Analysis and Applied Mathematics Seminar

Packing and locomotion with friction

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Abstract: We discuss two problems dealing with the motions of thin deformable bodies under frictional forces. In the first problem, elastic filaments are confined within slowly-shrinking circular boundaries. The filaments undergo deformations that are a mixture of spiraling and bifurcations, primarily the former with small friction and the latter with large friction. With zero friction, a simple model predicts that the maximum curvature and the total elastic energy scale as the wall radius to the -3/2 and -2 powers respectively. With nonzero friction, the elastic energy follows a similar scaling but with a prefactor up to 8 times larger, due to delayering and bending with a range of small curvatures. The second problem examines models of snakes as thin filaments that deform and locomote due to friction. We examine optimal motions of two-link, three-link, and smooth bodies with a variety of friction coefficients. With large friction transverse to the snake, the optimal motion is a retrograde traveling wave with amplitude scaling as the friction coefficient the -1/4 power. With zero transverse friction, a triangular direct wave is optimal. Between these extremes we find a variety of local optima including standing waves (or ratcheting motions).

Monday, January 24 at 4:00 PM in Zoom