Effects of Collective Scattering in Langmuir Lattice Gas: Post-Soliton Structures and Shock-Wave Enhancement by Disorder

O. V. Kliushnychenko and S. P. Lukyanets

Institute of Physics, Kiev, Ukraine

kliushnychenko@iop.kiev.ua, lukyan@iop.kiev.ua

We show several specific effects of collectively induced scattering for a cloud or cluster of heavy impurities exposed to Langmuir-gas stream. We study formation of common density perturbation and shock waves generated by the collection of scatterers at a sudden stream activation [1]. First, we demonstrate that the scattering of gas stream can be essentially amplified, due to nonlinear collective effects, upon fragmentation of a solid obstacle into a cluster of impurities, i.e., for heterogeneously fractured obstacle. Secondly, a cluster of disordered impurities is shown to produce considerably stronger scattering accompanied by enhanced and accelerated shock wave, as compared to a regularly ordered cluster. In addition, we show that the final steady-state density distribution is formed as a residual perturbation left after the shock front passage, i.e., as a post-soliton structure. As a particular case, a kink-like steady distribution profile can be formed as a result of shock front stopping effect. Also, the possibility of the onset of solitary diffusive density-waves, reminiscent of avalanche or precursor-solitons, is shown.

Particular results concerning specific properties of the non-Newtonian wake-mediated interaction between impurities and its asymptotic behavior [2] are also presented and discussed.

1. Kliushnychenko O. V., Lukyanets S. P. Effects of collectively induced scattering of gas stream by impurity ensembles: Shock-wave enhancement and disorder-stimulated nonlinear screening. Phys. Rev. E, 2018, 98, 020101(R).
2. Kliushnychenko O. V., Lukyanets S. P. Effects of gas interparticle interaction on dissipative wake-mediated forces. Phys. Rev. E, 2017, 95, 012150.