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Physics of Untied Rotating Space Elevators STEVEN KNUDSEN, KeyLogic Systems, Inc., LEONARDO GOLUBOVIC, West Virginia University — We explore fundamental aspects of the physics of a novel class of dynamical systems, Rotating Space Elevators (RSE) [L. Golubović and S. Knudsen, Europhys. Lett. 86, 34001 (2009); S. Knudsen and L. Golubović, Eur. Phys. J. Plus 129, 242 (2014)]. An RSE is a loopy string reaching deep into outer space. The floppy RSE loop executes a double rotating motion due to which the objects sliding along the RSE string (climbers) can be transported far away from the Earth's surface without using internal engines or propulsion. By extensive numerical simulations and analytic calculations, this study addresses an interesting and provocative question at the very heart of the RSE physics: What will happen if one *unties* the rotating space elevator from the Earth? We find that the untied RSE exhibits rich nonlinear dynamics. In particular, strikingly, we find that the untied RSE may still behave as if it were tied to the planet. Such a quasi-tied yet untied RSE remains close to the Earth and exhibits persistent shape and enduring double rotating motion. Moreover, the climbers sliding along such a quasi-tied RSE move in much the same way as they do along a tied RSE. Under some conditions however we find that the untied RSE may undergo an instability leading it to a dynamical state in which the RSE hops well above the Earth surface. By changing the untied RSE parameters, the maximum height reached during hopping may be made to diverge. Such an untied RSE unbinds from the Earth to infinity, i.e., to interplanetary space.

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