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Experimental study of the chaotic waterwheel GEORGE RUTHERFORD, AMY ERXLEBEN, EPAMINONDAS ROSA, JR., Illinois State University — The chaotic waterwheel is often given as an example of a mechanical system that can exhibit chaotic behavior. Its early demonstration by Malkus and the realization that it can be modeled by the Lorenz equations has secured it a prominent place in almost every general presentation of chaos. It seems quite surprising, then, that no experimental investigations of this textbook system have ever been published. To fill this historic gap, and to initiate an experimental study of this incredibly rich dynamic system, our lab has constructed a research-grade waterwheel consisting of a vacuum-formed polycarbonate frame in which 36 cylindrical cells are mounted on an 18 inch diameter. The wheel and its axis can be tilted, and water is fed into the top of the wheel and drains out through thin tubes at the bottom of each cell. An aluminum skirt at the wheel's periphery passes through a variable gap magnet to provide magnetic braking. Angular time series data are collected with an absolute rotary encoder. The data are smoothed and angular velocity and acceleration are calculated via fast fourier transforms. The data show quasi-uniform rotation as well as periodic and chaotic motion and agree fairly well with computer simulations of the idealized wheel equations. We will discuss differences between the experimental data and the simulation predictions as well as plans for future studies.

George Rutherford
Illinois State University

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