Collective scattering of gas stream by impurity clusters: wake-mediated interaction, post-soliton structures and disorder-enhanced shock waves

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We show specific effects of collective scattering for a cloud of heavy impurities (a cluster) exposed to Langmuir-gas stream. Formation is presented of a common density perturbation and shock waves, both being generated collectively by a system of scatterers at sudden application of the stream-inducing external field. Our results demonstrate that (i) 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 (heterogeneously fractured obstacle); (ii) a cluster of disordered impurities can produce considerably stronger scattering accompanied by enhanced and accelerated shock wave, as compared to a regularly ordered cluster. We also show that the final steady-state density distribution is formed as a residual perturbation left after the shock front passage (a post-soliton structure). In particular, a kink-like steady distribution profile can be formed as a result of shock front stopping effect. The possibility of the onset of solitary diffusive density-waves, reminiscent of avalanche (or precursor-solitons), is shown. Specific properties of non-Newtonian induced dissipative interaction and its asymptotic behavior are discussed.

[1] O.V. Kliushnychenko, S.P. Lukyanets, Phys. Rev. E. **98**, 020101(R) (2018)

[2] O.V. Kliushnychenko, S.P. Lukyanets, Phys. Rev. E. **95**, 012150 (2017)