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Free-standing inflatable solar chimney: experiment and theory[1]
PETER VOROBIEFF, ANDREA MAMMOLI, NIMA FATHI, The University of New Mexico, VAKHTANG PUTKARADZE, The University of Alberta — Solar chimneys (or solar updraft towers) offer an attractive way to use solar energy for production of baseload power. In a power plant of this type, sunshine heats the air under a wide greenhouse-like roofed collector surrounding the central base of a tall chimney. The heated air drives an updraft flow through the tower, whose energy is harvested with turbines. For a sufficiently large plant of this type, the thermal mass of the heated ground under the collector is sufficient to drive the flow even when the sun is down. The primary challenge in building the solar chimney power plant is the construction of the chimney that generates the updraft, which must be very tall (hundreds of meters for a commercial-sized plant). Here we present a study of an inflatable chimney which is a self-supporting, deformable, free-standing stack of gas-filled tori. The structure is stabilized via a combination of shape, overpressure, and buoyancy. Theoretical considerations suggest that filling the tori with air rather than with a light gas may be advantageous for stability. The chimney shape is optimized for deformation under wind loading. A prototype chimney has demonstrated the viability of the concept, with experimental results in good agreement with theoretical predictions.

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