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Collective Dynamical Screening of Disordered Ensembles: Correlation Function, Local Force Fluctuations and Structure Factor

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We study the effects of nonequilibrium correlations and interactions between constituent particles of a bunch, arising under the scattering of particle stream on a cluster or finite cloud of impurities. These induced correlations and dynamical friction forces on impurities are manifested most pronouncedly in the case of collective dynamical screening effect and are enhanced in the case of a nonlinear medium when strong local fluctuations of scattered field begin to act as additional scattering elements due to the collective blockade effect near impurities. In addition, collective scattering effects depend on the degree of impurity cloud disorder. The description of the impurity cluster in terms of effective parameters breaks down due to the presence of strong fluctuations in the spatial distribution of scatterers, besides, quantities characterizing the cluster may lose self-averaging. The presence of strong fluctuations of the scattered field is shown to give rise to strong local fluctuations of nonequilibrium forces acting on certain particles within the impurity cluster that can be a precursor of dynamical instability of the cluster, which is manifested in the peculiar behavior of the tails of probability distribution function for the drag force. The form of appropriate correlation function relating the statistical properties of impurity cloud structure with local forces is discussed. This is to estimate dynamics of impurity cloud in time: stability of moving cluster, the role of local pairing (depletion forces), and possible nonlinear compression of the cluster as a whole.

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

[2] O.V. Kliushnichenko, S.P. Lukyanets, Phys. Rev. E **98**, 020101(R) (2018); arXiv: 2012.09266 (2020).

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