M2 Internship or/and PhD (2023-2024)

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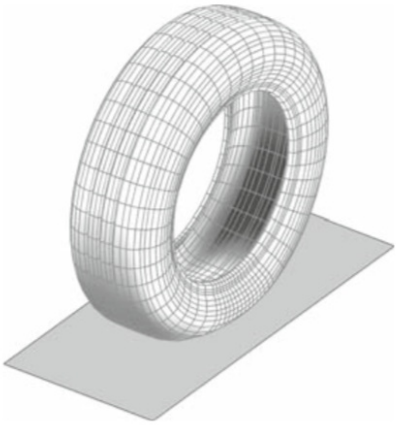
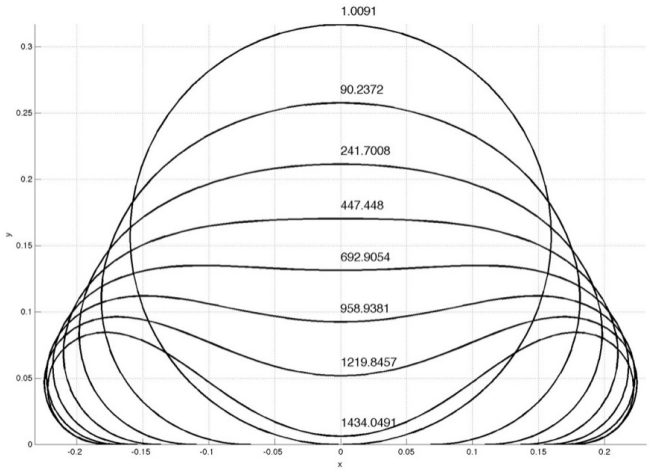
Rolling instabilities of elastic ribbons

Our team studies theoretically, numerically, and experimentally the statics and dynamics of elastic structures, and in the present project we want to focus on the dynamical instabilities of a rolling elastic body in interaction with a support in the presence of friction. The adhesion and friction interactions with the support are thought to induce a parametric loading on the structure and hence to be responsible for the loss of stability of the steady rolling solution. A first version of the modeling will be restricted to planar configurations, but 3D approaches involving torsion will then be developed.



FE model of radial tire
(Ziefle+Nackenhorst 2008)



Circular elastic beam bent under its own weight.

The project involves a mix of **theory** (buckling, bifurcation), **modeling** (variational formulation, dimensional reduction), and **numerics** (minimization under inequality constraints), but depending on the candidate background, some experiments could be carried out and a comparison between the two approaches would then be performed.

Numerical work includes either path following and shooting techniques, finite element modeling, or minimization and root solving, in Python, Mathematica, or C/C++.

These problems are also relevant to biological systems (such as the tank-treading instability of human red blood cells), microfluidic systems (where droplets experience periodic bouncing behavior on the channel boundary), or industrial applications (such as the standardized friction tests for rubber tires - Grosch-wheel model).

Rolling instability of a soft elastic wheel