D'yakov–Kontorovich instability in expanding reactive shocks

Calvo-Rivera A[1], Velikovich A L[2] and Huete C[1,@]

[1] Universidad Carlos III de Madrid, Avenida Universidad 30, Leganés, Madrid 28911, Spain

[2] United States Naval Research Laboratory, 4555 Overlook Ave SW, Washington, District Columbia 20375, United States

[@] chuete@ing.uc3m.es

D'yakov–Kontorovich instability is the name of the instability that is associated with steady shock waves. Despite the extensive literature accumulated since the pioneering works in the 1950s, see [1] for a complete compendium and discussion, the stability of steady shocks is still an open question when realistic boundary conditions are accounted. The consideration of a supporting mechanism, which is indeed a necessary condition for shock steadiness, modifies the shock dynamics in this unstable range. The Noh problem is a suitable example to form steady expanding shocks. In this work, we extend the generalized Noh problem, both base-flow solution and linear stability analysis, to conditions with endothermic or exothermic transformations undergoing across the shock. The explicit dispersion relationship for the shock perturbation growth rate, provided for an arbitrary equation of state in [2], is computed for shocks involving energetic transformations. Within the spontaneous acoustic emission conditions found for a van der Waals gas [3], we find that cylindrical and spherical expanding shocks become literally unstable for sufficiently high mode numbers. Counter-intuitively, the effect of exothermicity or endothermicity across the shock is found to be stabilizing or destabilizing, respectively.

[1] Fortov V 2021 *Intense Shock Waves on Earth and in Space* (Springer International Publishing)

[2] Huete C, Velikovich A L, Martínez-Ruiz D and Calvo-Rivera A 2021 *J. Fluid Mech.* **927**

[3] Bates J W and Montgomery D C 2000 *Phys. Rev. Lett.* **84** 1180