

## RE-ENTRY DYNAMICS OF UNCONTROLLED MARS PROBE

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Landing of the number of small probes on the surface of Mars is the great opportunity to explore his geology and atmosphere on big territory simultaneously. These probes should be simple enough to decrease the project expenses.

Therefore it looks reasonable to use uncontrolled ballistic descent during the probes' landing. But in this case it is necessary to understand well the re-entry dynamics and, in particular, the features of the probe's attitude motion.

Taking into account, we investigated the uncontrolled ballistic descent of probe with the special emphasis on its attitude dynamics. It was supposed that the mass distribution inside and the shape of the probe are axially symmetrical, the aerodynamic damping is negligible.

In general the probe's angular motion can be described as the regular precession with imposed oscillations (so called nutational oscillations). To specify the regular precession it is convenient to use the quantities  $(W, \Theta)$ , where  $W$  is the angular velocity of probe's axis of dynamic symmetry,  $\Theta$  is the angle between this axis and the velocity vector of the probe's mass center. One more motion parameter is the amplitude of the nutational oscillations  $c$ .

The influence of aerodynamic torque causes the evolution of the attitude motion parameters. To study this evolution we applied semianalytic approach, based on numeric integration of mass center motion equations and analytic treatment of the averaged attitude motion equations.

As an example we presented in Fig. 1 the deformation of the grid in the space of the regular precession parameters. This grid has regular structure at the initial moment of time and the shown complex structure at the moment of maximum of aerodynamic torque. The regions where an increase of amplitude of nutational oscillations takes place are shaded.

The developed semianalytic approach allows to accelerate substantially the studies of uncontrolled re-entry dynamics.

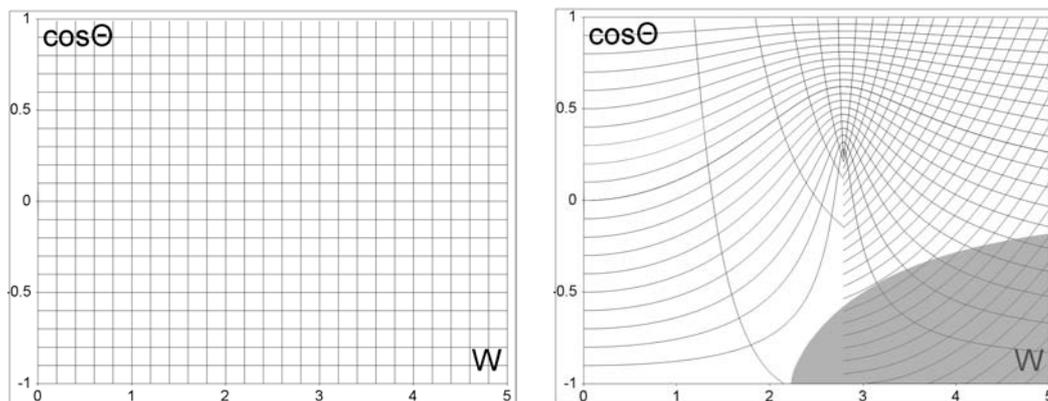


Fig. 1.