

**A91-29831 Effect of local surface heating on the transition to turbulence in a three-dimensional boundary layer of a gas (Vozdeistvie lokal'nogo nagrevaniia poverkhnosti na perekhod k turbulentnosti v trekhmernom pogranichnom sloe gaza).** A. V. DOVGAL', V. I. A. LEVCHENKO, and V. A. TIMOFEEV, *Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seria Tekhnicheskii Nauki* (ISSN 0002-3434), Dec. 1990, pp. 43-48. 18 Refs.

In earlier studies, the possibility of using local heating to increase the stability of a laminar boundary layer of a gas has been demonstrated theoretically and experimentally for two-dimensional boundary layers. In the study reported here, experiments were carried out to determine the effect of local heating on the laminar-turbulent transition in a three-dimensional boundary layer. It is shown that local heating can be used to delay the laminar-turbulent transition in three-dimensional boundary layer flows. In particular, local heating lowers the requirements for the acceptable surface roughness for laminar boundary layers.

**A91-29829 Evolution of an incompressible turbulent wall flow in the region of curvilinear surface conjugation (Osobennosti razvitiia neszhimaemogo pristenogo turbulentnogo techeniia v oblasti sopriazheniia krivoliniinykh poverkhnostei).** V. I. KORNILOV, *Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seria Tekhnicheskii Nauki* (ISSN 0002-3434), Dec. 1990, pp. 22-30. 25 Refs.

Flow structure in the region of conjugation of curvilinear intersecting surfaces forming an open corner configuration was investigated experimentally with a view to finding configurations which would result in flow with no gradients in the longitudinal direction and free from boundary effects. The experiments were carried out on several different models in a subsonic low-turbulence wind tunnel at freestream velocity of 30 m/s, corresponding to  $Re_1 = 2 \times 10$  to the 6th/m. The experimental data are analyzed using power-law relations to approximate the velocity profiles. The effect of surface curvature on flow characteristics is discussed.

**A91-25280 Visualization of water streams in high-resolution radar imagery of the mouth of Neva River (Vizualizatsiia struinykh techenii v Nevskoi gube na radiolokatsionnykh izobrazheniakh vysokogo razresheniia).** S. V. VIKTOROV, L. L. SUKHACHEVA, V. V. VITER, I. I. POSTNIKOV, and P. A. SHIROKOV, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 315, No. 2, 1990, pp. 337-340.

High-resolution SAR imagery obtained with the Cosmos-1870 satellite on June 26, 1989 confirm the streamwise movement at the mouth of the Neva River. The imagery analysis made it possible to obtain the instantaneous pattern of streams in the river mouth, to determine the stream extent and width, and to identify the presence of intense stream zones.

**A91-25244 A polarization method for visualizing quasi-one-dimensional turbulent flows (Polarizatsionno-opticheskii metod vizualizatsii kvaziodnomernykh turbulentnykh techenii).** I. M. BYCHKOV, *Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seria Tekhnicheskii Nauki* (ISSN 0002-3434), Aug. 1990, pp. 61-64.

A polarization method for visualizing quasi-one-dimensional turbulent flows is described whereby an optically active fluid (e.g., a colloidal vanadium pentoxide solution) is illuminated, through the thickness, by polarized light. The method makes it possible to detect processes with a duration of 0.01-0.001 s by using normal photodetection; processes with durations of 0.0001-0.00001 s and 10 to the -6th s can be detected using high-speed and pulsed photodetection techniques, respectively. Results of visualization studies of flows out of rectangular capillaries are sented.

**A91-25263 A study of unsteady supersonic flow of air heated by a longitudinal electric discharge past bodies (Issledovanie nestatsionarnogo obtekaniia tel sverkhzvukovym potokom vozdukh, podogretym prodol'nym elektricheskim razriadom).** V. V. VITKOVSKI, L. P. GRACHEV, N. N. GRITSOV, I. U. E. KUZNETSOV, V. V. LEBEDENKO et al., *Teplotfizika Vysokikh Temperatur* (ISSN 0040-3644), Vol. 28, Nov.-Dec. 1990, pp. 1156-1163. 10 Refs.

Supersonic flow of air heated by a longitudinal electric discharge past hemispheres and cones was investigated experimentally using high-velocity visualization techniques. It is found that, in the presence of an electric discharge, flow past bodies is essentially unsteady, with characteristic time scales of the order of several microseconds, despite the low level of discharge current pulsations. The experimental data are compared with gas density distributions based on a one-dimensional model assuming the presence of thermal inhomogeneities in the flow.

**A91-25246 Visualization of unsteady supersonic jets (Vizualizatsiia nestatsionarnykh sverkhzvukovykh strui).** M. E. CHURBANOV and B. E. SINIL'SHCHIKOV, *Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seria Tekhnicheskii Nauki* (ISSN 0002-3434), Aug. 1990, pp. 84-87. 5 Refs.

A new system for the visualization of unsteady supersonic jets has been developed which makes it possible to study jets issuing from nozzles of large critical diameters. The system uses schlieren photography to study jets of any scale, the jet size being limited only by the size of the facility and by the power of the flashlamp. Results of visualization studies of unsteady gun-powder jets (critical nozzle diameter up to 15 mm) in a field of 50 x 70 critical nozzle diameters are examined.

**A90-49341 Visual investigation of vapour-gas zone in heat pipe condenser.** M. D. PARFENTLEY, Presented as Paper 901274 at the 20th SAE Intersociety Conference on Environmental Systems, Williamsburg, VA, July 9-12, 1990. 6 pp.

The paper presents the results of the visual investigations of the working fluid vapor and noncondensable gaseous impurities interacting in low-temperature heat pipe condensation zone. The effect of the transferred heat flow amount on the vapor and noncondensable gaseous impurity (NGC) separation is established. The obtained dependence makes it possible to determine the minimal amount of the transferred heat flow from which the vapor and NGC will be dynamic mixed and the temperature profile will be symmetric in the heat pipe condensation zone. Water, ethanol, acetone, and Freon-11 were used as the working fluid, while air, argon, and helium as NGC.

**A90-30331 Flow instability in the separation zone of a laminar boundary layer on a small surface irregularity (Neustoiichivost' techeniia v zone otryva laminarnogo pogranichnogo sloia na maloi nerovnosti poverkhnosti).** A. V. BOIKO, A. V. DOVGAL', V. V. KOZLOV, and V. A. SHCHERBAKOV, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), Jan.-Feb. 1990, pp. 16-22. 16 Refs.

The development of laminar flow perturbations in the separation zone behind a surface projection in the boundary layer of a flat plate is investigated experimentally. The linear instability characteristics of the separated flow are determined, and the interaction of oscillations generated in the separation zone with the mean flow is examined. It is shown that the frequencies and increments of perturbations arising in the separation zone are close to the values characteristic of inviscidly stable free shear flows.

## Japanese Aerospace Literature This month: *Spacecraft/Satellite Design*

**A92-12562 A conceptual study on a new style logistic service vehicle.** MITSUSHIGE ODA, KATSUMI KITOH, and TAKAHIRO ITOH, Presented as Paper 91-188 at the 42nd IAF International Astronautical Congress, Montreal, Canada, Oct. 5-11, 1991. 8 pp.

A conceptual study of an in-orbit deployable reentry vehicle which can be used for logistic support and space experiments is reported. The vehicle has a deployable capsule shell which can be extended in orbit to deploy solar paddles, radiator, and manipulator arm. The subelements of these systems are described and the systems' major characteristics are listed. The concepts are also graphically depicted.

**A91-13768 The design and orbital operation of Space Flyer Unit.** K. KURIKI, N. NINOMIYA, M. NAGATOMO, N. TSUYA, M. KAWACHI et al., Presented as Paper 90-055 at the 41st IAF International Astronautical Congress, Dresden, Federal Republic of Germany, Oct. 6-12, 1990. 12 pp.

The Space Flyer Unit (SFU) is an unmanned, reusable multipurpose platform to be launched by the Japanese H-II rocket and retrieved by the U.S. Space Shuttle. The SFU core system and payloads are described, and the SFU target mission and performance are summarized. SFU operation is examined, including the launch phase, early orbit phase, mission operation phase, preretrieval phase, retrieval phase, proximity operation phase, and return phase.

**A90-45696 Japan's space program—Building for the 21st century.** CRAIG COVAULT, *Aviation Week and Space Technology* (ISSN 0005-2175), Vol. 133, Aug. 13, 1990, pp. 36-43, 62-67, 70-72.

Japan is gearing its space program toward space station operations, development of an infrastructure for manned flight, and the launch of spacecraft to the moon, Venus, and Mars. The National Space Development Agency (NASDA) is responsible for handling large boosters and applications satellites. The Institute of Space and Astronautical Science (ISAS) develops medium boosters and science spacecraft. Japan's Ministry of Trade and Industry along with ISAS and NASDA is developing the 3.8-ton Space Flyer, the nation's first large retrievable satellite. The new H-2 launch facilities rival the largest U.S. or European sites. In addition, a large new rocket engine test stand has been constructed to test fire the oxygen/hydrogen LE-7 main engine that powers the first stage of the H-2 heavy booster. Initial space flight missions include the OREX orbiting reentry experiment, which is part of the HOPE spaceplane development. Launching of the ETS-6 is planned to demonstrate advanced geosynchronous satellite technologies. The Japanese Space Flyer, a 3.8-ton reusable spacecraft to carry various payloads, is scheduled for launch into a low earth orbit in late 1994. Additional details are provided for the HOPE unmanned spaceplane, the Marine Observation Satellites, the Earth Resources Satellite, and the Advanced Earth Observing Satellite.

**A92-12553 The development status of OREX (Orbital Re-entry Experiment) project in Japan.** TATSUSHI IZUMI, ISAO KAWANO, TOMOYUKI KOBAYASHI, HIROSHI SASAKI, MOTOMYUKI INABA, TOSHIO AKIMOTO, and YASUTOSHI INOUE, Presented as Paper 91-174 at the 42nd IAF International Astronautical Congress, Montreal, Canada, Oct. 5-11, 1991. 8 pp. 3 Refs.

The National Space Development Agency of Japan (NASDA) is presently studying the H-II Orbiting Plane (HOPE). HOPE is a space vehicle planned to be launched by the H-II rocket, to transport logistics to the international Space Station FREEDOM/JEM and to return back to the earth. NASDA is now planning the Orbital Reentry Experiment (OREX) to acquire engineering data for HOPE. The missions of OREX are acquisitions of aerodynamic data during entry period, thermal data on thermal protection system (TPS), data concerning communication blackout, and GPS experiment data for HOPE. Carbon/carbon material and ceramic tiles are adopted as TPS in order to measure the aerodynamic heating of TPS for HOPE and to test it. The blunt cone shape is selected to make aerodynamic heating rate at nose same as that of HOPE. The configuration of guidance and control system is based on that of NASDA launch vehicle.

**A92-12551 Study of Fire-in-the-Hole system for M-V launch vehicle.** TAKASHI NAKAJIMA, YOSHIFUMI INATANI, HIROKI MATSUO, MOTOKI HINADA, RYOJIRO AKIBA, HIDEO MARUTA, AKISATO TAKAHASHI, and NOBORU ONOJIMA, Presented as Paper 91-172 at the 42nd IAF International Astronautical Congress, Montreal, Canada, Oct. 5-11, 1991. 9 pp. 2 Refs.

The M-V launch vehicle, which represents the next generation of the Mu series, is currently under development by the Institute of Space and Astronautical Science, and the first one is planned for launch in early 1995. The M-V is designed to have the capability to launch about 2 tons of payload into LEO. In order to increase this capability, some challenges have had to be met. The first of these is in the design of staging system for the first and second stages, which takes into account that the second stage motor needs to be ignited before the burn-out of the first stage motor; that is, a system termed the 'Fire-in-the-Hole' (FITH) is going to be adopted. This paper describes the concept of a FITH staging system for the M-V which will reduce the inert weight of the second stage and allow safe separation with sufficient staging clearance. It also presents some results on experiments to estimate pressure and heat flux distributions caused by exhaust gas of the second stage and forces acting on the first stage.

**A92-12530 Overview of JERS-1 operation plan.** T. KOIZUMI, C. ISHIDA, S. KAWASE, T. NAGAI, K. YAMAYA, and K. TANAKA, Presented as Paper 91-135 at the 42nd IAF International Astronautical Congress, Montreal, Canada, Oct. 5-11, 1991. 11 pp. 2 Refs.

The Japanese Earth Resources Satellite-1 (JERS-1) mission (scheduled for launch in February 1992) is described, with particular attention given to the mission profile, the satellite's operational capabilities and constraints, the ground segment, and the mission planning procedures. JERS-1 will carry a SAR, an Optical Sensor system consisting of two separate radiometers (a visible and NIR radiometer and a short-wavelength IR radiometer), a data transmitter, and a data recorder. The satellite is currently undergoing a system check-out. The designed mission life is 2 years.

**A92-12485 JEM technology development.** KUNIAKI SHIRAKI, FUMIO OTSUKI, KAZUYUKI TASAKI, NAOKI SATO, NOBUYUKI TOMITA, HIROJIROU SHIOZAWA, and NOBUJI NISHINO, Presented as Paper 91-076 at the 42nd IAF International Astronautical Congress, Montreal, Canada, Oct. 5-11, 1991. 14 pp.

An overview is presented of the current status of the Japanese Experiment Module (JEM) and the major on-going technology developments. JEM is a multipurpose research and experiment laboratory in space to be permanently attached to the U.S. Space Station Freedom. The major elements of the laboratory are the pressurized module, the exposed facility, the experiment logistics module-pressurized section, the experiment logistics module-exposed section, and the remote manipulator system. Attention is given to the electrical power system, the environment control and life support systems, flight application software, and the payload attach mechanism.

**A91-14046 Engineering Test Satellite-VI and future applications.** K. NAKAMARU, S. TANAKA, H. KITAHARA, T. KATAGI, T. AKAEDA et al., Presented as Paper 90-455 at the 41st IAF International Astronautical Congress, Dresden, Federal Republic of Germany, Oct. 6-12, 1990. 10 pp. 7 Refs.

The major design features, technologies employed, and current development status of ETS-VI are discussed. Among the main objectives are the establishment of a 2-ton-class three-axis-stabilized spacecraft bus technology, confirmation of the launch capability of the H-II rocket, and on-orbit experiments and tests of the measurement equipment. Emphasis is placed on the spacecraft configuration, module design, payload mass and mounting area, lightweight structure, electrical power, attitude control accuracy, and telemetry and command channels. The ETS-VI mission payloads consist of six communications payloads and five bus experimental payloads. A development schedule extending into 1993 is presented, and the proposed areas of enhancement such as the adoption of Ni-H2 batteries, power supply to the ion engines from the batteries, and the reduction of the total mass structure by installing the propulsion system in the bus module are covered.

**A92-12490 JEM Electrical Power System architecture.** TAKEHIKO KATO, Presented as Paper 91-083 at the 42nd IAF International Astronautical Congress, Montreal, Canada, Oct. 5-11, 1991. 9 pp.

The architecture of the Japanese Experiment Module Electrical Power System (JEM EPS) designed for the Space Station Freedom is described and its requirements are documented. The relationship between the physical and functional aspects of the EPS are explained using a specially designed matrix representation. Special attention is given to the relationship between the EPS architecture to other subsystems of the Space Station Manned Base.

**A92-12478 The Japanese Experiment Module for Space Station Freedom.** K. IDA, H. MURAYAMA, and Y. HORIKAWA, Presented as Paper 91-066 at the 42nd IAF International Astronautical Congress, Montreal, Canada, Oct. 5-11, 1991. 6 pp.

The development of the Japanese Experiment Module (JEM) is examined with specific reference to proposed areas of investigation and their corresponding levels of preparation. The organization of the Space Station program in Japan is described to establish the financial and philosophical context of the JEM. JEM is developed according to operational requirements with the User Support Center which encompasses payload integration, training and logistics support facilities, and an information network system. The Space Station Integration and Promotion Center supports the activities for both JEM and Space-Station preparation. The utilization of JEM is proposed for observational, technological, and life science applications of interest to the general scientific community. The restructuring of the international Space Station project is concluded to have a significant impact on the development and scope of JEM.

**A91-55841 Attitude control system for Engineering Test Satellite-VI.** T. TORIUMI, T. TANAMACHI, Y. YAMAGUCHI, H. SOGA, M. MINE, H. KISHIMOTO, M. SHIGEHARA, Y. KAWADA, S. ICHIKAWA, and S. TANAKA, *Proceedings of the 3rd Pacific Basin International Symposium on Advances in Space Science Technology and its Applications, Space utilization and applications in the Pacific*, Los Angeles, CA, Nov. 6-8, 1989 (A91-55801 24-12). San Diego, CA, Univelt, Inc., 1990, pp. 509-525. 2 Refs. (AAS Paper 89-652).

The paper describes the Attitude Control System (ACS) design of Engineering Test Satellite-VI (ETS-VI). The ACS of ETS-VI is required to provide high attitude control accuracy, high reliability and high on-board operational automation. The ACS is designed to meet the above requirements. In design results, a high attitude control accuracy of  $\pm 0.05$  deg in roll/pitch and  $\pm 0.15$  deg in yaw is achieved in on-orbit and the ACS has highly on-board operational automation functions including the fault-tolerant system.

**A91-55833 ISAS' new satellite launcher M-V.** R. AKIBA, H. MATSUO, and M. KOHNO, *Proceedings of the 3rd Pacific Basin International Symposium on Advances in Space Science Technology and its Applications, Space utilization and applications in the Pacific*, Los Angeles, CA, Nov. 6-8, 1989 (A91-55801 24-12). San Diego, CA, Univelt, Inc., 1990, pp. 385-394. (AAS Paper 89-640).

The concept of the M-V, a new version of Japanese satellite launchers that is being developed by the Institute of Space and Astronautical Science, is described. The M-V is a three-stage solid propellant rocket that could lift about 2 tons of payload into LEO. Its first flight is scheduled to be at the beginning of 1995, when M-V will carry an engineering test satellite to prove the technology for Space VLBE. The basic parameters of the M-V launcher, the vehicle configuration diagram, and motor-design diagrams are presented.

**A91-55832 Development program of Japan's new launch vehicle - H-II rocket.** M. MIYAZAWA, Y. FUKUSHIMA, and J. KOCHIYAMA, *Proceedings of the 3rd Pacific Basin International Symposium on Advances in Space Science Technology and its Applications, Space utilization and applications in the Pacific*, Los Angeles, CA, Nov. 6-8, 1989 (A91-55801 24-12). San Diego, CA, Univelt, Inc., 1990, pp. 377-384. 4 Refs. (AAS Paper 89-639).

The H-II launch vehicle is being developed by the National Space Development Agency of Japan (NASDA), to meet the demands of Japan's applications satellite users for cost-effective, heavy-lift launches in the 1990s. At present, NASDA is conducting detailed design and development tests. Also, production of the Ground Test Vehicle (GTV) and the first flight model of the H-II have started toward the first test flight in 1993.

**A90-25622 Overview of next Japanese direct broadcasting satellite (BS-3).** SHUICHI MIURA, HARUAKI ITAGAKI, TUNENORI AKANUMA, and KEIZO NAKAGAWA, Technical Papers presented at the 13th AIAA International Communication Satellite Systems Conference and Exhibit Part 1, Los Angeles, CA, Mar. 11-15, 1990, (A90-25601 09-32). Washington, DC, American Institute of Aeronautics and Astronautics, 1990, pp. 169-175. (AIAA Paper 90-0797).

The development of the Japanese direct broadcasting satellite, BS-3, is discussed. The spacecraft configuration and performance are examined and the BS-3 subsystems are described. The BS-3 has full-redundant 3-channel transponders whose output power is greater than 120 W in the 12 GHz band. The apogee kick motor of the BS-3 is the same as that of the Japanese engineering satellite, ETS-V, which was launched in 1987. Consideration is given to the telemetry, tracking, command, attitude and orbit control, reaction control, and electrical power systems of the satellite.

**A91-55808 Development of earth resources satellite-1 (JERS-1).** TAMISUKE KOIZUMI, TAKASHI SUZUKI, MASANORI KOBAYASHI, and OSAMU KAKUICHI, *Proceedings of the 3rd Pacific Basin International Symposium on Advances in Space Science Technology and its Applications, Space utilization and applications in the Pacific*, Los Angeles, CA, Nov. 6-8, 1989 (A91-55801 24-12). San Diego, CA, Univelt, Inc., 1990, pp. 61-73. (AAS Paper 89-609).

The JERS-1 program, Japan's first satellite with SAR, is reviewed with particular attention given to configurations of the satellite system and subsystems. JERS-1, a sun-synchronous orbit satellite, uses a unique combination of mission instruments, namely, an L-band SAR and high-resolution optical sensors. Its global coverage capability with mission data recorder enables data acquisition in the areas where the ground stations have no coverage. The major mission objectives include the establishment of an integrated earth observation system, the development of earth observation instruments and verification of their performance, and the development of the earth observation satellite bus and verification of its performance.

**A91-38999 Space research satellite program in Japan.** TOMONAO HAYASHI, Technical Papers presented at the Space commercialization: Satellite technology; Symposium on Space Commercialization: Roles of Developing Countries, Nashville, TN, Mar. 5-10, 1989, (A91-38976 16-12). Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1990, pp. 271-281.

The space-research satellite program in Japan started in 1970 under the auspices of the Institute of Space and Astronautical Science (ISAS) is summarized. The historical background of ISAS going back to 1955 when the University of Tokyo participated in the International Geophysical Year is presented, and the mission objectives as well as orbit and launch parameters are considered. The work of a project team consisting of science and technology specialists from ISAS and engineers from manufacturing companies is outlined along with program control and testing procedures for scientific spacecraft. It is noted that though the size of the satellites is limited, the steady pace of their launches allows scientists to pursue long-term projects successfully.

**A91-38998 Communications and broadcasting satellites in Japan.** H. DOBASHI, E. KIMURA, and K. AIKYO, Technical Papers presented at the Space commercialization: Satellite technology; Symposium on Space Commercialization: Roles of Developing Countries, Nashville, TN, Mar. 5-10, 1989, (A91-38976 16-12). Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1990, pp. 259-270. 10 Refs.

The development of communications and broadcasting satellites in Japan initiated by the government in 1972 is reviewed. The review starts from a communications satellite (CS) and broadcasting satellite (BS) launched in 1977 and 1978, respectively, and continues with CS-2s and BS-2s put in operation in 1983 and 1984, respectively. The next-generation communications satellites, CS-3a and CS-3b launched in 1988 are discussed, and emphasis is placed on the increased demand for telecommunications services. Attention is focused on the next-generation broadcasting satellites, BS-3a and BS-3b scheduled for launching in 1990 and 1991, respectively. These satellites are supposed to broadcast three television programs including high-definition television services. It is pointed out that according to a new regulation policy in the communication field, two new commercial domestic communication-service companies founded in 1985 planned to launch two communications satellites in 1989.

**A91-38970 Japanese approach to the Space Station.** YASUSHI HORIKAWA, Technical Papers presented at the Space commercialization: Platforms and processing; Symposium on Space Commercialization: Roles of Developing Countries, Nashville, TN, Mar. 5-10, 1989, (A91-38951 16-29). Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1990, pp. 296-315.

The Japanese Experimental Module (JEM) design is described, and Japanese approaches to effective space environment utilization are discussed, including an experiment system depending on Space Shuttle use for the First Materials Processing Test and the International Microgravity Laboratory. Particular attention is given to microgravity experiments using a drop tower on the ground, aircraft, a small of expendable launch vehicle, and the H-II launch vehicle.

**A91-26642 Navigation and guidance of the H-11 orbiting plane.** T. IZUMI, T. SATO, S. TANAKA, Y. TAKIZAWA, and T. KIMURA, Selected Papers presented at the IFAC Symposium, Automatic control in aerospace, Tsukuba, Japan, July 17-21, 1989, (A91-26606 10-12). Oxford, England and New York, Pergamon Press, 1990, pp. 261-266. 8 Refs.

Various configurations of the navigation system for a NASDA unmanned winged space vehicle, the H-11 Orbiting Plane (HOPE), have been evaluated. Based on these analyses, reference configurations are tentatively obtained. It is concluded that on-orbit phase, inertial navigation with the inertial measurement unit, and precision states propagation are available. The GPS receiver and the star tracker must be used periodically to update position and velocity. During entry through the end of radio blackout phase, pseudo drag measurement is necessary, while, during post radio blackout phase, IMU-GPS configurations are adopted. Also, based on results of the entry guidance analysis, the design constraint due to the aeroheating restriction is clarified. This constraint gives a rough principle upon which to base HOPE guidance and design parameter selection in order to overcome the aeroheating criticality.

**A91-38928 ISAS's new launch vehicle for science use.** R. AKIBA, H. MATSUO, Y. MATOGAWA, and T. HOSOMURAT, Technical Papers presented at the Space commercialization: Launch vehicles and programs; Symposium on Space Commercialization: Roles of Developing Countries, Nashville, TN, Mar. 5-10, 1989, (A91-38926 16-12). Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1990, pp. 24-34.

The M-3SII rocket, developed by Japan's Institute of Space and Astronautical Science as the latest version of the Mu rocket family, is described. The medium-sized M-3SII was developed primarily for the Halley's Comet mission. A novel movable nozzle system was introduced, and the control system was digitalized to increase control logic design flexibility. The vehicle is a three-staged solid rocket with two strap-on boosters; a kick stage is added optionally for high-energy missions such as interplanetary flights. It can lift 700 kg of payload into a 250-km circular orbit with medium inclination. Attitude reference is given by three rate-integrating gyros mounted on the second stage, and two gyros on the first stage provide damping signals for the first-stage pitch and yaw control. The instrumentation system includes equipment for ground monitoring of the subsystems during prelaunch checkout and countdown, telemetry monitoring of flight performance, radar beacon tracking, and command-construct information.

**A91-26643 Navigation, guidance and control subsystem of Space Flyer Unit.** T. NISHIMURA, M. KAWACHI, T. YAMAGUCHI, M. SATO, and K. TSUKAHARA, Selected Papers presented at the IFAC Symposium, Automatic control in aerospace, Tsukuba, Japan, July 17-21, 1989, (A91-26606 10-12). Oxford, England and New York, Pergamon Press, 1990, pp. 267-272. 6 Refs.

The Space Flyer Unit (SFU), a retrievable and reusable platform which will be utilized for many kinds of scientific and engineering experiments in space, such as material processing and space observations, is described. The design status of autonomous navigation and guidance logic for rendezvous with STS, and operation in the proximity of STS, are discussed. In addition, two critical issues concerning attitude control are addressed: actuator sizing compatibility for many kinds of mission operations and stabilization for flexible appendages such as solar paddles.

**A91-13777 Development of Japanese Experiment Module (JEM).** KAZUO MATSUMOTO, KUNIAKI SHIRAKI, YASUSHI HORIKAWA, and NOBUYUKI TOMITA, Presented as Paper 91-188 at the 41st IAF International Astronautical Congress, Dresden, Federal Republic of Germany, Oct. 6-12, 1990. 8 pp.

The most recent JEM configuration, stowage allocation summary and launch configuration are presented. JEM system design activities and contractors are listed, and it is noted that system design began in early 1990. JEM major development items are listed and include power distribution unit, control processor, control system network, airlock, RMS control system elements, control system atmosphere, meteoroid/debris protection system, and payload attach mechanism. JEM project master and basic schedules are also presented. A number of major technological issues are briefly discussed including resource allocation, remote manipulator system operational feasibility test, air distribution and ventilation test, and an equipment exchange unit R&D test.

**A90-29466 Dynamics of the Exos-D satellite - Effects of various flexible appendages.** MICHIOHORI NATORI, ICHIRO NAKATANI, KEIKEN NINOMIYA, TOSHIHIRO KURII, and KEN MAEDA, Presented as Paper 90-0993 at the 31st AIAA, ASME, ASCE, AHS, and ASC, Structures, Structural Dynamics and Materials Conference, Long Beach, CA, Apr. 2-4, 1990. 7 pp. 6 Refs.

The Japanese Exos-D satellite is examined, noting the satellite's deployable appendages for scientific measurements. The spacecraft configuration is illustrated and preliminary in-orbit data for the initial operation phase are presented. Consideration is given to the orbital parameters, attitude control system, and analytical investigations performed to predict the in-orbit behavior of the Exos-D. Wire antenna appendages such as a three-axis orthogonal loop antenna and coilable longeron extendible masts are used as electric field, VLF wave, and plasma wave detectors. The initial data on the effects of these appendages are presented, including changes in spin rate and spin period before and after deployment of the antennas.

**A90-19941 Numerical simulation of hypersonic viscous flow for the design of H-II orbiting plane (HOPE).** YUKIMITSU YAMAMOTO, TOSHIO AKIMOTO, NAOKYU SUZUKI, Presented as Paper 90-0601 at the 28th AIAA Aerospace Sciences Meeting, Reno, NV, Jan. 8-11, 1990. 16 pp. 12 Refs.

The H-II orbiting plane (HOPE) is an unmanned winged vehicle for space transportation whose current baseline configuration is that of a double delta wing with tip fins. Hypersonic CFD analysis is performed for the four types of proposed HOPE configurations, and aerodynamic and aerothermodynamic characteristics are investigated. Numerical computations are carried out for the HOPE 62A, 62B, and 62C models at Mach 7, Reynolds number  $2.5 \times 10^6$  to the 6, and at angles of attack from 0-40 degrees. The aerodynamic characteristics are compared with experiments performed in a hypersonic wind tunnel. For the HOPE 63 model, calculations are made at the above conditions at angles of attack up to 50 degrees. In addition, Reynolds and Mach number effects are also analyzed for this model. Numerical results of heat transfer distributions are compared with experimental data obtained by the phase change paint methods.