Summary: The aim of the present study is to investigate the linear and nonlinear wave dynamics of a falling incompressible viscous fluid when the fluid undergoes an effect of odd viscosity. In fact, such an effect arises in classical fluids when the time-reversal symmetry is broken. The motivation to study this dynamics was raised by recent studies (Ganeshan & Abanov, Phys. Rev. Fluids, vol. 2, 2017, p. 094101; Kirkinis & Andreev, J. Fluid Mech., vol. 878, 2019, pp. 169-189) where the odd viscosity coefficient suppresses thermocapillary instability. Here, we explore the linear surface wave and shear wave dynamics for the isothermal case by solving the Orr-Sommerfeld eigenvalue problem numerically with the aid of the Chebyshev spectral collocation method. It is found that surface and shear instabilities can be weakened by the odd viscosity coefficient. Furthermore, the growth rate of the wavepacket corresponding to the linear spatio-temporal response is reduced as long as the odd viscosity coefficient increases. In addition, a coupled system of a two-equation model is derived in terms of the fluid layer thickness $h(x,t)$ and the flow rate $q(x,t)$. The nonlinear travelling wave solution of the two-equation model reveals the attenuation of maximum amplitude and speed in the presence of an odd viscosity coefficient, which ensures the delay of transition from the primary parallel flow with a flat surface to secondary flow generated through the nonlinear wave interactions. This physical phenomenon is further corroborated by performing a nonlinear spatio-temporal simulation when a harmonic forcing is applied at the inlet.

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