Magnetic pressure and tension

The magnetic force is

$$\vec{F}_L = -\frac{1}{8\pi}\nabla\vec{B}^2 + \frac{1}{4\pi}(\vec{B}\cdot\nabla)\vec{B}$$

Rewrite with

$$\vec{B} = B\vec{s},$$

where $\vec{s}$ is a unit vector pointing in the direction of $\vec{B}$.
Then, the Lorentz force becomes

$$-\frac{1}{8\pi}\nabla\vec{B}^2 + \underbrace{\frac{1}{4\pi}(\vec{B}\cdot\nabla)\vec{B}}_{\displaystyle \parallel \atop \displaystyle \frac{1}{4\pi}(B\vec{s}\cdot\nabla)(B\vec{s})} = -\frac{1}{8\pi}\nabla B^2 + \frac{1}{8\pi}\vec{s}(\vec{s}\cdot\nabla B^2) + \frac{B^2}{4\pi}(\vec{s}\cdot\nabla)\vec{s}$$

product

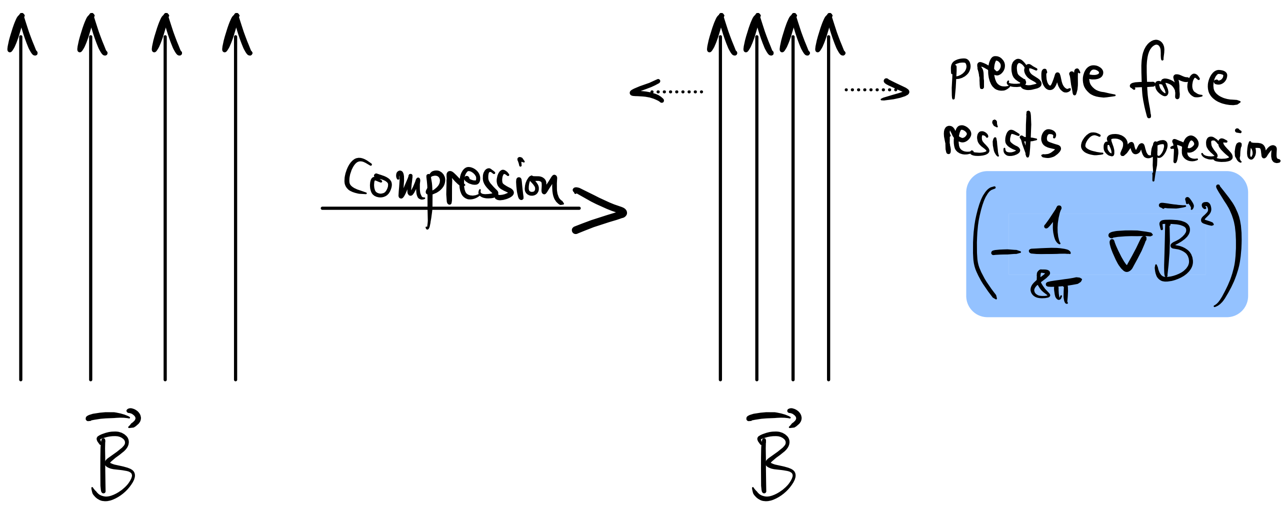
$$= -\frac{1}{8\pi}\nabla_\perp B^2 + \frac{B^2}{4\pi}(\vec{s}\cdot\nabla)\vec{s},$$

where $\nabla_\perp = \nabla - \vec{s}(\vec{s}\cdot\nabla)$ is the projection of the gradient operator in the direction perpendicular to $\vec{s}$, and $\vec{s}(\vec{s}\cdot\nabla) = \nabla_\parallel$ is the grad. op. along $\vec{s}$.

Thus, the first term, $-\frac{1}{8\pi}\nabla_\perp B^2$, is the magnetic pressure, always acting in the direction perpendicular to $\vec{B}$.

Since $\vec{s}\cdot\nabla$ is the projection of the grad. op. along $\vec{s}$, $(\vec{s}\cdot\nabla)\vec{s}$ is the rate of change of $\vec{s}$ along its own direction. Thus, the second term, $\frac{B^2}{4\pi}(\vec{s}\cdot\nabla)\vec{s}$, describes the magnetic force due to curvature of $\vec{B}$ $\Rightarrow$ tension.

Pressure



Tension