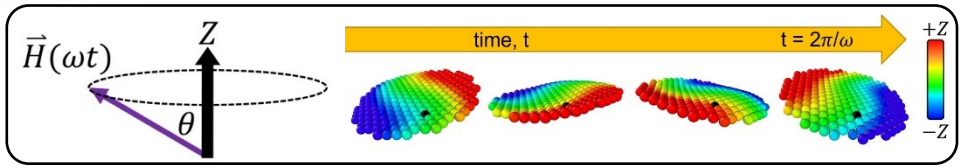
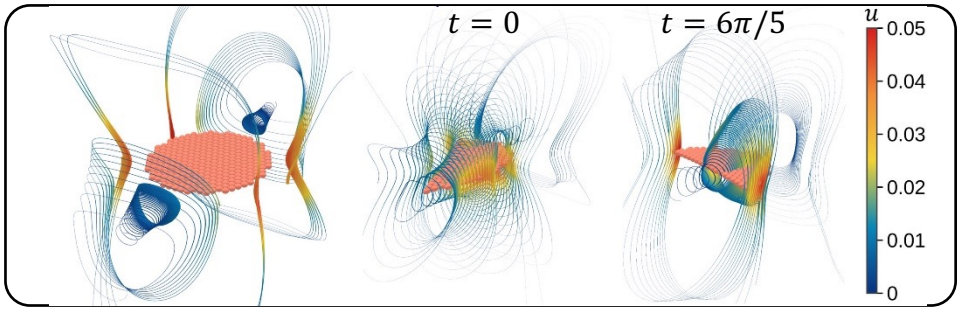
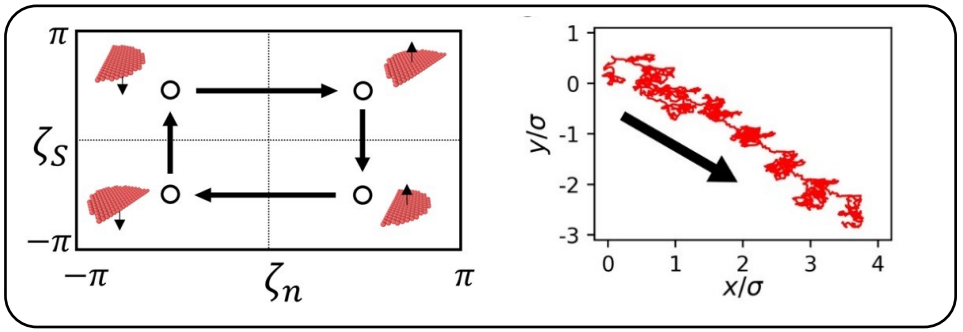
Elastic Sheet Swimming using Dynamic Magnetic Fields







Upper, left: Magnetic field $\vec{H}$ rotating around an axis.
Upper, right: Transverse waves propagating around the sheet with negligible sheet rotation (see black particle).
Middle: Uncut (left) and cut (middle, right) magnetic sheet causing fluid flow around the sheet, u.
Lower, left: Swimming is induced by manipulating the sheet to control the orientation of the cut (ζ_S) and face (ζ_n).
Lower, right: Lateral motion of sheet over time.

Scientific Achievement

Swimming of homogeneous 2D elastic sheets made from magnetic particles.

Significance and Impact

Understanding how to use a dynamic magnetic field and sheet symmetry to induce locomotion reduces the complexity of sheet synthesis and advances the design of autonomous, soft microrobots.

Research Details

- Above a critical rotation frequency for the magnetic field, traveling waves are produced around the magnetic sheet.
- Fluid flow caused by the motion of sheet with broken symmetry moves the sheet along a circular path.
- A sequence of nonreciprocal sheet motion will cause swimming along a predetermined path.
- The swimming velocity can be computed by accounting for the broken sheet symmetry.

CA Brisbois, and M Olvera de la Cruz. *Phys. Rev. Res.* **2022**, 4, 023166.

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Work was performed at Northwestern University.

CBES Center for Bio-Inspired Energy Science

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