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Jet-Induced Granular 2-D Crater Formation with Horizontal Symmetry Breaking[1] ABE CLARK, ROBERT BEHRINGER, Duke Physics — We investigate the formation of a crater in a 2-D bed of granular material by a jet of impinging gas, motivated by the problem of a retrograde rocket landing on a planetary surface. As the strength and height of the jet are varied, the crater is characterized in terms of depth and shape as it evolves, as well as by the horizontal position of the bottom of the crater. The crater tends to grow logarithmically in time, a result which is common in related experiments. We also observe an unexpected horizontal symmetry breaking at certain well-defined conditions. We present data on the evolution of these asymmetric states and attempt to give insights into the mechanism behind the symmetry-breaking bifurcation. This horizontal symmetry breaking is highly suggestive of a pitchfork bifurcation, and we give evidence to classify it as forward or backward in different regimes of operation. As we will demonstrate, the formation of an asymmetric crater could be of considerable practical concern for lunar or planetary landers, particularly in the case of a backward pitchfork bifurcation, which is characterized by hysteresis and very rapid transitions.

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