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On mode formation and transitions in self-sustained friction induced vibrations

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Abstract: Despite of intensive attempts to understand the dynamics of friction interface, many unanswered questions still persist. For instance, it remains unclear how the interaction between molecular structures of two bodies eventually triggers large scale acoustic modes producing the squeal effect. Although a large number of experimental and theoretical studies have been conducted in order to clarify physical conditions under which the system prefers acoustic wave radiation to heat generation, no satisfactory answer has been found yet. Note that the situation is complicated by the plurality of friction phenomena due to different material properties. It is known that qualitative features of the friction induced dynamics are very sensitive to variations of the adapted friction law. This makes reliable quantitative predictions hardly possible. However, formation of spatial-temporal wave shapes in the interacting layers and their transitions may appear to follow qualitatively universal scenarios. In the present work such scenarios are analyzed on relatively simple discrete models of mass-spring chains interacting with moving surfaces. Under different conditions imposed on physical parameters of conservative and non-conservative forces different mode formations can be observed. In the case of two degrees-of-freedom, nonlinear in-phase, antiphase, and local synchronous vibration modes, as well as transitions between them can be observed.

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