the fluid particles visualized using dye, mixing process of a fluid is examined. On the basis of the comparison with the results in theoretical computations, it is found that whether the particles' motion is chaotic or not is an important factor in the study of the mixing process.

Study of Crack Propagation in a Discrete Lattice in View of Griffith Theory

By Kazuhito OHSAWA, Eiichi KURAMOTO
and Takayoshi SUZUKI

The critical stresses for crack propagation and healing are calculated in the discrete lattice with $2N+1$ crack lenght, in which the bonds in the crack plane are non-linear springs and others are linear. The critical stresses of the lattice for five kinds of nonlinear springs are approximately proportional to $N^{-1/2}$, which corresponds to Griffith theory which is based on the continuous elastic theory. However, the absolute values are larger than those expected by the Griffith theory.

Positron Annihilation Lifetime Calculation in BCC Fe Vacancy in Consideration of Lattice Relaxation.

By Yasushi KAMIMURA, Fuminobu HORI,
Tetsuo TSUTSUMI and Eiichi KURAMOTO

Lattice relaxation arround an atomic vacancy has not been considered into the conventional calculations of positron annihilation lifetime. In this work, the stable arrangement of atoms arround the vacancy was simulated by using the *N-body* potential (Finnis-Sinclair potential) based on the embeded atom method, and then the positron lifetime was calculated according to the method of Puska and Nieminen. Consequently, the positron lifetime in a relaxed vacancy was worked out to 170psec, 20psec lower than that in unrelaxed one. The present result is closer to the experiments.
Key words: positron annihilation lifetime, iron, vacancy, lattice relax-

ation, embedded atom method, N-body potential, local density functional approximation

Anomalies in the Kuroshio Extension Region Detected by a Satellite Altimeter and Radiometers

By Shigeru AOKI, Shiro IMAWAKI and Kaoru ICHIKAWA

From the GEOSAT radar altimeter data from November 1986 to November 1987, the sea surface dynamic topography (SSDT) anomalies are derived in order to investigate the behavior of individual anomalies and their statistical properties for the Kuroshio Extension region. The sea surface temperature (SST) anomalies are also analyzed on the basis of the NOAA Advanced Very High Resolution Radiometer (AVHRR) data.

Propagation of several anomalies is traced in the time series of both the SSDT and SST field. Locations of high (low) anomalies in SSDT almost coincide with locations of warm (cold) anomalies in SST, which fact indicates the baroclinicity. In particular, it is clearly observed that two cyclonic cold anomalies moved steadily westward without changing their relative positions and finally coalesced at 147°E. This process is understood as a pinching-off of a Kuroshio Extension meander in the absolute SSDT field which is approximately estimated by the sum of the fluctuation SSDT and climatological mean SSDT.

Statistically, westward propagating baroclinic anomalies are dominant. The westward phase speed varies in the upstream region (140°-160°E) and downstream region (160°E-180°). It decreases with increasing latitudes in the upstream region, and is faster than that of the theoretical long Rossby waves of the first baroclinic mode. In the downstream region, it is consistent with that of the theoretical Rossby wave, but is faster at around 35°N. SSDT anomalies have the structure like isolated eddies in the upstream region, while they have the structure like plane waves with their crests oriented NW-SE in the northern part and NE-SW in the southern part of the downstream region (170°E-180°).

The tendency of the eastward acceleration of mean flow by anomalies is observed from the distribution of the Reynolds stress derived from SSDT on the assumption of geostrophy. The strong acceleration tendency is found at 170°E-180°, which is apparent from the wave like

structures of anomalies described above. There are prominent bathymetries in this region, suggesting that the acceleration of mean flow by anomalies may be related with these major bathymetries.

Impurity Behavior and Radiation Damage under Long Duration Tokamak Discharge in TRIAM-1M

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Prethinned specimens of Mo, Al and Cu were exposed to the boundary plasma under long pulse operation of the superconducting high-field tokamak TRIAM-1M to examine radiation effects of tokamak plasma on a microstructural change of plasma-facing materials. TEM observation of the specimens showed that interstitial-type dislocation loops and large elongated defects were formed, whose size and density depended on the position of the specimens. The former are considered to be formed by irradiations of energetic charge exchanged neutral hydrogen atoms. The latter are probably clusters of hydrogen atoms formed by strong bombardment of relatively low-energy hydrogen ions in the scrape-off layer. These defects are expected to have a strong influence on hydrogen recycling and degradation of plasma facing materials.

Current Drive Efficiency of Long-Duration and High Density Discharge in TRIAM-1M

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The current drive experiment using high frequency (8.2GHz) lower hybrid waves was carried out, and the long-pulsed plasma up to 20s with the fairly high electron density ($\bar{n}_e \sim 2.0 \times 10^{19} m^{-3}$) was achieved to maintain. The purposes of this experiment are to confirm the appropri-

ate conditions for the higher current drive efficiency and to apply these conditions to the steady-state tokamak plasma. We adopted the efficiency as $\eta_{CD}=\bar{n}_e I_p R/P_{RF}$ at the first stage of the discharge and compared the results with the theoretical predictions. It was found that η_{CD} takes the highest value for $\Delta\phi=90°$ ($\Delta\phi$ is phase difference between the adjacent waveguides) and increases with the magnitude of the toroidal magnetic field. Such properties can be explained from the launched $N_{//}$ power spectrum and the accessibility condition. However the absolute value of η_{CD} is smaller than the simply calculated one and increases with line averaged electron density in spite of the deterioration of the accessibility. It is found to be necessary to take into accounts of the plasma confinement conditions such as effects of impurities and the confinements of the high energy electrons.

Temporal evolution of η_{CD} was also investigated during the long-pulse ($\geq$10s) discharge. At the beginning of the discharge, η_{CD} is about $1.0(10^{19}m^{-2}A/W)$. However, plasma current and line averaged electron density decrease from 4s to 8s, and η_{CD} decreases to $0.4(10^{19}m^{-2}A/W)$ accordingly. Accompanied with the decrease of η_{CD}, the increase of the impurities are observed.

Hard X-Ray Measurement during High-Density Long Duration Discharge on TRIAM-1M

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Current drive experiments with high frequency (8.2GHz) lower hybrid waves were carried out in the TRIAM-1M tokamak. The hard X-ray emission from high energy electrons was measured with sodium iodide scintillation spectrometers. The measured radial profiles of the emission were localized to the center. The fact indicates that the current carrying high energy electrons exist primarily within the inner region of the plasma column. Plasma parameter scans were done and the variations in the X-ray emission profiles were measured. These observations are consistent with the conditions as changed by the launched Fourier power spectrum and as imposed by lower hybrid wave accessibility. It is found that the dependence of the radial profile width

in the X-ray emission profile on the phasing between adjacent waveguides corresponds to the dependence of the current drive efficiency $\eta = I_P \cdot \bar{n}_e \cdot R / P_{rf}$ on the phasing between adjacent waveguides. The sudden decrease in the plasma current at several seconds later is seen in long pulse discharge using the initially optimum operational conditions. During the decrease, high Z impurity of the low ionized states increases near the plasma periphery. The radial profiles of high energy X-ray emission ($E \geq 100$keV) has been found to become more peaked and the effective X-ray temperature to rise in the inner region of the plasma column. After the plasma current and density decrease, the high energy X-ray emission profile returns to the original shape and remains unchanged. This fact indicates that the impurity contamination occurs during the plasma current decrease.

An Efficient Method for Computing Nonlinear Energy Transfer among Wind Waves

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The WAMDI group (1988) in Europe successfully developed a third-generation model for wave forecast, that explicitly incorporates the nonlinear energy transfer based on the discrete interaction approximation (Hasselmann et al., 1985). That approximation, however, is quite drastic in that it adopts only one representative configuration of resonant four waves among an infinite number of configurations, so that it would fail to compute correct nonlinear energy transfer for some forms of wave spectra. Hence we developed a new method by which to calculate efficiently nonlinear energy transfer in nearly rigorous manner on the basis of an exact method by Masuda (1980). Its high efficiency is achieved by making full use of the symmetric properties of wave interaction; it can compute 150 times faster than Masuda's with loss of neither stability nor accuracy. Applied to various types of spectra, the present method showed its high precision. In particular, we found that the present method compute well the nonlinear energy transfer even for steep spectra or double-peaked spectra, which cannot be dealt with well by the discrete approximation method of the WAMDI group.

A Thermally Stratified Wind Tunnel for Environmental Studies

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A new wind tunnel was constructed to study the effects of thermal stratification on flow and diffusion in the atmospheric boundary layer. The wind tunnel is of a suction type and has a 1.5m wide by 1.2m high by 13.5m long rectangular working section. Designed to produce thermally stratified flows, the tunnel is equipped with two independent temperature systems of an air-flow heating unit(AHU) and a floor temperature controling unit(FTCU). The AHU is horizontally divided into 40 stories with thin SUS plates every 3cm and the air flow passing through each story is heated individually up to 120°C by electric heater rods at a wind speed of 1m/s. The FTCU consists of 10 heating and cooling floor panels (each 1.5m wide by 1.0m long), water tanks with heater units and a refrigerator. The temperature of each floor panel can be set independently ranging from 4 to 80°C, Using the AHU and FTCU, a wide range of thermal stratification can be generated. The wind is generated by a turbofan with the flow speed in the range of $U=0.2-2.0$m/s. Both in neutral and stratified flows, the tunnel can provide a uniform smooth flow with a low turbulence intensity of about 0.4% at $U=0.75$m/s. The performance of the wind tunnel and the characteristics of the thermally stratified flows are discussed.