

## Japanese Aerospace Literature

### This month: *Structural or Aerodynamics Computerized Simulation*

**N94-29710 Microgravity by parabolic flight with MU-300 aircraft (MU-300 bijinesu jettoki ni yoru maikuro g furaito).** M. SATO. *In Society of Medical Research for Space Station, The MERSS 5th Symposium on Space Medicine: Medical and Physiological Experiment Utilizing Parabolic Flight*, pp. 1-8 (SEE N94-29709 08-52). Documents available from Aeroplus Dispatch.

Parabolic flight has an advantage to achieve microgravity with ease and at a low-cost, as well as to enable the performance of science experiments by payload specialists themselves. This report summarizes results of a simulation study and actual flight for microgravity. Model flight pattern was determined on the basis of the most appropriate values for recovery gravity, maximum rising degree, maximum descending degree and pull-up gravity which were obtained by results of simulating calculation and test flights measuring gravity every 5 deg during chandelling and nose driving. In the test flights, the plane was controlled by manual steering, assuming that the stabilizer trim was out of order. As a result, 1/100 to 5/100 G was achieved for an average of 20 seconds, maximum 24 seconds. The safety was confirmed in simulation calculation, determination of flight pattern, and structure and checking of the airframe. The microgravity experiments have been utilized for various fields, such as life science, material engineering, and physics. (Author)

**N94-28696 Structure of neutrally stratified turbulent Ekman layer as predicted by closure models with prognostic equation for master length scale.** N. KINOSHITA. *In its Papers in Meteorology and Geophysics*, Vol. 44, No. 1, pp. 17-28 (SEE N94-28693 08-42). Documents available from Aeroplus Dispatch.

The turbulent Ekman boundary layer in a neutral atmosphere is studied by means of a second order turbulence closure model incorporated with a prognostic equation for the master length scale and those of a one-and-a-half order closure model. The results of the second order closure model are compared with those of a second order closure model incorporated with an equation for the dissipation rate, an E-epsilon model and a direct numerical simulation. It is shown that the height of the Ekman layer simulated by the present model is higher than those by the other closure models and that the turbulence kinetic energy and turbulent momentum fluxes in the upper part of the boundary layer are larger. These differences result from the fact that the length scale predicted by the present model is longer than those by the other closure models. The structure of the Ekman boundary layer simulated by the present second order closure model is close to that by a direct numerical simulation. The results of the one-and-a-half order closure model coincide with the present results, though it is found that the growth of the boundary layer is a little slower than that of the present second order closure model. (Author)

**N94-28681 Ab initio study of vibrational frequency shift upon the 1:1 acetone-iodine complex formation (Aseton-Yoso Sakutai No Shindosu Shifuto Ni Kansuru Rironteki Kento).** O. SETOKUCHI and M. SATO. *In its Journal of NIRE*, Vol. 2, No. 2, pp. 41-50 (SEE N94-28675 08-25). Documents available from Aeroplus Dispatch.

Vibrational frequency shift upon the 1:1 acetone-iodine complex formation was determined from geometries optimized at the SCF (Self Consistent Field) and MP2 (Moller-Plesset Second Order Perturbation) levels using the ab initio MO (Molecular Orbital) theory, and comparison was made with experimental results. The SCF calculation with DZ (Double Zeta) basis sets augmented by a single set of d polarization functions gave values consistent with experimental results. The MP2 calculation failed to indicate even the sign of the shift, when using DZ basis sets without d polarization functions. Also, the shift of the nu (sub 19) acetone vibrational band was over estimated. These results are discussed from structural and energetical points of view. The origin of vibrational frequency shift is explained as being due to the behavior of orbital electrons, based on the natural bond orbital theory. (Author)

**N94-28556 Experimental and analytical studies of high heat flux components for fusion experimental reactor.** M. ARAKI. Japan Atomic Energy Research Inst., Tokyo (Japan), Mar. 1993, Page:142P. Documents available from Aeroplus Dispatch.

In this report, the experimental and analytical results concerning the development of plasma facing components of ITER are described. With respect to developing high heat removal structures for the divertor plates, an externally-finned swirl tube was developed based on the results of critical heat flux (CHF) experiments on various tube structures. As the result, the burnout heat flux, which also indicates incident CHF, of 41 (+/-) 1 MW/sq m was achieved in the externally-finned swirl tube. The applicability of existing CHF correlations based on uniform heating conditions was evaluated by comparing the CHF experimental data with the smooth and the externally-finned tubes under one-sided heating condition. As the results, experimentally determined CHF data for straight tube show good agreement, for the externally-finned tube, no existing correlations are available for prediction of the CHF. With respect to the evaluation of the bonds between carbon-based material and heat sink metal, results of brazing tests were compared with the analytical results by three dimensional model with temperature-dependent thermal and mechanical properties. Analytical results showed that residual stresses from brazing can be estimated by the analytical three directional stress values instead of the equivalent stress value applied. In the analytical study on the separatrix sweeping for effectively reducing surface heat fluxes on the divertor plate, thermal response of the divertor plate was analyzed under ITER relevant heat flux conditions and has been tested. As the result, it has been demonstrated

that application of the sweeping technique is very effective for improvement in the power handling capability of the divertor plate and that the divertor mock-up has withstood a large number of additional cyclic heat loads. (DOE)

**A95-15781 Measurement and study of the embedding impedance presented by the whisker antenna of a Schottky diode corner cube mixer.** C. M. MANN, T. NOZOKIDO, J. J. CHANG (Inst. of Physical and Chemical Research, Nagamachi, Japan), T. SUZUKI, and K. MIZUNO (Tohoku Univ., Sendai, Japan), *International Journal of Infrared and Millimeter Waves* (ISSN 0195-9271), Vol. 15, No. 11, Nov. 1994, pp. 1867-1881. 11 Refs. Documents available from Aeroplus Dispatch.

A 250x scale model of a Schottky diode corner cube mixer designed for operation in the terahertz region has been built and tested. It has been successfully used to measure the embedding impedance presented to the diode at the whisker tip and also determine the impedance of the whisker antenna itself. The results have been input into a computer analysis to determine as to how the performance may be improved. With regards to improving the physical raggedness of such mixers, a simple equivalent whisker structure has been determined and a new technique that may be used to fabricate a space qualified corner cube mixer intended for terahertz operation is disclosed. (Author)

**A95-12801 LAC/HAC system with a variable feedback gain for flexible space structures (low authority control/high authority control).** S. HOKAMOTO (Saga Univ., Saga, Japan) and N. GOTO (Kyushu Univ., Fukuoka, Japan), *JSME International Journal, Series C* (ISSN 1340-8062), Vol. 37, No. 3, Sept. 1994, pp. 431-435. 6 Refs. Documents available from Aeroplus Dispatch.

This paper proposes a new control technique, based on the low authority control/high authority control (LAC/HAC) concept, to suppress the vibration of flexible space structures. The control system designed by the new control technique has a mechanism to adjust the HAC feedback gain between zero and one in such a manner as to enhance the effectiveness of control and to obtain global stability even when the magnitude of the LAC gain is not suitable. The paper first describes the theoretical mechanism of the new control technique and proposes a numerical method for determining the HAC feedback gain based on a neural network system. Then it shows the characteristic features of the new technique by computer simulation examples. The computer simulation shows that the new technique is quite effective in suppressing the spillover effects, and quite feasible for implementation. (Author)

**A95-12129 Control of structures and time-averaged flow properties of a plane wake by subharmonic instability modes.** H. MAEKAWA (Univ. of Electro-Communications, Chofu, Japan) and N. N. MANSOUR (NASA, Ames Research Center, Moffett Field, CA), *JSME International Journal, Series B* (ISSN 1340-8054), Vol. 37, No. 4, Nov. 1994, pp. 806-814. 14 Refs. Documents available from Aeroplus Dispatch.

Structures and time-averaged flow properties in the transition region of a plane wake perturbed by the unstable subharmonic modes are studied by means of direct numerical simulations. The unstable modes of the Orr-Sommerfeld equations are used to perturb a Gaussian wake of the inlet plane. The statistics of the wake forced by the unstable modes and the corresponding numerical structures of the vortices are presented.

**A94-30981 Navier-Stokes simulation of transonic flows about a space-plane.** K. MATSUSHIMA (Fujitsu, Ltd., Makuhari Systems Lab., Chiba, Japan) and S. TAKANASHI (National Aerospace Lab., Tokyo, Japan), *In: AIAA Applied Aerodynamics Conference*, 12th, Colorado Springs, CO, June 20-22, 1994, Technical Papers. Pt. 1 (A94-30939 10-02), Washington, DC, American Institute of Aeronautics and Astronautics, 1994, pp. 471-479. 14 Refs. Documents available from Aeroplus Dispatch.

Navier-Stokes simulation of transonic flow about a space-plane has been performed using the LU-ADI scheme with TVD type upwind differencing. CFD simulation results are compared with wind tunnel results. For aerodynamic forces, computational results are in very good agreement with experimental data.

**N94-28157 Numerical simulation of turbulent free jet by TFKE model (TFKE moderu ni yoru ranryu jiyu funryu no suchi shimyureshon).** M. YAMAZAKI and S. KAMIYAMA, *In its Journal of NIRE*, Vol. 2, No. 4, pp. 85-94 (SEE N94-28147 07-45). Documents available from Aeroplus Dispatch.

Free turbulent shear flows such as turbulent jets are characterized by the intermittent phenomenon that rotational and irrotational states appear randomly and separately. In a turbulent jet flame, momentum, mass and heat transport between the fluid fragments of fuel and air resulting from the intermittent fluid motion inside the jet plays a dominant role in determining its structure and combustion characteristics. In this report, the TFKE (Two-Fluid Kappa Epsilon Two-Equation) turbulence model constructed for the prediction of the intermittency by integrating the two-fluid model and kappa epsilon two-equation model is described and the numerical calculations based on the TFKE model for the intermittency and diffusion characteristics of a unburnt axisymmetric turbulent free jet are discussed. It is presented that the numerical predictions satisfy quite well the existing experimental results and the TFKE model can provide the zone averages as well as time averages of the turbulence properties and the length scale distribution. This suggests, therefore, that the TFKE model is one of the promising turbulence models for further numerical simulation of turbulent jet flames. (Author)

**N94-25564 Study on computerized experiment of amorphous transformation process by solid phase reaction (Koso hanno ni yoru amorphous selsei katei no keisanki jikken ni kansuru kenkyu).** K. KUSUNOKI, M. ENOMOTO, and T. OGUCHI, *In its Bulletin of National Research Institute for Metals in Fiscal Year 1993*, No. 14, pp. 173-185 (SEE N94-25544 07-26). Documents available from Aeroplus Dispatch.

Recently, attention has been shifted from the traditional liquid quick cooling to amorphous alloy composition by solid phase reaction. Computer simulation at the atomic level was conducted to clarify the transformation of stable crystal phase to metastable amorphous phase. Molecular dynamics of Leonard-Jones type interatomic potential was employed to simulate the annealing of single crystals and diffusion couples as well as tension of single crystals, and changes in structure were studied. Crystals do not become amorphous in groups containing only simple substances and atomic holes. It requires alloy groups or processes which generate a large amount of negative excess volume to make crystal amorphous by solid phase reaction regardless of the amount of mixed enthalpy. For crystals to become amorphous, atomic couples in different sizes must occur at random to break the crystal regularity. (Author)

**N94-23460 Tracking sharp interface of two fluids by the CIP (Cubic-Interpolated Propagation) scheme.** T. YABE (Gunma Univ., Kiryu, Japan) and F. XIAO (Gunma Univ., Kiryu, Japan). Documents available from Aeroplus Dispatch.

A method to treat a sharp discontinuity by the density function is proposed. The surface of the density function is described by one grid throughout the calculation even when the surface is largely distorted. This description is made possible by the CIP method combined with variable transformation. This scheme is applied to the linear wave propagation in one- and two-dimensions. In the nonlinear case, the injection of heavier fluid into lighter fluid is calculated and the winding of mushroom structure is successfully treated by the density function. (DOE)

**N94-22648 Laboratory structure of the heliopause.** S. MINAMI, *In ESA, Fourth International Toki Conference on Plasma Physics and Controlled Nuclear Fusion*, pp. 177-179 (SEE N94-22624 05-75). Documents available from Aeroplus Dispatch.

The size and structure of the heliopause, which is the hypothesized boundary separating the antiferowing solar wind from the interstellar medium, is discussed. The results of laboratory simulations found the existence of such a boundary as a highly asymmetrical and open structure not yet predicted. The heliopause is produced as a collisionless interaction between the supersonic plasma flow and another supersonic magnetized plasma flow flowing relative to the solar system. Earlier, a laboratory simulation of a cometary magnetosphere produced as an interaction between the solar wind plasma flow and a subsonic plasma flow was performed. Heliosphere is formed as a collisionless interaction between the magnetized plasma flow and the other supersonic plasma flow. (ESA)

**A94-18972 Multifactor damage simulation analysis of high temperature low cycle fatigue for superalloy based on the statistical information of crack distribution.** K. FUJIYAMA, I. MURAKAMI, Y. YOSHIKAWA, and N. OKABE (Toshiba Corp., Yokohama, Japan), *Japan Society of Materials Science, Journal* (ISSN 0514-5163), Vol. 42, No. 481, Oct. 1993, pp. 1212-1217. In Japanese. 6 Refs. Documents available from Aeroplus Dispatch.

A discrete-cluster model of a material, and the associated damage state matrix, are presently used to solve a high-temperature low cycle fatigue damage problem for the case of the FSX414 Co-base superalloy. Crack number, maximum crack length, and mean crack length trends against fatigue cycles appeared to be of chaotic complexity, due to the interaction between cracks and the material structure. The method could be applicable for damage detection in actual structural components.

**A94-17411 An enroute ATC simulation experiment for sector capacity estimation.** N. TOFUKUJI (Electronic Navigation Research Inst., Tokyo, Japan), *IEEE Transactions on Control Systems Technology* (ISSN 1063-6536), Vol. 1, No. 3, Sept. 1993, pp. 138-143. 5 Refs. Documents available from Aeroplus Dispatch.

A series of enroute ATC simulation experiments was conducted to estimate the airspace capacity of existing sectors in Japan and to evaluate a new route structure for accommodating the traffic increase in the future. This paper presents a simulation method for capacity estimation and the results of the experiments focusing on the controller's workload limit. From the results of regression analysis, the relationship between the airspace capacity and the controller's intervention in the traffic flow is discussed. About 40 percent increase of capacity is attained with an introduction of parallel routes and traffic flow management. (Author (revised))

**A94-10355 Automatic production of a cell network on a flow field with large variation of density in the Monte Carlo direct simulation.** M. USAMI, H. KYOGOKU, M. UMEHARA, and S. KATO, *Japan Society of Mechanical Engineers, Transactions B* (ISSN 0387-5016), Vol. 59, No. 563, July 1993, pp. 2195-2201. In Japanese. 11 Refs. Documents available from Aeroplus Dispatch.

The double structure of cells is a very flexible, powerful tool to find the cell in which a particular molecule is located using the Monte Carlo direct simulation. The flow field is first divided into very small rectangular grid cells (small cells). Since the macrocell in which intermolecular collisions are counted and macroscopic properties are sampled is constructed of many grid cells, the simulated region of physical space can be divided freely into a network of

macrocells. Although a table indicating the macrocell to which each grid cell belongs is essential in the double-cell structure, it is troublesome work to obtain a reasonable table, especially for complicated flow fields. A computer program for assembling grid cells and constructing a network of macrocells is generated by both a common computational method and a method utilizing a neural net. Cell networks calculated with these methods are shown and discussed. (Author (revised))

**N94-13660 The study on test of docking mechanism system, part 1 and 2 (Dokkingu kikou shisutemu shiken no kenkyuu).** Documents available from Aeroplus Dispatch.

An overview of the study of docking mechanism system test is presented. The following aspects of the research and development are outlined: (1) overall scheme of the research and development; (2) research and development in each FY (Fiscal Year); (3) research and development in FY 1990, including total assembly of the docking mechanism system test model, test equipment, mechanism system test, and the results of the research and development; (4) research and development in FY 1991, including comparative evaluation of the system test and simulation analysis, and the conceptual design of the docking mechanism for the ETS-7 (Engineering Test Satellite-7); and (5) docking mechanism for ETS-7 composed of latching, umbilical connection, and separation mechanisms, and driving circuit section. (Author)

**N94-13659 The study on large space structure assembly technology: The study on deployable truss structure, part 2 and 3 (Oogata kouzoubutsu kumitate gijutsu no kenkyuu: Tenkai kumitate kouzou no kenkyuu).** Documents available from Aeroplus Dispatch.

An overview of the results of the study on large structure assembly technology is presented. The following aspects of the study are outlined: (1) overall scheme of technology development for assembling and constructing large structure operated on orbit; (2) a brief description of the development from FY (Fiscal Year) 1998 through FY 1991; (3) design study on system and element technologies; (4) simulation analysis, including studies on the analytic software and mathematical model, and problems in analyzing technology; (5) ground test; (6) survey on the next generation structural materials; and (7) concept of on-orbit validation experiment. (Author)

**N94-13658 The study on large space structure assembly technology: The study on deployable truss structure, part 1 (Oogata kouzoubutsu kumitate gijutsu no kenkyuu: Tenkai kumitate kouzou no kenkyuu).** Documents available from Aeroplus Dispatch.

An overview of the results of the study on large structure assembly technology is presented. The following aspects of the study are outlined: (1) placement and scope of the study; (2) study on large structure assembly technology, establishment of the dimensional requirements for the deployable structure, and extraction of critical elements in deployable structure system technology; (3) design study on critical elements, including study on the deployable structure systems, design study on one dimensional deployable truss structure and element technologies, and study on deployment simulation software and deployment test equipment; (4) planning of the trial production and test program; and (5) WBS (Work Breakdown Structure) for the deployable assembly structure study. (Author)

**A93-54246 Robust and simple adaptive control system design.** Z. IWAI, I. MIZUMOTO (Kumamoto Univ., Japan), and H. OHTSUKA (Kumamoto National College of Electronics and Information Technology, Japan) *International Journal of Adaptive Control and Signal Processing* (ISSN 0890-6327), Vol. 7, No. 3, May-June 1993, pp. 163-181. 27 Refs. Documents available from Aeroplus Dispatch.

Recently, the simple adaptive control (SAC) method has attracted considerable interest because of the simple structure of its adaptive controller. The method can only be applied to plants with so-called almost strictly positive real (ASPR) characteristics. Unfortunately, most real plants do not satisfy this condition. Furthermore, real plants contain disturbances such as uncertain elements. This paper deals with such problems and proves that the implementation of a parallel feedforward compensator makes it possible to apply the SAC method to non-ASPR SISO plants with plant uncertainties. Furthermore, a robust SAC algorithm in the presence of a class of external disturbances is also considered. The effectiveness of the parallel feedforward compensator and robust adaptive controller designed in this way is examined through several numerical simulations.

**A93-51986 A special-purpose computer for N-body simulations—GRAPE-2A.** T. ITO, J. MAKINO, T. FUKUSHIGE, T. EBISUZAKI, S. K. OKUMURA, and D. SUGIMOTO (Tokyo Univ., Japan), *PASJ: Publications of the Astronomical Society of Japan* (ISSN 0004-6264), Vol. 45, No. 3, 1993, pp. 339-347. 9 Refs. Documents available from Aeroplus Dispatch.

We have developed GRAPE-2A, which is a back-end processor used to accelerate simulations of gravitational N-body systems, such as stellar clusters, a proto planetary system, and the structure formation of the universe. GRAPE-2A calculates the forces exerted on one particle from all other particles. The host computer, which is connected to GRAPE-2A through a VME bus, performs other calculations, such as time integration. In the simulation of gravitational N-body systems, almost all of the computing time is consumed in calculating the forces between particles. GRAPE-2A performs this force calculation with a speed that is much faster than that of a general-purpose computer. GRAPE-2A can be used for cosmological N-body simulations with periodic boundary conditions using the Ewald method, and for molecular-dynamics simulations of proteins and crystals. The computational speed of GRAPE-2A is 180 Mflops.