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Three-dimensional rotational dynamics of superparamagnetic microrods MARC FERMIGIER, NAIS COQ, SANDRINE NGO, OLIVIA DU ROURE, DENIS BARTOLO, ESPCI ParisTech — We investigate experimentally and theoretically the dynamics of paramagnetic microrods tethered to a solid wall and driven by a precessing magnetic field. We identify two distinct regimes : at low driving frequencies, the response of the rod is synchronous whatever the inclination of the field. Above a characteristic frequency, two qualitatively different behaviors are distinguished, depending on the inclination θb. For small field inclinations, the response of the filament remains synchronous at all frequencies. Conversely, when the field inclination exceeds a critical value $\sim 55°$, the response becomes asynchronous, and the tip of the rod follows a complex trajectory exhibiting three-dimensional back-and-forth patterns. A minimal model, neglecting the flexibility of the rod and the hydrodynamic interaction with the wall, captures the main features of both regimes. We thus show that the complex trajectory patterns are chiefly due to the geometrical nonlinearities in the magnetic dipolar coupling. The critical angle is itself set by a purely geometrical criterium, arising from the superparamagnetic nature of the rod.

Marc Fermigier
ESPCI ParisTech

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