

Magnetic fields Generated by Magnets Moving Along Epicyclic Paths

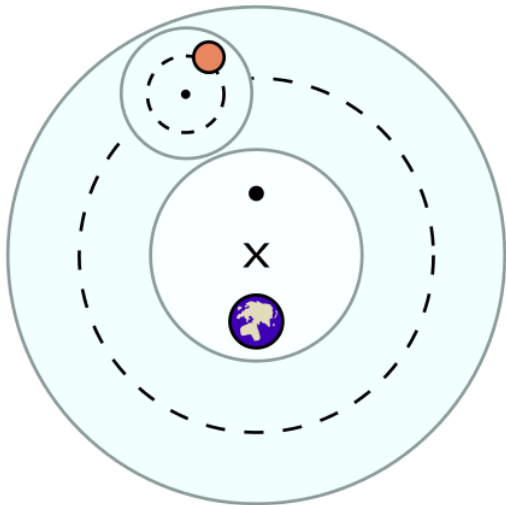
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Pitotech Co Ltd



Introduction (Epicyclic Paths)

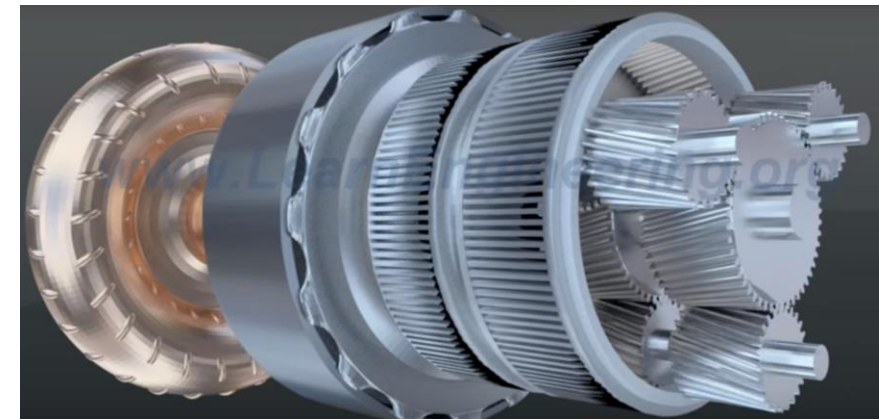
- Epicycle: “circle moving on another circle” -- Greek Astronomer
- Describe apparent relative positions of Sun, Moon, Earth, planets.



https://en.wikipedia.org/wiki/Deferent_and_epicycle



<http://www.unicyclist.com/forums/showthread.php?t=120161>



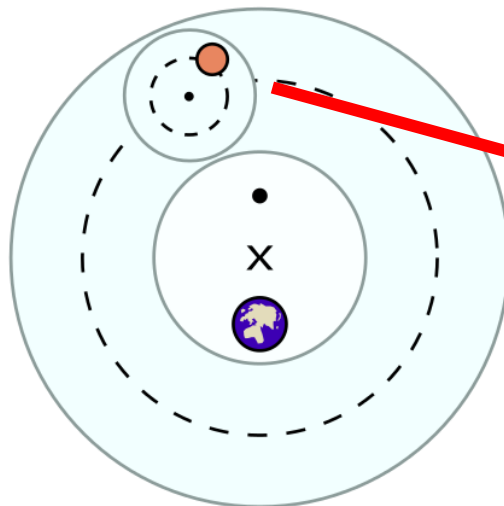
https://www.youtube.com/watch?v=u_y1S8C0Hmc

- used in wrist watches, automobiles, bicycles, PVD, ...

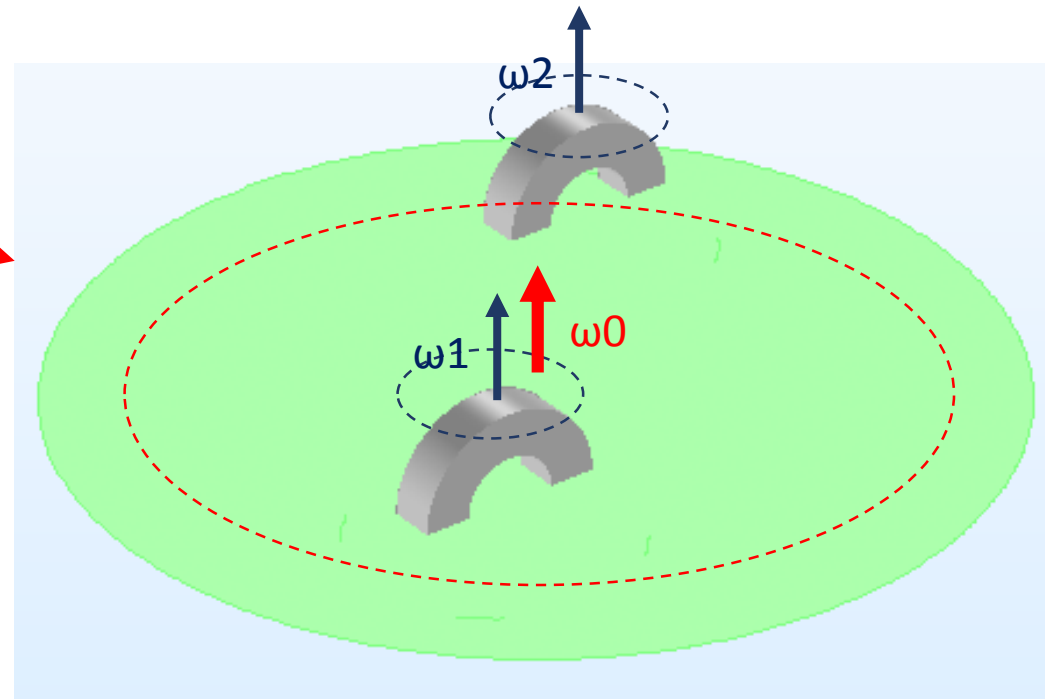


Motivation

- Study magnetic field distributions generated by magnets moving in epicyclic paths
- Implement epicyclic motion of magnets in magnetostatic simulation

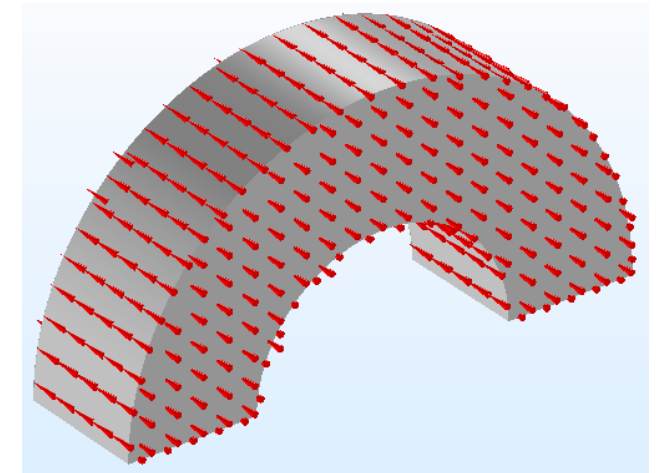
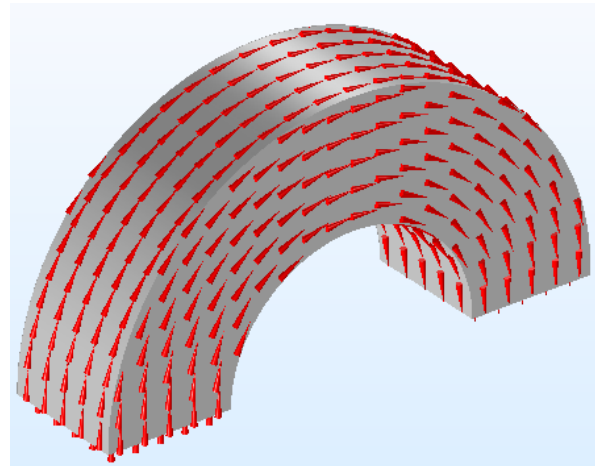


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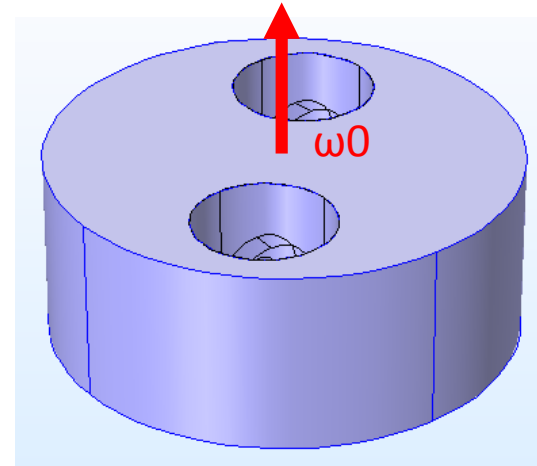
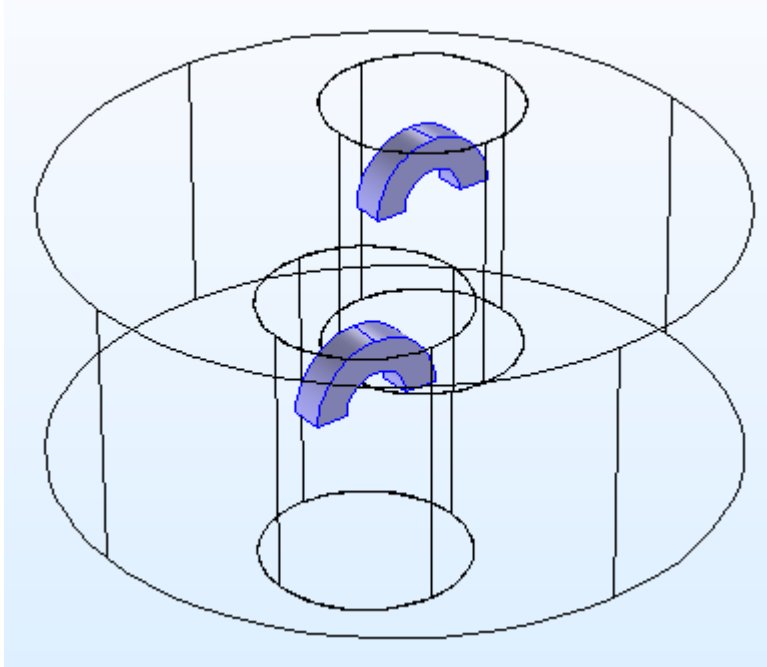
Model

- Horseshoe magnets
- Finding out magnetization(M) configurations within magnets
- Curvilinear coordinates

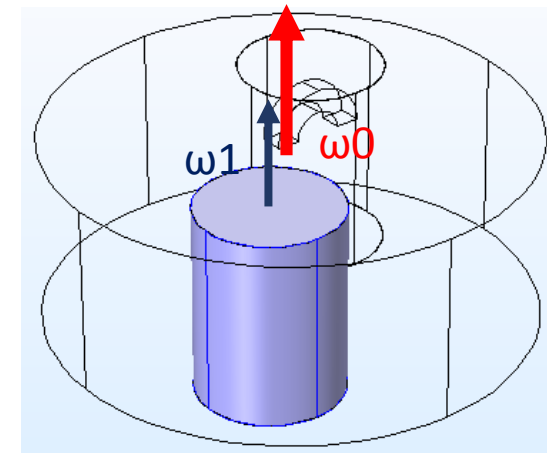
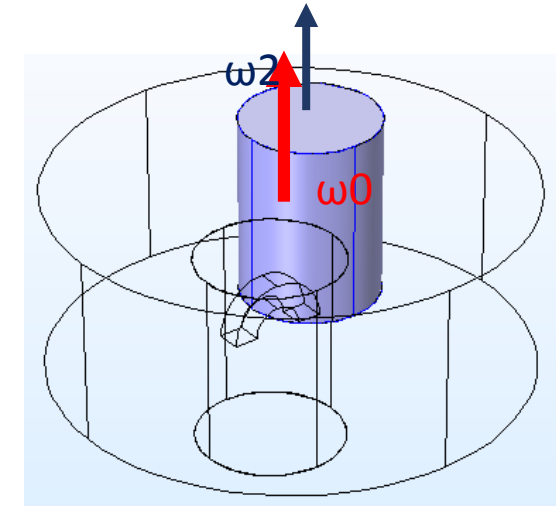


Model

- Magnetic Fields no current
- Deformed Mesh

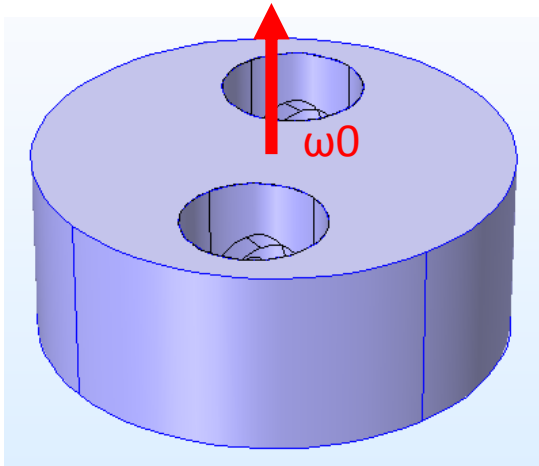


Universal rotation



Model

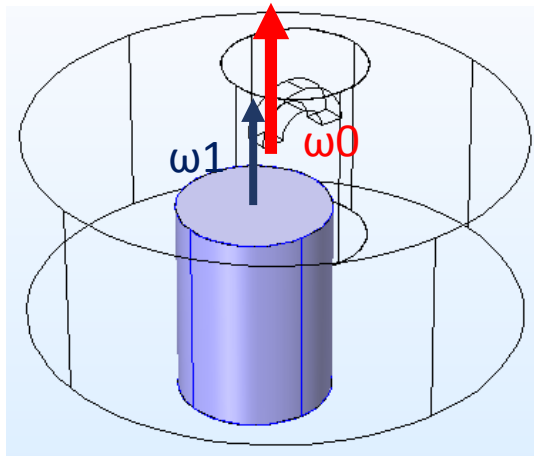
- Universal Rotation



$$\begin{bmatrix} x_{universal}(x_0, y_0, t) \\ y_{universal}(x_0, y_0, t) \\ z_{universal}(t) \end{bmatrix} = \begin{bmatrix} \cos(\omega_0 t) & -\sin(\omega_0 t) & 0 \\ \sin(\omega_0 t) & \cos(\omega_0 t) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_0 - x_{0,center} \\ y_0 - y_{0,center} \\ z_0 \end{bmatrix}$$

Model

- Self-rotation



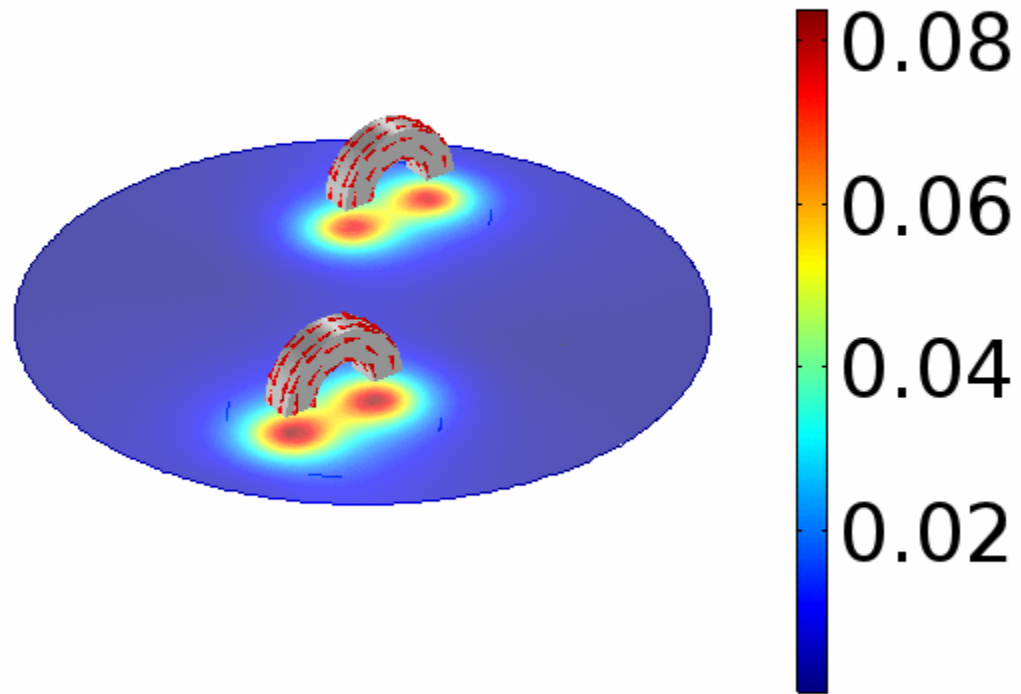
$$\begin{bmatrix} x_{1,Center}(t) \\ y_{1,Center}(t) \end{bmatrix} = \begin{bmatrix} x_{universal}(x_{1,Center}(0), y_{1,Center}(0), t) \\ y_{universal}(x_{1,Center}(0), y_{1,Center}(0), t) \end{bmatrix}$$

$$\begin{bmatrix} x_1(t) \\ y_1(t) \\ z_1(t) \end{bmatrix} = \begin{bmatrix} \cos(\omega_1 t) & -\sin(\omega_1 t) & 0 \\ \sin(\omega_1 t) & \cos(\omega_1 t) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_{universal}(t) - x_{1,Center}(t) \\ y_{universal}(t) - y_{1,Center}(t) \\ z_0 \end{bmatrix}$$

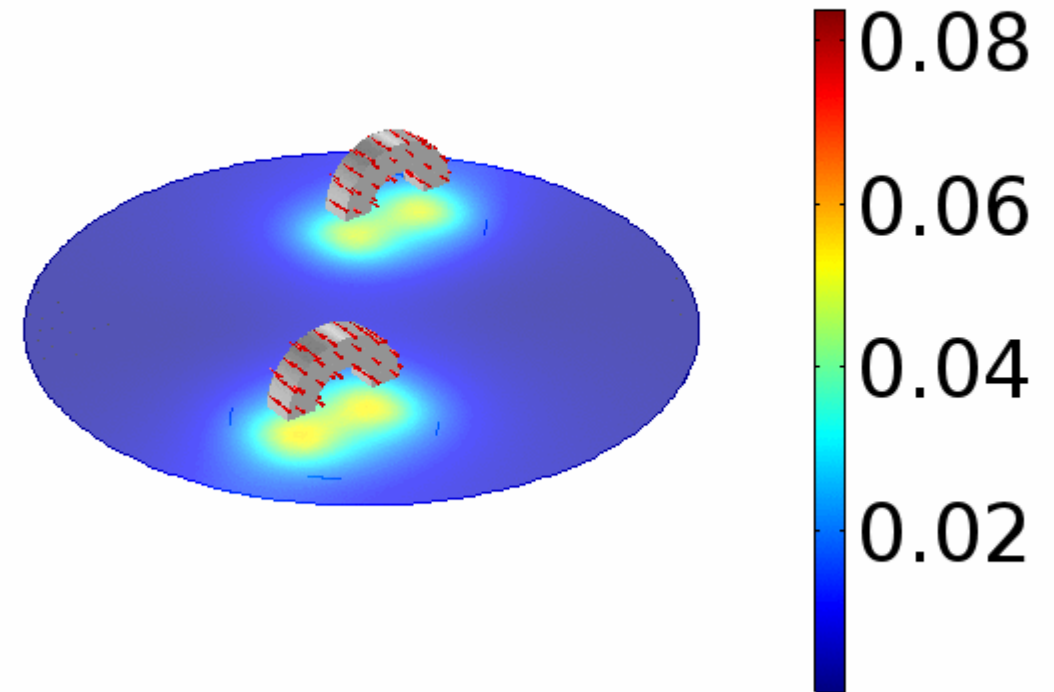
- Similarly for ω_2 rotation



Results



<http://www.pitotech.com.tw/Magnetic%20Configuration%201.gif>



<http://www.pitotech.com.tw/Magnetic%20Configuration%202.gif>



Thank you

