Guided by curvature:
A theoretical model of cellular shape dynamics and motility, coupling curvature and activity

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How cells can control their shapes, and utilize these shape changes functionally, for example during migration, is an ongoing challenge in biology. We theoretically explore a mechanism whereby the membrane is deformed by curved membrane proteins that recruit cytoskeleton-based forces, such as the recruitment of actin polymerization to the membrane. Combining these two membrane deforming mechanisms, opens up the possibility for a variety of feedbacks. For example, convex proteins (protruding outwards) enhance their aggregation when recruiting protrusive forces (due to actin polymerization), and this coupling can induce strong pattern formation that spontaneously breaks the uniform state. The study of how membranes deform and evolve when driven by this curvature-activity coupling for unrestricted (large) deformations, has only just began. We have found that this system can explain the lamellipodia-driven spreading of adhering cells, and that it contains the minimal ingredients to exhibit spontaneous motility. Surprisingly, this minimal model can explain a variety of observed cellular dynamics, such as phagocytosis and how migrating cells move over curved surfaces. The simplicity of the model, with a small number of components, enables us to gain deep understanding and understand the physics driving biological phenomena.

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MPI-DS, Prandtl Lecture Hall
Am Fassberg 11, Göttingen, and
Zoom Meeting ID: 959 2774 3389
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