Gapped momentum states and mechanisms of dissipation and momentum transfer in condensed matter under intensive loads

Naimark O B[1,@], Razorenov S V[2] and Utkin A V[2]

[1] Institute of Continuous Media Mechanics of the Ural Branch of the Russian Academy of Sciences, Academician Korolev Street 1, Perm 614013, Russia

[2] Federal Research Center of Problems of Chemical Physics and Medicinal Chemistry of the Russian Academy of Sciences, Academician Semenov Avenue 1, Chernogolovka, Moscow Region 142432, Russia

[@] naimark@icmm.ru

Gapped momentum states (GMS) are related to dissipation and momentum transfer in out-of-eqiulibrium systems. GMS experiments have shown the existence of propagating shear waves at low frequency providing the k-gap. The existence of specific type of criticality, structural-scaling transition in condensed matter with defects allowed the interpretation of different GMS due to the generation of collective modes of defects (breathers, solitary waves, blow-up dissipative structures). These collective modes have specific spatial-temporal dynamics responsible for critical momentum cutoff and subordination of condensed matter relaxation properties to dynamics of these modes. Qualitative change of relaxation properties and the mechanism of dissipation were supported by experiments in shocked liquid established power universality of shock wave front and viscosity limit that are characteristic of plastic wave fronts in metals. Other asymptotic limit corresponding to the strong coupled mesoscopic systems was studied in the experiment for shock wave loading of the fused quartz rod, when the failure wave was initiated with characteristic delay. The failure wave dynamics was explained as the resonance initiation of the consequent set of the blow-up collective modes in the microshear ensemble that provide qualitative new mechanisms of momentum transfer and dissipation. This research was supported by the Russian Science Foundation (project No. 21-79-30041, https://rscf.ru/en/project/21-79-30041/).