The extraordinary circumstances of Lord Rayleigh: Can thin elastic sheets be always considered inextensible?

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Abstract

The two families of deformations for a thin elastic sheet are stretching and bending. The energy cost for those deformations is proportional to t for the stretching and proportional to $t3$ for the bending. Because t is small, it is reasonable to assume that a thin sheet might deform without stretching. This idea was already discussed by Lord Rayleigh in a paper from 1881 in which he states that, for a thin sheet "**under ordinary circumstances**, the deformation takes place [...] as if the sheet were **inextensible**". In this presentation, I will discuss some situations of *extra*ordinary circumstances (in the words of Rayleigh) in which thin sheets cannot be considered inextensible. I will notably show that, in those situations, nonlinear regimes play a central role in the appearance of stretching in thin plates.

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