Gapped momentum states and critical dynamics of momentum transfer in condensed matter under intensive loading

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Critical dynamics and gapped momentum states (GMS) related to the initiation of collective modes of defects are considered as the mechanism of momentum transfer in condensed matter under extreme loading. Generation of collective modes of defects of different complexity was predicted by statistically based thermodynamics of ensembles of typical mesoscopic defects (microshears, microcracks) revealing special type of critical phenomena, the structural scaling transition. GMS are realized due to the excitation of the collective modes of defects (solitary waves and blow-up dissipative structures) with the nature of the self-similar solutions of the evolution equation for the order parameter of condensed matter with defects (defect induced strain). Above collective modes are localized on the set of spatial scales with characteristic temporal dynamics providing defects induced mechanisms of momentum transfer and dissipation. The localized spatial scales are related to the set of scales associated with GMS wave numbers. Critical dynamics of condensed mater under intensive loading and GMS are illustrated by original experimental data in shocked condensed matter (solid and liquid) under the study of self-similar steady shock wave fronts, failure wave dynamics, fragmentation dynamics. The work was carried out as part of a major scientific project funded by the Ministry of Science and Higher Education of the Russian Federation (Agreement No. 075-15-2024-535 dated 23 April 2024).