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Nonlinear stability of periodic waves in the Benjamin-Ono equation

We construct the Lyapunov functional for the periodic waves of the Benjamin–Ono equation based on the conservation of momentum, energy, and a higher-order energy, which exists due to integrability. Positivity of the second variation of the Lyapunov functional for perturbations in Sobolev space $H^1(\mathbb{R})$ is established by utilizing the basis properties of eigenfunctions of the linearized Benjamin–Ono equation in $L^2(\mathbb{R})$. Coercivity of the Lyapunov functional for co-periodic and multiple-periodic perturbations yields the nonlinear orbital stability of the periodic waves in the periodic domain.