Asymmetric Bending Boundary Layer

Nathan Vani*[1], Alejandro Ibarra[2], José Bico[3], Etienne Reyssat[3], and Benoit Roman[4]

[1]Physique et mécanique des milieux hétérogenes (UMR 7636) – Ecole Supérieure de Physique et de Chimie Industrielles de la Ville de Paris, Sorbonne Universite, Centre National de la Recherche Scientifique, Université Paris Cité – ESPCI, 7 Quai Saint Bernard 75005 Paris, France
[2]Experimental soft matter physics, University of Luxembourg – Luxembourg
[3]Laboratoire PMMH (CNRS - UMR 7636) – PMMH, CNRS, ESPCI Paris, Université PSL, Sorbonne Université, Université Paris Cité – France
[4]PMMH – ESPCI ParisTech – France

Abstract

We investigate the mechanics of two ribbons bound at one end and pulled apart at the other ends. We provide a thorough experimental and analytical characterization of the elastic junction and conceptualize it as a 'bending boundary layer'. The rotational stiffness of the structure exhibits a non-linear but universal behavior. The ratio of the bending stiffnesses fully prescribes its shape independently of the pulling force.
Remarkably, the angle of the bound end with the pulling force acts as a scale-free geometric marker of the bending stiffness. Our results thus challenge the standard assumption of neglecting bending stiffness of thin shells at large tensile loading. We furthermore highlight how this specific boundary layer appears in various areas of active research (*kirigamis*, inflatables, architected metamaterials) as well as in everyday objects (food packaging, double-sided tape, magazines).
Finally by exploiting the self-similar shape of the junction, we introduce the $\lambda-test, a novel method for characterizing the be$
$to-quantify material property.$

*Speaker