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A mechanism of stick-slip fault sliding without friction rate dependence and supersonic wave propagation

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Stick-slip sliding is often observed at various scales and in particular in fault sliding and the accompanied seismic events. Stick-slip is conventionally associated with rate-dependent friction, in particular the intermittent change between static and kinetic friction. However the accumulation of elastic energy in the sliding plates on both sides of the fault can produce oscillations in the velocity of sliding even if the friction coefficient is constant. This manifests itself in terms of oscillations in the sliding velocity somewhat resembling the stick-slip movement. Furthermore, over long faults the sliding exhibits wave-like propagation. We present a model that shows that the zones of non-zero sliding velocities propagate along the fault with the velocity of p-wave. The mechanism of such fast wave propagation is the normal (tensile/compressive) stresses in the neighbouring elements (normal stresses on the planes normal to the fault surface). The strains associated with these stresses are controlled by the Young's modulus rather than shear modulus resulting in the p-wave velocity of propagation of the sliding zone. This manifests itself as a supersonic (with respect to the s-waves) propagation of an apparent shear rupture.