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Nonlinear Plane strain elasticity and complex analysis.

When a specimen of non-trivial shape is deformed under dead load or active processes, the only technique for evaluating the deformations is numerical finite element simulation. Classic books describe complicated techniques for evaluating stresses and strains for semi-infinite and rectangular objects, including rings and cylinders (solid or hollow). However, the exact results are limited, and we know that elasticity (linear or nonlinear) is strongly intricated to geometry.
Sometimes, when the specimen retains its initial shape or symmetry, it is possible to determine exact deformations, essentially for low values of loading, and to prove that there is a threshold above which the specimen loses its stability. It s then possible to go a step further by applying perturbation techniques (linear and nonlinear bifurcationtheory). If we can explain wrinkles on top of semi-infinite samples, the next steps towards ridges, folds and cusps and creases, commonly observed in experiments remain a challenging.
In this talk, I will present how many aspects may be simplified or discovered by the use of complex analysis about the Biot instability and what we can obtain about more complex thin planar objects such as leaves , embryoic jellyfishes …

References
Wrinkles, creases and cusps in growing soft matter, Review of Modern Physics , in press, Mars 2025.

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