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A Low-Altitude Satellite Interaction Study

The problem:

To devise a theoretical technique for calculating the interaction effects of a high-speed spacecraft on the environment at altitudes from 90 to 150 km. The free-molecular theory and the ordinary continuum fluid theory do not give accurate results for bodies in the superthermal velocity region.

The solution:

Two computer programs: EXT, which determines the fluid field in the neighborhood of bodies of certain arbitrary geometries in the so-called transitional flow regime; and INT, which uses the output from EXT and measures the flow conditions inside the body cavity of a spacecraft.

How it's done:

The programs utilize a Monte Carlo approach, based on Bird's direct numerical simulation technique, to conduct numerical experiments with a model gas. In the external flow program EXT, a velocity sample is determined for both the free-stream and the interacted molecules. This velocity sample is in tabular form. A user-specified velocity range is defined by a number of equally-spaced velocity values. The table lists the velocity values along with the fractional number of colliding molecules which have velocities less than the tabulated values. The fractions of free-stream and interacted molecules are also printed out. This information is used as input for the internal flow program, INT. The input velocity sample is curve-fitted by a polynomial subroutine which is then used to generate

the velocity distributions of the molecules at the orifice opening of the cavity.

The output of both programs includes initialization and periodic flow field parameter printouts. INT output includes periodic cavity surface parameter printouts and twelve molecular velocity distributions produced from the velocity sample input data.

Notes:

1. This program is written in FORTRAN IV for use on the IBM-360 computer.
2. Subroutine REMTIM is a machine dependent subroutine and therefore is not included with the distributed versions of EXT and INT. The user of EXT and INT must provide his own version of this subroutine.
3. Requests for further information may be directed to:

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Patent status:

No patent action is contemplated by NASA.

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