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Dynamic rupture propagation and radiation along kinked faults

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Numerical simulation of earthquake source dynamics provides valuable insights for understanding the physics of the dynamic rupture propagation. In particular, high frequency radiation during earthquake rupture propagation, in relation with complex fault geometries and potential rupture velocity variations, is a problem of great importance for strong motion prediction. Data analysis, as well as kinematic inversions, have already pointed out potential links between super-shear rupture velocity transition and fault geometry, as in the case of Denali and Kocaeli earthquakes. Recent laboratory experiments of sub- and super-shear rupture propagation along kinked interfaces have also shed complementary lights on these phenomena.

We present here a numerical investigation, using a non smooth spectral element method, of the propagation, the seismic radiation and the energy balance including potential off-fault damage, along two-dimensional kinked faults. Rupture dynamics along a such geometrically complex structure is found to be quite different from that of plane faults. At kinks, strong high frequency radiation is found to occur, associated with static stress concentration that may induce local damage processes. Special care must be taken at the kink, where static elastic stress singularities may develop in relation with the well known elastic wedge paradox. We provide here discussions of this problem and of its numerical treatment in the frame of the variational formulation of non smooth spectral element methods. Extension to the problem of the interactions between free surface and rupture front dynamics and implications for strong motions and off-fault damage will be discussed in light of the numerical experiments.