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Dynamics of compressional shocks in 2D dusty plasmas

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The propagation dynamics of compressional shocks in 2D dusty plasmas are investigated using MD simulations under various conditions. The shock Hugoniot curves of the relationship between the shock front speed and the mean particle speed after shocks are obtained, and analytically fit to parabolic expressions. Combining the obtained shock Hugoniot curves with the Rankine-Hugoniot jump relations, analytic expressions of pressure and energy after the shocks in 2D Yukawa systems are obtained [1], which are functions of the observable quantities, like the shock front speed or the mean particle speed or the specific volume. A universal relationship between the thermal and the drift velocities after shocks is discovered in 2D Yukawa systems [2], which can be explained from the equation of state (EOS) of 2D Yukawa liquids [3], and the obtained pressure from the Rankine-Hugoniot relation. Derived from the combination of the Rankine-Hugoniot relation around the shock front and the universal relationship [2] for the temperature in the postshock region, the temperature-pressure Hugoniot curves of compressional shocks in 2D Yukawa systems are found to be useful in the quantitative investigation of the shock-induced melting of dusty plasmas [4]. For the compressional conditions roughly corresponding to the melting point for the postshock region, it is found that the postshock region clearly exhibits the coexistence of the solid close to the compressional boundary and the liquid in the other part [5], from both the structural and dynamical diagnostics. The elastic-plastic transition of compressional shocks in a perfect 2D dusty plasma crystal is systematically studied using the theory of elasticity [6]. In additional, fast particles overtaking shock front are also quantitatively investigated [7] and compared to the dispersive shock wave theories.

References

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