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The Physics of Turbulence Generation in a Fluid: Numerical Investigation Using a 1D Damped-MNLS Equation

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Abstract : This study investigates the generation of turbulence in a deep-fluid environment using a damped 1D-modified nonlinear Schrödinger equation model. The well-known damped modified nonlinear Schrödinger equation (d-MNLS) is solved using numerical methods. Artificial damping is added to the MNLS equation, and turbulence generation is investigated through a numerical simulation. The numerical simulation employs a finite difference method for temporal evolution and a pseudo-spectral approach to characterize spatial patterns. The results reveal a recurring periodic pattern in both space and time when the nonlinear Schrödinger equation is considered. Additionally, the study shows that the modified nonlinear Schrödinger equation disrupts the localization of structure and the recurrence of the Fermi-Pasta-Ulam (FPU) phenomenon. The energy spectrum exhibits a power-law behavior, closely following Kolmogorov's spectra steeper than $k^{-5/3}$ in the inertial sub-range.

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