

16th IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)  
Conceptualizing Space Elevators and Tethered Satellites (3)

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MAINTAINING STABILITY OF THE MULTI-STAGE SPACE ELEVATOR

**Abstract**

Previous work has shown that it is possible to maintain the stability of a structure in the atmosphere that is supported by fast-travelling objects called bolts using magnetic levitation in evacuated tubes. This applies particularly in the presence of gusting cross winds and led to the proposal for High Stage One to relieve the tether of the challenges of dealing with Earth's turbulent atmosphere.

The multi-stage space elevator needs higher structures called stages. The first stage is at 100 km altitude, but higher stages are thousands of kilometres from Earth. These stages support parts of the tether to allow weaker materials to be used in its construction. In the atmosphere, a vertical form of High Stage One can use the same method of maintaining stability and support a platform at 100 km altitude. To support the higher stages while avoiding space debris, the bolts travel in streams in the vacuum of space.

One challenge for the streams of bolts in free space is to aim them so that they arrive at the correct position on the intended upper stage. To achieve this, ascending and descending streams are paired and a magnetic connection is established between them. This uses a similar mechanism to that proposed for High Stage One, albeit at a higher speed. The next challenge is to maintain stability. It is possible for a pair of streams to diverge unless steps are taken to prevent it. A method has been developed which uses quantities that are easy to calculate locally in each bolt using electronics that are readily available. It relies on integrals that are stable in the presence of moderate errors. The method is mathematically proven, and a simulation shows it working correctly.

By developing these techniques, we have the chance to build the space elevator using today's materials while taking advantage of any improvements that become available.