DYNAMICS OF LARGE DEPLOYABLE STRUCTURES

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1. Introduction

Since the middle of the 1970's the staff of M1 Department "Space Vehicles and Launchers" of the Bauman Moscow State Technical University (MSTU) have been investigating the mechanics of large structures in space. From that date, the requirement has arisen to create large high-precision radio-telescopes, communication antennae, solar energy concentrators, solar light reflectors, solar sails, extended cable systems, and multi-mass structures for a new generation of space stations.

New space structures have been developed by many organisations, such as the "Energia" Scientific-Industrial Association, the Institute of Space Research of the Russian Academy of Sciences, the "Salute" Design Office, the Drafting Department of the Moscow Power Engineering Institute, and the Lavochkin Scientific-Industrial Association. While working on feasibility studies for these new structures, many new non-traditional problems of space vehicle mechanics appeared. The M1 Department of the Bauman MSTU worked in co-operation with these institutions investigating these problems.

This paper reviews four large space structures whose mechanics were investigated by the Bauman MSTU. The four structures are a toroidal inflatable space antenna, a deployable communication antenna, a deployable solar light reflector and a deployable high-precision space radio telescope. The first three of these structures have already been tested in orbit.
2. Toroidal Inflatable Space Antenna

The investigation of the inflatable toroidal space antenna was carried out in the "Energia" Scientific-Industrial Association and the M1 Department of the Bauman MSTU. As well as developing models of the behaviour of the inflatable structure in space, they made an educational film demonstrating peculiarities of the deployment of the antenna.

A view of the fully deployed toroidal inflatable antenna is shown in Figure 1. The packaged antenna was launched in a Progress transport spacecraft. After the spacecraft had undocked from the Mir orbital station, covers to the container containing the packaged antenna were blown off. The outer toroid, made of an insulated fabric, was then gradually inflated to give a final internal pressure of 3 kPa. The process of the antenna opening was filmed from Mir.

During the development of the antenna, Bauman MSTU simulated a regular, ordered antenna deployment; it was expected that low frequency oscillations would accompany the deployment of the antenna. Bauman MSTU also developed a mathematical model of the fully deployed antenna, and used it to determine stiffness and damping characteristics.