



## Books & Reports

### ⊕ **Staggering Inflation To Stabilize Attitude of a Solar Sail**

A document presents computational-simulation studies of a concept for stabilizing the attitude of a spacecraft during deployment of such structures as a solar sail or other structures supported by inflatable booms. Specifically, the solar sail considered in this paper is a square sail with inflatable booms and attitude control vanes at the corners. The sail inflates from its stowed configuration into a square sail with four segments and four vanes at the tips. Basically, the concept is one of controlling the rates of inflation of the booms to utilize in mass-distribution properties to effect changes in the system's angular momentum.

More specifically, what was studied were the effects of staggering inflation of each boom by holding it at constant length for specified intervals between intervals of increasing length until full length is reached. The studies included sensitivity analyses of effects of variations in mass properties, boom lengths, rates of increase in boom length, initial rates of rotation of the spacecraft, and several asymmetries that could arise during deployment.

The studies led to the conclusion that the final attitude of the spacecraft could be modified by varying the parameters of staggered inflation. Computational studies also showed that by

feeding back attitude and attitude-rate measurements so that corrective action is taken during the deployment, the final attitude can be maintained very closely to the initial attitude, thus mitigating the attitude changes incurred during deployment and caused by modeling errors. Moreover, it was found that by optimizing the ratio between the holding and length-increasing intervals in deployment of a boom, one could cause deployment to track a desired deployment profile to place the entire spacecraft in a desired attitude at the end of deployment.

*This work was done by Marco Quadrelli and John West of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-42176*

### ⊕ **Bare Conductive Tether for Decelerating a Spacecraft**

A document describes a prototype of electrically conductive tethers to be used primarily to decelerate spacecraft and/or generate electric power for the spacecraft. Like prior such tethers, this tether is designed so that when it is deployed from a spacecraft in orbit, its motion across the terrestrial magnetic field induces an electric current. The Lorentz force on the current decelerates the spacecraft. Optionally, the current can be exploited to convert some orbital ki-

netic energy to electric energy for spacecraft systems. Whereas the conductive portions of prior such tethers are covered with electrical insulation except for end electrodes that make contact with the ionosphere, this tether includes a conductive portion that is insulated along part of its length but deliberately left bare along a substantial remaining portion of its length to make contact with the ionosphere. The conductive portions of the tether are made of coated thin aluminum wires wrapped around strong, lightweight aromatic polyamide braids. The main advantages of the present partly-bare-tether design over the prior all-insulated-tether design include greater resistance to degradation by the impact of monatomic oxygen at orbital altitude and speed and greater efficiency in collecting electrons from the ionosphere.

*This work was done by Les Johnson, Jason Vaughn, Ken Welzyn, and Judy Ballance of Marshall Space Flight Center; Joe Carroll of Tether Applications; Enrico Lorenzini and Bob Estes of the Smithsonian Astrophysical Observatory; Pete Schuler, Hamid "Bob" Mojazza, and John Lennhoff of Triton Systems; and Kai Shen Hwang of Computer Sciences Corp. Further information is contained in a TSP (see page 1).*

*This invention is owned by NASA, and a patent application has been filed. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at [sammy.a.nabors@nasa.gov](mailto:sammy.a.nabors@nasa.gov). Refer to MFS-31490-1.*