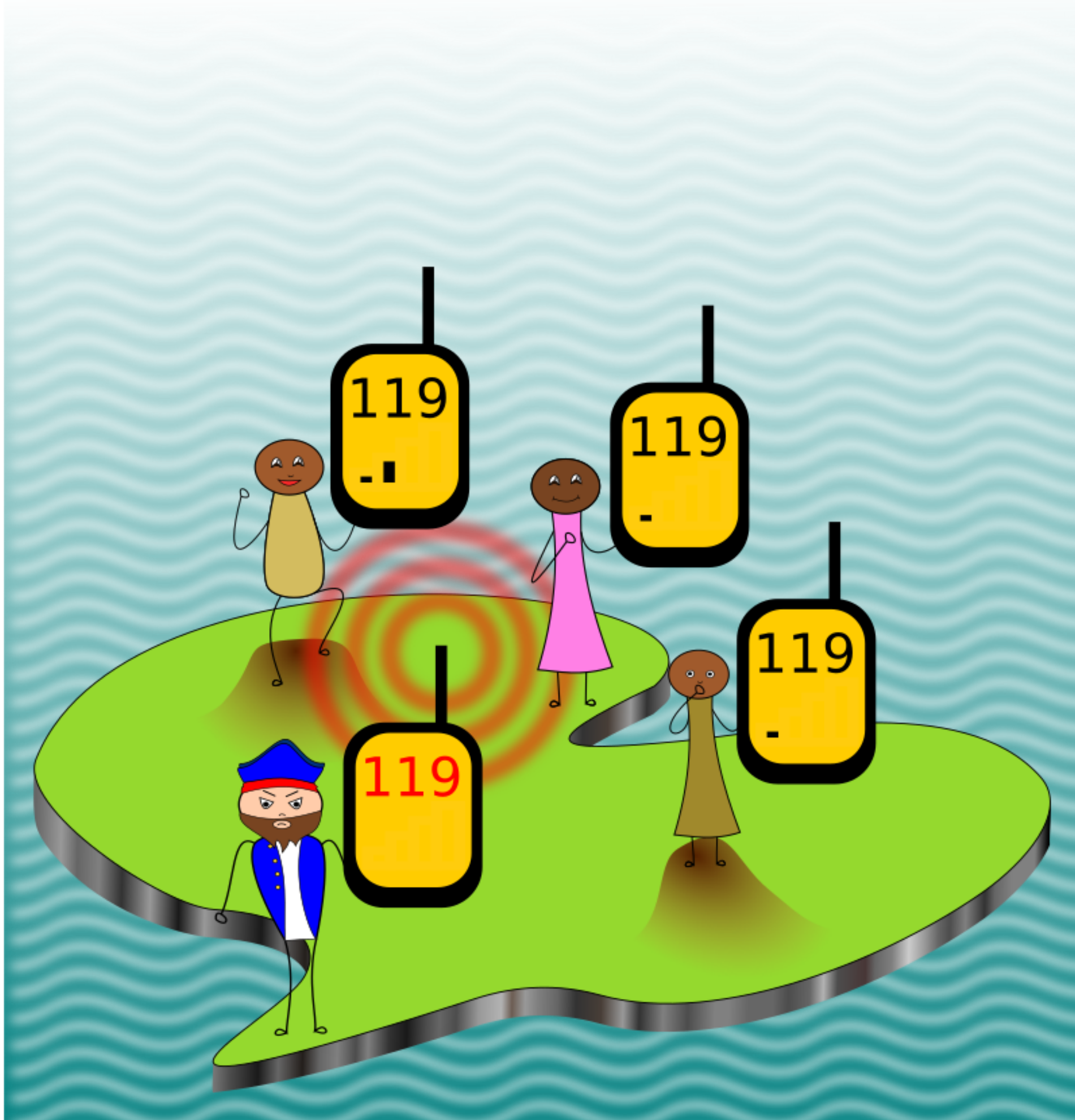
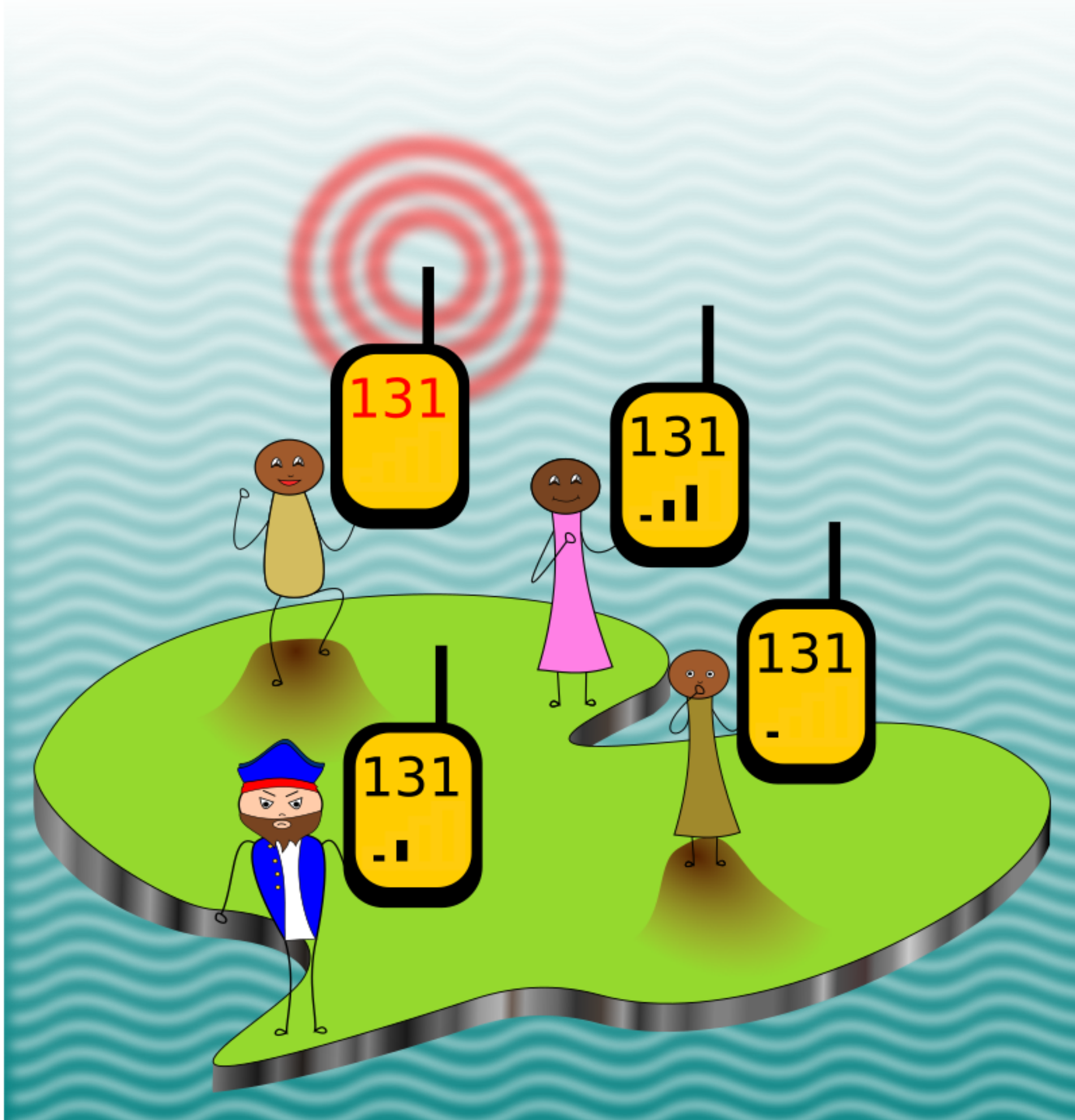


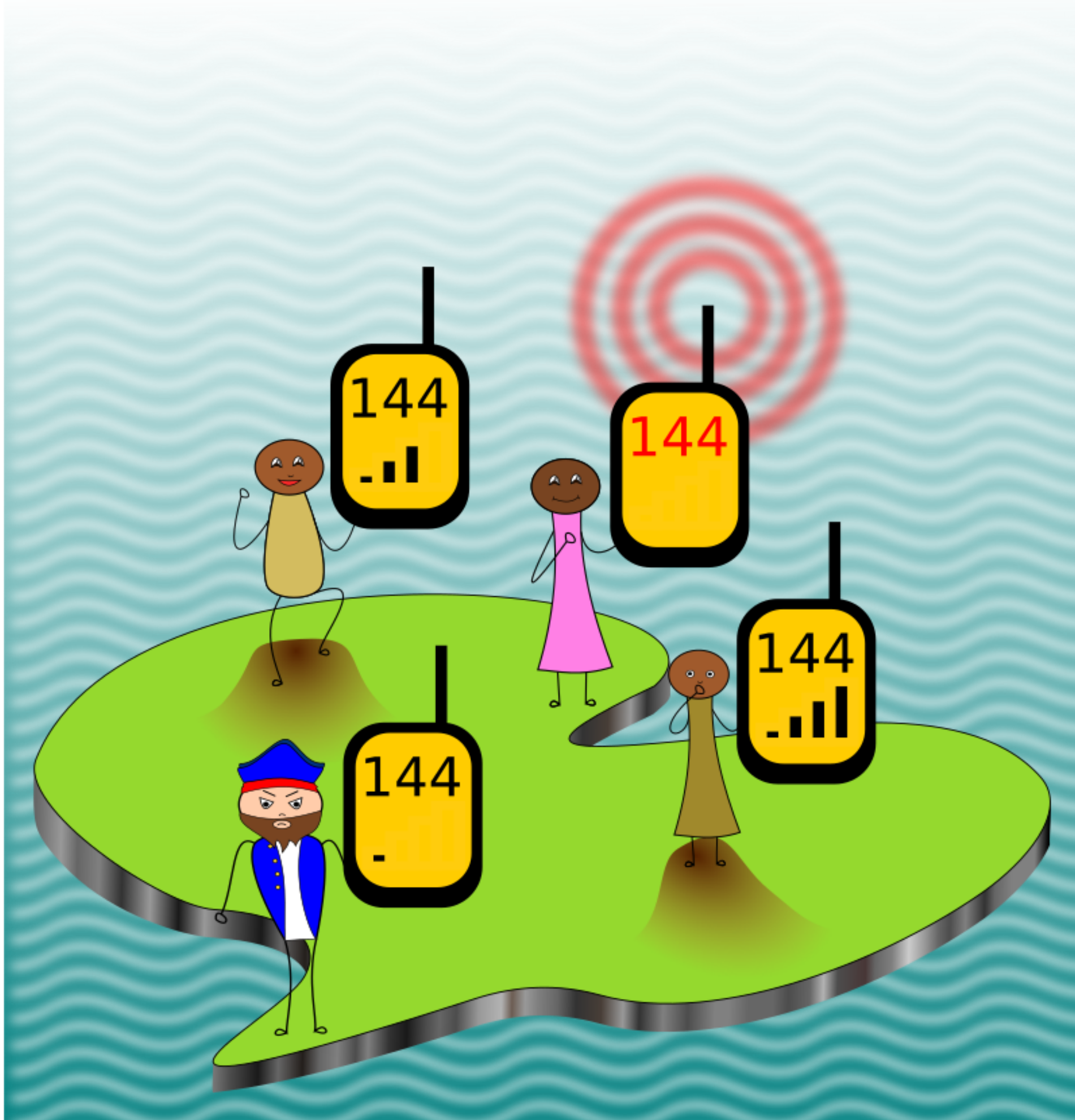
LECTURE 1a

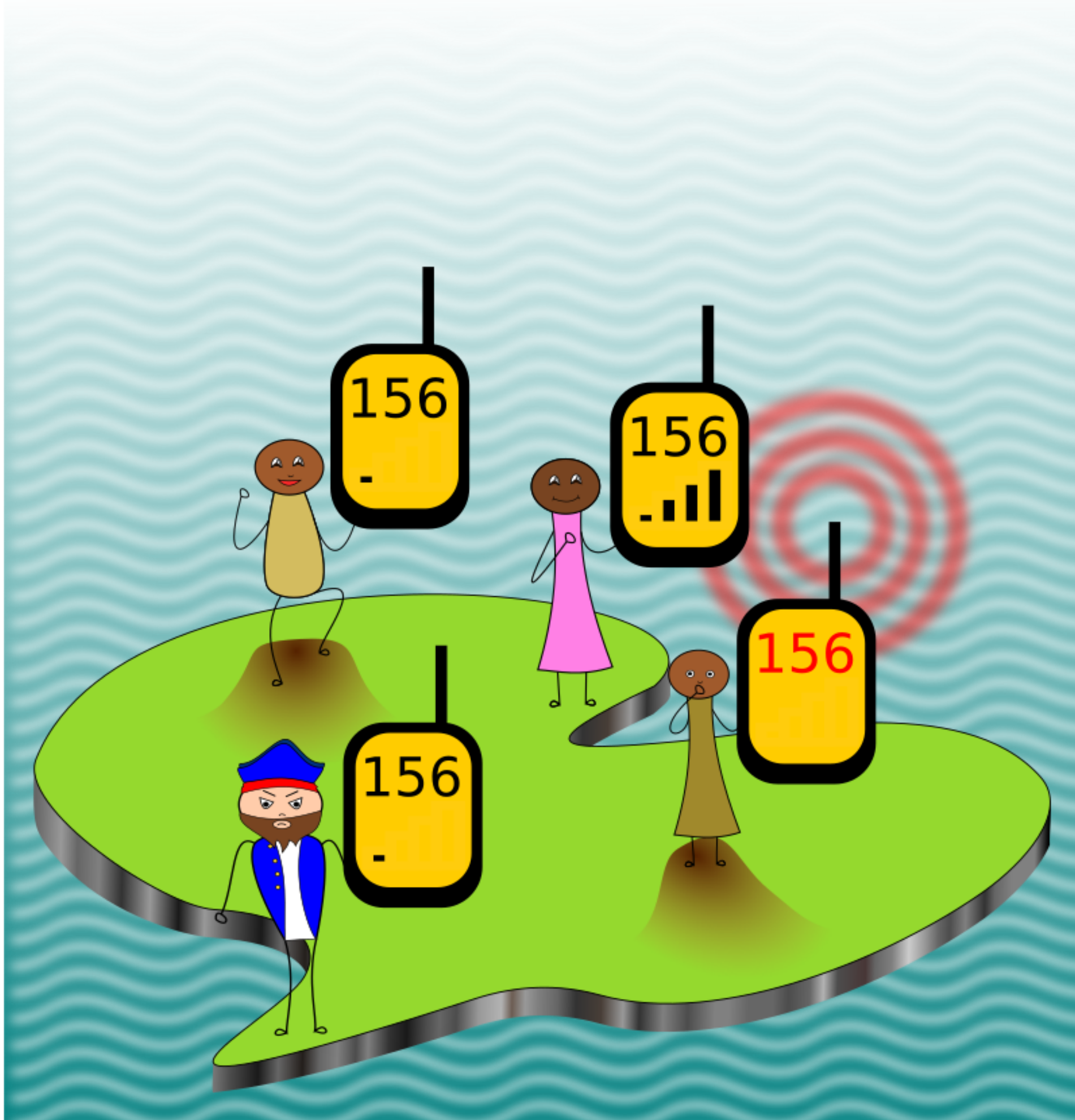
- *Is my protein folded?*
- *3D structure determination*
- *Specific structural details*
- *Intermolecular interactions*
- *Molecular motions (hydrodynamics, internal)*
- *Kinetics and thermodynamics*
- *In vivo measurements*
- *Spatial resolution*

- *Solubility*
- *Stability*
- *Stable isotope labeling*
- *Scaling up production*
- *Size*
- *Separation from impurities*
- *Salt content*

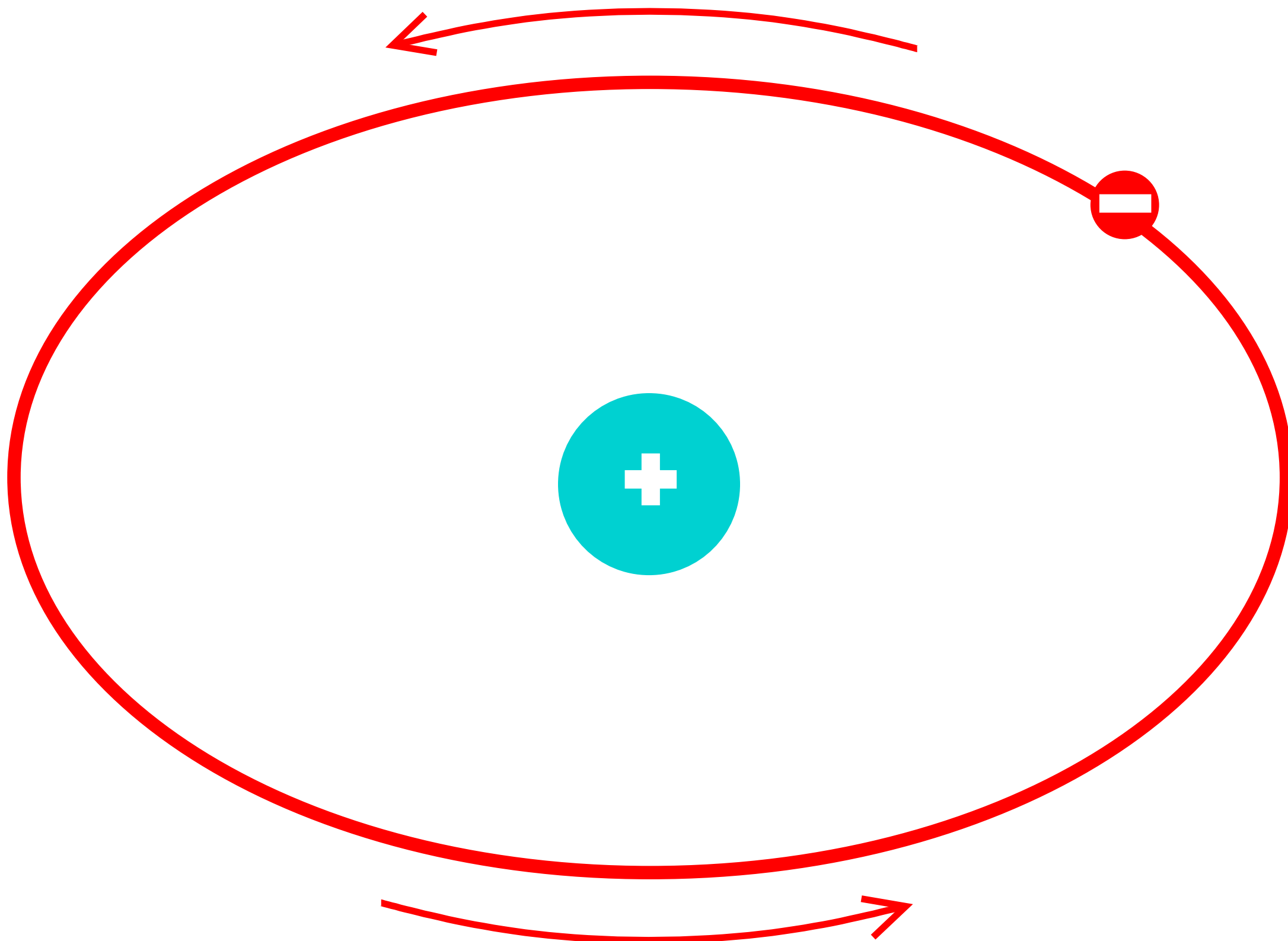


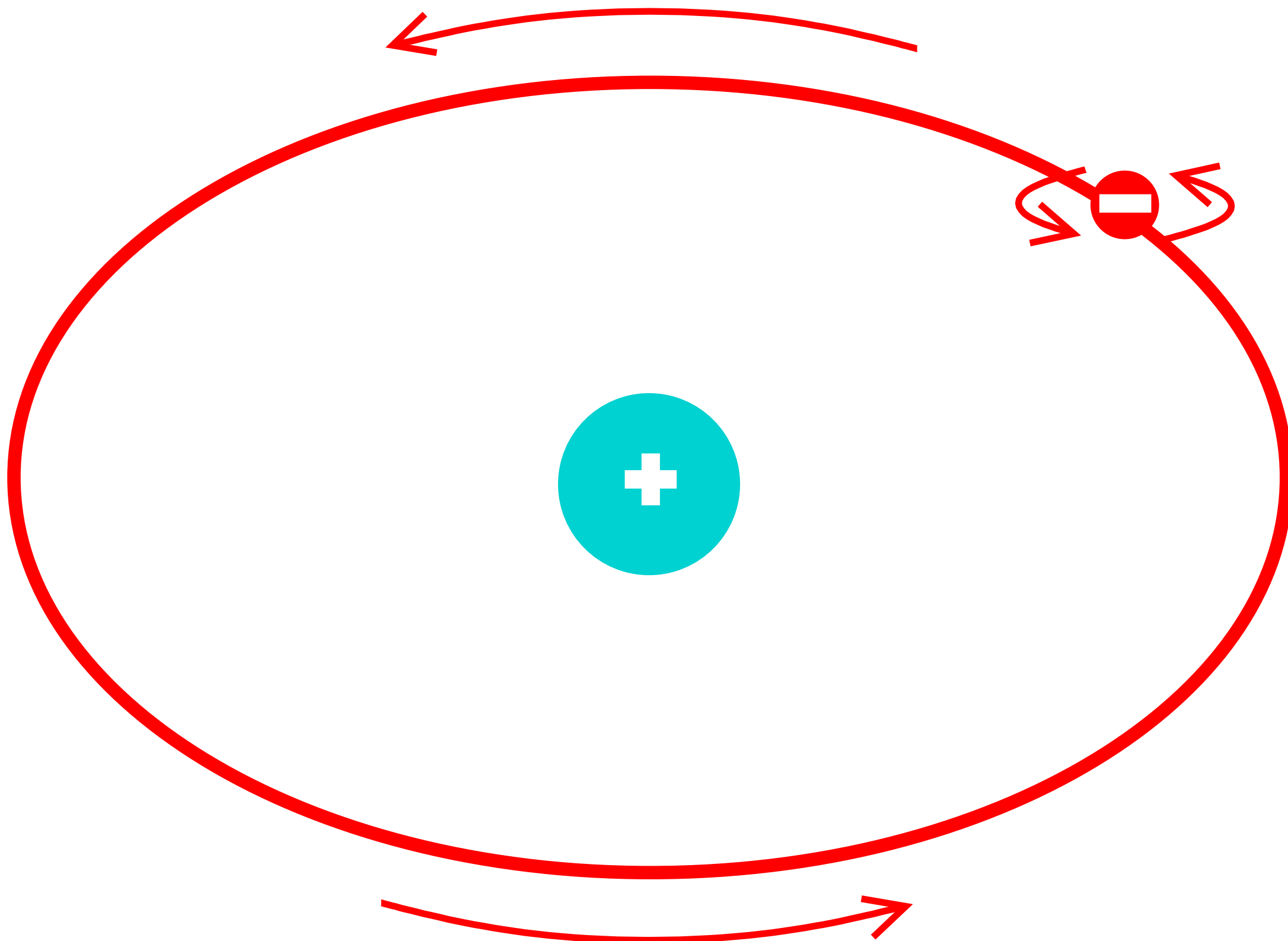


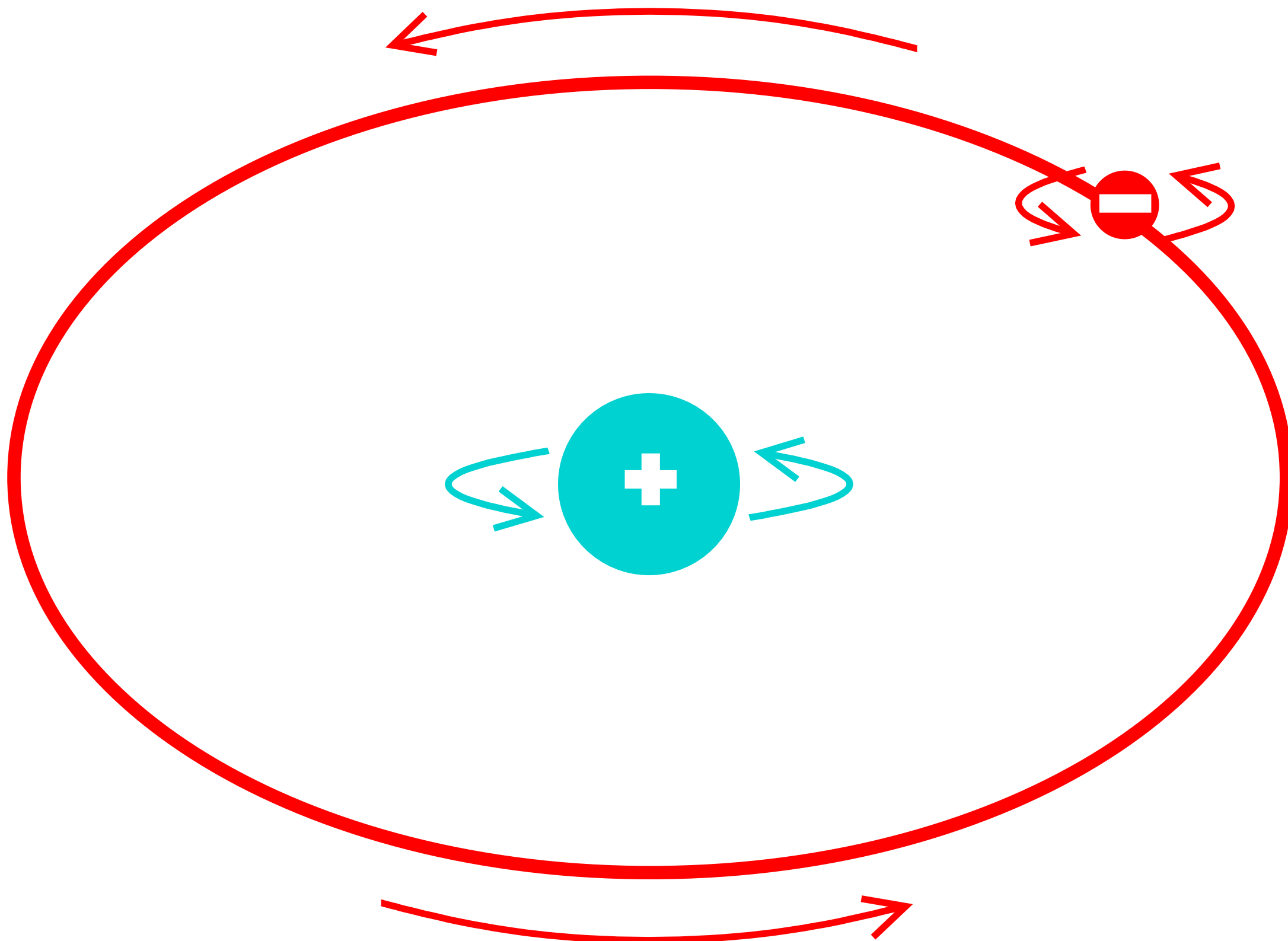




LECTURE 1b







Dirac-like nuclei:

	$\frac{10^{-9}\gamma}{\text{rad s}^{-1}\text{T}^{-1}}$	% in Nature
e^-	-182.000	100
^1H	0.277	99.98
^{13}C	0.067	1.1
^{15}N	-0.027	0.4
^{19}F	0.252	100
^{31}P	0.108	100
^{129}Xe	-0.075	24.4

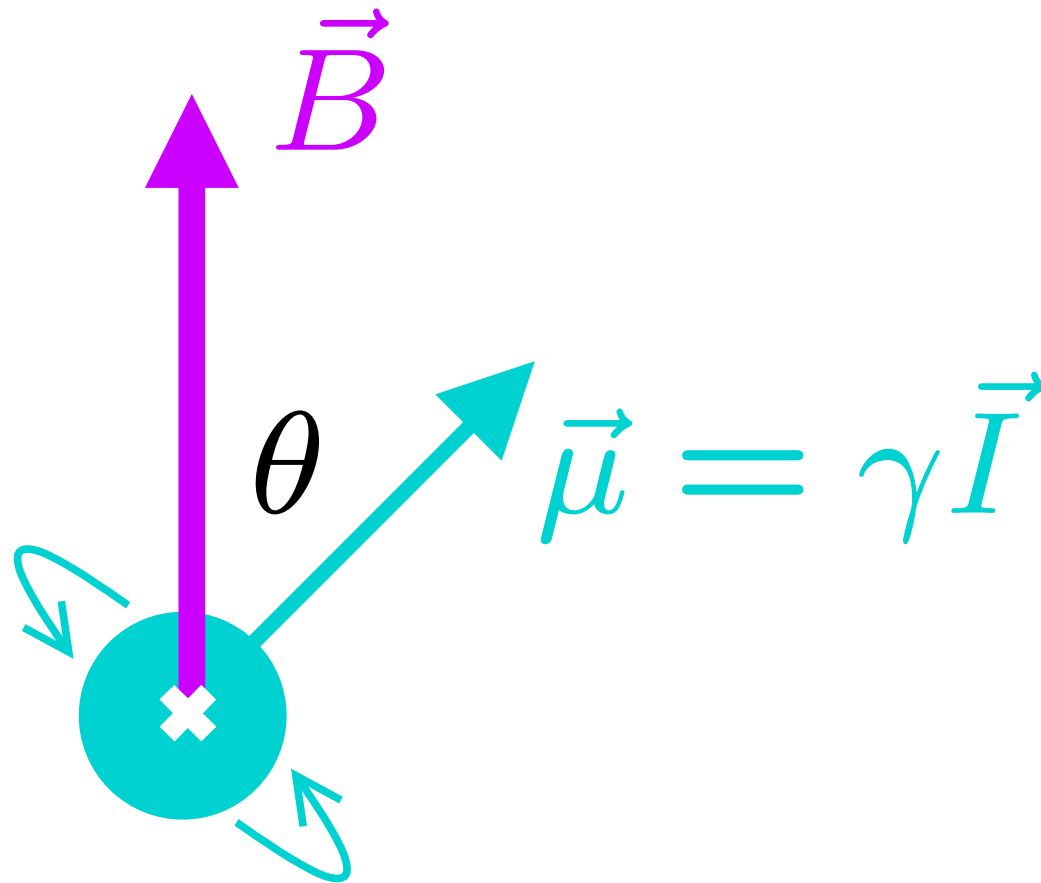
rare isotopes (require enrichment)

Magnetic moment

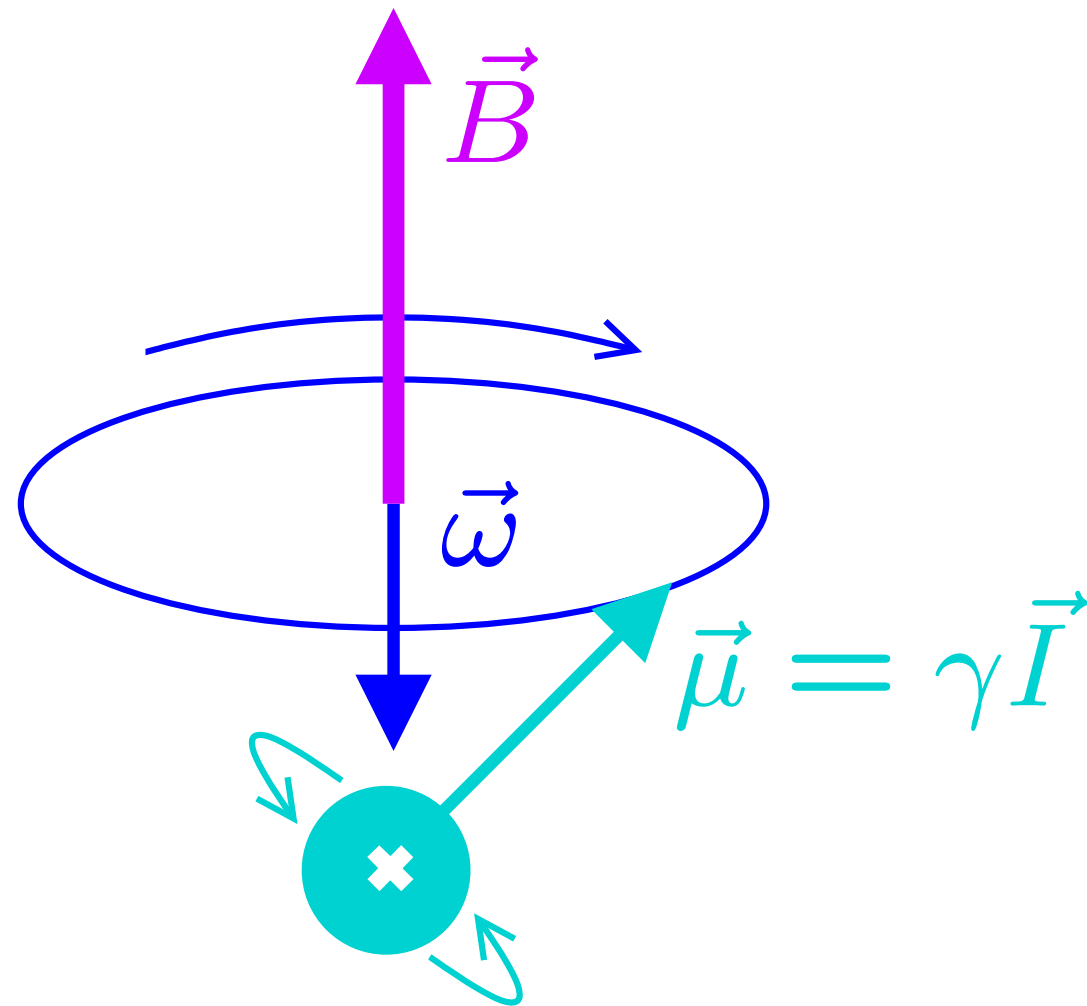
$$\vec{\mu} = -\gamma I$$

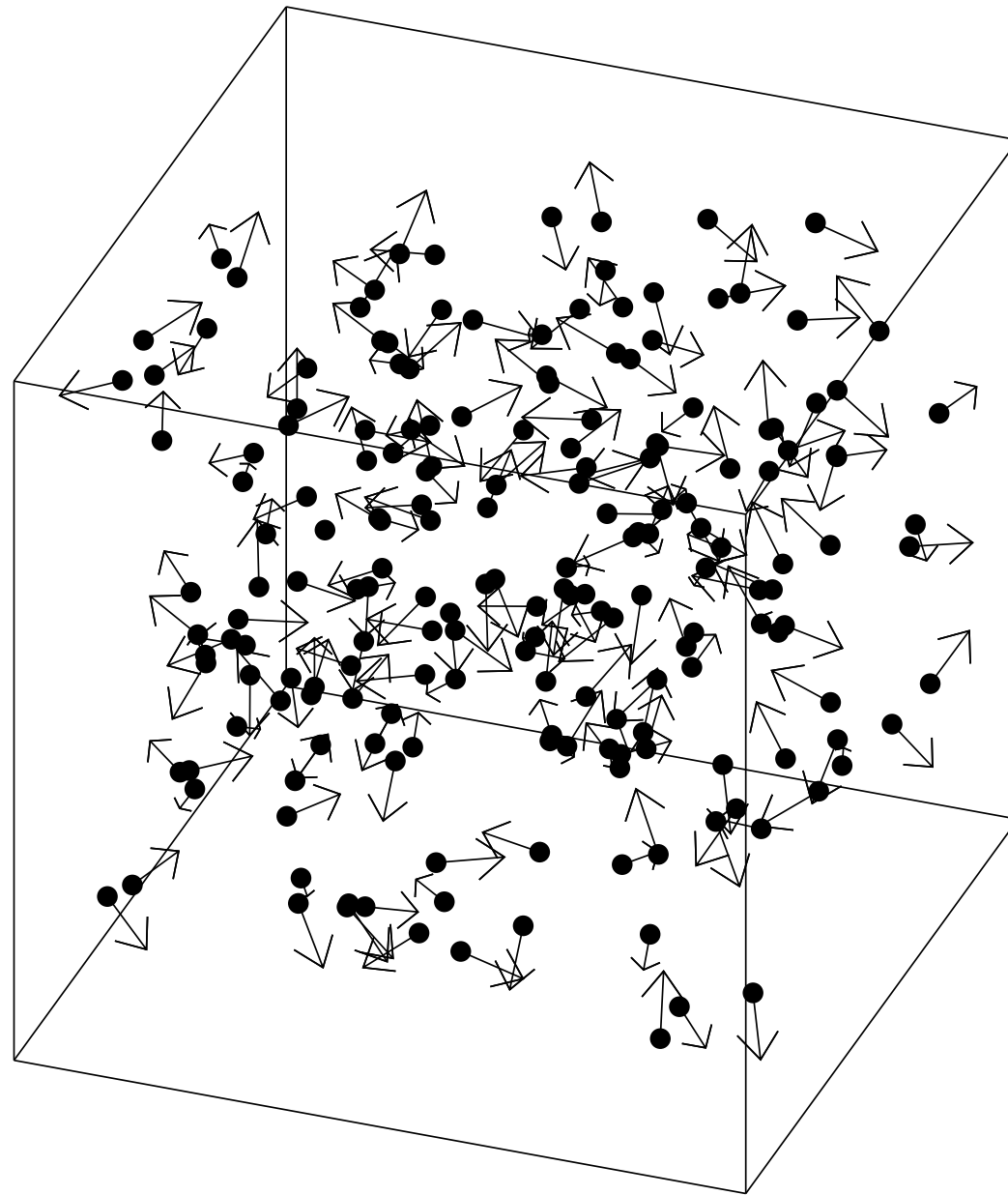
Energy

$$E = -\vec{\mu} \cdot \vec{B} = -|\mu||B| \cos \theta$$

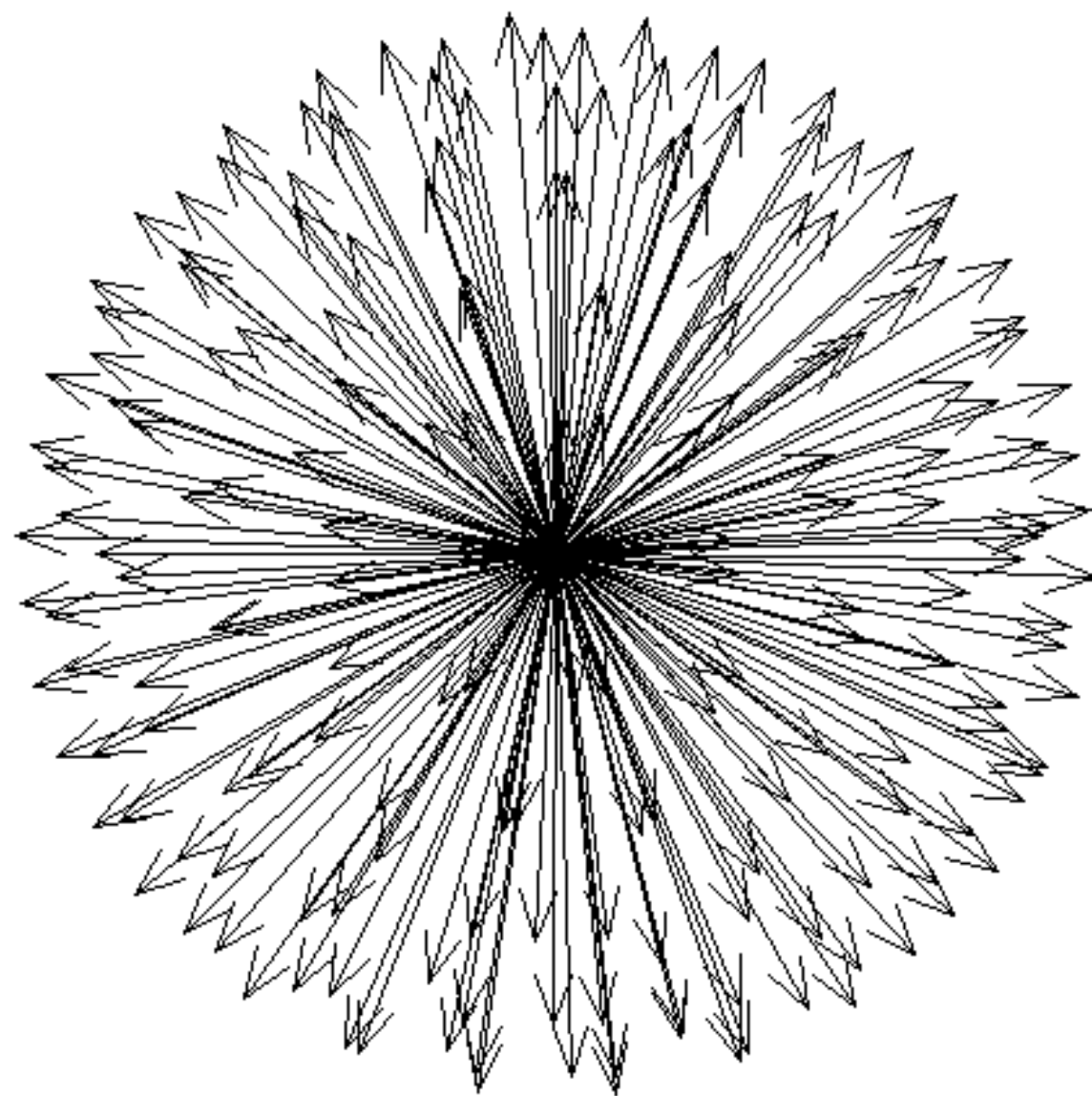


Angular precession frequency $\vec{\omega} = -\gamma \vec{B}$

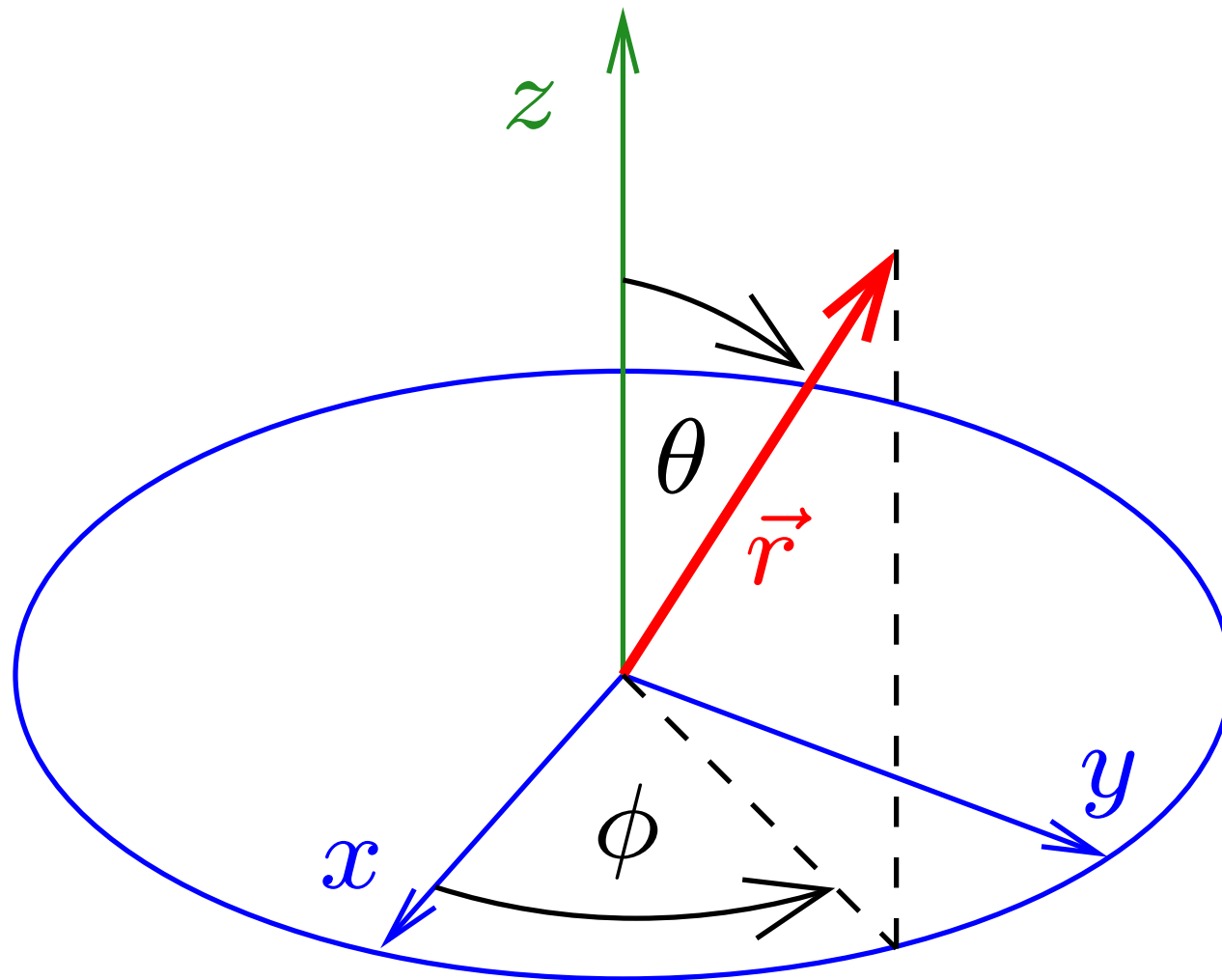


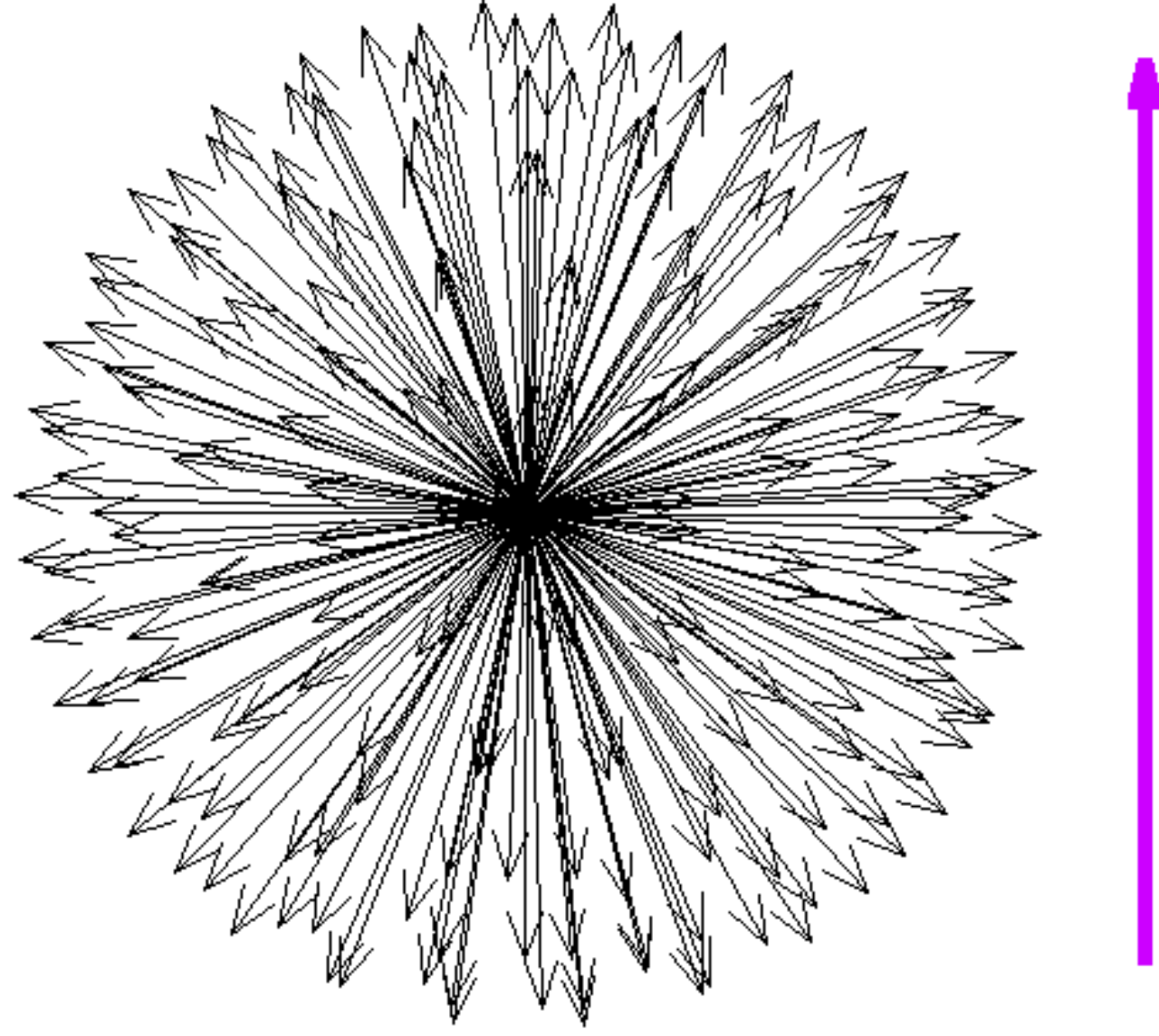


$$\vec{M} = (\vec{\mu}_1 + \vec{\mu}_2 + \vec{\mu}_3 + \vec{\mu}_4 + \vec{\mu}_5 + \vec{\mu}_6 + \cdots) / V \quad \text{Magnetization}$$

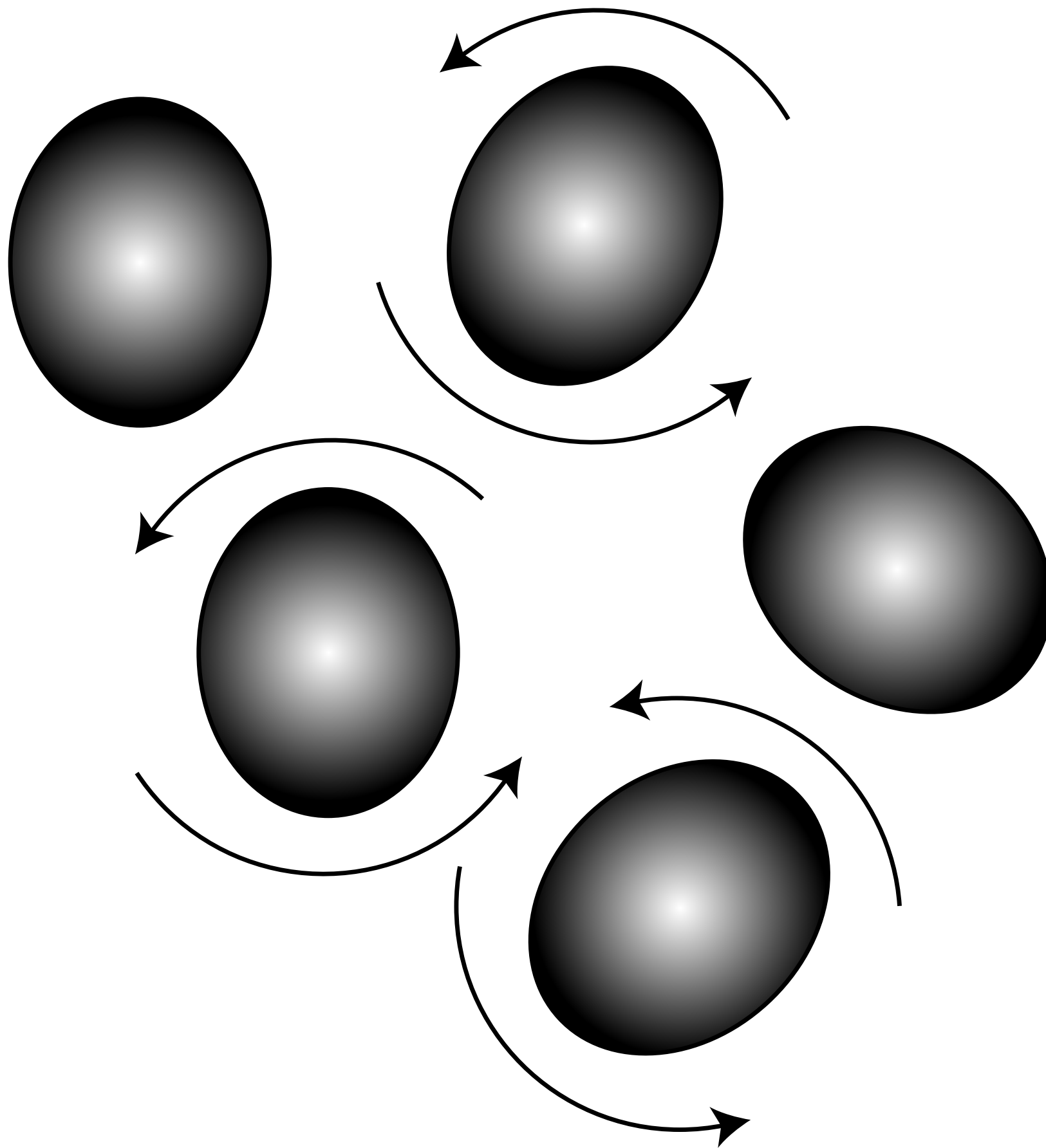


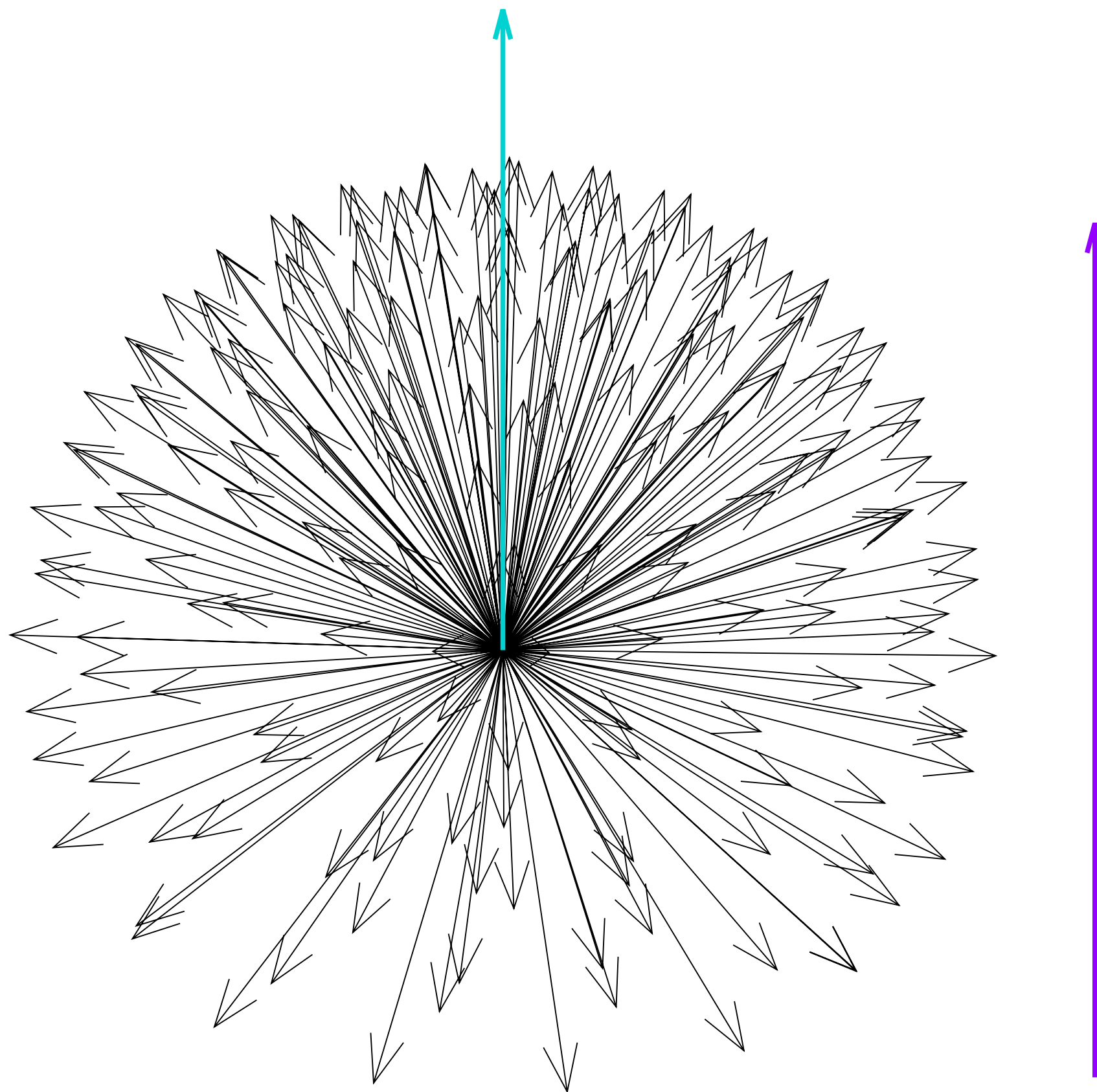
Spherical coordinates



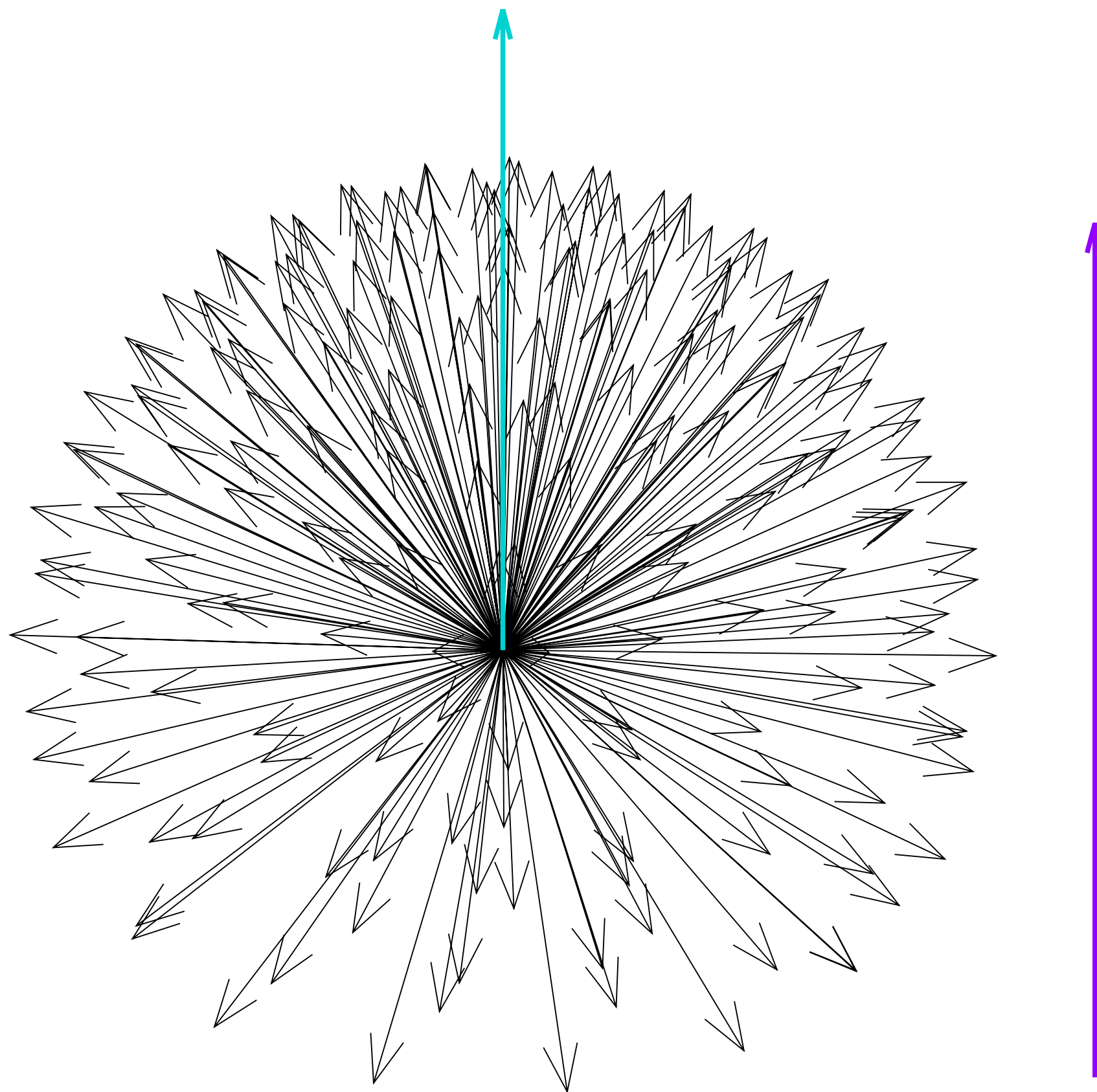


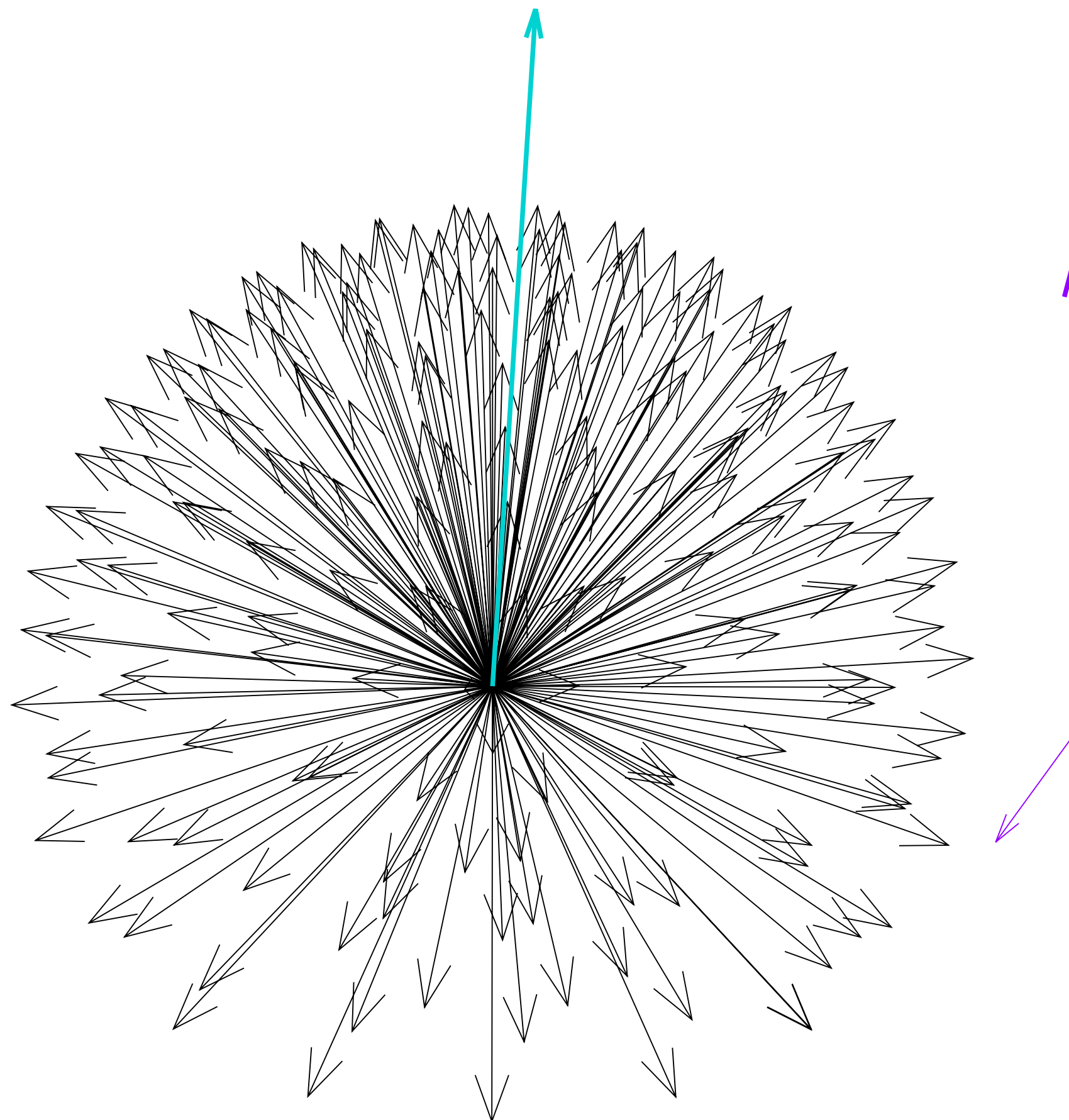
Magnetic moments in magnetic field

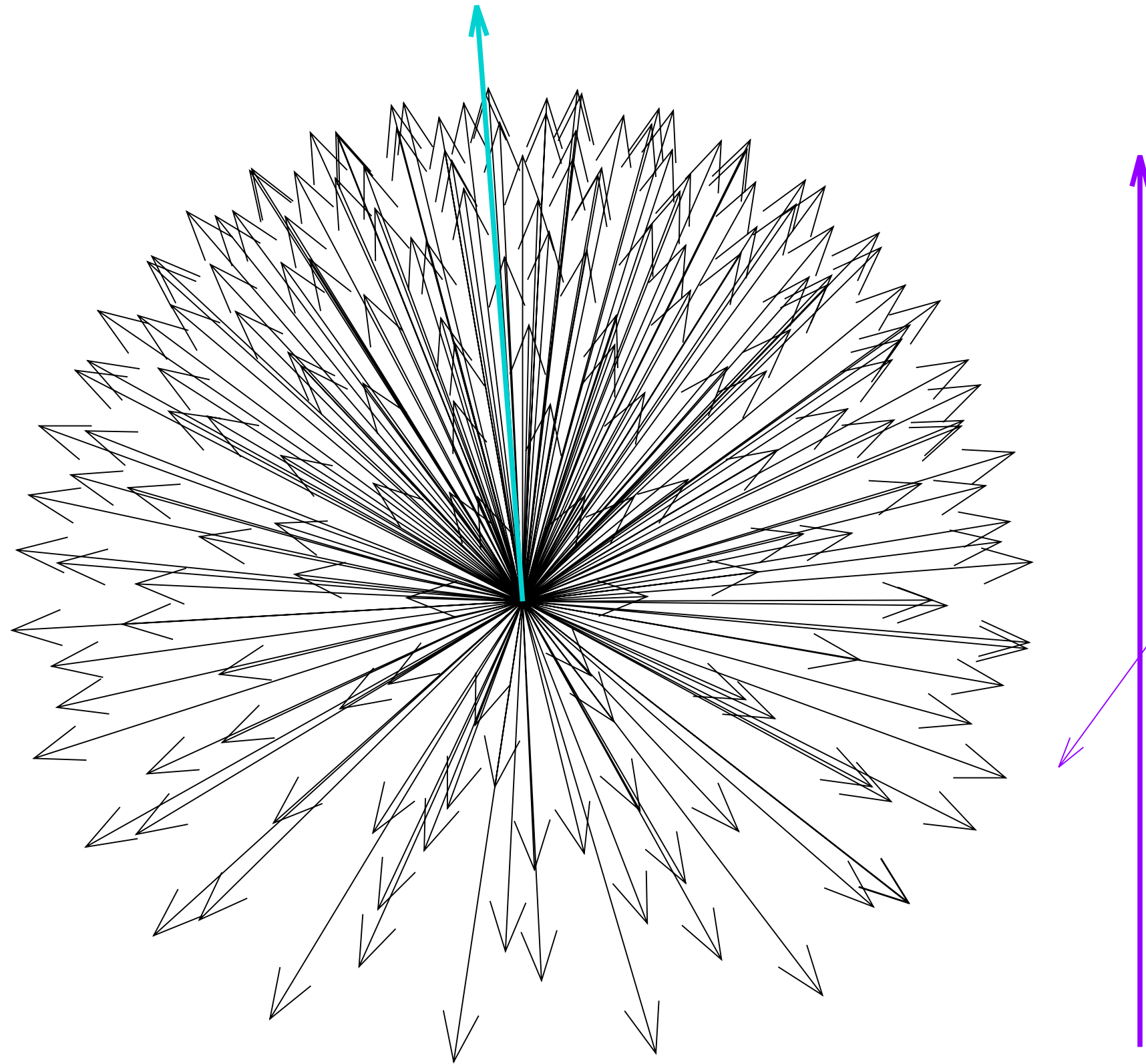


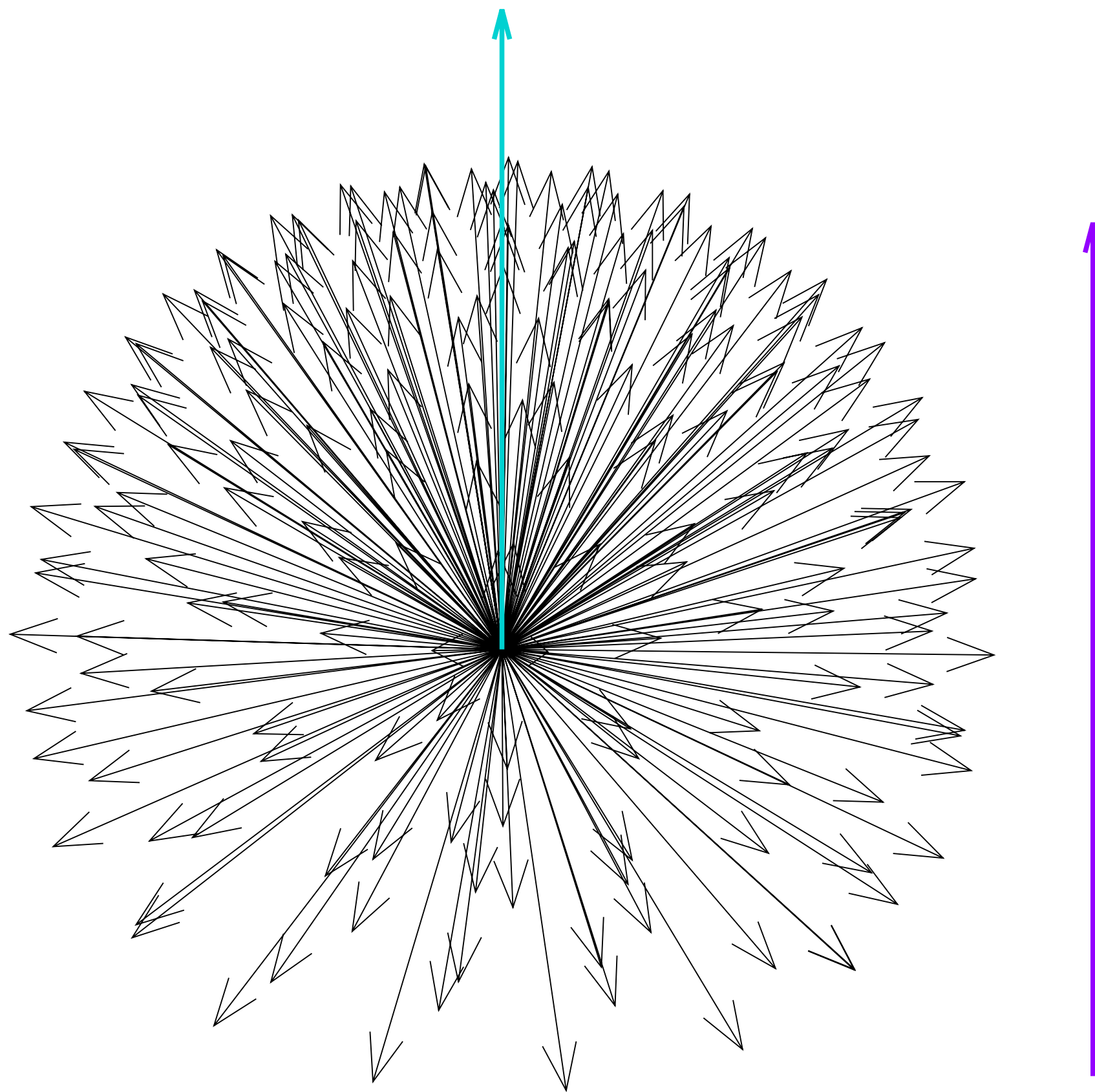


Longitudinal polarization

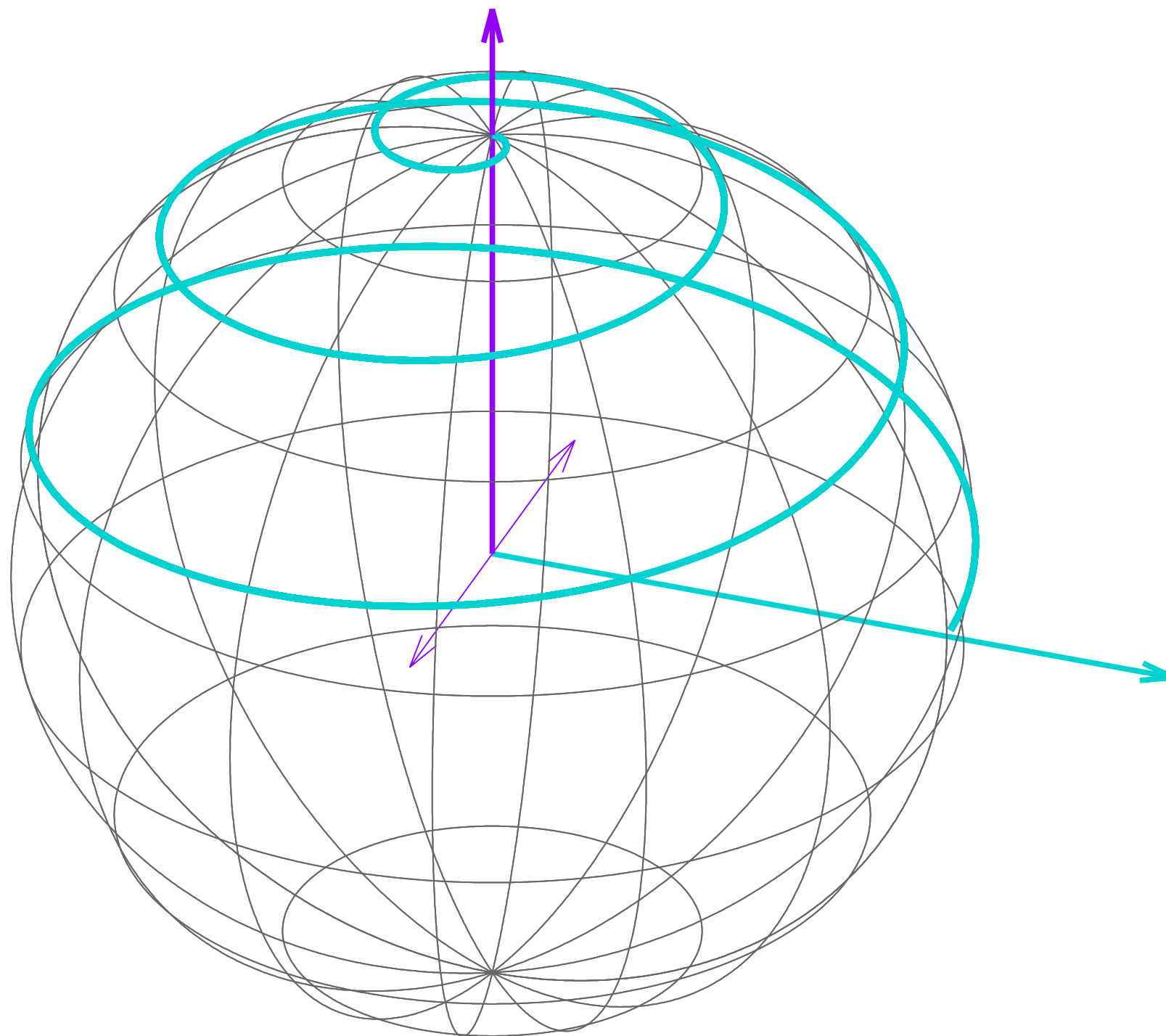


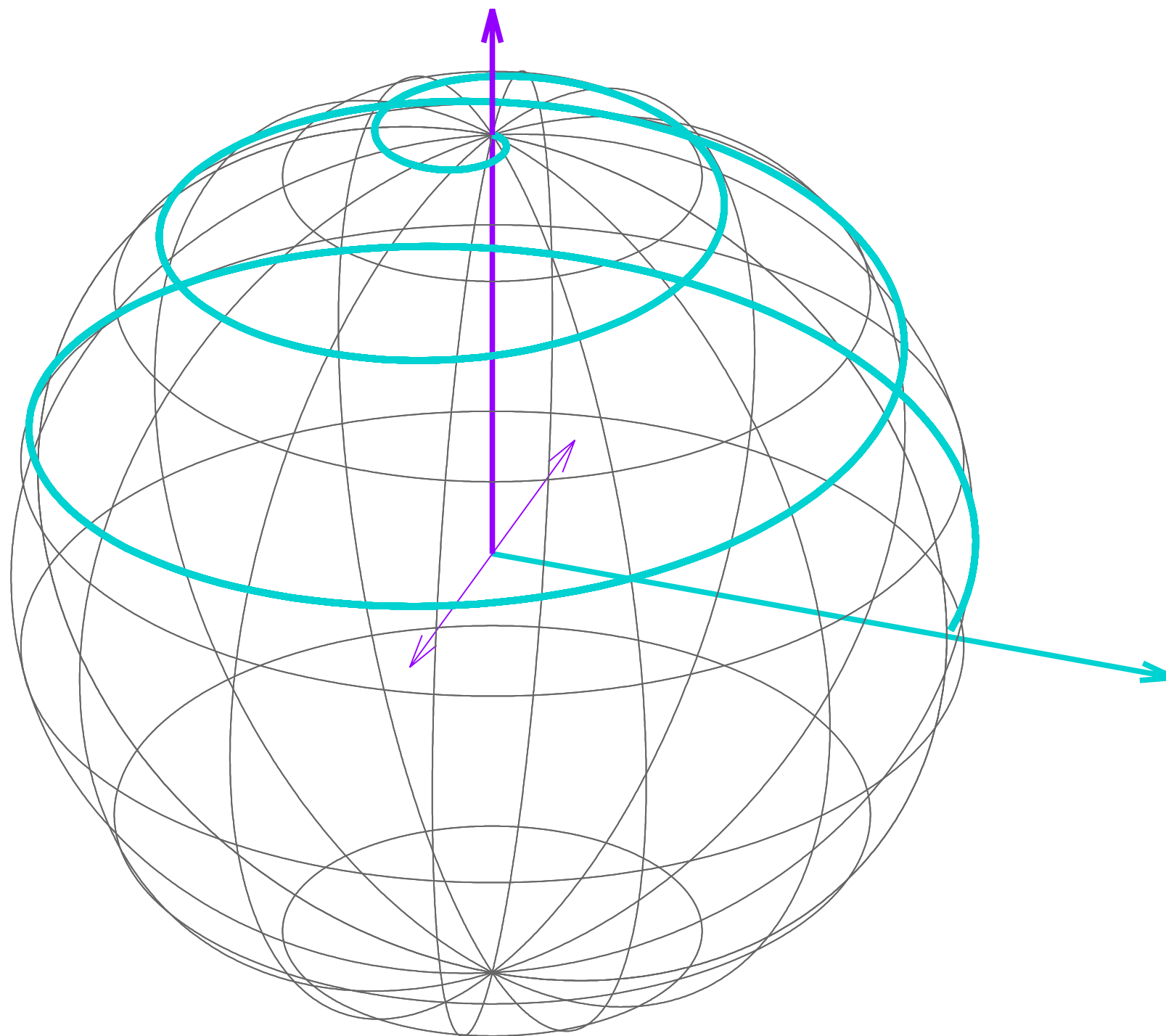


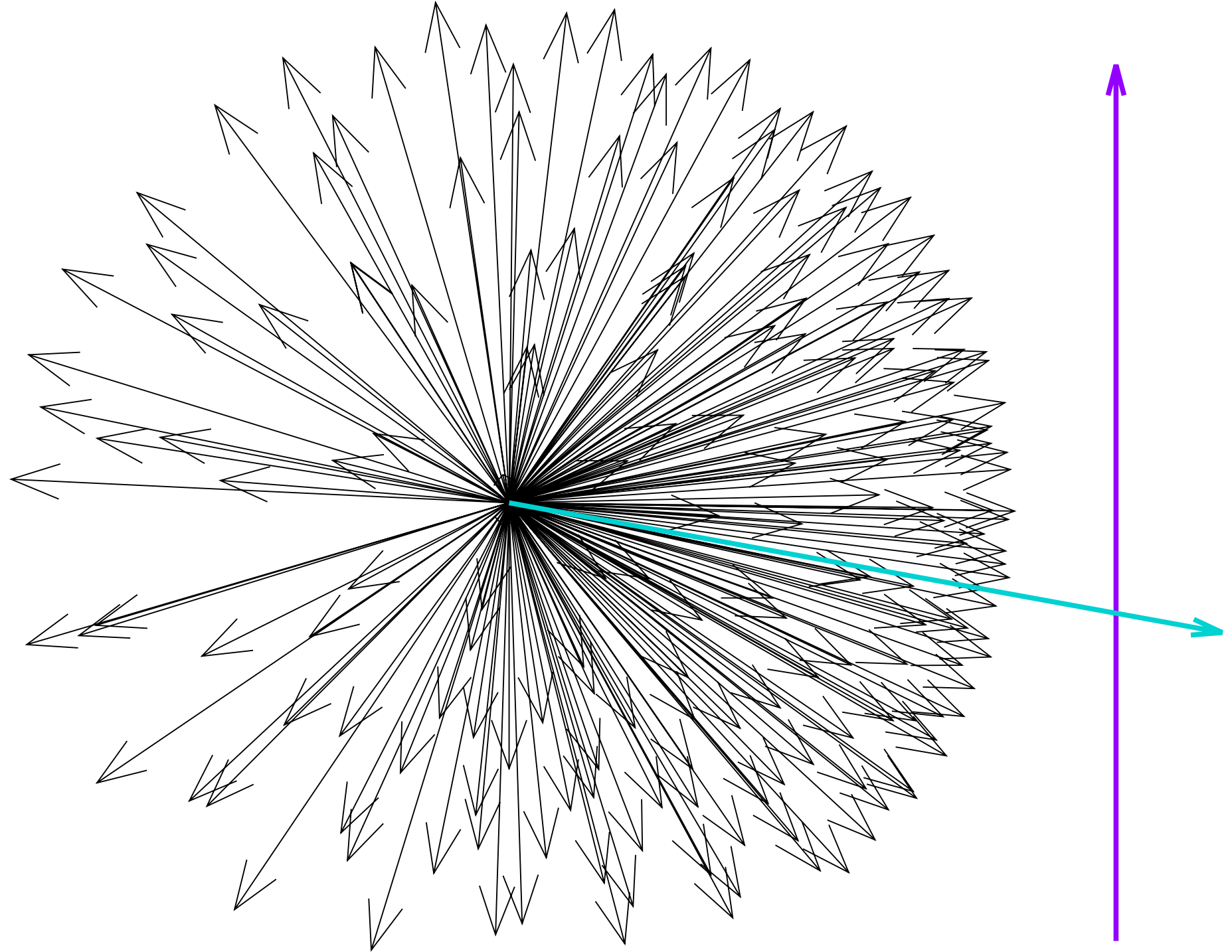




Flipping magnetization







Transverse polarization

