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Jetting Instability Mechanisms of Particles from Explosive Dispersal

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The formation of post-detonation "particle" jets is widely observed in many problems associated with explosive dispersal of granular materials and liquids. Jets have been shown to form very early, however the mechanism controlling the number of jetting instabilities remains unresolved despite a number of active theories. Recent experiments involving cylindrical charges with a range of central explosive masses for dispersal of dry solid particles and pure liquid are used to formulate macroscopic numerical models for jet formation and growth. The number of jets is strongly related to the dominant perturbation during the shock interaction timescale that controls the initial fracturing of the particle bed and liquid bulk. Perturbations may originate at the interfaces between explosive, shock-dispersed media, and outer edge of the charge due to Richtmyer-Meshkov instabilities. The inner boundary controls the number of major structures, while the outer boundary may introduce additional overlapping structures and microjets that are overtaken by the major structures. In practice, each interface may feature a thin casing material that breaks up, thereby influencing or possibly dominating the instabilities. Hydrocode simulation is used to examine the role of each interface in conjunction with casing effects on the perturbation leading to jet initiation. The subsequent formation of coherent jet structures requires dense multiphase flow of particles and droplets that interact though inelastic collision, agglomeration, and turbulent interaction. Macroscopic multiphase flow simulation shows clustering of particles and merging of smaller instabilities with major jet structures. The methods are further applicable to particles premixed with explosive, which are known to form jets with only an external interface. Late-time dispersal is controlled by particle drag and evaporation of droplets. Numerical results for clustering and jetting evolution are compared with experiments. The work is extended to include interaction of particle and droplet jets with surrounding obstacles and associated combustion phenomena.