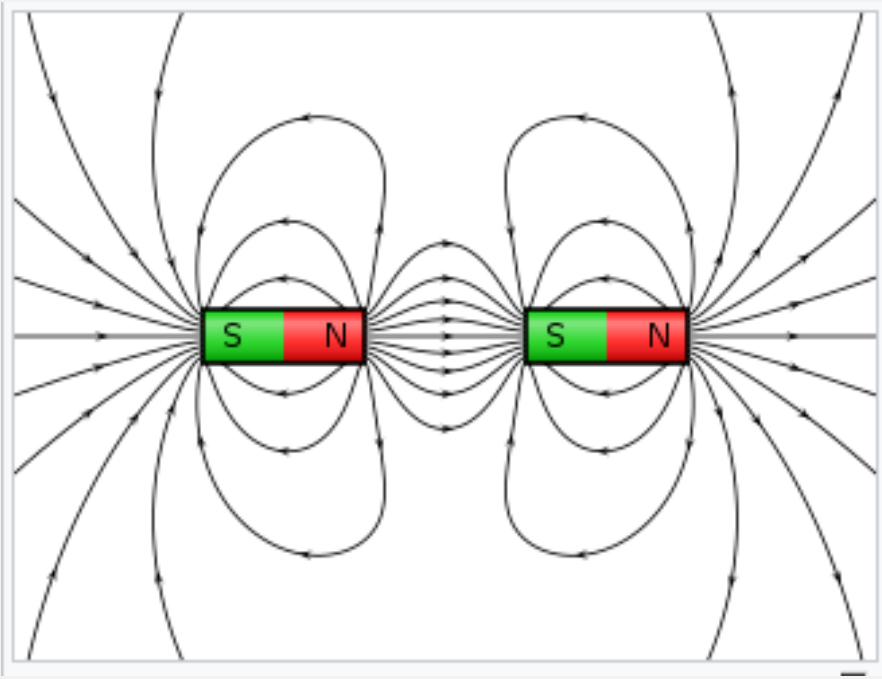
By: Gianna Rotellini
UT Physics

Force Between Two Cylindrical Magnets



For n-n’ group meeting
October 19, 2023
University of Tennessee, Knoxville

References:

[1] Wikipedia Contributors. “Force between Magnets.” https://en.wikipedia.org/wiki/Force_between_magnets
[2] see also Journal of Magnetism and Magnetic Materials 321 (2009) 3758–3763

Equations used for aligned dipoles in the limit $x \gg R$

$$F(x) \approx \frac{\pi \mu_0}{4} M^2 R^2 \left[\frac{R^2}{x^2} + \frac{R^2}{(x+2L)^2} - \frac{R^2}{(x+L)^2} \right]$$

R - is the radius of each of the two magnets, under the assumption of equal radii
L - is the length of two magnets equal length
x - is the normal distance between the two parallel faces of the magnets
M - is the magnetization of the magnets

Magnets parameters used

$B = 30 \times 10^{-4}\, T = 30\, Gauss$

$L = 1.7359\, m$

$R = 0.1016\, m$

$\mu_0 = 4\pi \times 10^{-7} \frac{H}{m}$

$$B = \frac{\mu_0}{2} M$$

$M = \frac{2B}{\mu_0}$ = 4774.65

$$F(x) \approx \frac{\pi \mu_0}{4} M^2 R^4 \left[\frac{1}{x^2} + \frac{1}{(x+2L)^2} - \frac{2}{(x+L)^2} \right]$$

$e.g. for\ x = 4'' \rightarrow 0.1016\, m$

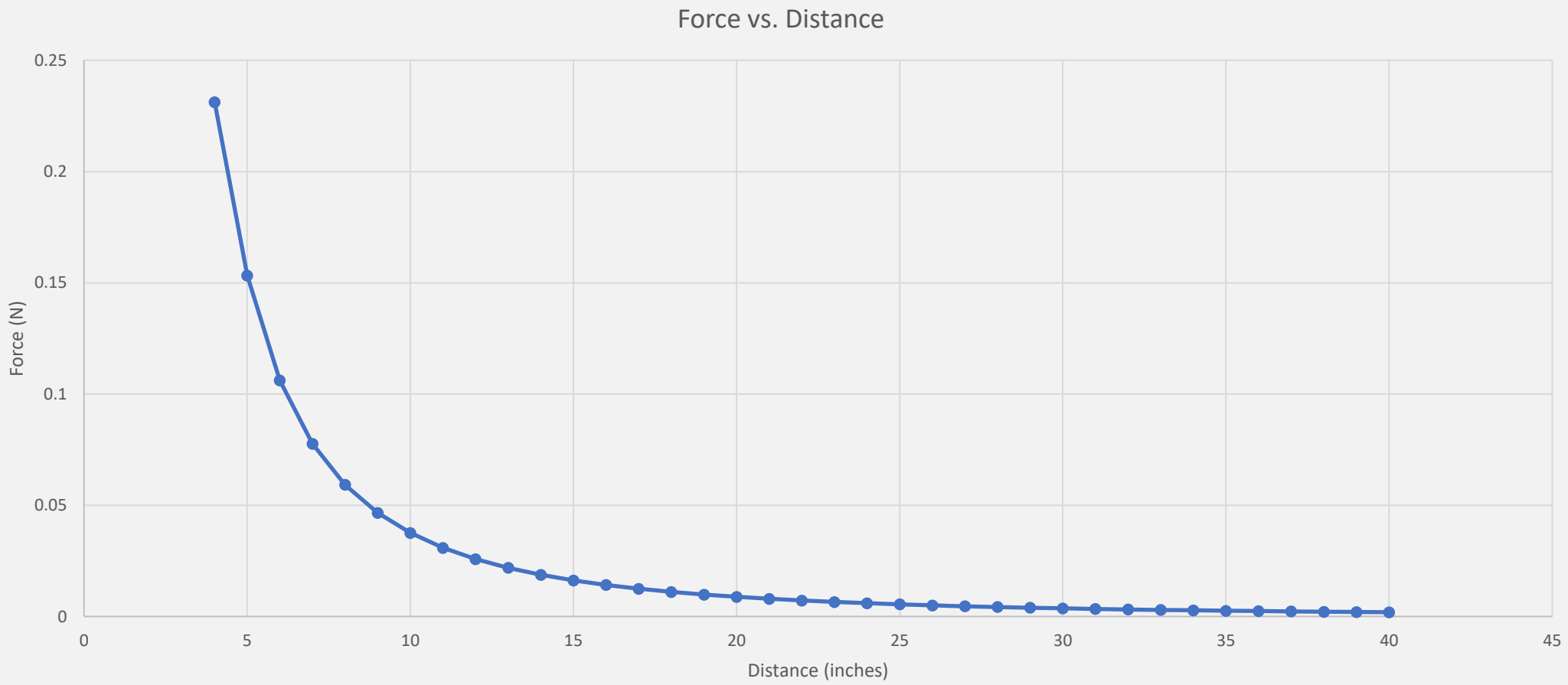
F = 0.2313 N

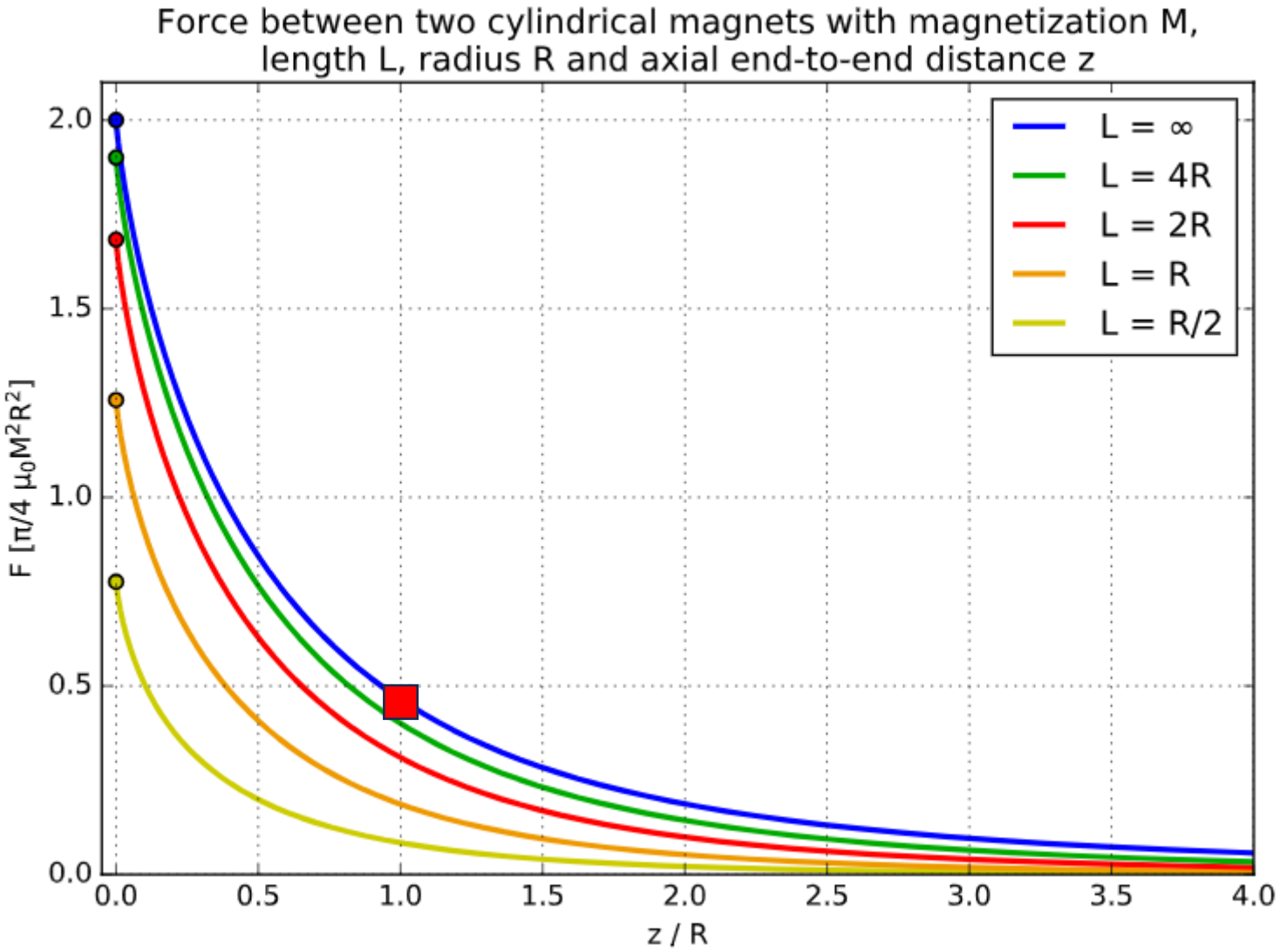
Calculation results

$$x = (4 - 40\ inch.)$$

$$4'' \rightarrow 0.1016\ m \quad F = 0.2313\ N$$

$$40'' \rightarrow 1.016\ m. \quad F = 0.00195\ N$$





If $z \equiv x = R = 4"$

$$\frac{\pi\mu_0}{4} M^2 R^2 = 0.2323\ N$$

Total force at $x = 4"$

F =0.12 N

Exact force between two coaxial cylindrical bar magnets for several aspect ratios.