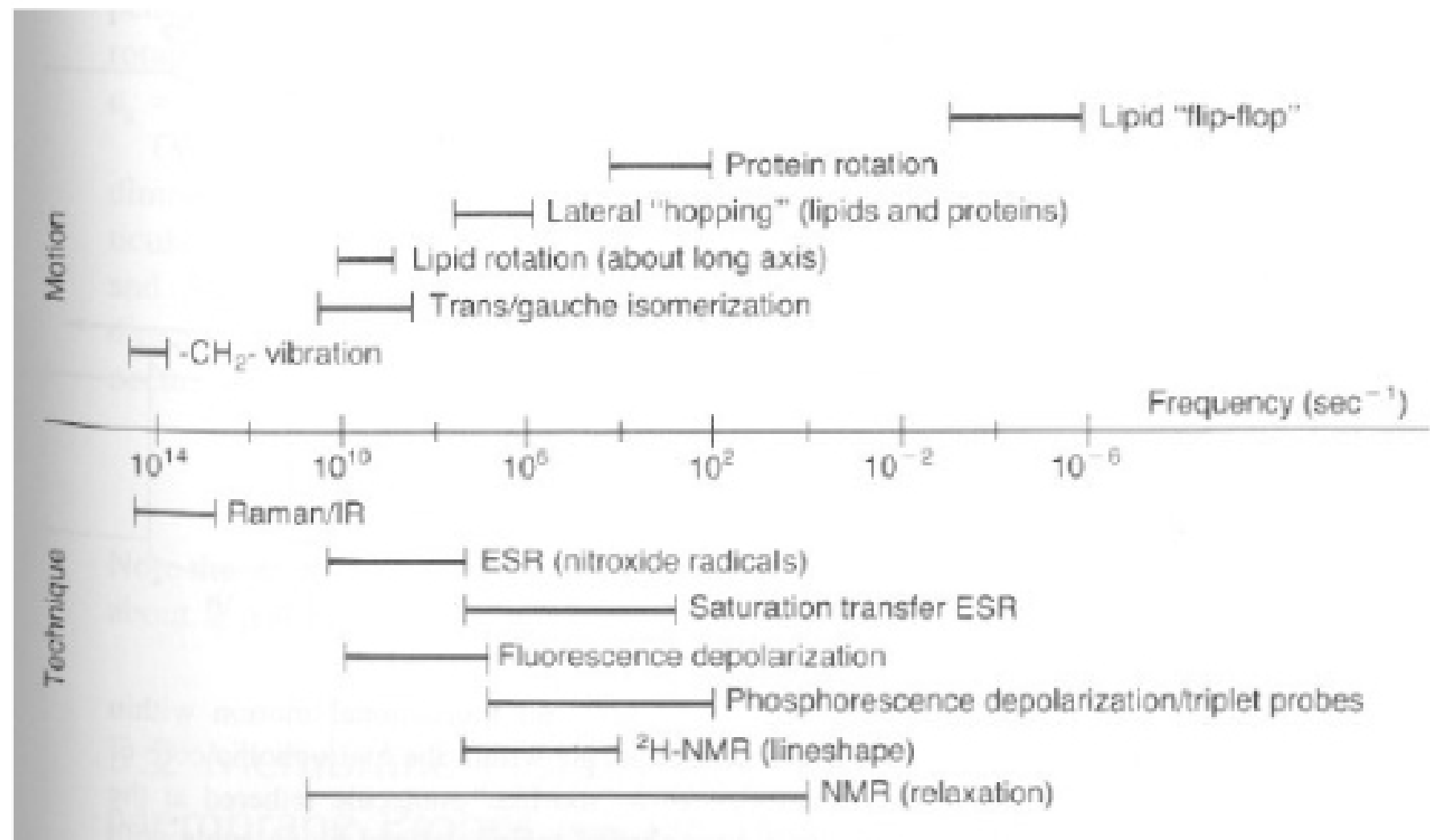
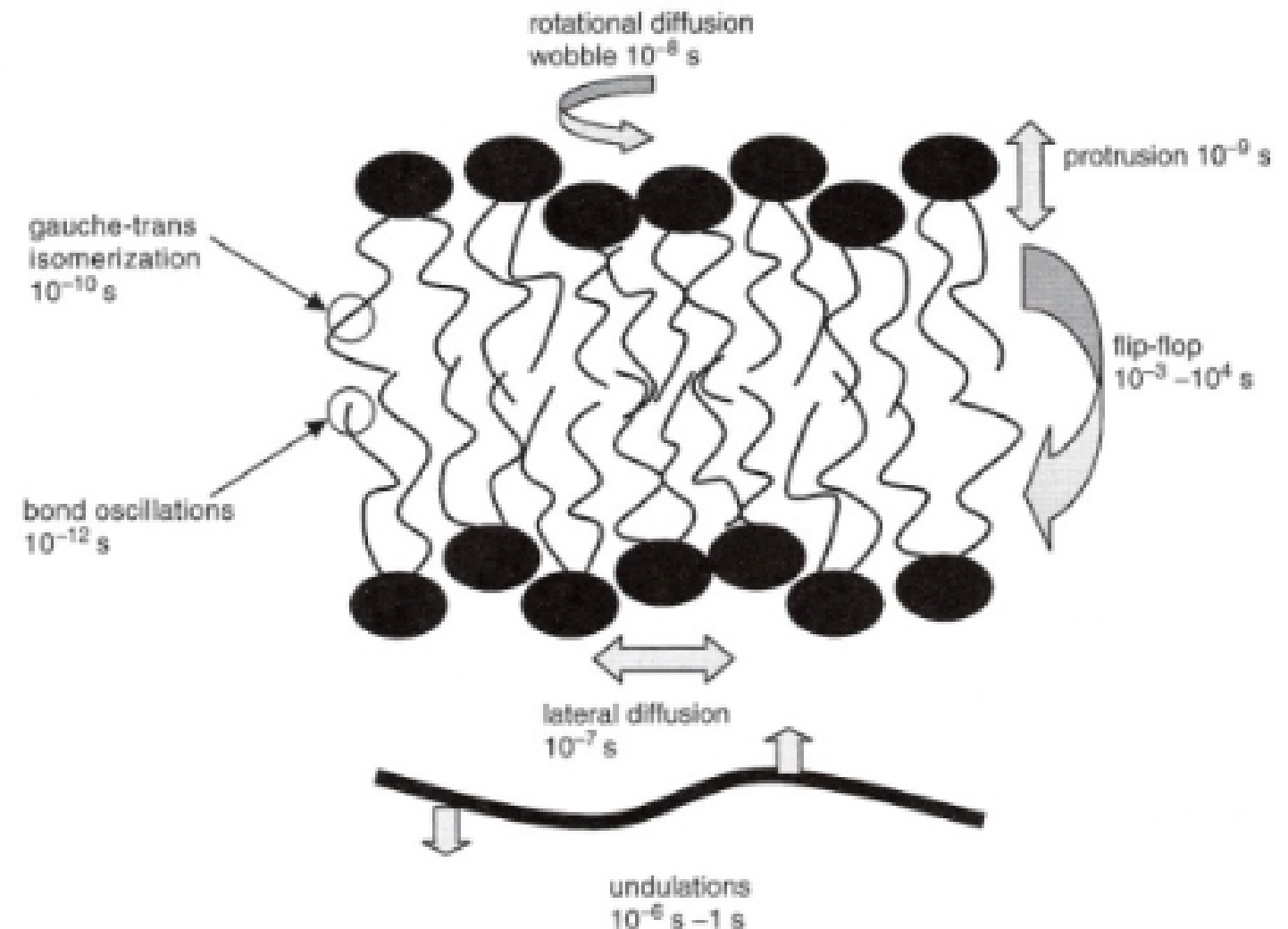
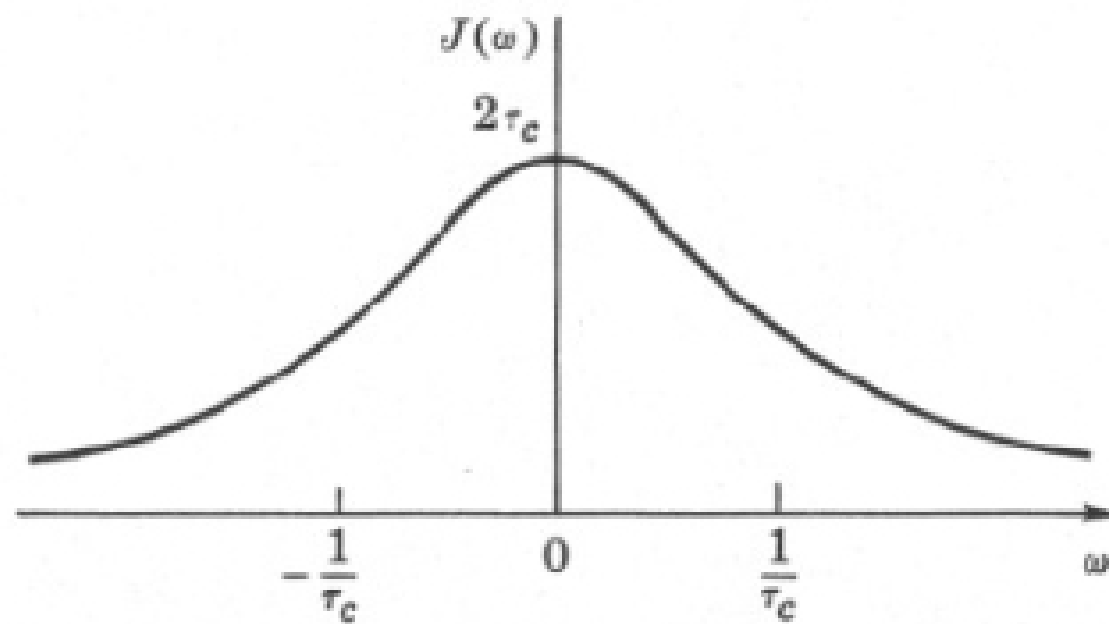
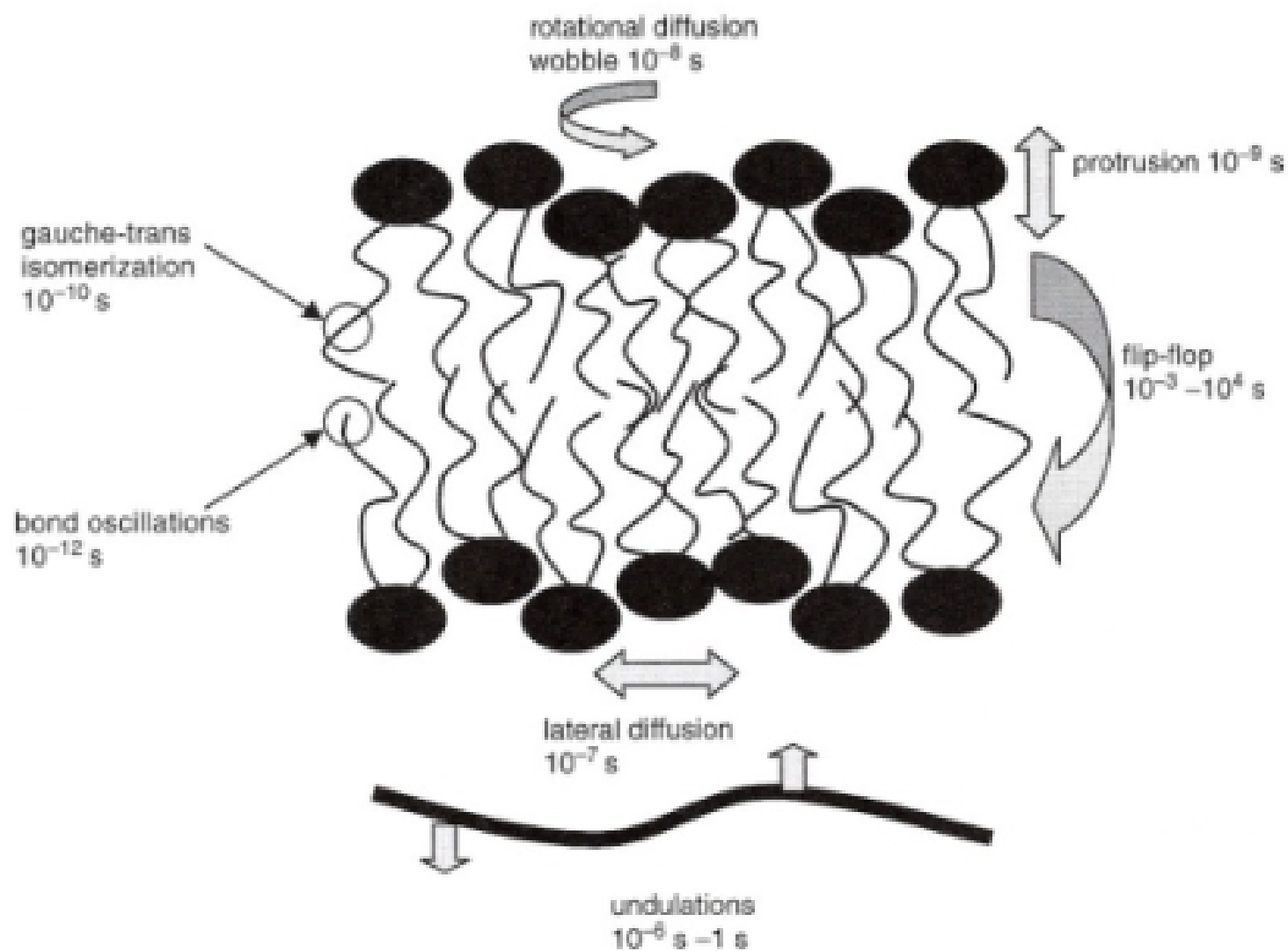


Lipid Dynamics: Motions, time scales and experimental methods



Relationship between frequency and correlation time

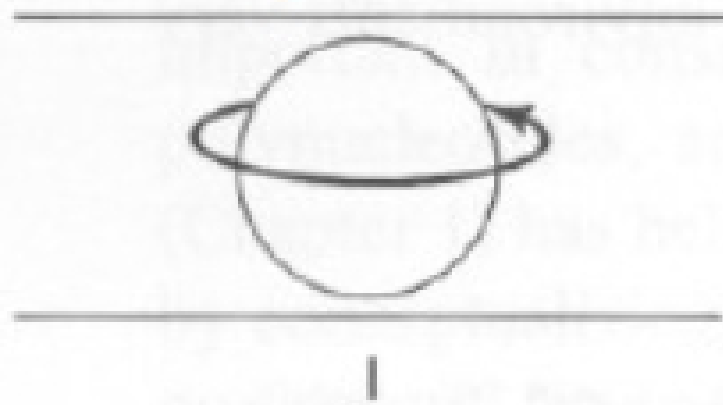




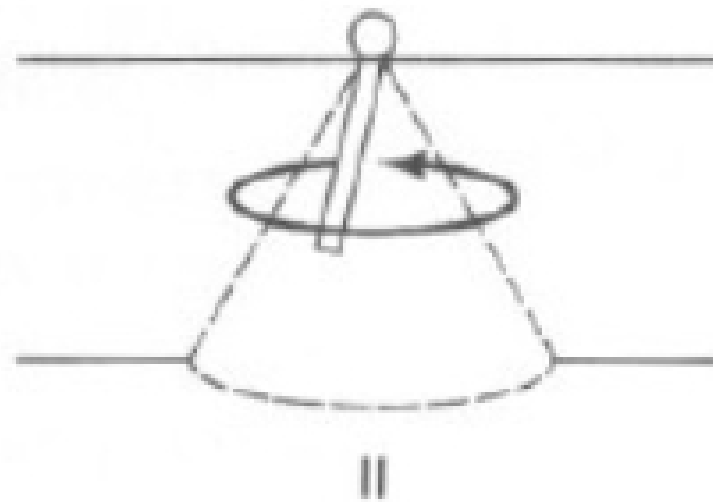
- Vibrations of bond length and bond torsional oscillations (subpicosecond range)
- Librational motions of bond orientation (picoseconds)
- Rotations about chemical bonds, *gauche/trans* isomerization (pico- to nanoseconds)
- Diffusional reorientation of lipid molecules about their long axis (nanoseconds)
- Wobble of lipids (nanoseconds)
- Lateral diffusion in the plane of the bilayer (nano- to microseconds for movement over a distance of 0.8 nm, the approximate lateral lattice spacing between two lipids)
- Undulatory motions of bilayer patches (microseconds to seconds)
- Flip-flop of lipids between the two monolayers of a bilayer (milliseconds to hours)

Models of Motion for lipids and proteins in bilayers

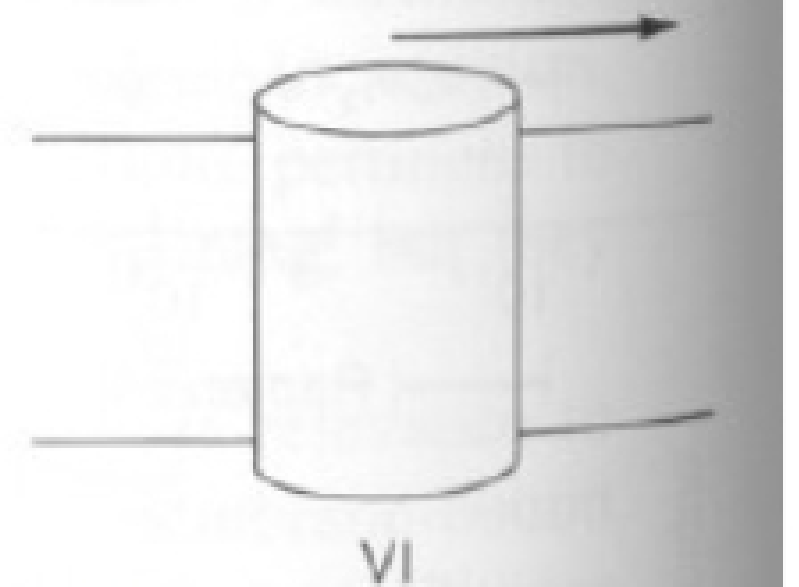
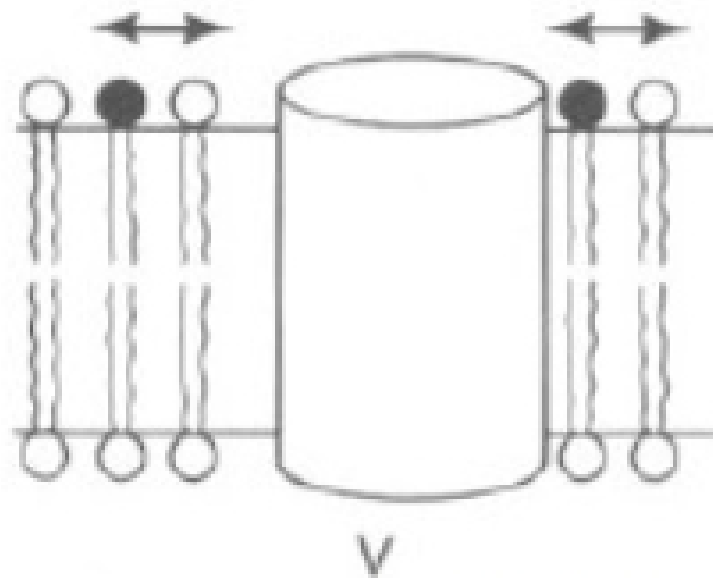
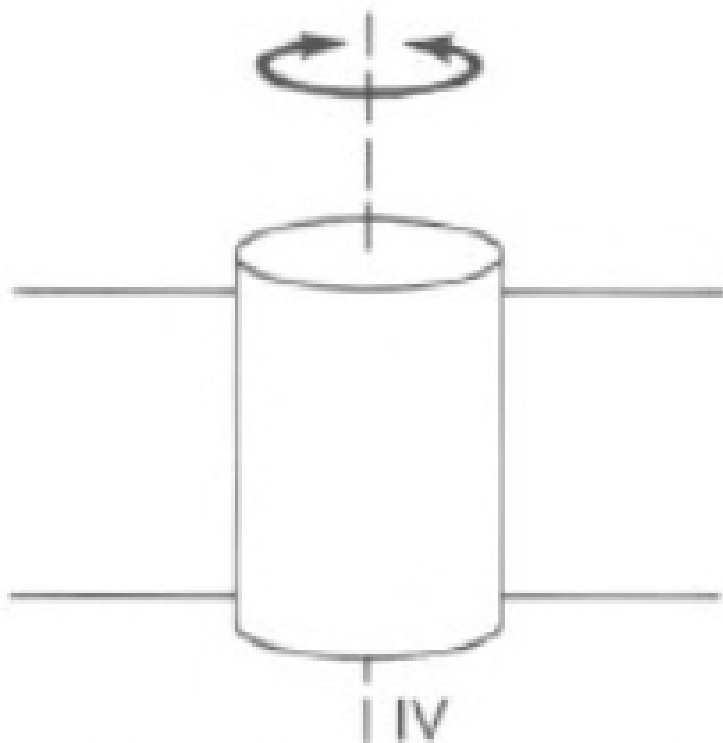
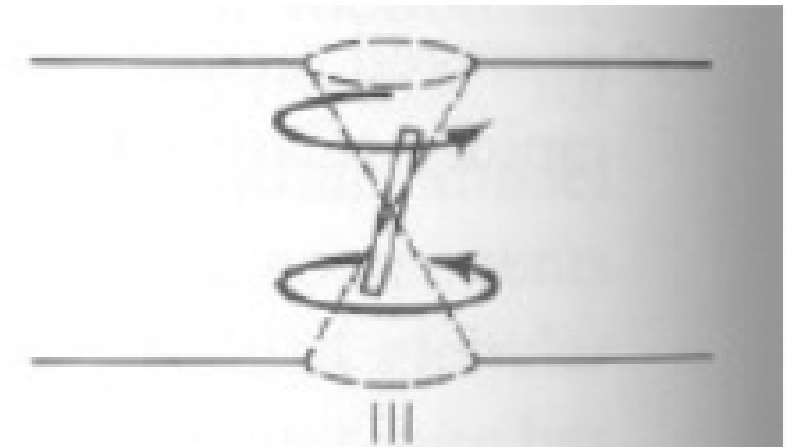
Isotropic rotation



Conical rotation



Isotropic rotation



Rotation along long axis

Diffusion in the plane