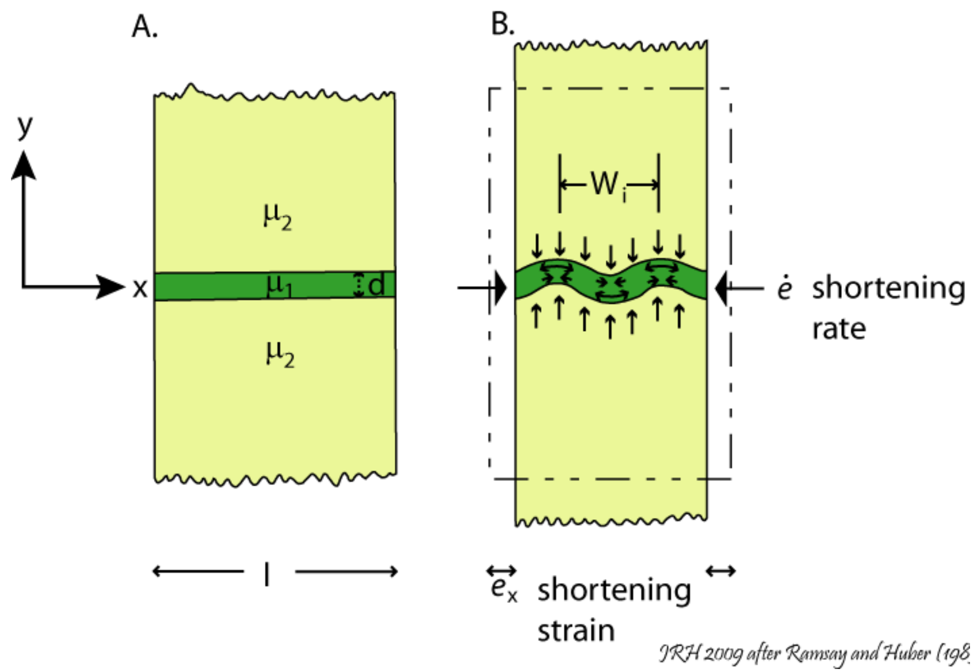
Mechanics of Single Layer Fold

Layer of thickness d and visocosity μ_1 embedded in infinitely thick matrix of viscosity μ_2

Shortening (e_x) and shortening rate (e-dot$_x$)that parallels to layering leads to formation of buckle folds with characteristic initial wavelength W_i



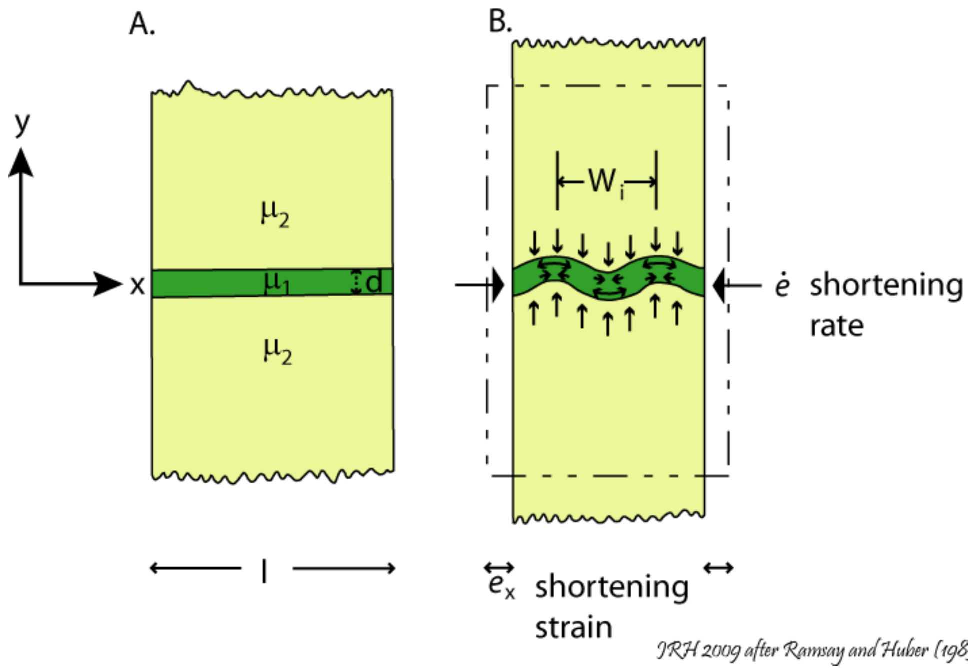
Mechanics of Single Layer Fold

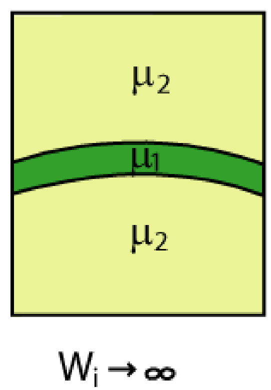
Simple assumption of Newtonian materials

Resistance to folding of layer exerted by matrix

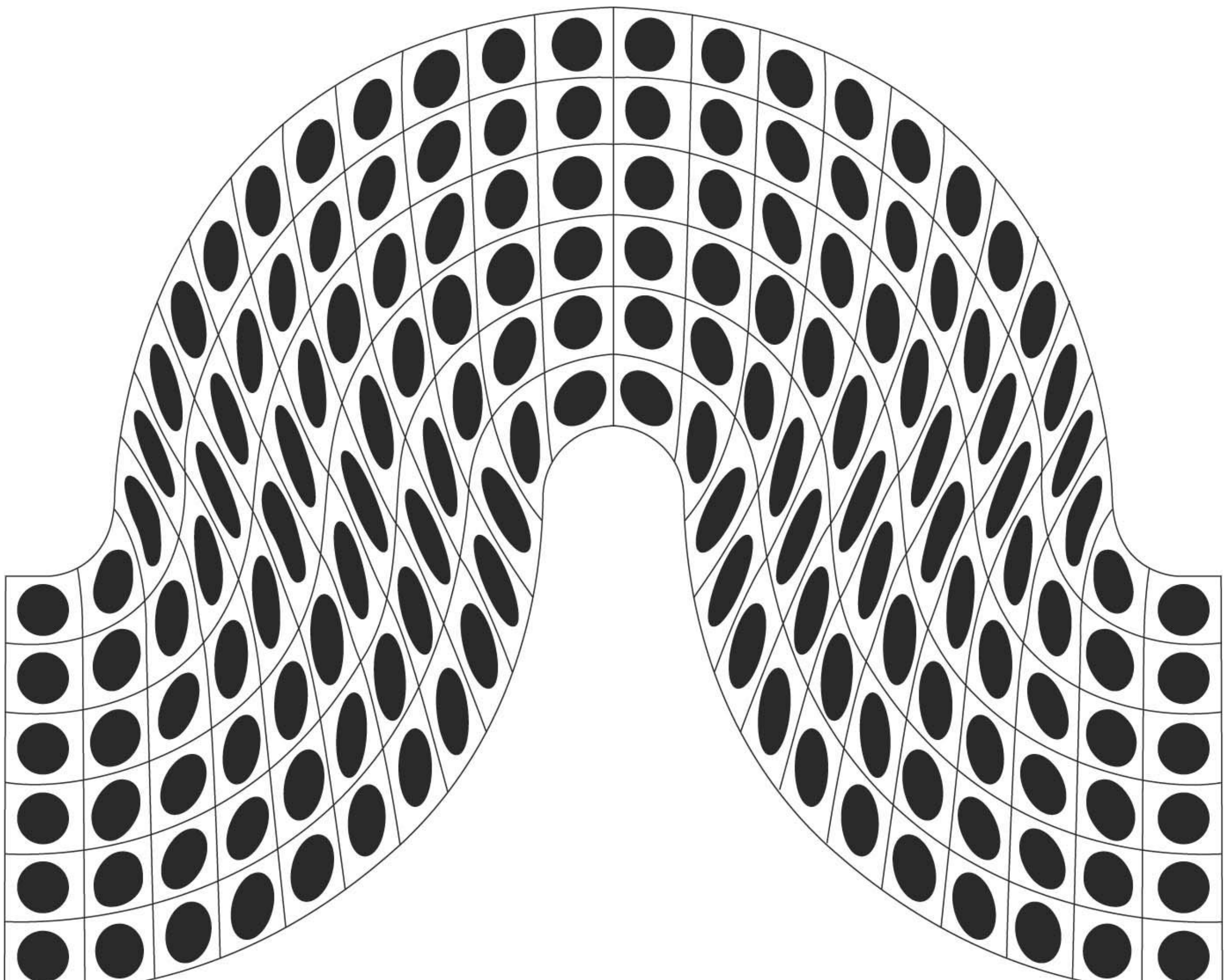
$F_{int} = (2\pi^2\mu_1 d^3 \text{e-dot}_x)/(3W_i^2 e_x)$

If matrix didn't exist to resist the sideways deflection of the folded layer, then the layer would form with the *largest* possible wavelength.

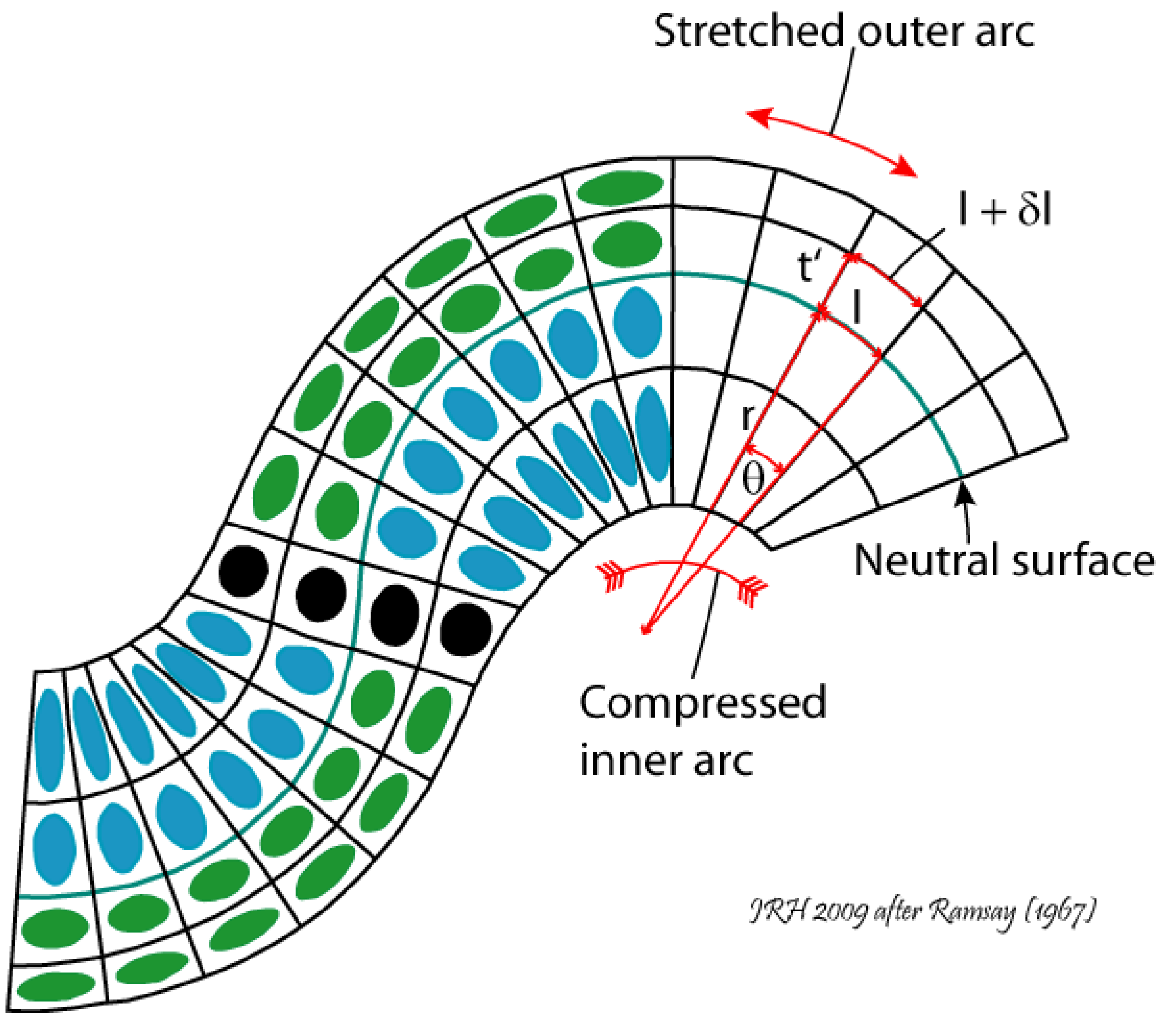




Characteristic strain pattern of flexural folds



Characteristic strain pattern of neutral-surface folding



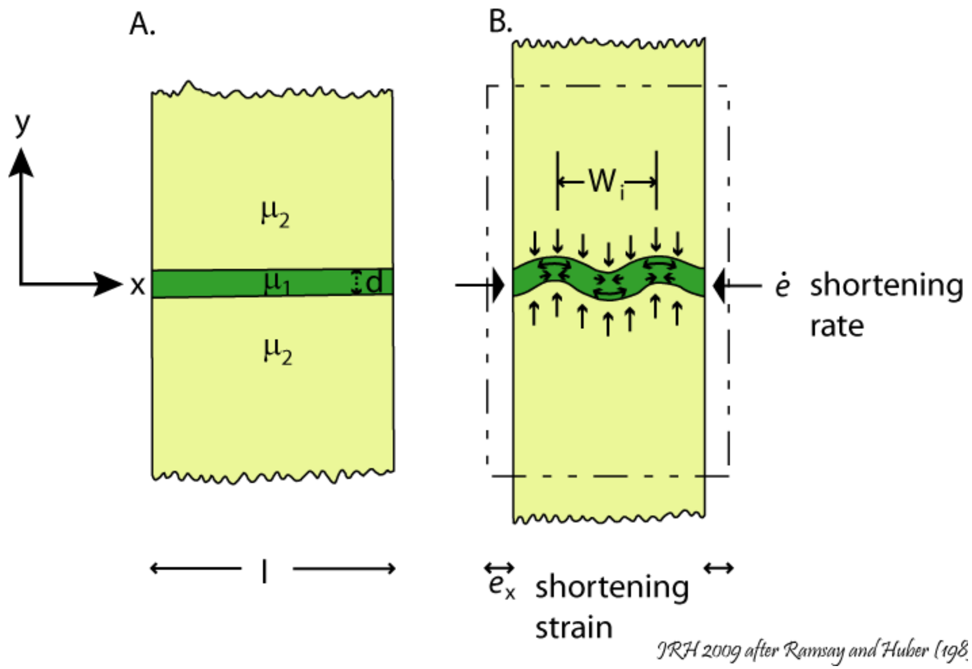
Mechanics of Single Layer Fold

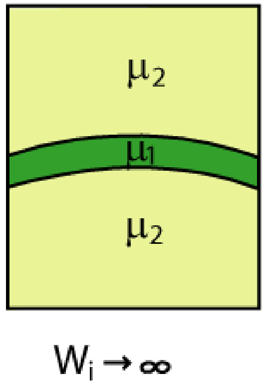
Simple assumption of Newtonian materials

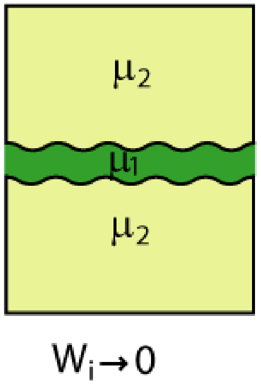
Resistance to folding of layer exerted by matrix

$F_{int} = (2\pi^2 \mu_1 d^3 \text{e-dot}_x)/(3W_i^2 e_x)$

If matrix didn't exist to resist the sideways deflection of the folded layer, then the layer would form with the *largest* possible wavelength. If matrix alone controlled the wavelength, then the layer would have a crenulated interface.







If you buckled a ruler, it only forms into a half-wavelength – not anything less.

Mechanics of Single Layer Fold

Simple assumption of Newtonian materials

Resistance to folding of layer exerted by matrix

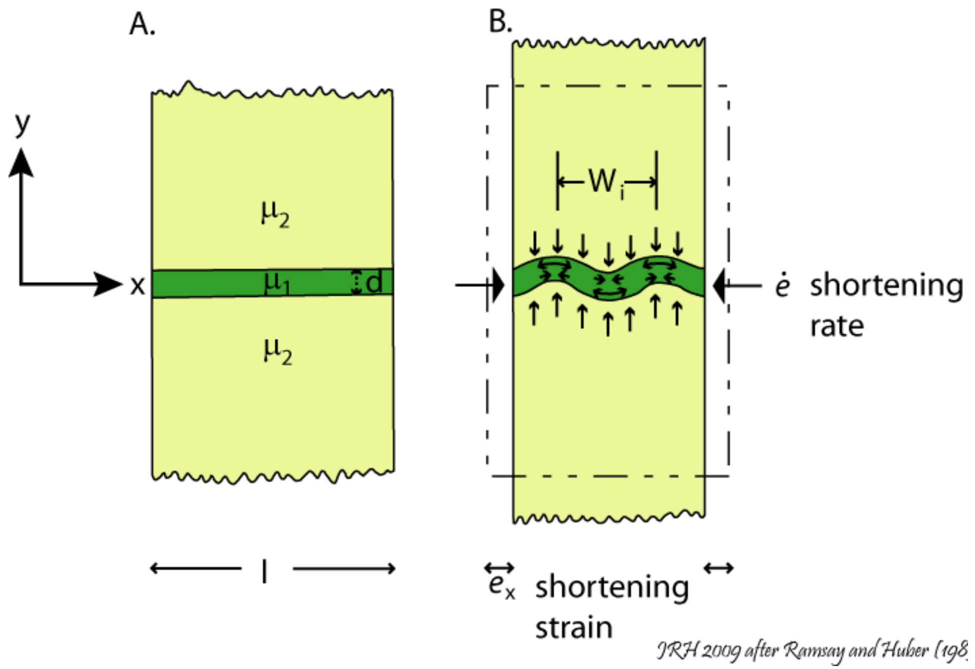
$F_{int} = (2\pi^2 \mu_1 d^3 \text{e-dot}_x)/(3W_i^2 e_x)$

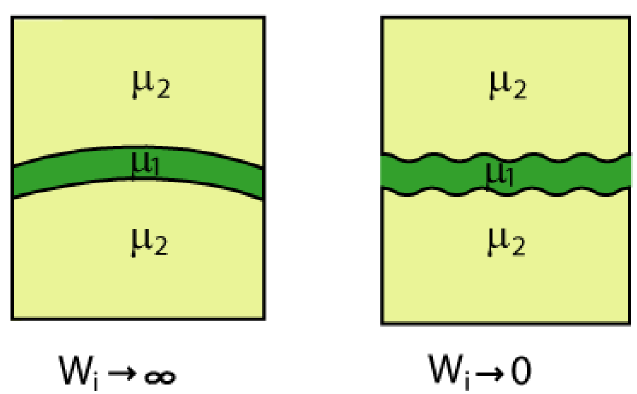
Resistance to folding of layer that arises within the matrix:

$F_{ext} = \mu_2 W_i \text{e-dot}_x / \pi e_x$

Relates to forces acting in the y-direction

Linear dependence of W_i for smallest possible wavelength (least energy)





Layer and matrix battle each other to determine the initial wavelength.

Figuring It Out

$F_{int} = (2\pi^2\mu_1 d^3 \text{e-dot}_x)/(3W_i^2 e_x)$

$F_{ext} = \mu_2 W_i \text{e-dot}_x/\pi e_x$

$$F_{tot} = F_{ext} + F_{int}$$

After simplifying the calculations, this equation results (Biot-Ramberg equation):

$$W_i = 2\pi d(\mu_1/6\mu_2)^{1/3}$$

Buckle fold relationships

- Biot-Ramberg equation
    - Arc length is proportional to thickness and the cube root of viscosity ratio.
    - Thus, thickness of dominant member determines the wavelength of a buckle fold at all scales.