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RECOVERY OF A MICROGRAVITY ROCKET USING THE "FLAT-SPIN" PHENOMENA

Abstract

ILR-33 "Amber" is a two-stage, unguided sounding rocket designed to reach an apogee of over 100 km (Karman's line) with a 5 kg payload. It enables to perform microgravity experimentation for over 150 seconds. The payload compartment, with an on-board computer, is separated pyrotechnically from the non-recovered propulsion system (at this stage of the project the rocket motor is not to be reused). Three phases can be distinguished during recovery. The first one ("flat-spin"), occurring from the apogee to lower parts of the troposphere, is caused by relative change of the position of the center of gravity and the center of pressure after propulsion system separation. This allows decelerating the payload to the velocity of 70 $\frac{m}{s}$, thus enabling a safe drag parachute opening. Subsequently, the main parachute is opened at an altitude of 1 km. The paper contains analytical considerations of the so-called flat-spin phenomena, where the mathematical model is discussed. Results from numerous simulations are shown in the paper. Experimental drop-tests were performed to validate calculations and proper parachute recovery system operation-the model was dropped from a helicopter at altitudes of 3-4 km while the computer with IMU was registering all flight parameters. A comparison of experimental results and analytical calculations is also presented in this paper.