

Numerical Simulation of Obstacle-Induced Solitons in Strongly Coupled Plasmas

Nonlinear wave structures (solitons) in strongly coupled Plasmas arise from the interplay of dispersion, nonlinearity, screening, and interparticle correlations [1-3]. Depending on the Mach number, a moving or localized source can excite upstream precursor solitons or pinned solitons that remain locked to the source [4]. In this study, precursor and pinned solitons are first analyzed within the Quasi-Localized Charge Approximation (QLCA) framework, which provides useful insights but exhibits limitations when applied across broad ranges of the coupling parameter Γ and screening parameter κ . To overcome these restrictions, we develop a unified fluid framework [2] with a realistic equation of state and a forced Korteweg–de Vries formulation, enabling a consistent description over an extended parametric space [3]. A central outcome is the identification of the boundary separating precursor and pinned soliton regimes in Yukawa systems. We demonstrate that this transition is governed primarily by screening, with only weak dependence on coupling strength. The theoretical predictions are validated using pseudo-spectral fluid simulations and molecular dynamics.

- (1) Sandip Dalui, Prince Kumar, and Devendra Sharma, *Physics of Plasma* (2025)
- (2) Prince Kumar, D. Chakraborty and Devendra Sharma, *Contribution to plasma physics*, (2025)
- (3) Prince Kumar and Devendra Sharma, *Journal of plasma physics* (2025)
- (4) P. Bandyopadhyay and A. Sen, *Reviews of Modern Plasma Physics* 6 (2022): 28

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