

## APPLICATION OF THE METHOD OF PROBE PARTICLES TO THE AERODYNAMIC CALCULATION OF SPACECRAFT

*Institute of Technical Mechanics  
of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine  
15 Leshko-Popel St., Dnipro 49005, Ukraine; e-mail: office.itm@nas.gov.ua*

The aim of this paper is to overview the results of the work of the Institute of Technical Mechanics of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine on further development of the method of probe particles (MPP) and to present the software developed on its basis. The MPP fundamentals are briefly described. The works where the MPP algorithm was tested in one-, two-, and three-dimensional formulation are overviewed. The calculated gas-dynamic parameters (density, velocity, and temperature) in the vicinity of an obstacle, surface distributed heat fluxes, and drag coefficients were compared with their values found analytically, with the results calculated by other methods, and with the calculated and experimental data available in the literature. The testing of the method has shown its workability in different regimes of flow about a body.

The paper shows the spectrum of problems where the MPP is used and the functional capabilities of the software for the calculation of the aerodynamic characteristics of spacecraft and gas-dynamic process in their vicinity developed on its basis. Calculated results are presented for the flow about the third stage of the Cyclone-4 launch vehicle with an aerodynamic deorbiting system – a deployed sail braking system in the form of coaxial conical tori. The drag coefficient and the drag area calculated for different angles of attack are compared with their estimated values for a nonoriented spacecraft motion.

**Keywords:** *Monte-Carlo method, method of probe particles, numerical simulation, rarefied gas, 3D flow about a body, gas-dynamic parameters, aerodynamic characteristics.*

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