Pattern Interaction: Can We Generate Propulsion?

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Abstract
The propulsive effect generated by heated grooves has been studied using parallel horizontal plates with the upper plate free to move, while the lower plate is equipped with grooves and subjected to periodic heating. Two effects were found to contribute to the propulsion. The first effect relies on nonlinear thermal streaming, which occurs due to sinusoidal heating in a smooth channel. It is observed that this effect exists for all heating wavenumbers when sufficient heating intensity is applied. This effect is represented by pitchfork bifurcation and can cause the flow to move in either the positive or negative x-direction. The second effect relies on the thermal drift effect originating from the combination of heating and groove patterns. It is known that this effect can be modulated by changing the relative positions of the heating and groove patterns. We have only considered cases where the heating and grooves are represented by the same wavenumber. The thermal drift is maximized when the groove and heating peaks are a quarter of the wavelength away from each other and minimized when the peaks are at the same location or half a wavelength from each other. The direction of the flow can also be controlled by placing the heating wave to the right or left of the grooves. Both propulsion methods have the potential to drive flow with relatively minimal flow losses. The strength of propulsion can also be increased by increasing the heating amplitude or adding uniform heating.