CubeSat Club Meeting
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Last Time

- Learned about MATLAB
- Compared a Cubesat to Cloudsat

Today

- Starting our flight vehicle design!
- Decide whether to use an air core coil or steel core
- Goal is to produce the desired control torque with the minimum coil mass and power consumption
- Torque from our torquer is the product of the dipole moment times the magnetic field
- T = MB (Torque equals dipole moment times the magnetic field intensity)
- Design our torquers!

Air Coil

- Dipole moment M = NIA
  - A is the coil area (one face of a CubeSat), I is the current in the coil and N is the number of turns of wire
  - One CubeSat face is 10 cm by 30 cm so each loop is 80 cm or 0.8 m in length
  - The area of the coil is 0.03 m^2 (0.1 m x 0.3 m)
- Compare to the steel core coil
  - $M = NIA/(1/\mu_r + N_d)$, $\mu_r = 2000$ is the N_d demagnetization factor
  - M = 2000 NIA
  - The area of the rod is much smaller!

Mass of Each Torquer

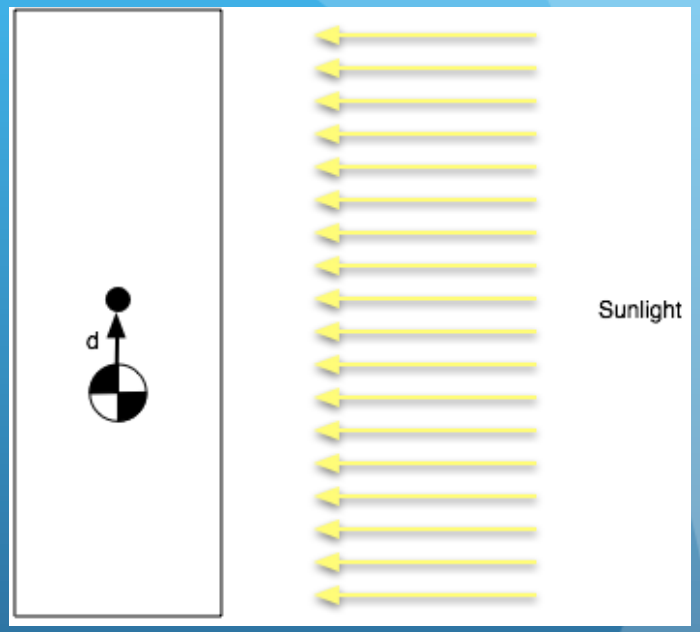
- Air coil mass
  - $m = \rho_{Cu} N c \pi a^2$
  - ρ_{Cu} is the density of the copper, a is the radius of the wire, c is the circumference of the coil
- Steel core coil mass
  - $m = \rho_{Cu} N (2\pi r) \pi a^2 + \rho_h \pi r^2 l$
  - $l = 2Na$ if we don't overlap windings
  - ρ_h is the density of the steel
  - You can simplify this expression!
- $\rho_{Cu} = 8960\ kg/m^3$ $\rho_h = 8200\ kg/m^3$

Power Consumption

- $P = I^2R$
- $R = \rho_w l_w / \pi a^2$ $\rho_w = 1.678 \times 10^{-8}$ Ohm-meters
  - Notice ρ has a different meaning in this equation!
- For the air coil $l_w = Nc$
- For the steel core $l_w = N2\pi r$

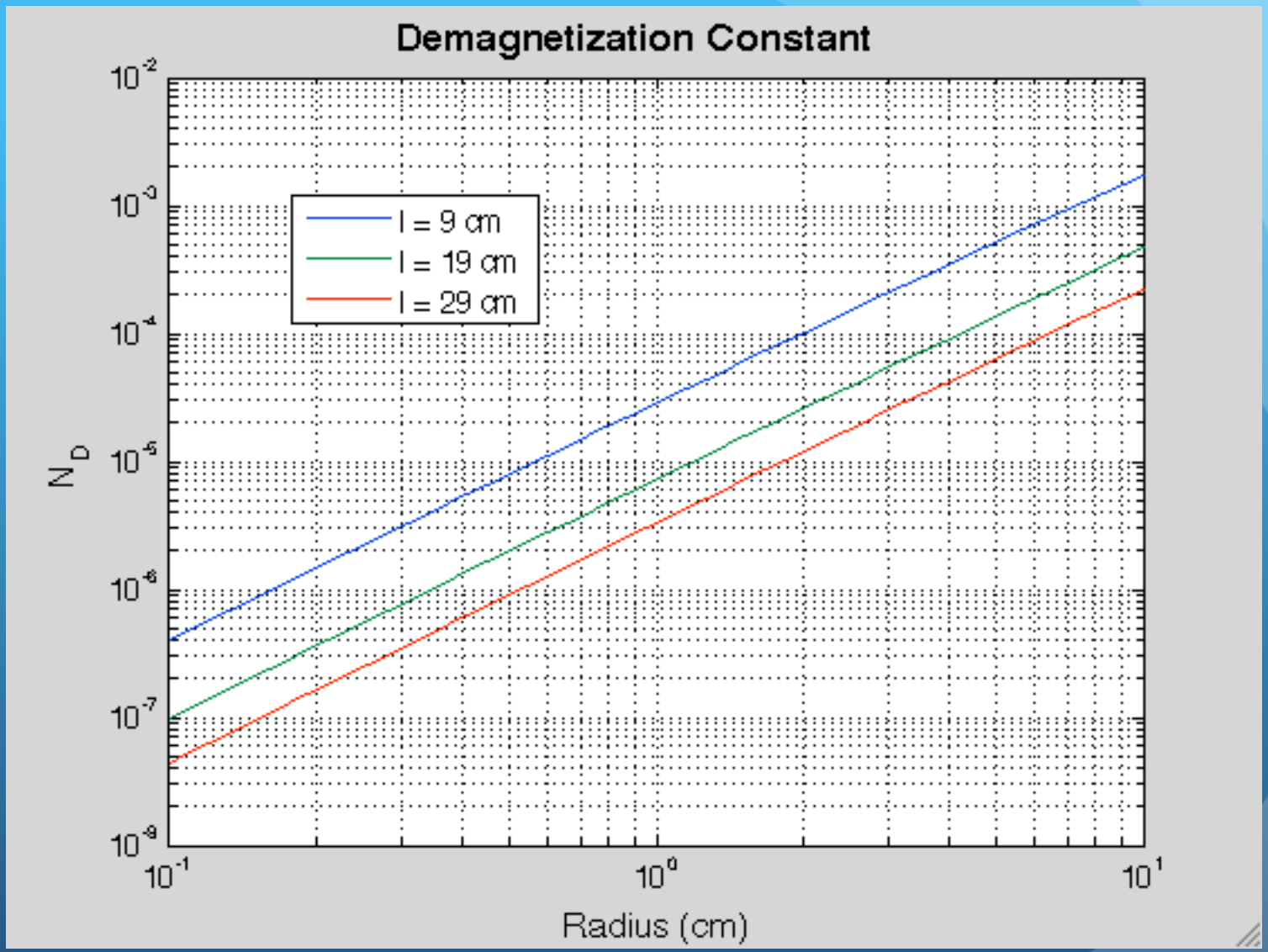
How much torque?

- Magnetic field is B = 2.2 x 10^{-5} T (Tesla)
- We need to control disturbances due to solar pressure
- Torque = 2d A 1367 /c
- d is the moment arm
- c is the speed of light 3 x 10^{8} m/s
- 1367 W/m^2/c is the solar pressure
- From our model last time d = 0.1 m



Tasks

- Design the torquer for our flight vehicle
- Choose between air or steel core
  - Compute mass and power consumption
- Explain why you chose the air or steel core
- Build an air core torquer
  - Compare with our steel core torquers


Demagnetization Constant
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
N_D
l = 9 cm
l = 19 cm
l = 29 cm
10^{-1}
10^{0}
10^{1}
Radius (cm)