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Electrodynamic Tether at Jupiter. 1. Capture operation and constraints

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Tethered spacecraft (SC) missions are considered for the *Jovian* system, which suits electrodynamic-tether use because $i)$ characteristic magnetic stresses are 10^2 times greater than at *Earth*; *ii*) the Jovian stationary (circular, equatorial) orbit is 1/3 the relative distance for Earth; and *iii*) moon *Io*, at *Laplace* resonance with *Europa* and 10 times closer to *Jupiter* than the *Moon* is to Earth, is a giant plasma source. The (bare) tether is a reinforced aluminum tape with tens-of-kilometre length L and fraction-of-millimetre thickness h, which collects electrons as a giant *Langmuir* probe, allowing detailed design for both propulsion and power. This work presents the analysis of the SC capture-phase, which is critical because, once closed, orbits can substantially evolve under repeated Lorentz force. Design parameters L, h and capture-perijove radius face opposite criteria. Efficient capture requires low perijove and high $L^{3/2}$ / h ratio. Combined bounds on tether bowing and tensile-stress (arising from a tether spin made necessary by the low Jovian gravity-gradient) require a low $L^{5/2}$ / h ratio. Keeping tape temperature within bounds require a low $L^{3/8}$/(*emissivity*)$^{1/4}$ ratio. Also, bounds on both tether temperature and bowing/tensile-stress require a high perijove. Optimal design values, and both SC mass and power generated at capture, are discussed. The case for Saturn is also considered.