A90-29067 Enhancing the information content of satellite-borne observations of objects on the earth's surface (Povyshenie informativnosti nabliudenii nazemnykh ob'ektov s ISZ). M. IU. BELIAEV and D. N. RULEV, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 28, Jan.–Feb. 1990, pp. 56–68.

The paper determines the orbit parameters of a satellite in the case of which the information content of the observation of ground objects is maximal for minimal expenditures of fuel required for satellite maneuvers. The problem's solution is reduced to a linear-programming problem. The efficiency of the proposed approach is shown using numerical estimates for the Mir orbital station.

A90-17226 Stabilization of a satellite with flexible rods. I (O stabilizatsii sputnika s gibkimi sterzhniami. I). S. I. ZLOCHEVSKii and E. P. KUBYSHKIN, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 27, Sept.–Oct. 1989, pp. 643–651. 6 Refs.

The problem of the stabilization of the angular position of a satellite with flexible rods is considered. A solution of the boundary value problem of the plane elastic vibrations of the flexible rods of a satellite obtained with the D-splitting method is used to construct the stability region on the parameter plane of the stabilization system with allowance for the entire frequency spectrum of the rods. It is shown that this region constitutes only a part of the stability region for a satellite with rigid rods.

A89-38429 Stability of the equilibrium states of a shielded earth satellite (Ob ustoichivosti polozhenii ravnovesiia ekranirovannogo sputnika zemli). L. I. KUZNETSOV and A. A. TIKHONOV, *Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia* (ISSN 0024-0850), Jan. 1989, pp. 66–71. 5 Refs.

The stability of the equilibrium states of an earth satellite with an electrostatic shield moving along a circular orbit in the geomagnetic field is analyzed in orbital coordinates. The necessary and sufficient stability conditions are obtained. The way in which the Lorentz forces affect the stability of the equilibrium states of the satellite is determined.

A89-32164 Investigation of the optimal two-parameter control of a spacecraft moving in an atmosphere (Issledovanie optimal'nogo dvukhparametricheskogo upravleniia pri dvizhenii KA v atmosfere). N. L. SOKOLOV, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 27, Jan.–Feb. 1989, pp. 64–70. 15 Refs.

The optimal control of a spacecraft in a planetary atmosphere is examined theoretically. The structure of two-parameter control is defined for problems with different optimized functionals and boundary conditions. In particular, expressions are presented which define the structure of the optimal control of attack and roll angles for two variational problems.

A90-17178 Positioning of a star camera with respect to the axes of the spacecraft (O razmeshchenii zvezdnoi fotokamery otnositel'no osei KLA). A. F. STETSENKO, *Geodeziia i Aerofotos'emka* (ISSN 0536-101X), No. 2, 1989, pp. 83–86.

The paper examines the accuracy of the determination of the orientation angles of a spacecraft according to star photographs in relation to the setting angles of the star camera with respect to the axes of the spacecraft. Graphs illustrating the dependence of the orientation accuracy on the setting angles for various conditions are presented.

A90-16523 Orientation of large orbital stations. V. A. SARYCHEV, M. IU. BELIAEV, V. V. SAZONOV, and T. N. TIAN, *Proceedings of the IUTAM/IFAC Symposium, Dynamics of controlled mechanical systems*, Zurich, Switzerland, May 30–June 3, 1988 (A90-1651604-31). Berlin and New York, Springer-Verlag, 1989, pp. 193–205. 7 Refs.

The single-axis gravitational orientation mode is considered for the Salyut 6 and 7 orbital stations. An integral statistical technique is described for determining the real rotational motion of the stations in this mode by the solar and magnetic sensor indications. The technique is illustrated by computations of residual microaccelerations aboard the station; their knowledge is important for an analysis of some technological experiments.

A89-32163 Mathematical substantiation of a theory of orbital correction using a solar sail (Matematicheskoe obosnovanie teorii orbital'noi korrektsii, vypolniaemoi s pomoshch'iu solnechnogo parusa). E. N. POLIAKHOVA and A. S. SHMYROV, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 27, Jan.–Feb. 1989, pp. 54–63. 8 Refs.

The paper examines the two-dimensional problem of the optimal correction of the geocentric elliptical orbit of a spacecraft using a solar sail. A combination of the averaging and small-parameter methods is used to obtain an approximately optimal solution. The problem is examined for arbitrary initial conditions in the sense of the orientation of the apsidal lines and the dimensions of the elliptical orbit with fixed constraints on the solar-sail thrust force.

A89-30078 Theory of semianalytical inertial damped structures invariant to external data errors (K teorii poluanaliticheskikh inertsial'nykh dempfirovannykh sistem, invariantnykh k pogreshnostiam vneshnei informatsii). R. M. KUKULIEV, *Priborostroenie* (ISSN 0021-3454), Vol. 32, Jan. 1989, pp. 40–45. 5 Refs.

An inertial navigation system is considered which uses external data signals for system damping. Theorems are proved concerning the impossibility of attaining absolute invariance of the error of gyroplatform deviation from the reference vertical to the external data errors.

Japanese Aerospace Literature
This month: *Supersonics*

A91-44657 Effects of chordwise displacement and nonrigid section deformation on unsteady aerodynamic response of subsonic and supersonic oscillating cascades. MASANOBU NAMBA and KAZUHIKO TOSHIMITSU, ASME Paper 90-GT-246 presented at the ASME 35th International Gas Turbine and Aeroengine Congress and Exposition, Brussels, Belgium, June 11–14, 1990. 9 pp. 5 Refs.

The double linearization theory is applied to lightly loaded two-dimensional subsonic and supersonic cascades undergoing oscillation with chordwise displacement or nonrigid section deformation. Numerical examples demonstrating parametric dependence of unsteady aerodynamic work on blades are presented. The chordwise displacement can be favorable or unfavorable for stabilizing the translational oscillation, depending upon the phase difference between the chordwise and normal components of the blade motion. For supersonic cascades the role of the effect of displacement of shock reflection points on unsteady aerodynamic response is significantly enhanced by the chordwise blade motion. The unsteady aerodynamic work for nonrigid section deformation is substantially influenced by steady loading.

A91-19289 Numerical prediction of two and three dimensional sonic gas transverse injections into supersonic flow. T. FUJIMORI, M. KAWAI, H. IKEDA, Y. ANDO, Y. OHMORI et al., AIAA Paper 91-0415 presented at the AIAA 29th Aerospace Sciences Meeting, Reno, NV, Jan. 7–10, 1991. 12 pp. 18 Refs.

Two- and three-dimensional sonic gas injections into supersonic flows are studied by two- and three-dimensional Navier-Stokes equation solvers, which have been developed by the authors recently. The results are compared with experimental data. For two-dimensional injection, close agreement of numerical results with experimental data are obtained. For three-dimensional cases, the qualitative agreements are obtained, but front separation area of the numerical results are larger than that of the experimental ones. To investigate mixing of injectant with primary flow in three-dimensional case, a transport equation of injectant is solved by a postprocessing method.

A91-44092 Supersonic air-intake study aiming at future airbreathing engine. K. SAKATA, S. HONAMI, and A. TANAKA, AIAA Paper 91-2012 presented at the AIAA, SAE, ASME, and ASEE 27th Joint Propulsion Conference, Sacramento, CA, June 24–26, 1991. 7 pp.

A development status evaluation is presented for Japanese efforts toward development of SST/HST airbreathing propulsion system air intakes featuring a minimum cruise Mach number of 3.0 and mixed compression operation within a two-dimensional ramp-type geometry framework. Experimental investigations have thus far encompassed a three-shock ramp system, multishock ramps with bleed systems, variable-geometry inlets, and inlets optimized for SST airframe integration. The avoidance of boundary-layer separation and the minimization of bleed airflow rates are identified as the most important steps toward achievement of performance goals.

A91-40585 Shock waves generated by an opposing jet. MICHIO NISHIDA, KOJI TESHIMA, KAZUYUKI UENO, and SHIGEKI TANAKA, *Proceedings of the 17th International Symposium on Shock Waves and Shock Tubes, Current topics in shock waves*, Bethlehem, PA, July 17–21, 1989 (A91-40576 17-34). New York, American Institute of Physics, 1990, pp. 114–119. 11 Refs.

The shock waves generated by a sonic nose jet exhausting counter to a supersonic free stream of a Mach number 3 were visualized by means of a laser induded fluorescence method. The experiments were conducted for various values of the ratio of opposing jet total pressure to free stream total pressure. The ratio of a jet exit diameter to a body diameter was taken to be 0.2 and 0.4. The results show that the shock waves generated by the opposing jet are significantly affected not only by the ratio of jet total pressure to free stream total pressure but also by the ratio of the jet exit diameter to the body diameter. It was also observed that at low pressure ratios, there exists unstable flow regime. Simple analysis is applied to the prediction of the position of a free stream shock and a Mach disk, and compared with the experimental result. The comparisons show good agreement.

A91-44091 Aerodynamic characteristics of Mach-3 air-intake tested in supersonic wind tunnel. R. YANAGI, S. SHINDO, A. MURAKAMI, K. SAKATA, S. HONAMI et al., AIAA Paper 91-1755 presented at the AIAA, SAE, ASME, and ASEE 27th Joint Propulsion Conference, Sacramento, CA, June 24–26, 1991. 8 pp. 9 Refs.

Turbulent properties in the shock wave/turbulent boundary layer interaction induced by blunt fins with semicylindrical leading edge have been investigated. Flow fields are visualized by the Schlieren method and the oil flow technique. Pressure fluctuations are measured in the whole interaction region in order to understand the phenomena and provide sufficient information for turbulent modeling. Distributions of standard deviations and higher moments of pressure fluctuations are also measured. Quite complicated distributions of standard deviations and higher moments of pressure fluctuations are obtained. Those properties show significant changes in the interaction region and quite interesting characteristics are observed. Also in the interaction region intermittent phenomena due to the shock wave motion are observed. Those complicated results suggest that more sophisticated turbulent modeling is necessary to simulate the flow field.

A91-43000 A study of supersonic aerodynamic mixing in the scramjet combustor. YASUNORI ANDO, MASAFUMI KAWAI, TOSHIRO FUJIMORI, HIDETO IKEDA, YASUNORI OHMORI, et al., *Ishikawajima-Harima Engineering Review* (ISSN 0578-7904), Vol. 31, Jan. 1991, pp. 1–7. 7 Refs.

Two-dimensional and three-dimensional CFD codes are described for predicting the mixing and combustion of hydrogen fuel in the turbulent flowfield of supersonic combustion ramjets, which use a TVD to efficiently capture the discontinuous surfaces. The experimental validation of the codes is performed and the applicability of the codes to simulations of realistic scramjet combustor flowfields is evaluated.

A91-42817 Parametric study of airframe-integrated scramjet cooling requirement. TAKESHI KANDA, GORO MASUYA, YOSHIO WAKAMATSU, NOBUO CHINZEI, and AKIO KANMURI, *Journal of Propulsion and Power* (ISSN 0748-4658), Vol. 7, May–June 1991, pp. 431–436. 17 Refs.

The cooling requirement of a hydrogen-fueled airframe-integrated scramjet engine as well as an airframe is examined, and effects of various parameters including flight Mach number, flight dynamic pressure, engine wall temperature, and engine scale, on the engine characteristics are analyzed. The coolant required for the airframe is about 20 percent of the total coolant. Simple equations that correlate coolant flow rate with those parameters are derived.

A91-42567 Supersonic inlet flow computations using fortified Navier-Stokes approach. SHINICHI KURODA and KOZO FUJII, AIAA Paper 91-1730 presented at the AIAA 22nd Fluid Dynamics, Plasma Dynamics and Lasers Conference, Honolulu, HI, June 24–26, 1991. 12 pp. 12 Refs.

Two-dimensional flow fields about the basic experimental inlet model of mixed-compression type designed at Mach number 3.0 is numerically simulated using the Fortified Navier-Stokes (FNS) approach. Complete inlet system including the flow-plug which controls the back pressure in the experiment is considered. Computations with adequate back pressure and with excessive one are performed. Comparison with the experimental data is presented in terms of the schlieren photograph and the static pressure. A preliminary computation for the flow field about the inlet model with bleed chamber is also included.

A91-37422 Propellant feed system of a regeneratively cooled scramjet. TAKESHI KANDA, GORO MASUYA, and YOSHIO WAKAMATSU, *Journal of Propulsion and Power* (ISSN 0748-4658), Vol. 7, Mar.–Apr. 1991, pp. 299–301. 9 Refs.

An expander cycle for an airframe-integrated hydrogen-fueled scramjet is analyzed to study regenerative cooling characteristics and overall specific impulse. Below Mach 10, the specific impulse and thrust coincide with the reference values. At Mach numbers above 10, a reduction of the specific impulse occurs due to the coolant flow rate requirement, which is accompanied by an increase of thrust. It is shown that the thrust may be increased by injecting excess fuel into the combustor to compensate for the decrease of the specific impulse.

A91-19365 Numerical study on mixing and combustion of injecting hydrogen jet in a supersonic air flow. A. KOICHI HAYASHI and MASAHIRO TAKAHASHI, AIAA Paper 91-0574 presented at the AIAA 29th Aerospace Sciences Meeting, 29th, Reno, NV, Jan. 7–10, 1991. 14 pp. 29 Refs.

A two-dimensional sonic hydrogen jet transversely injected into a supersonic hot air flow is simulated numerically to understand the phenomena and mechanism of mixing and combustion processes. The flowfield is governed by the two-dimensional Reynolds averaged full Navier-Stokes equations with an algebraic eddy viscosity model developed by Baldwin and Lomax (1978). Chemical kinetics are described by 9 species (H2, O2, H2O, O, H, OH, HO2, H2O2 and N2) and 19 elementary reactions of the full hydrogen-oxygen system with the third body efficiencies assuming nitrogen is inert. The governing equations are solved full-implicitly using the implicit TVD scheme with the point-implicit treatments of chemical source terms. The numerical results are compared with a two-dimensional experiment to study validities of the turbulence model and chemical kinetics model.

A91-34439 Interaction between two jets exhausted from nozzles arranged in parallel. NATSUO HATTA, HITOSHI FUJIMOTO, and JUN-ICHI KOKADO, *Kyoto University, Faculty of Engineering, Memoirs* (ISSN 0023-6063), Vol. 53, Jan. 1991, pp. 19–48. 16 Refs.

The flow structures of two interacting free jets expanded from uniform sonic nozzles into a stagnant ambient gas region are studied. A two-dimensional Cartesian coordinate system is used for the present simulations. A choked underexpanded supersonic single free jet is investigated in the context of continuum ideal gas dynamics.

A91-32174 Parachute deployment experiment in transonic and supersonic wind tunnels. MOTOKI HINADA, YOSHIFUMI INATANI, TAKASHI NAKAJIMA, MASAHISA HONDA, KOJU HIRAKI, et al., AIAA Paper 91-0859 presented at the AIAA 11th Aerodynamic Decelerator Systems Technology Conference, San Diego, CA, Apr. 9–11, 1991, Technical Papers (A91-32151 12-03). Washington, DC, American Institute of Aeronautics and Astronautics, 1991, pp. 207–215. 16 Refs.

Preliminary wind tunnel tests have been made in ISAS in order to study the characteristics of the parachutes at transonic and supersonic Mach number regions. A device has been made to eject a model parachute into a wind tunnel flow and to measure the drag force acting on it. Some experimental studies on parachute deployment have been carried out by using the device set on the inside wall of transonic and supersonic wind tunnels having test sections of 60 cm square in ISAS with the flow conditions of Mach number from 0.8 to 3.0 and Reynold number from 2.2 to 2.9 × 10 to the 7th/m. Parachute models employed in this study have been made of practical parachute materials. The relations between the Mach number and the drag, parachute diameter, oscillating angle are obtained, and these comparative aerodynamic characteristics were discussed, including the effect of forebody wake. Some typical phenomena such as 'breathing' at supersonic speed are observed, and their frequencies are measured.

A91-31512 Numerical study of interaction of a jet with a supersonic cross flow. NOBUHIKO YAMASAKI, MASANOBU NAMBA, and WEIGUANG HUANG, *Kyushu University, Faculty of Engineering, Memoirs* (ISSN 0023-6160), Vol. 50, Dec. 1990, pp. 467–488. 13 Refs.

The paper presents FDM solutions of two-dimensional Navier-Stokes equations in a conservative-law form for a jet injected into a supersonic-main flow. The effects of the jet-main flow pressure ratio, the injection angle, and the injection flow Mach number on the jet-main flow interaction are studied. A flow field is shown where a rearward-facing step is placed upstream of the jet injection and the effects of the position of the step from the injection on the flow field. It is found that the boundary layer separation and the shock pattern caused by jet-main flow interaction are heavily dependent upon not only the injection flow Mach number but also the injection angle and the configuration of the rearward-facing step.

A91-25332 Translational non-equilibrium in a supersonic free-jet expansion. NORIO TAKAHASHI, KOJI TESHIMA, and MICHIO NISHIDA, *Kyushu University, Technology Reports* (ISSN 0023-2718), Vol. 63, Oct. 1990, pp. 559–565. 8 Refs.

Translational nonequilibrium phenomena in highly expanded jets are presented both theoretically and experimentally. Experimental results in a wide range of stagnation conditions, especially in the temperature range 100-8000 K, are described by a scaling parameter which was proposed by Toennius and Winkelmann (1967) on the basis of an assumption of the Maxwell velocity distribution and a source flow expansion. An extension of the model to jets of a binary gas mixture is made, and the result gives good agreement with experiments.

A91-21335 Experimental study on mixing phenomena in supersonic flows with slot injection. SHIGERU ASO, MASAFUMI KAWAI, YASUNORI ANDO, and SATOSHI OKUYAMA, AIAA Paper 91-0016 presented at the AIAA 29th Aerospace Sciences Meeting, Reno, NV, Jan. 7–10, 1991. 7 pp. 9 Refs.

The complex flowfields induced by gaseous secondary flow injected into supersonic flow have been studied experimentally at free-stream Mach 3.8, total pressure of 1.2 MPa, and Reynolds number of 2.0 x 10 to the 7th. The results show that the bow shock wave/turbulent boundary layer interaction induces the boundary layer separation in front of the injection. In the interacting flow, barrel shock waves and Mach disk are observed clearly. As the total pressure ratio or thickness of nozzle is increased, the separation region, the extent of the interaction region and shock structures enlarge significantly.

A90-47300 Numerical study of interaction of a jet with a supersonic cross flow. WEIGUANG HUANG, NOBUHIKO YAMASAKI, and MASANOBU NAMBA, *Kyushu University, Technology Reports* (ISSN 0023-2718), Vol. 63, June 1990, pp. 243–285. 8 Refs.

A method for planar measurement of temperature in a compressible flow by means of two-line laser-induced iodine fluorescence is proposed. Temperature is determined from the ratio of the intensities of fluorescence, which are obtained by irradiation of two laser beams of different wavelength. Use of a high-sensitivity vidicon camera permits multiple-point measurements of temperature in the flow field. This method is applied to a supersonic free jet. It is found that the results obtained by P(16)/R(18) (514.720 nm) and P(26)/R(28) (514.942 nm) absorption lines in the transition of B 3Pi(+)ou (v-prime = 43) – X 1Sigma(+)g (v-double prime = 0) can predict temperature below 300 K with an accuracy of + or – 5 K.

A90-36465 Oscillation of circular shock wave. MYEONG KWAN PARK, SHUZO OSHIMA, and RYUICHIRO YAMANE, *JSME International Journal, Series II* (ISSN 0914-8817), Vol. 33, May 1990, pp. 208–215. 10 Refs.

Oscillation modes of a circular shock wave in a supersonic radial flow were studied both experimentally and theoretically. The pressure fluctuation was measured in concentric positions to investigate the modes of the circular shock wave in the case of mean radii of 70 and 77 mm, and the A-D converted signals were statistically correlated. A simple model of an oscillating shock wave was proposed. The frequency of the oscillation increased from low to high values with increasing radius. The oscillation mainly consisted of mode 0 superposed by modes of 1, 2 and 4. The mode 1 is considered to be weak. The experimental frequency of each mode agreed well with the theoretical results.

A91-21198 Theoretical analysis of supersonic gas-particle two-phase flow and its application to relatively complicated flow fields. NATSUO HATTA, HITOSHI FUJIMOTO, RYUJI ISHII, JUN-ICHI KOKADO, *Kyoto University, Faculty of Engineering, Memoirs* (ISSN 0023-6063), Vol. 52, July 1990, pp. 115–185. 22 Refs.

Supersonic flows of a two-phase gas-particle mixture are considered in several complex situations. For a flow field in which the gas and particle phases interact, a model is constructed by incorporating the particle-trajectory method into the gas phase equations in the two-fluid model. Single-phase and two-phase flows of jets exhausted from a sonic nozzle are examined in detail. Single-phase results are compared with experimental results to see if the scheme is reliable. For two-phase results, particles with the same velocity and temperature as those of the gas are injected at the nozzle exit plane, and the effect of the presence of particles is studied by comparison with single-phase results. Next, results of numerical experiments in which jets impinge on a flat plane normal to the jet axis are considered for both the single-phase and two-phase cases. For a single-phase flow, periodic unstable oscillations are found to give fairly good agreement with experimental results. Finally, supersonic gas-particle two-phase flows around a sphere are simulated. The instability in particle motion near the stagnation region in the shock layer is discussed in detail.

A91-19562 Supersonic gas-particle two-phase flow around a sphere. R. ISHII, N. HATTA, Y. UMEDA, and M. YUHI, *Journal of Fluid Mechanics* (ISSN 0022-1120), Vol. 221, Dec. 1990, pp. 453–483. 26 Refs.

The TVD scheme developed by Chakravarthy and Osher (1985) is presently used to describe the supersonic flows of a gas-particle mixture around a sphere, solving the particle phase through the application of a discrete particle-cloud model. It is shown that a temporal reverse-flow region of the gas is induced near the body axis in the shock layer; this is responsible for the appearance of the gas flow region where the pressure gradient becomes negative along the body surface. The results obtained support a flow model for the particle-induced flow field associated with the 'heating augmentation' noted in heat-transfer measurements of hypersonic particle erosion environments.

A91-14452 Newly constructed high speed wind tunnel at the Institute of Space and Astronautical Science (ISAS) and related activities. YOSHIFUMI INATANI, KEIICHI KARASHIMA, KOZO FUJII, NOBUHIRO TANATSUGU, and TAKASHI ABE, AIAA Paper 90-5226 presented at the AIAA 2nd International Aerospace Planes Conference, Orlando, FL, Oct. 29–31, 1990. 9 pp. 6 Refs.

The Institute of Space and Astronautical Science (ISAS) built a new high-speed wind tunnel facility in 1989 in Sagamihara campus. The objective of the facility construction is to conduct the aerodynamic research of high-speed air and space transportation systems, air-breathing propulsion systems and recovery systems, as well as basic studies in the field of high-speed aerodynamics. The facility consists of a set of high pressure air-supply system and a transonic and a supersonic tunnel. Although both wind tunnels are of conventional blow-down type, the manual procedures in tunnel operations and measurements are highly simplified by making use of fully automatic control systems to save manpower and driving energy necessary for the execution of the wind tunnel experiments. Brief summaries of the facility and its performance, and some of the results obtained in tunnel verification tests as well as a proposed experimental study are summarized.

A91-13048 Annular cascade study of low back-pressure supersonic fan blade flutter. H. KOBAYASHI, (ASME, International Gas Turbine and Aeroengine Congress and Exhibition, 34th, Toronto, Canada, June 4-8, 1989) *ASME, Transactions, Journal of Turbomachinery* (ISSN 0889-504X), Vol. 112, Oct. 1990, pp. 768–777. Research supported by MITI. 20 Refs. (ASME Paper 89-GT-297).

An oscillation-controlled annular cascade test facility has been used to investigate torsional-mode low back-pressure blade flutter in a supersonic fan. The blades were measured at a range of reduced frequencies, six different interblade phase angles, and inlet flow velocities from subsonic to supersonic flow. Reductions in flutter-boundary frequency substantially increased when the blade suction flow became subsonic. The interblade phase angles causing flutter were in the range from 40 to 160 deg, for flowfields ranging from high subsonic to supersonic; shock-wave movements due to blade oscillation generated large, unsteady aerodynamic forces that powerfully stimulated blade oscillation.

A91-19150 Numerical investigation of supersonic inlet with realistic bleed and bypass systems. AKIRA FUJIMOTO, NOBUO NIWA, and KEISUKE SAWADA, AIAA Paper 91-0127 presented at the AIAA 29th Aerospace Sciences Meeting, Reno, NV, Jan. 7–10, 1991. 9 pp. 14 Refs.

A supersonic mixed-compression inlet was designed for Mach 2.5 and aerodynamically analyzed using CFD approach. Its ramp bleed and throat bypass systems were simulated in order to examine the physical nature of a flow around the systems. From the calculation, two types of 'unstart' were predicted. One is a shock/boundary-layer interaction induced 'unstart'. The other is usual 'unstart' due to failure of pressure balance. The boundary-layer control bleed was found to play an important role for avoiding the former 'unstart'. For avoiding or delaying the latter 'unstart', a throat bypass system plays an important role. The shock capturing and stabilizing effect by the throat bypass was also confirmed numerically. Furthermore, the mechanism of improving pressure recovery ahead of an inlet 'unstrat' was examined in detail. As a result, the role of a throat gap, or a slot, was revealed quantitatively for the first time. A streamline passing over the gap automatically constructs an optimum equivalent wall boundary in accordance with the flow conditions around the system. This noteworthy result could be obtained by the great advantage of the CFD approach.

A91-14451 Conceptual study of space plane powered by hypersonic airbreathing propulsion system. MASATAKA MAITA, YOSHIAKI OHKAMI, TATSUO YAMANAKA, and TAKASHIGE MORI, AIAA Paper 90-5225 presented at the AIAA 2nd International Aerospace Planes Conference, Orlando, FL, Oct. 29–31, 1990. 10 pp. 6 Refs.

The paper describes the investigations of aerospace plane concept, conducted by the National Aerospace Laboratory (NAL) of Japan, with particular attention given to a concept which integrates a scram/liquid air cycle engine (LACE) hypersonic propulsion system fueling with slush hydrogen. The key requirements in achieving the space plane using scram/LACE propulsion system are described along with the mission requirements and the vehicle characteristics. Typical outputs of SSTO analysis are presented.

A90-42017 Some governing parameters of plasma torch igniter/flameholder in a scramjet combustor. G. MASUYA, K. KUDOU, A. MURAKAMI, T. KOMURO, K. TANI et al., AIAA Paper 90-2098 presented at the AIAA, SAE, ASME, and ASEE 26th Joint Propulsion Conference, Orlando, FL, July 16–18, 1990. 9 pp. 14 Refs.

Effects of various operational parameters of plasma torch igniters/flameholders were experimentally studied in a hydrogen-fueled supersonic combustor with a rectangular cross-section. The stagnation temperature of the airstream at the ignition limit almost linearly decreased as input electric power increased, while it did not significantly change with the flow rate of feedstock. The effectiveness of the argon plasma torch igniter was remarkably improved by adding small fraction of hydrogen, but it showed rather modest improvement for further increase of the hydrogen contents. Modification of the combustor top wall design led to successful ignition of fuel jets injected from opposing side walls by a single plasma torch igniter and great reduction of airstream temperature at the ignition limit.

A90-40612 A numerical investigation of supersonic inlet using implicit TVD scheme. JUNJI SHIGEMATSU, KAZUOMI YAMAMOTO, KAZUO SHIRAISHI, and ATSUSHIGE TANAKA, AIAA Paper 90-2135 presented at the AIAA, SAE, ASME, and ASEE 26th Joint Propulsion Conference, Orlando, FL, July 16–18, 1990. 10 pp. 11 Refs.

The compressible Navier-Stokes equations were solved to investigate supersonic inlet flowfield. In two-dimensional analysis, the mass flowplug which control the back pressure was modeled numerically for close modeling of experimental case. The three-dimensional computation was done to predict three-dimensional flow behavior such as corner vortex and interaction between oblique shock wave and side wall turbulent boundary layer. The two-dimensional numerical analysis could predict the complicated flowfield on various mass flowplug condition respectively. The results by three-dimensional computation could show the viscous effects caused by the interaction between ramp oblique shock wave and the side wall turbulent boundary layer. The computations were compared with the experimental results of wind tunnel test. The numerical solutions were successfully agreed with the experimental results.

A91-31402 Numerical computation of internal flows for supersonic inlet. SHIN-ICHI KURODA and KOZO FUJII, *Ishikawajima-Harima Engineering Review* (ISSN 0578-7904), Vol. 30, Nov. 1990, pp. 456–462. 16 Refs.

Supersonic inlet is one of the important components for realizing the supersonic/hypersonic air-breathing engines. In this paper, numerical simulations of the flow around and inside the inlet are performed by solving the two-dimensional thin-layer Navier-Stokes equations. Roe's upwind scheme with the higher-order extension by MUSCL interpolation is used on the righthand side and LU-ADI implicit time-integration algorithm on the lefthand side. The Fortified Navier-Stokes (FNS) approach is used to simulate supersonic inlet flow fields with mixed external-internal compressions in a single computational zone. The FNS has been conventionally used to enforce the proper solution in the appropriate flow region, but here it is used to introduce the wall-boundary condition into the computational domain. Computed results show good agreement with the experimental Schlieren photographs.