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Mode transitions in strings with an abrupt change in mass density

TYLER ALLEN, NATHANIEL WELLS, BONNIE ANDERSEN, Utah Valley University — Previous research with bottle-shaped thermoacoustic prime movers has revealed hysteresis with transitions to higher modes as the cavity length is varied. A string with an abrupt change in mass density was studied to investigate potentially similar behavior. Three base guitar strings were studied at three different tensions with weights of 25, 30, and 35 lbs. Each string consisted of a “thin side” that was stripped to the stainless steel core and a “thick side” with an outer wrapping of nickel around the core. The strings studied had diameters of 0.65, 0.45, and 0.50 mm on the thin side and 2.14, 1.31, and 1.24 mm on the thick side, respectively. An anchor was attached on one end of a short board with a pulley at the other for hanging the weight. The end of the thick side of the string was attached to the anchor, and the string was guided over the pulley, with the change in mass density occurring approximately 12 cm from the pulley. Measurements were taken after placing a glass jar under the thick end of the string, between 42 cm and the position of the change in mass density, in 3-cm steps. The string was plucked and the dominant frequency was recorded with a microphone at each location. Frequency data is generally consistent with a solution to a 1D wave equation. Preliminary results indicate mode transitions occurring for all strings, with several hysteresis region candidates.

Bonnie Andersen
Utah Valley University

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