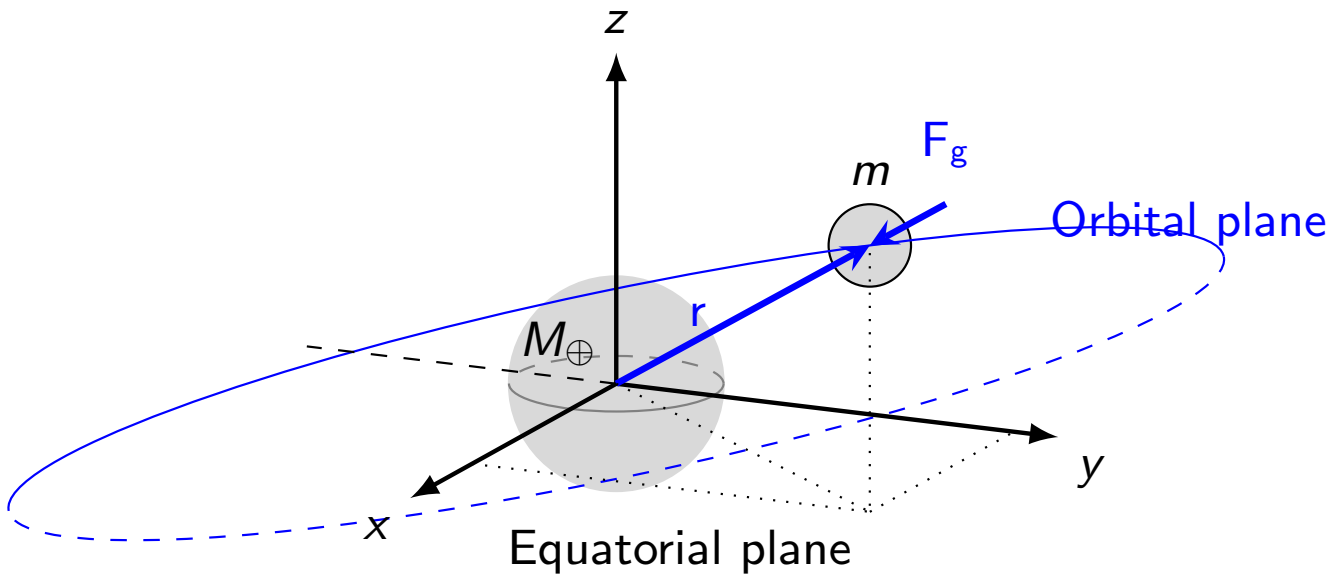
Newton's law of universal gravitation



Newton's law of universal gravitation: $\mathrm{F_g} = -G\dfrac{M_\oplus m}{r^2}\left(\dfrac{\mathrm{r}}{r}\right)$ (1)

Kepler's second law

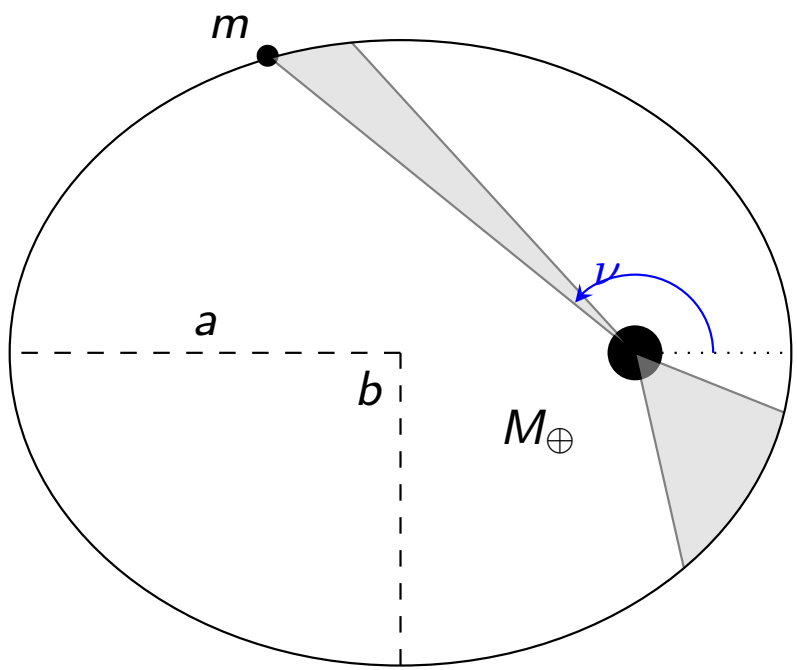


Figure: Kepler's second law.

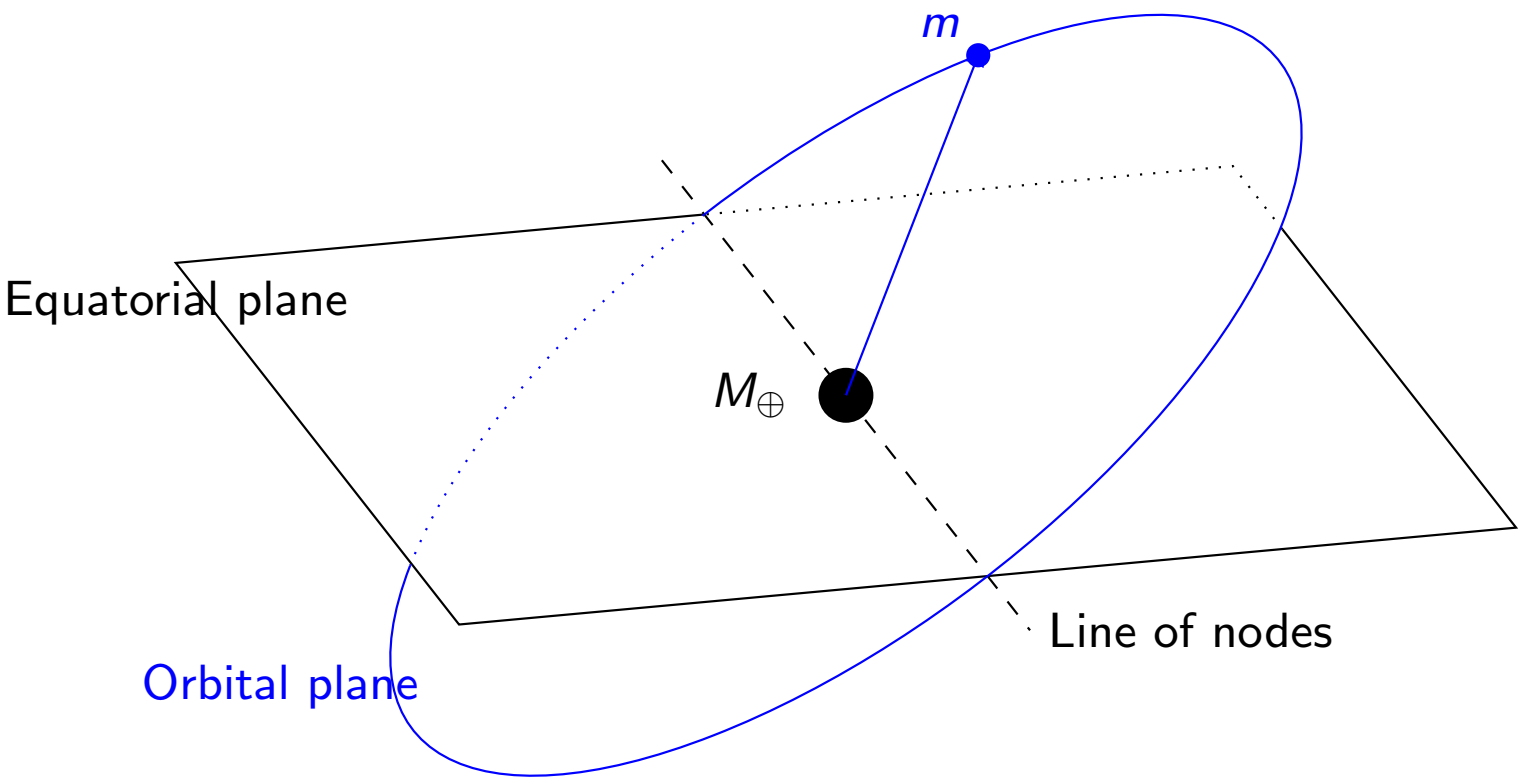


Figure: Orbital elements or Keplerian elements

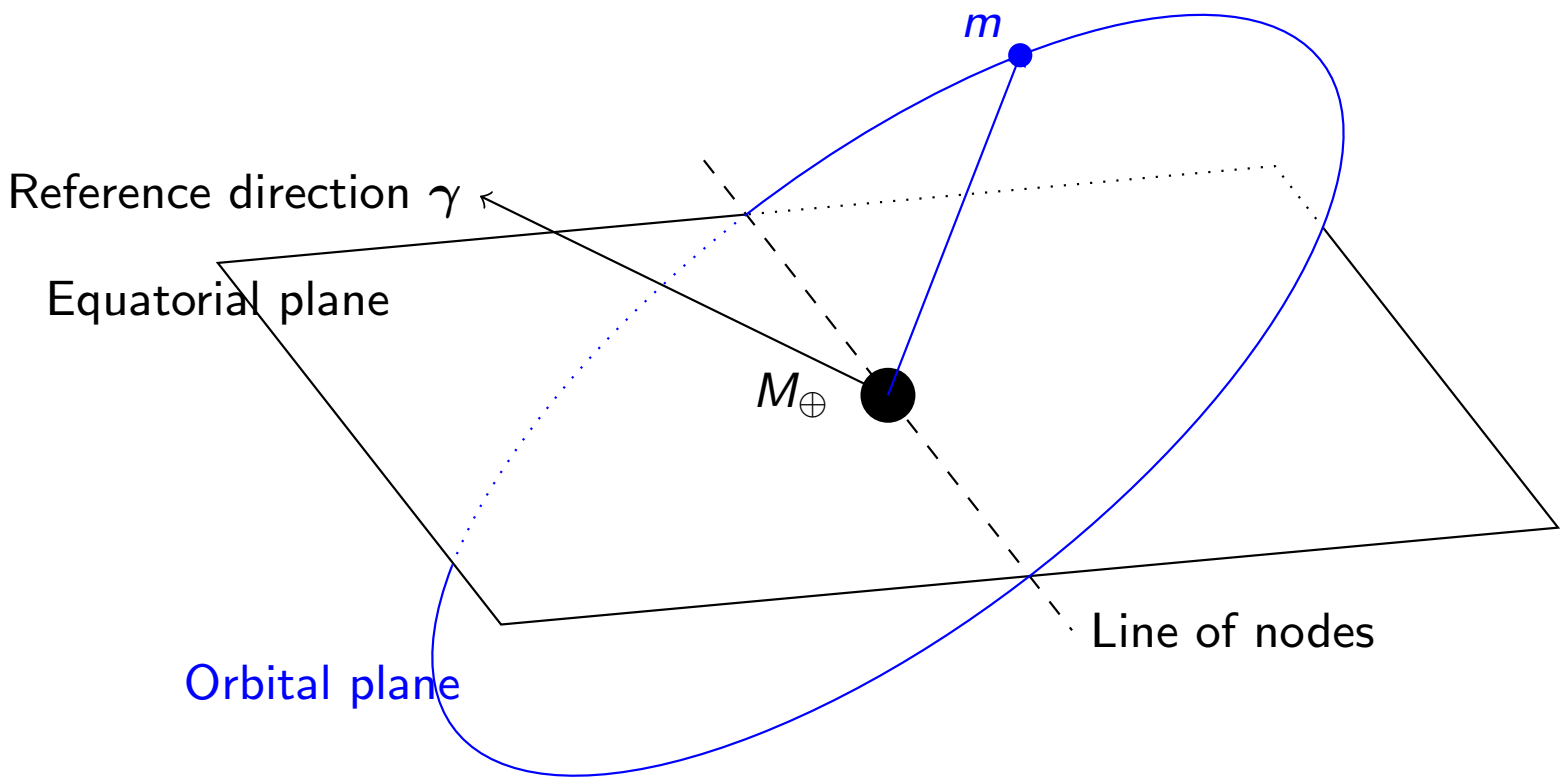


Figure: Orbital elements or Keplerian elements

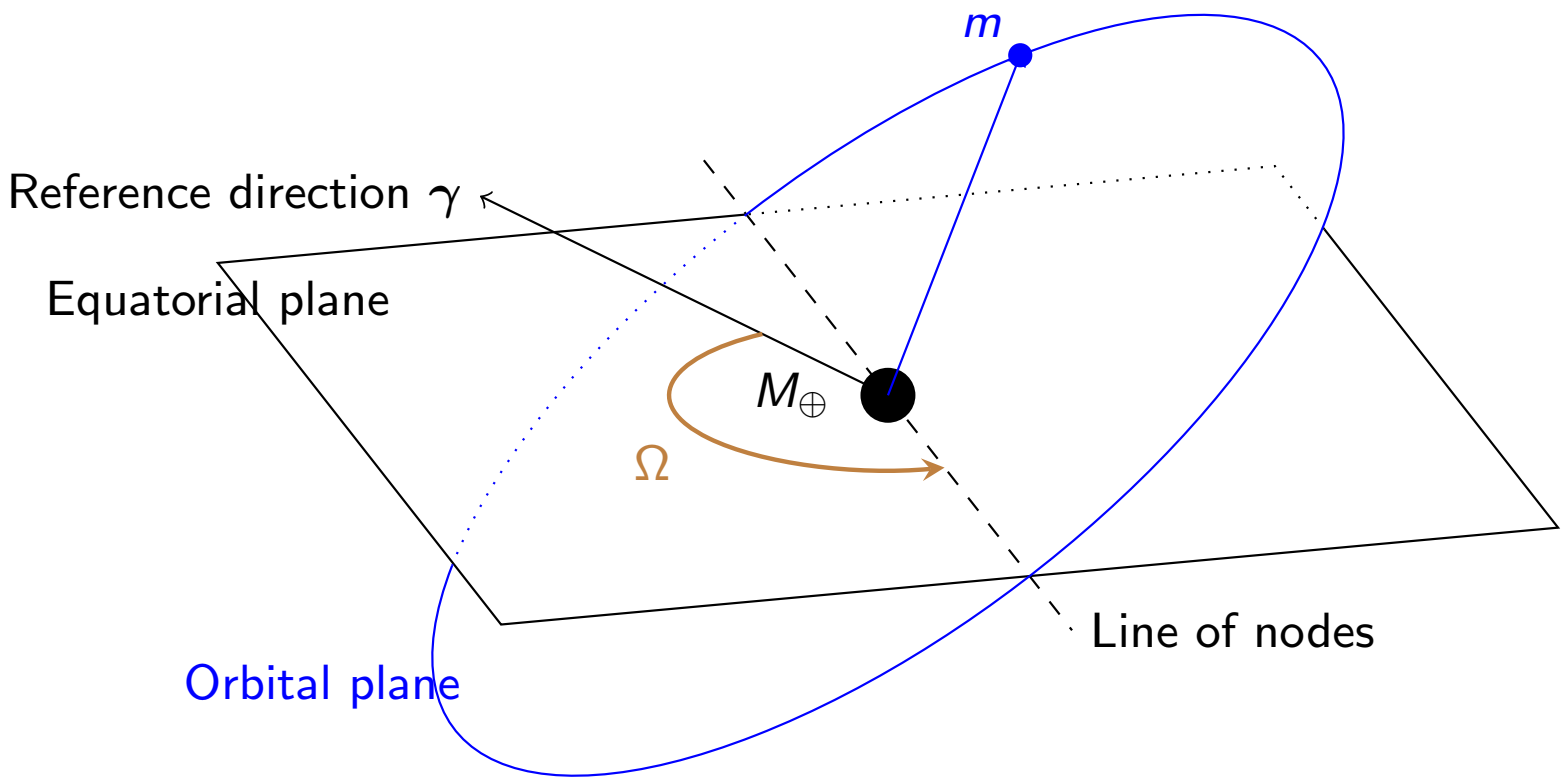


Figure: Orbital elements or Keplerian elements

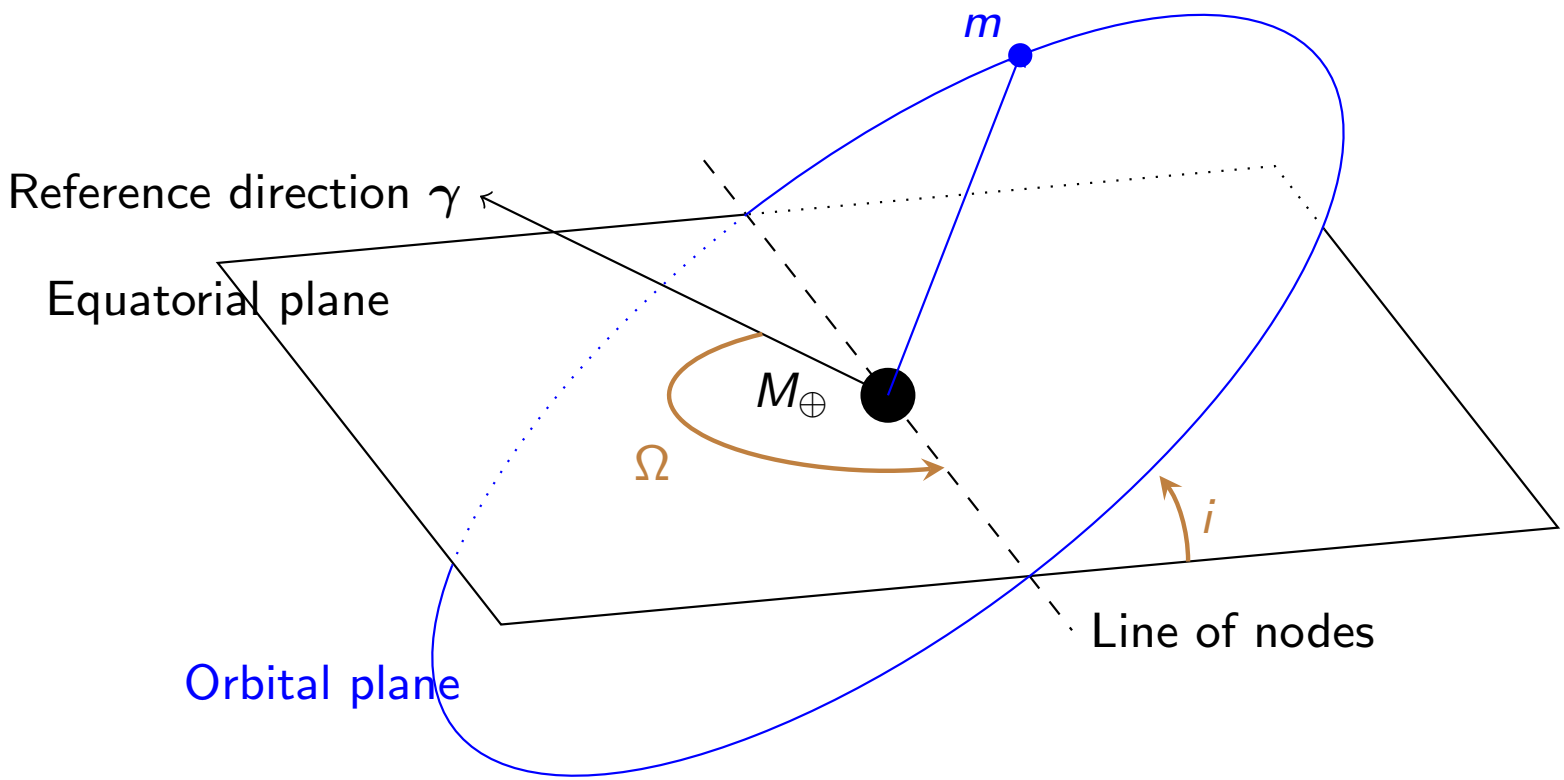


Figure: Orbital elements or Keplerian elements

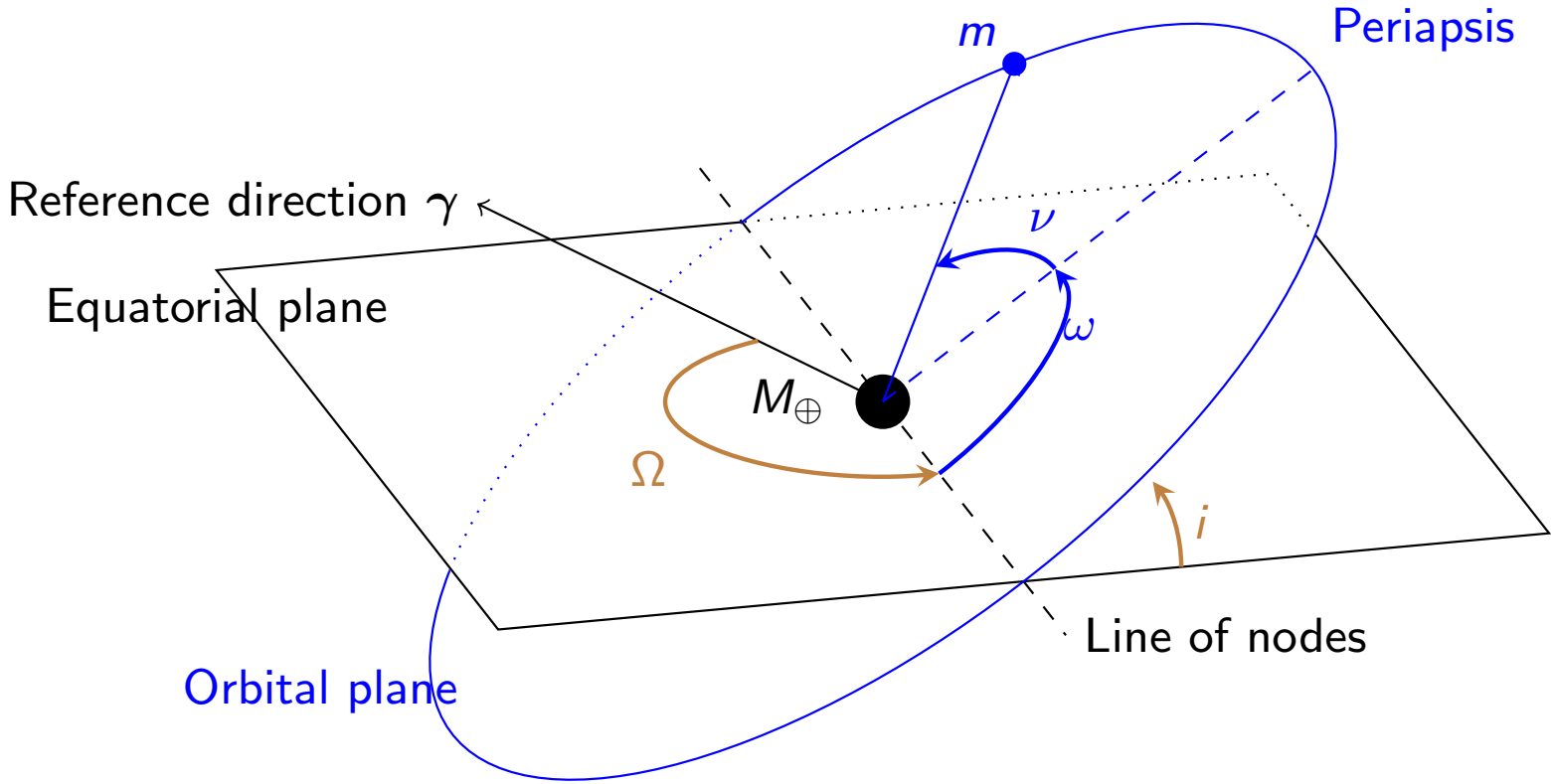
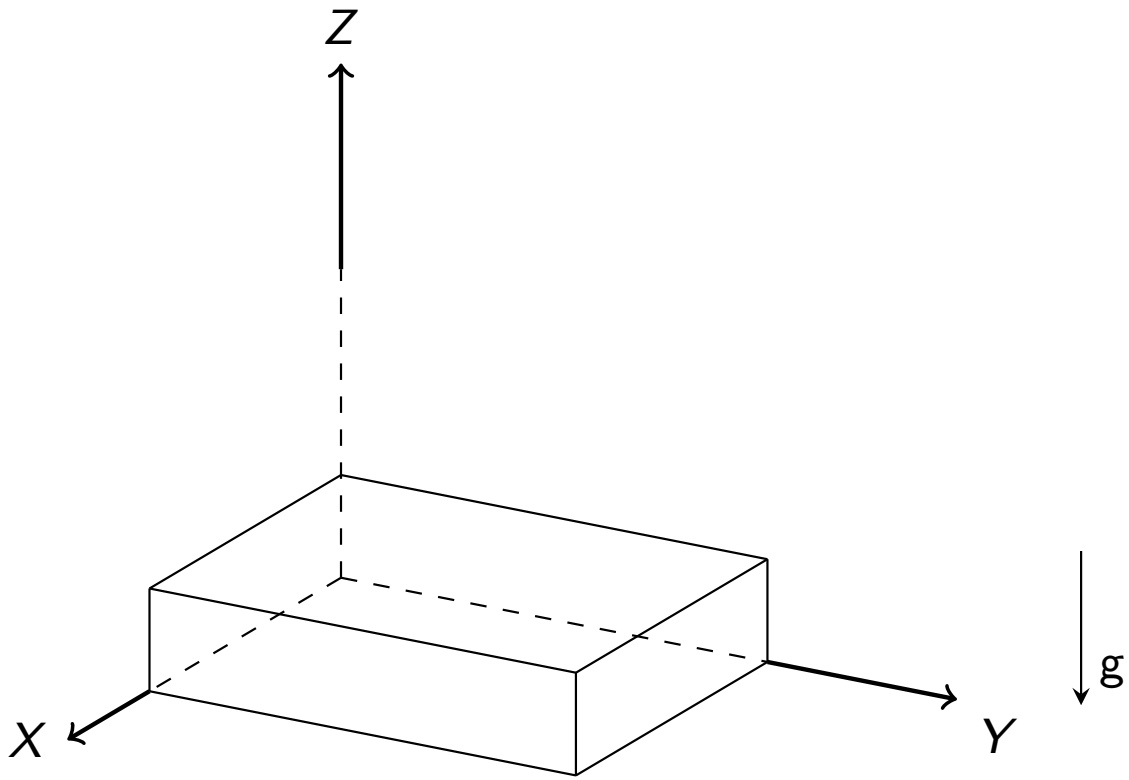
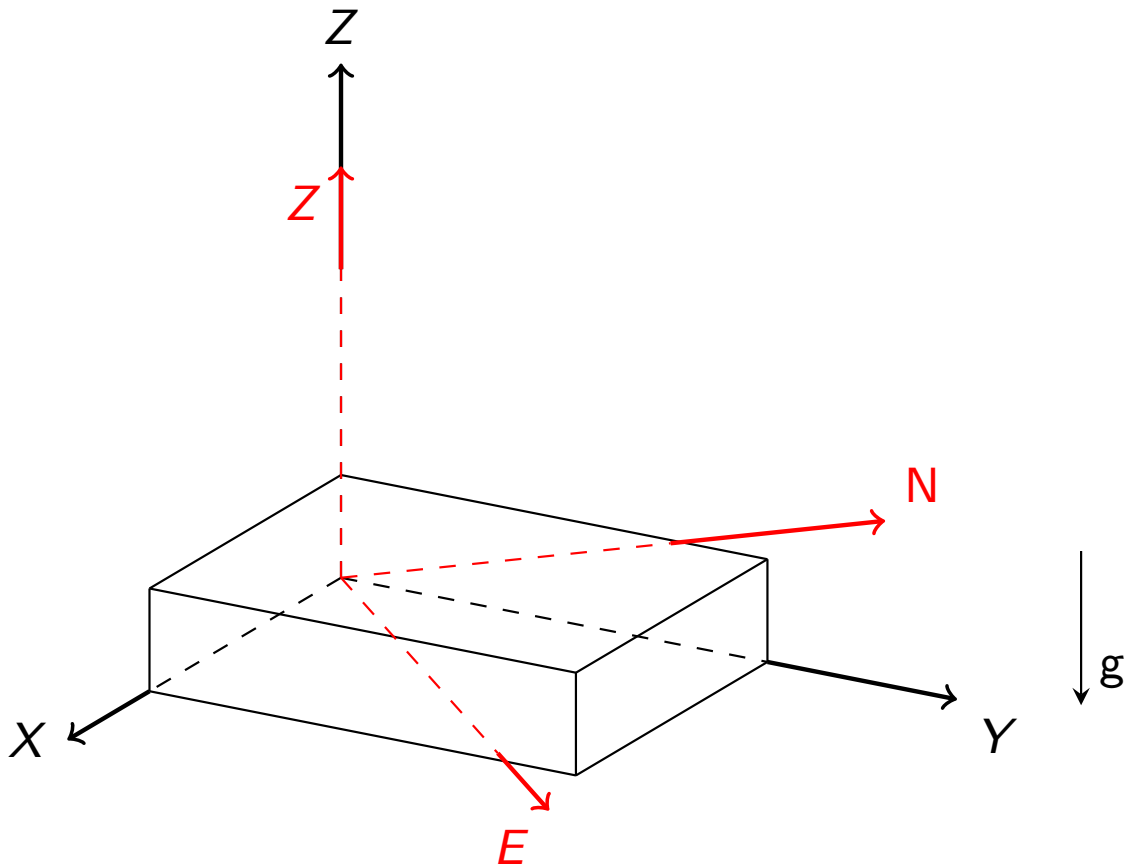


Figure: Orbital elements or Keplerian elements

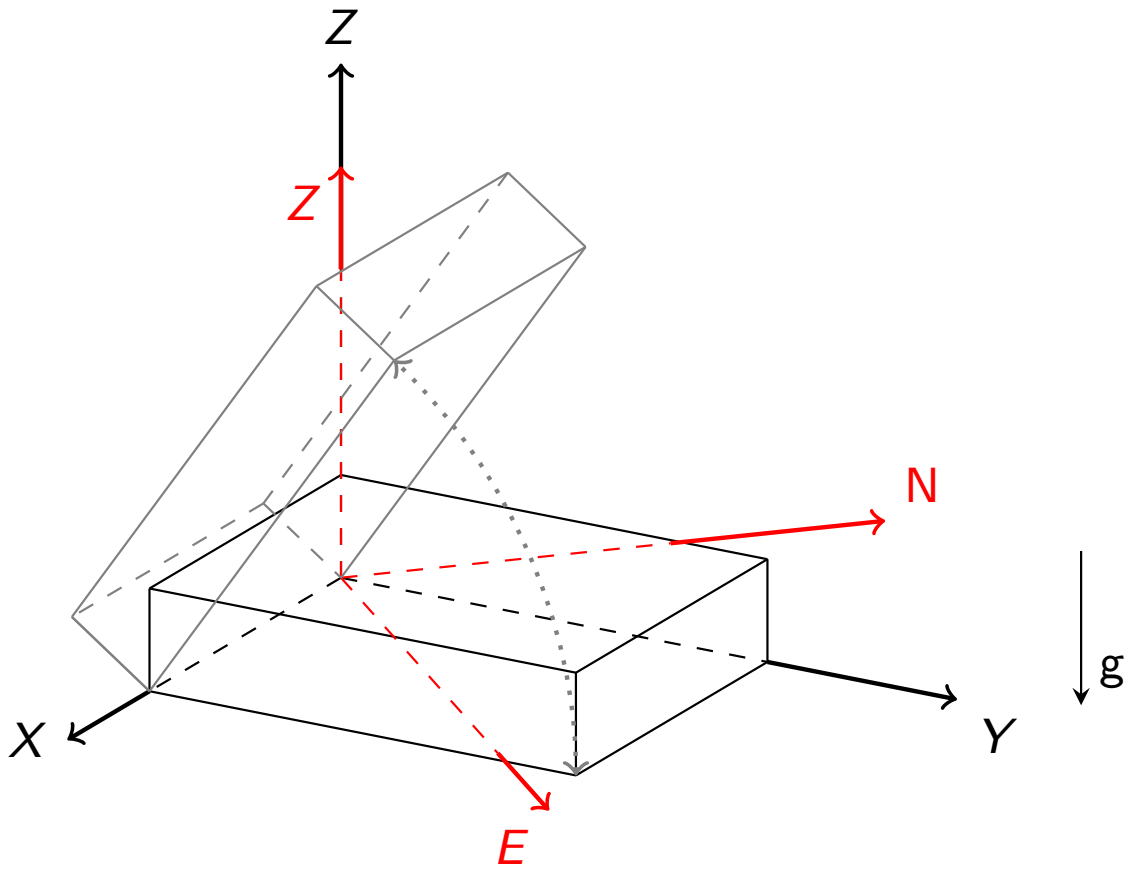
Rotate box around X axis.



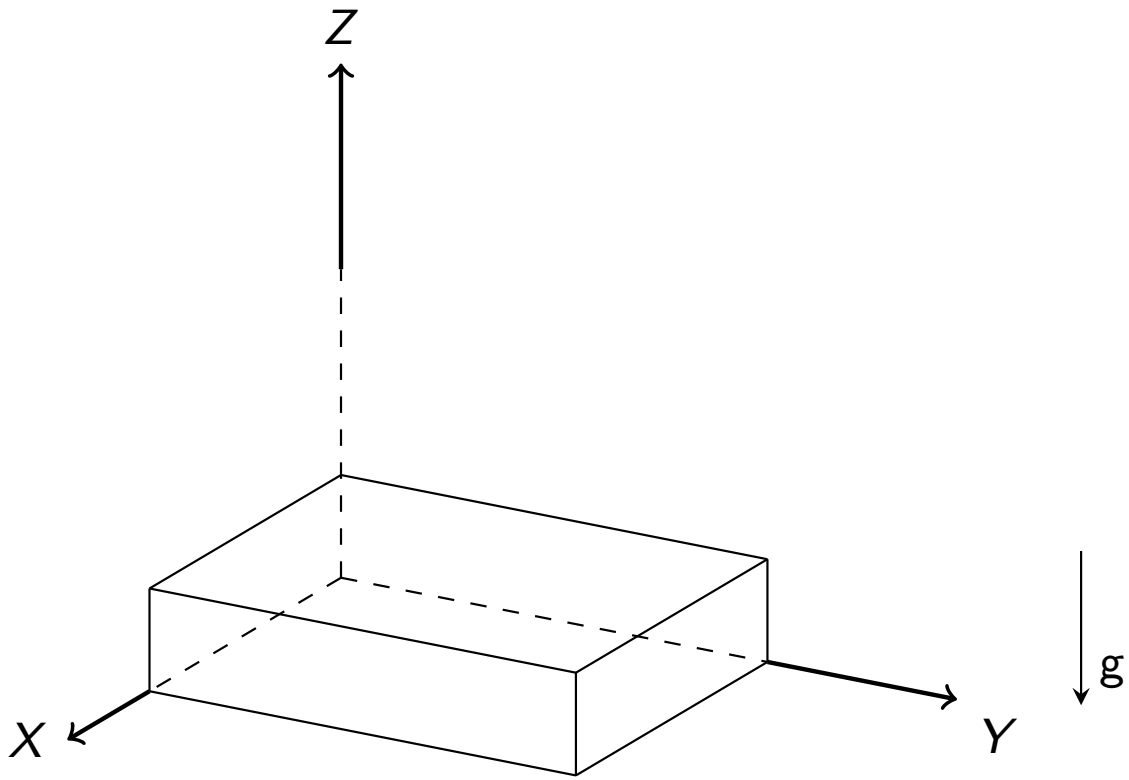
Rotate box around X axis.



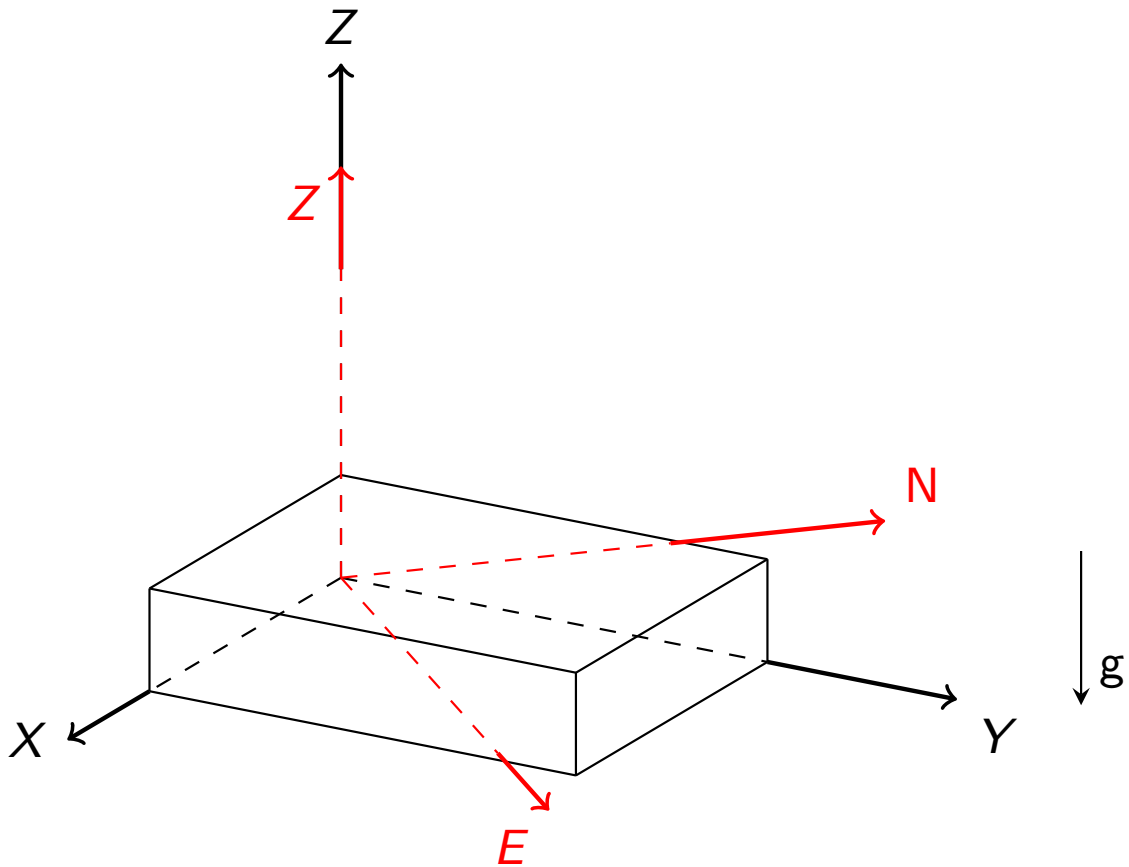
Rotate box around X axis.



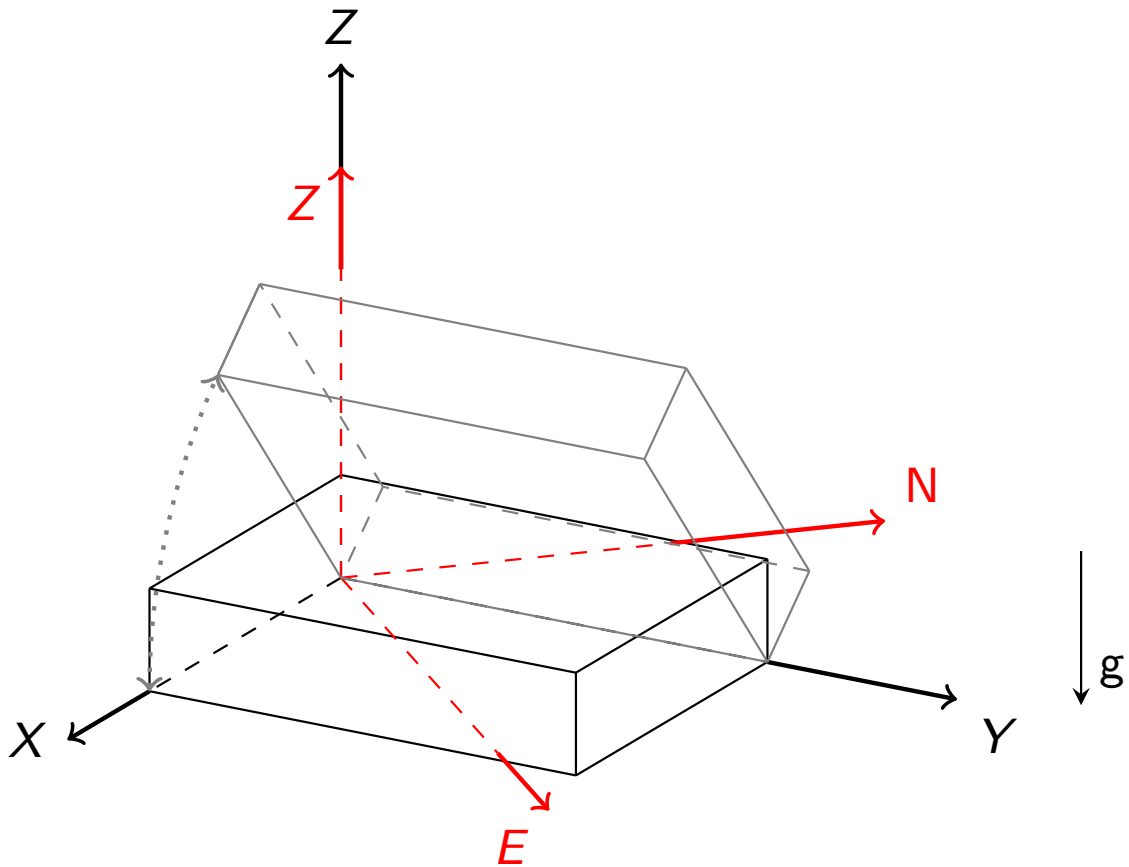
Rotate box around Y axis.



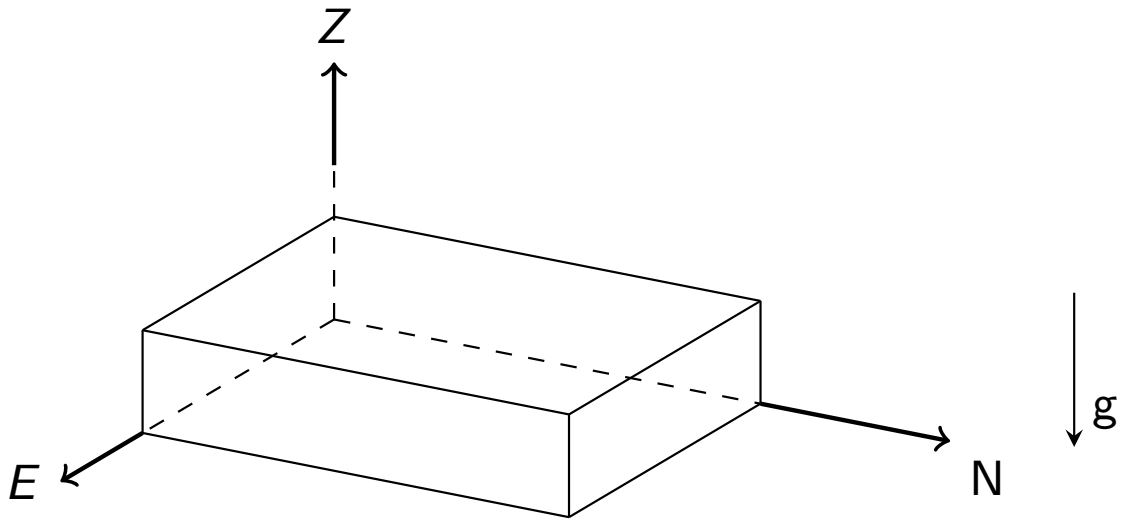
Rotate box around Y axis.



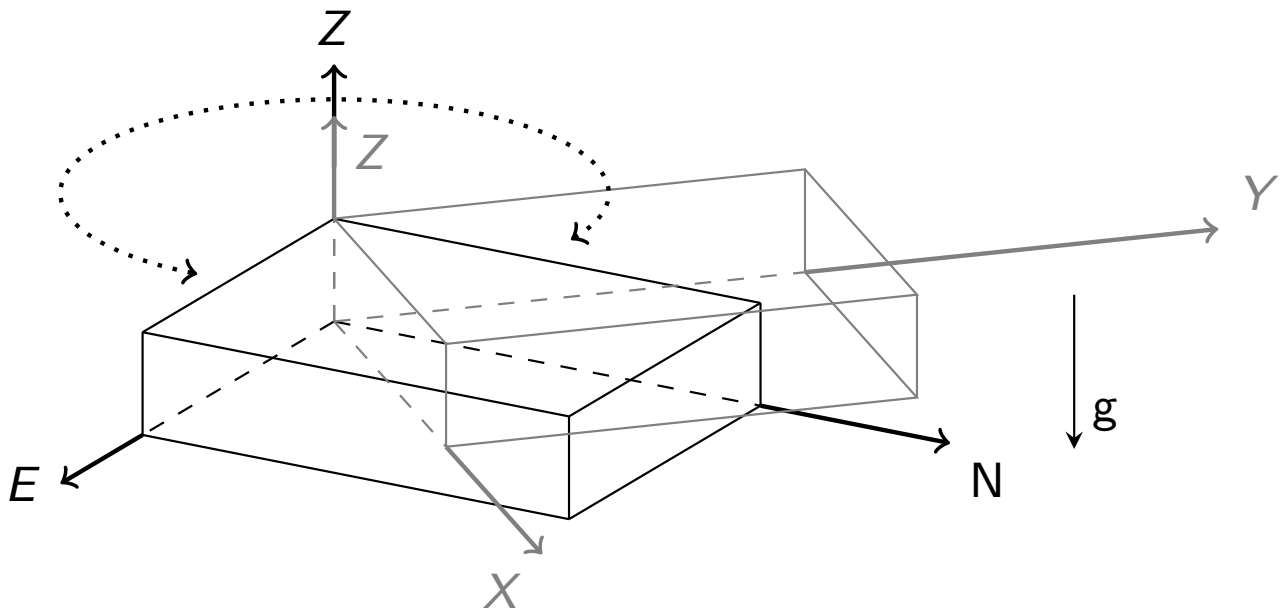
Rotate box around Y axis.



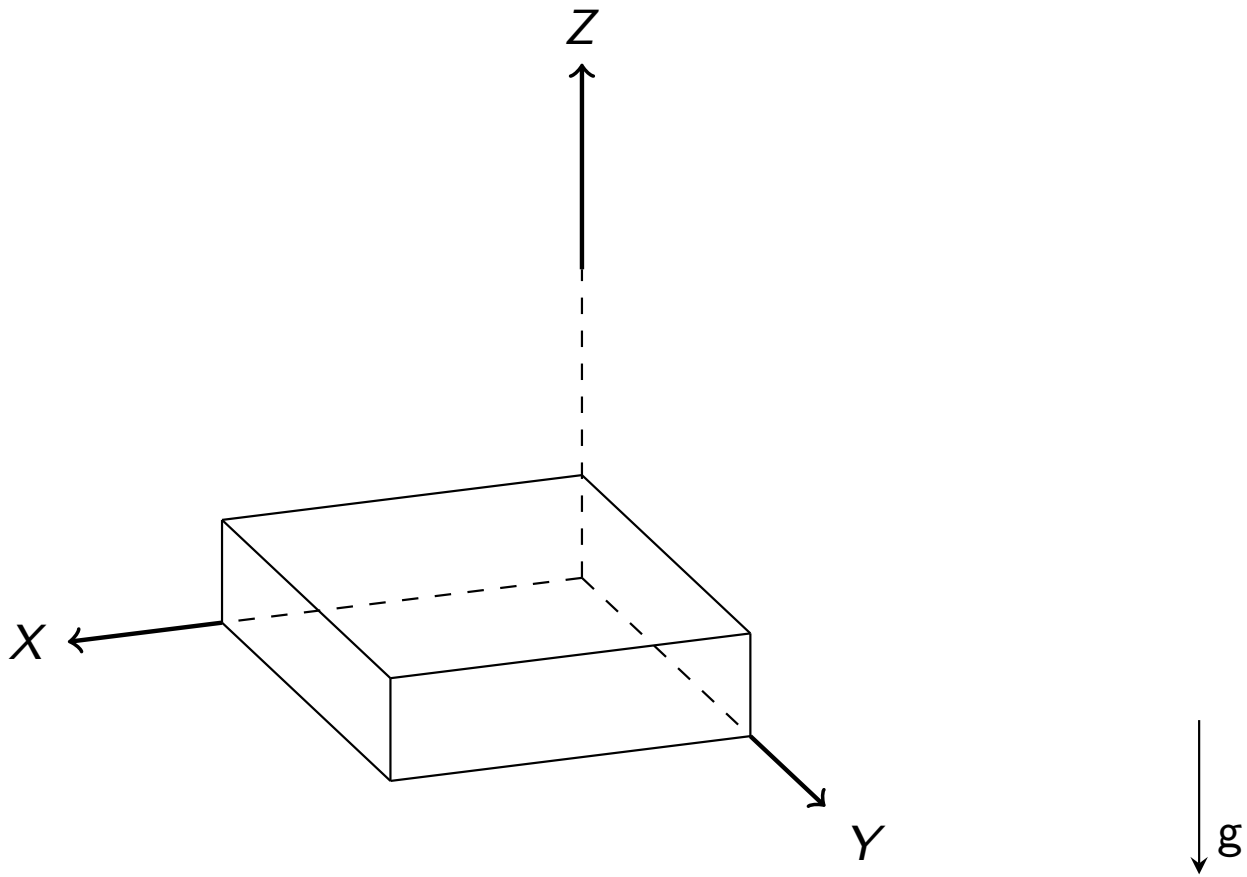
Rotate a box around Z axis



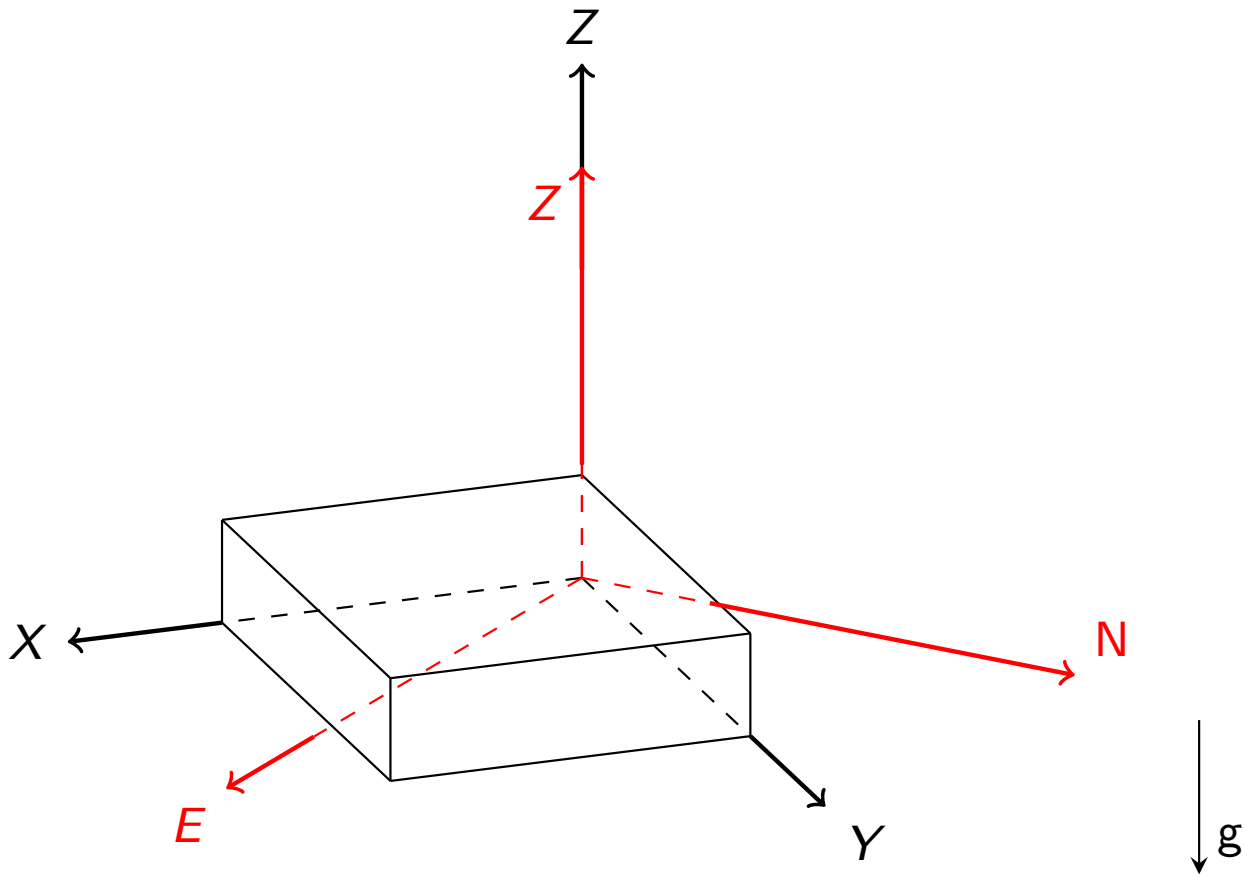
Rotate a box around Z axis



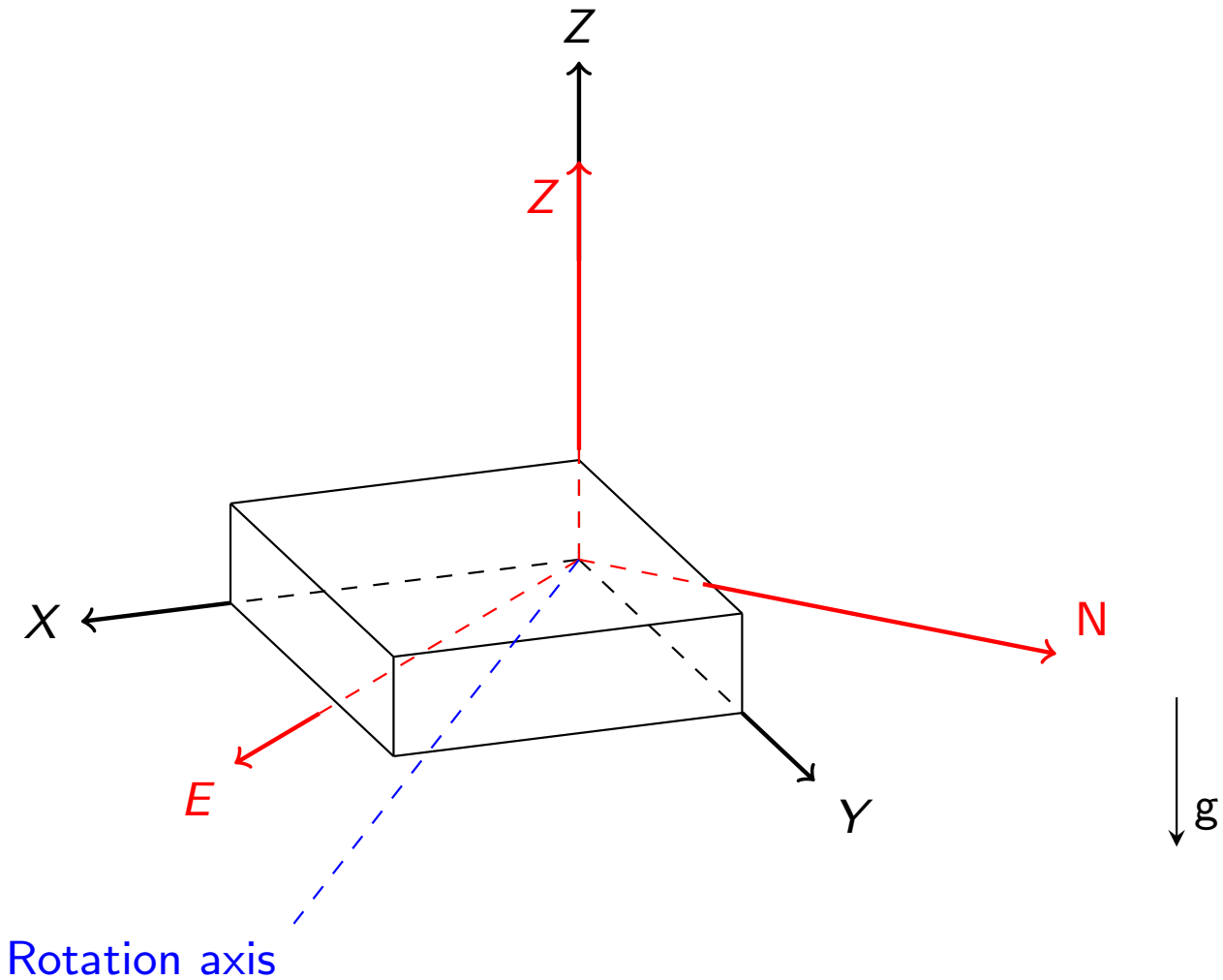
Rotate a box aroud any axis



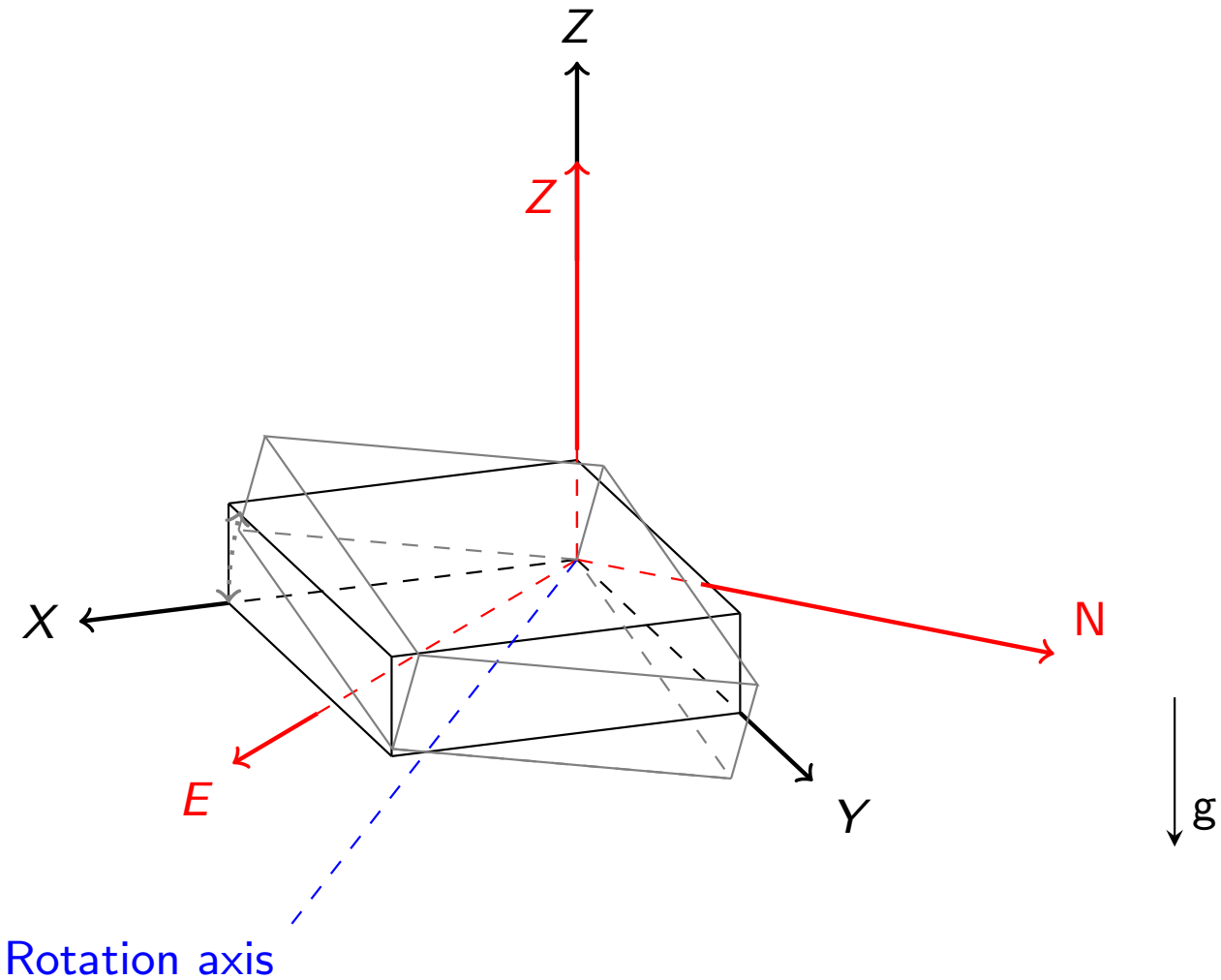
Rotate a box aroud any axis



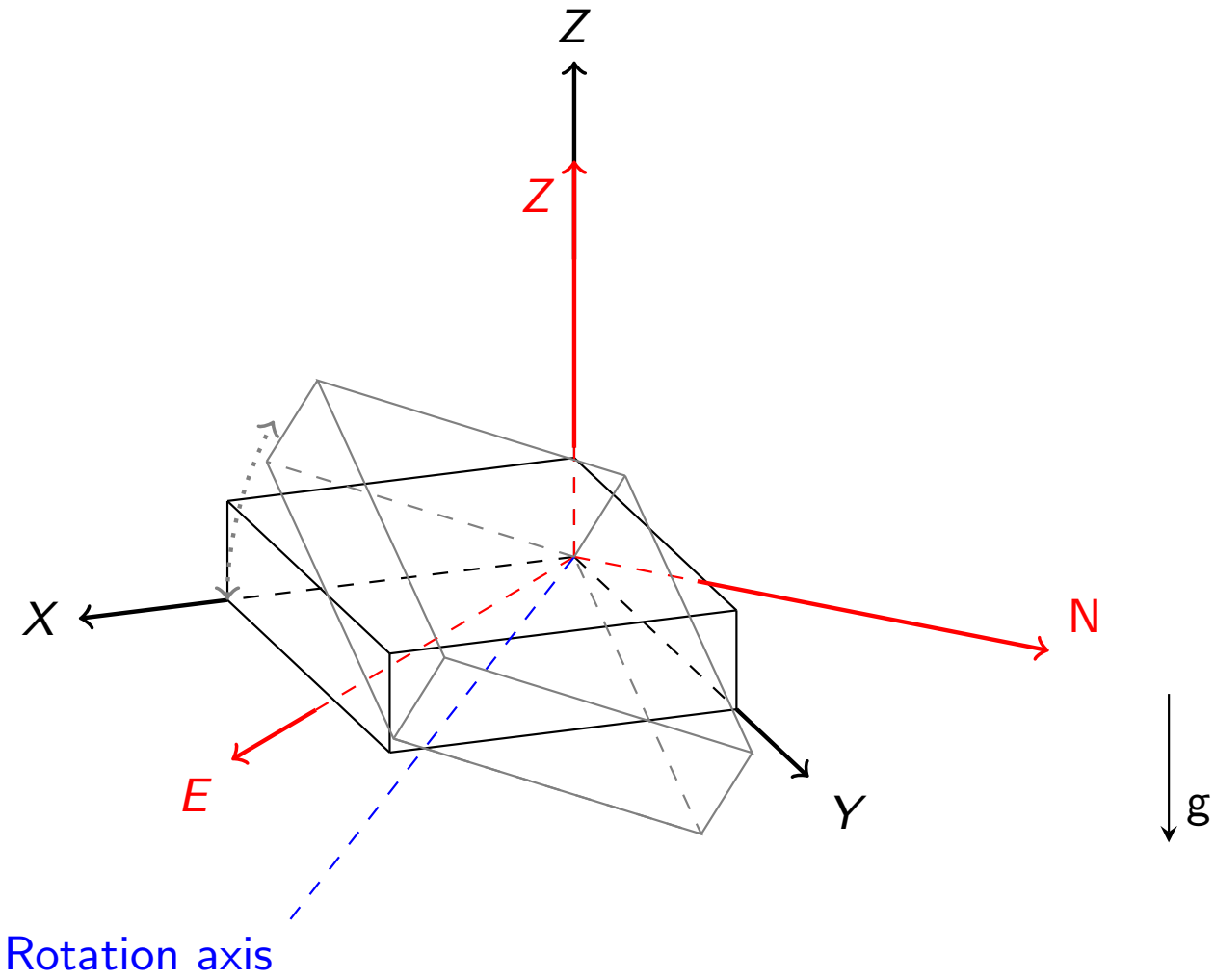
Rotate a box aroud any axis



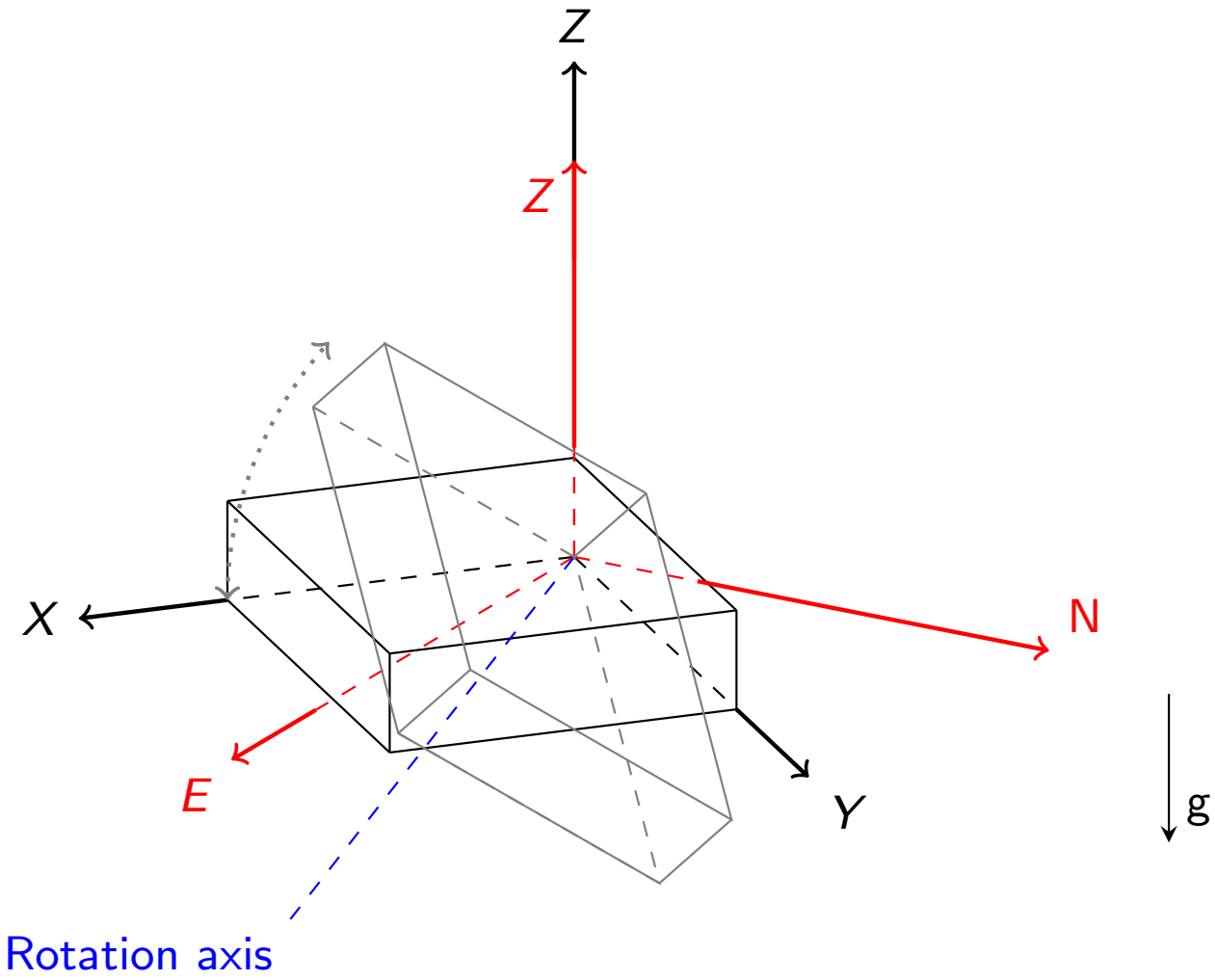
Rotate a box aroud any axis



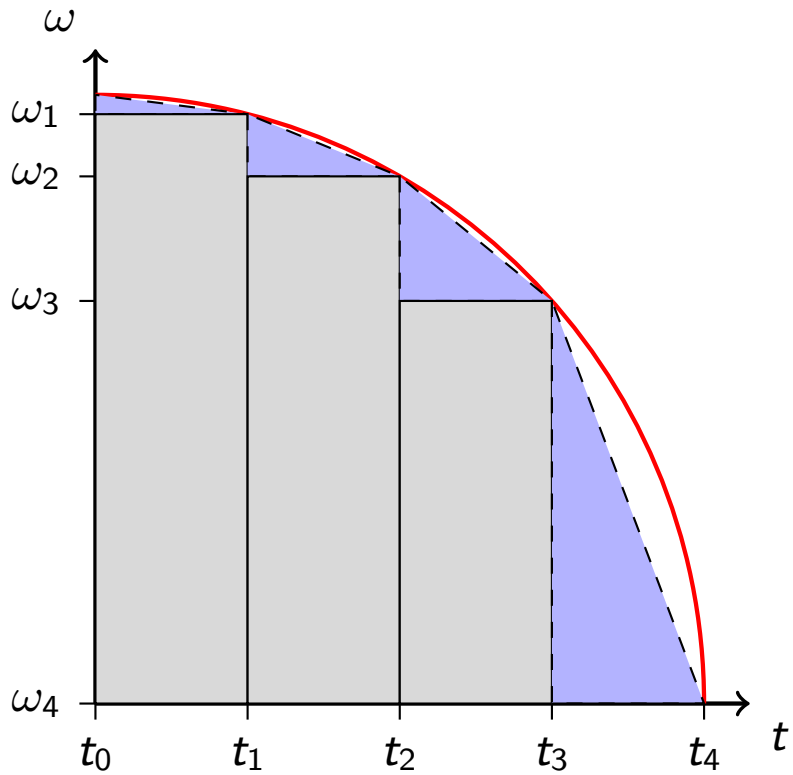
Rotate a box aroud any axis



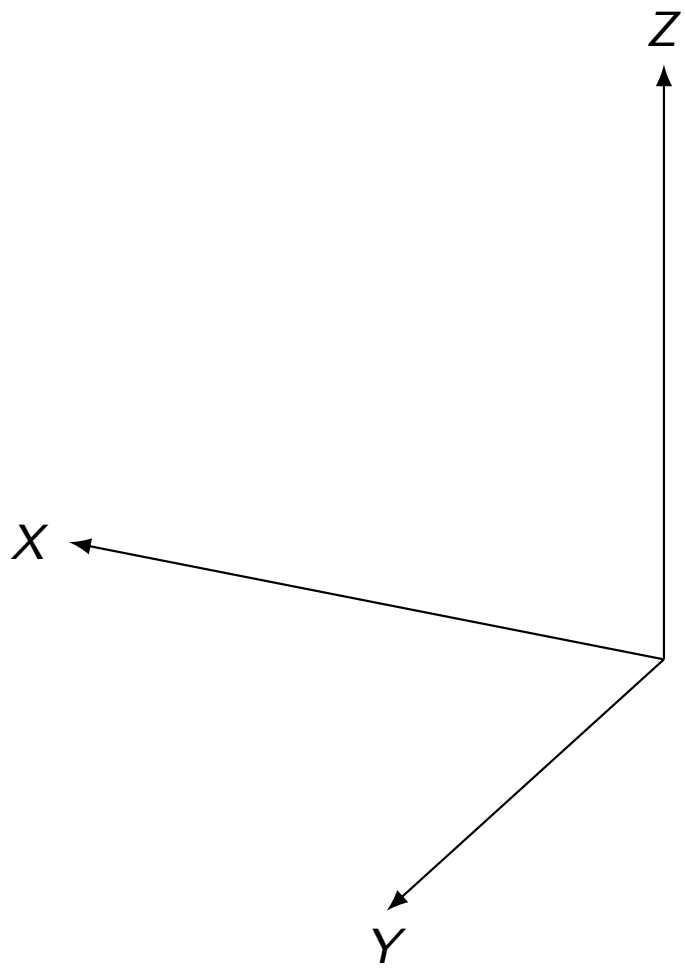
Rotate a box aroud any axis

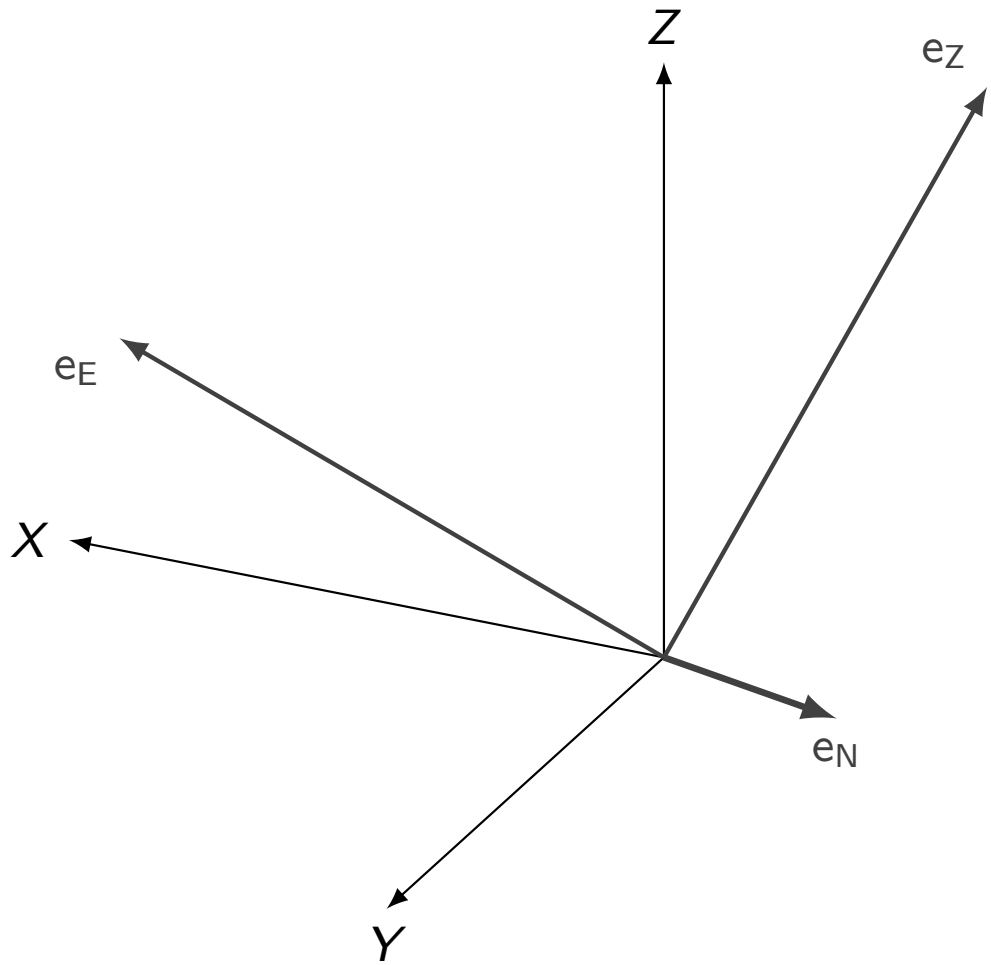


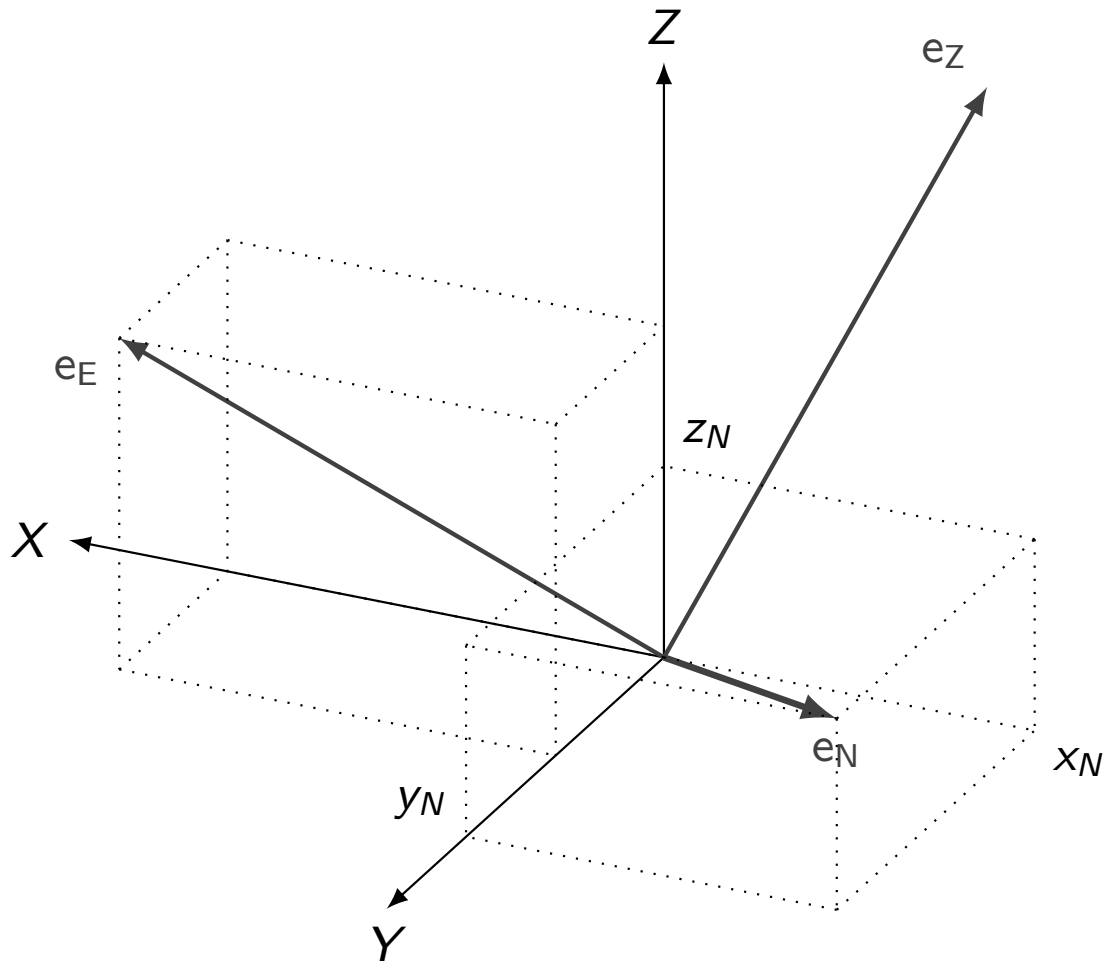
Area ≈ Rectangles + Triangles

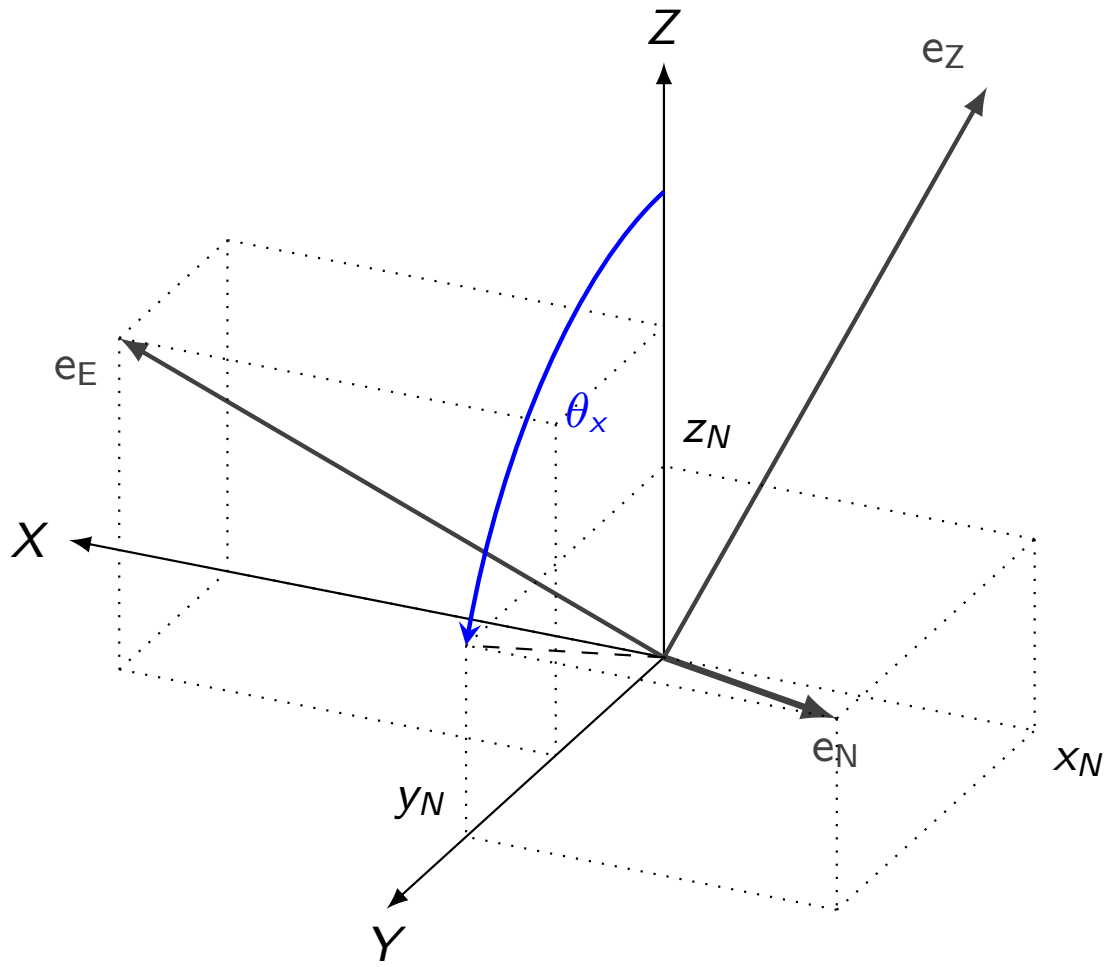


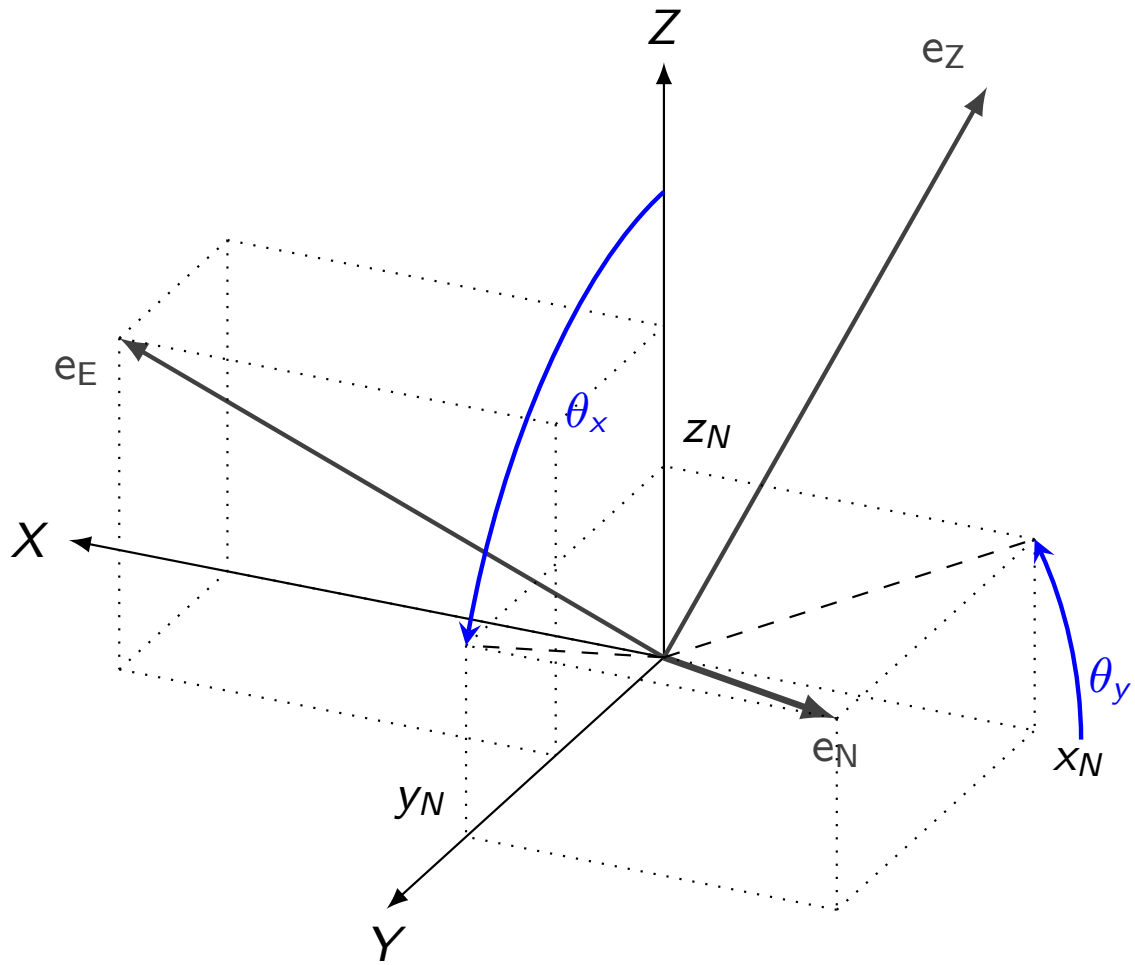
$$\boldsymbol{\theta}_k \approx \boldsymbol{\theta}_{k-1} + (t_k - t_{k-1})\boldsymbol{\omega}_{k-1} + \frac{1}{2}(t_k - t_{k-1})(\boldsymbol{\omega}_k - \boldsymbol{\omega}_{k-1}), \quad k \geq 1 \qquad (2)$$

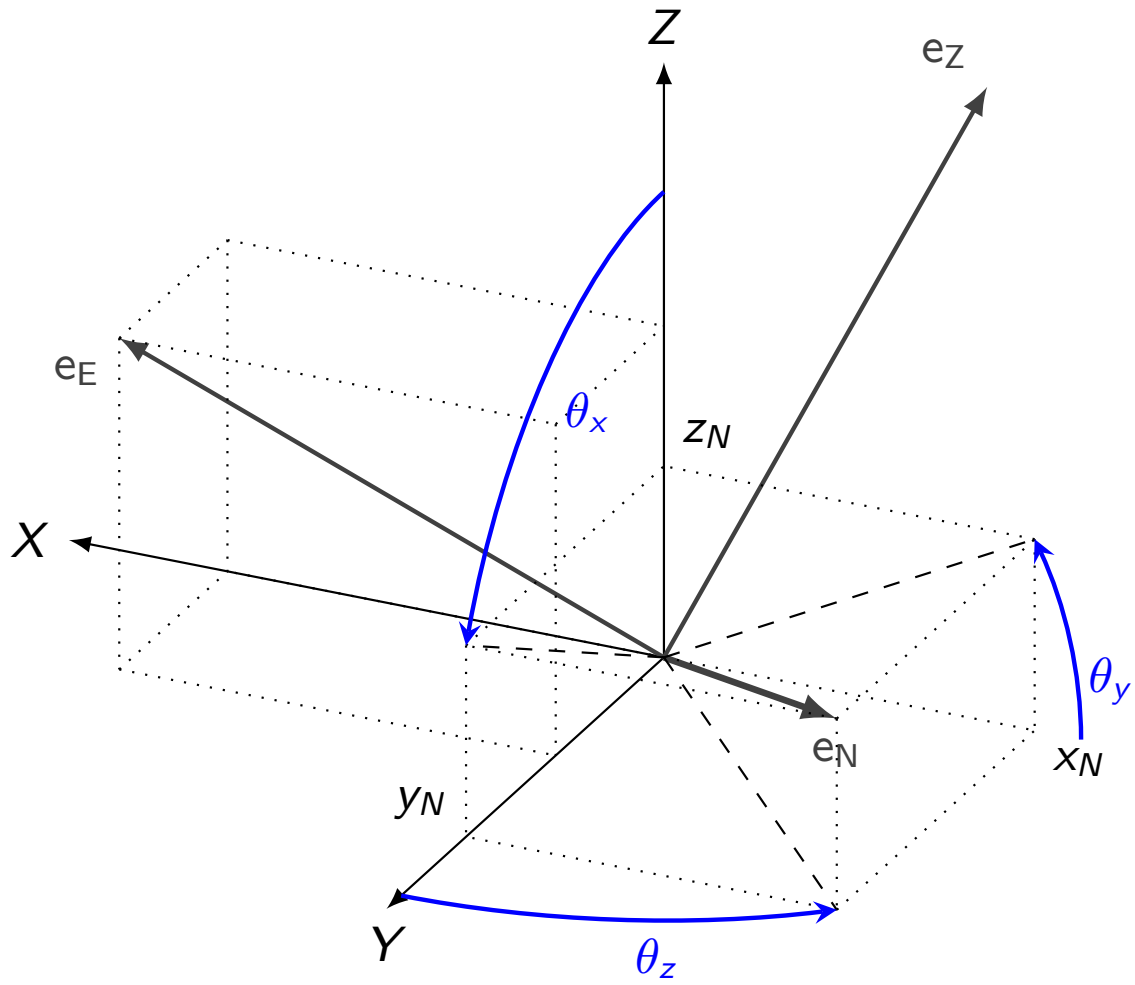

Z
X
Y

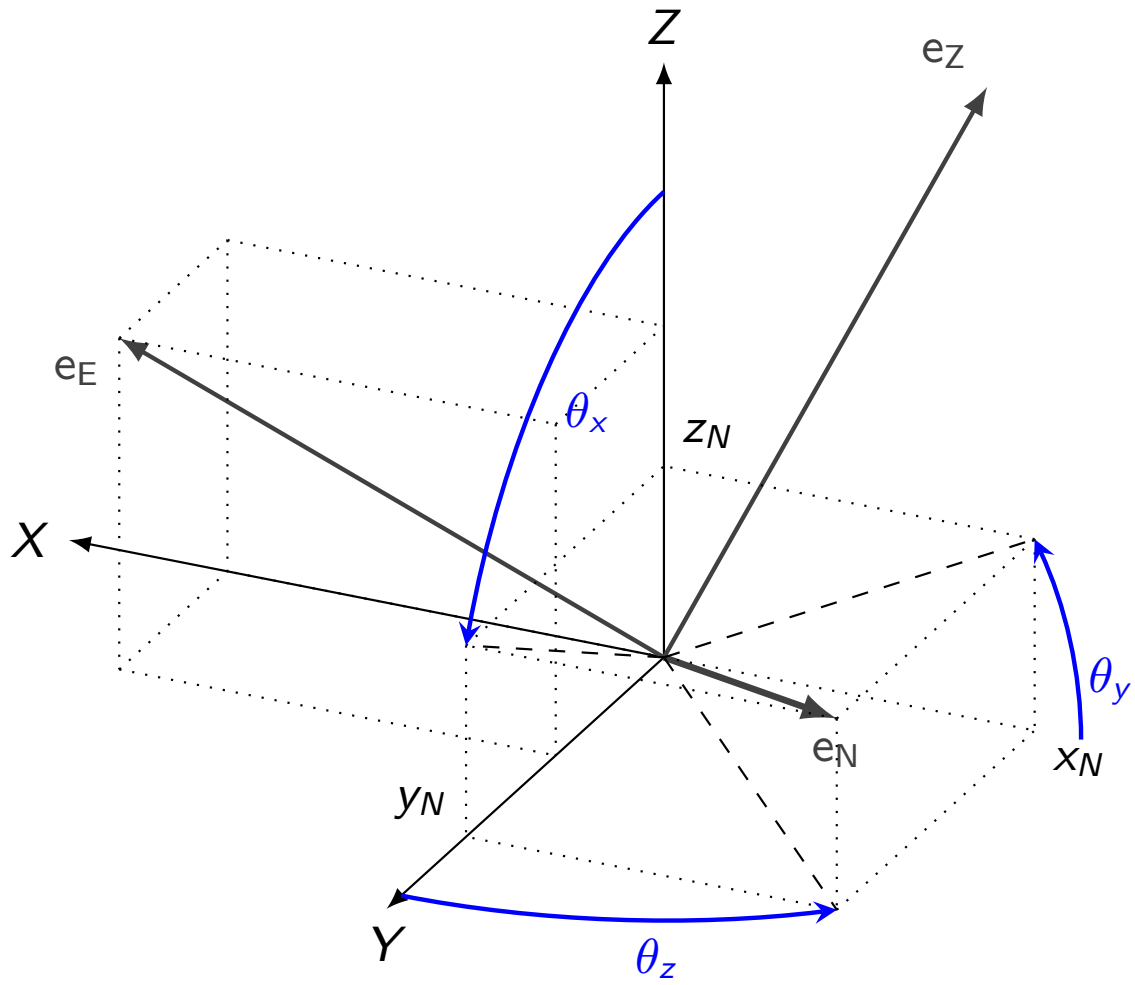

Z
eZ
eE
X
eN
Y


Z
eZ
eE
zN
X
eN
xN
yN
Y


Z
eZ
eE
θx
zN
X
eN
xN
yN
Y


Z
eZ
eE
θx
zN
X
eN
θy
xN
yN
Y

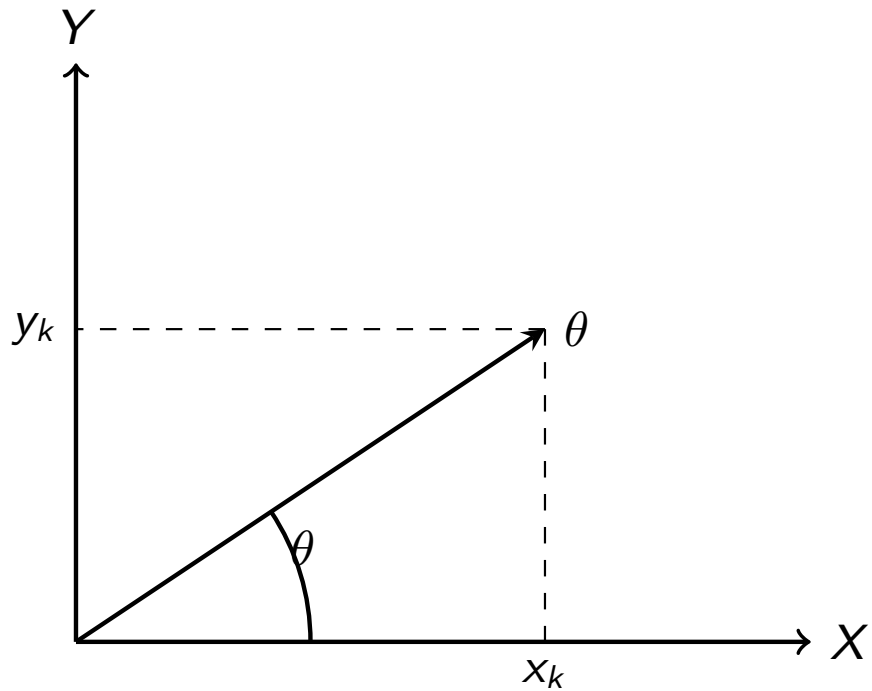

Z
eZ
eE
θx
zN
X
eN
θy
xN
yN
Y
θz

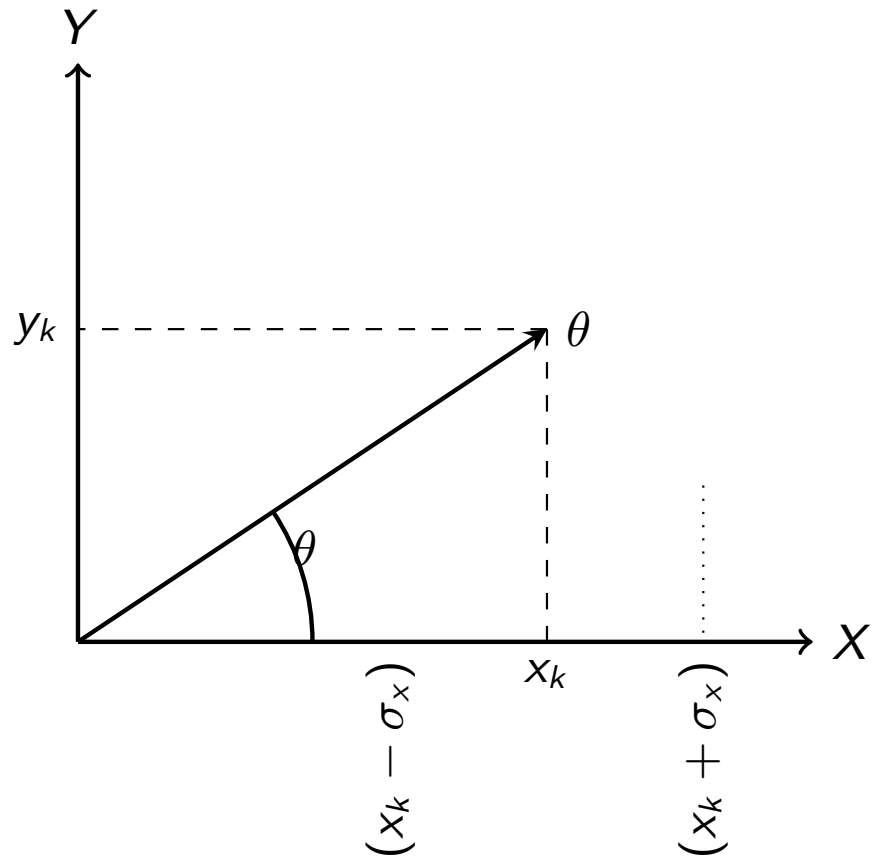


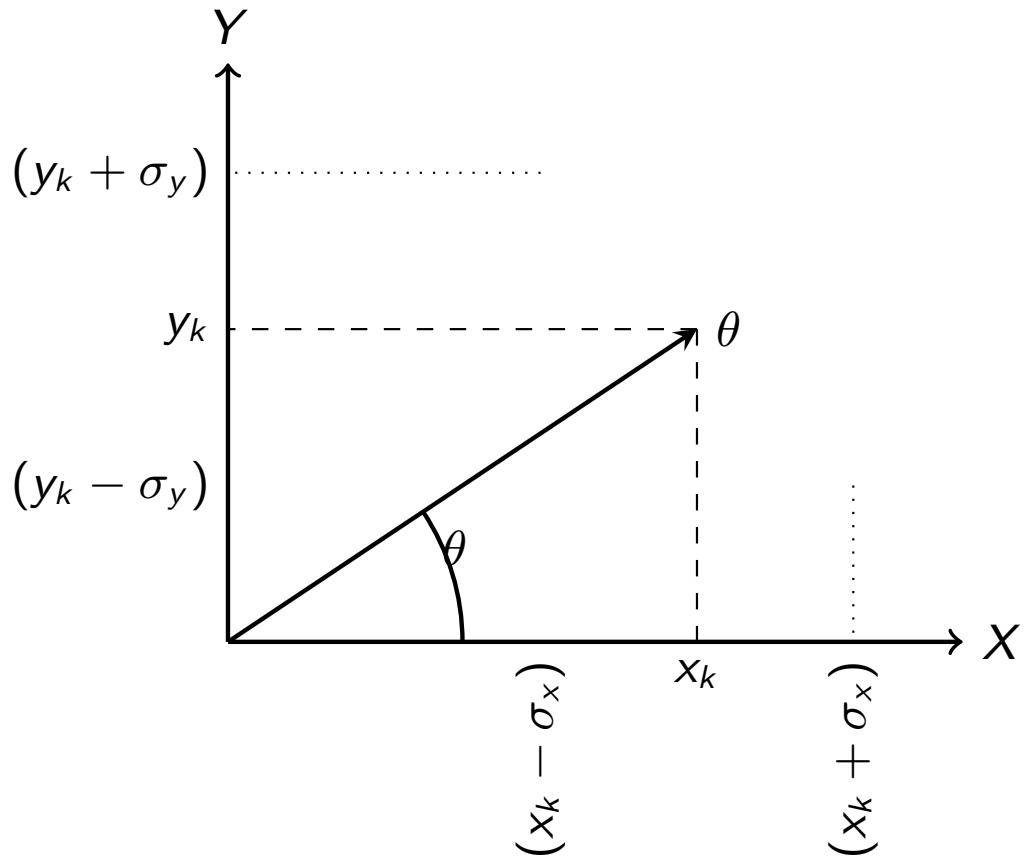
$$Roll(\mathrm{b}): \quad \theta_x = \arctan\left(Y_N/Z_N\right) - 90^\circ \tag{3}$$

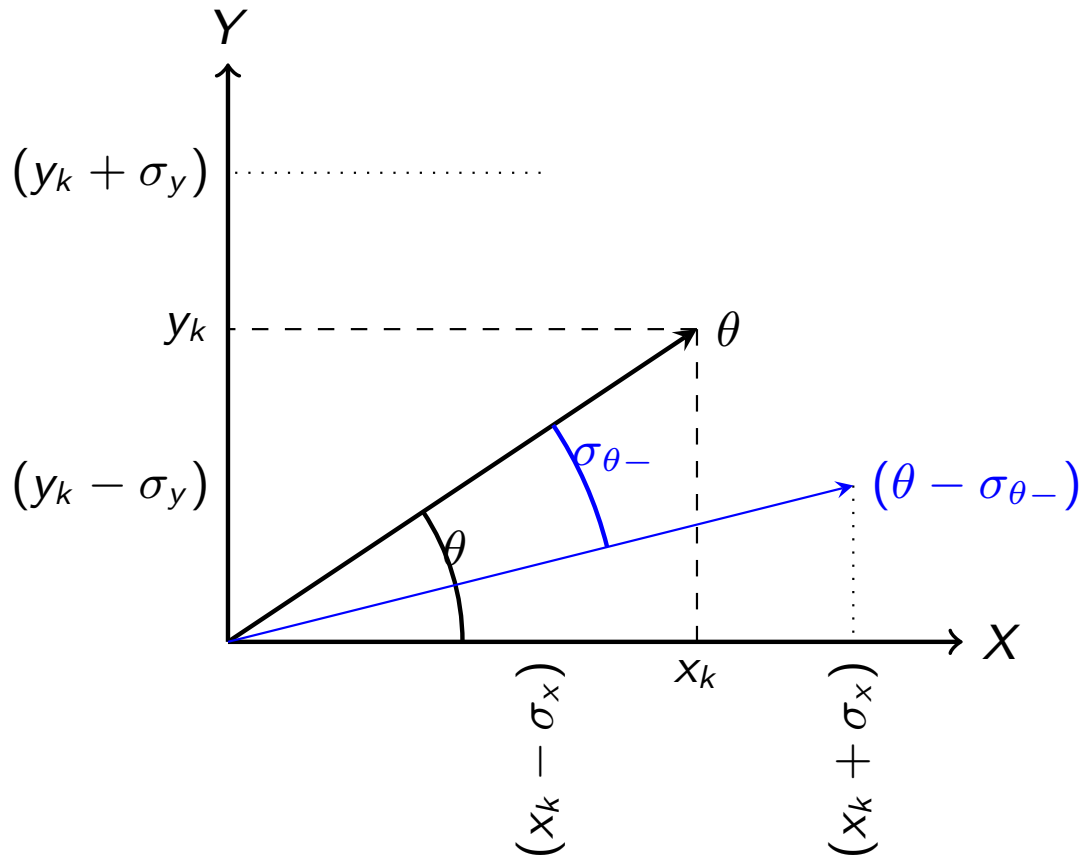
$$Pitch(\mathrm{b}): \quad \theta_y = \arctan\left(Z_N/-X_N\right) \tag{4}$$

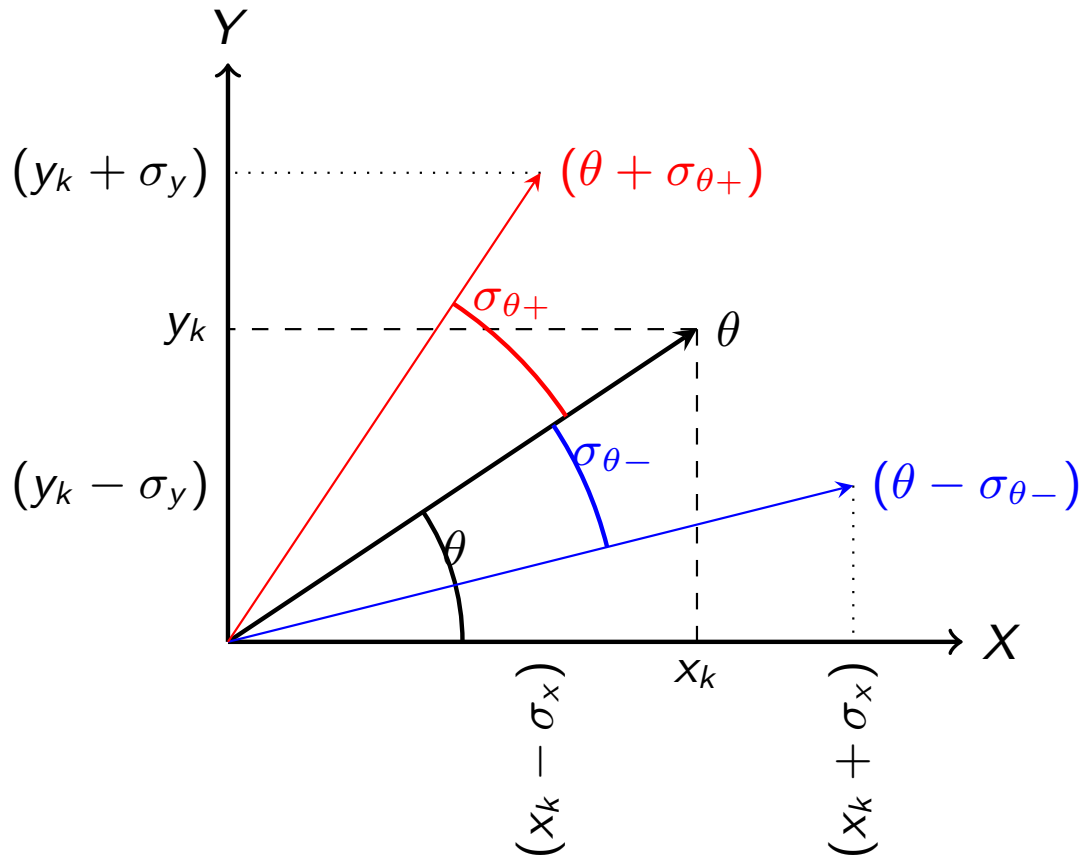
$$Yaw(\mathrm{b}): \quad \theta_z = \arctan\left(-X_N/Y_N\right) \tag{5}$$

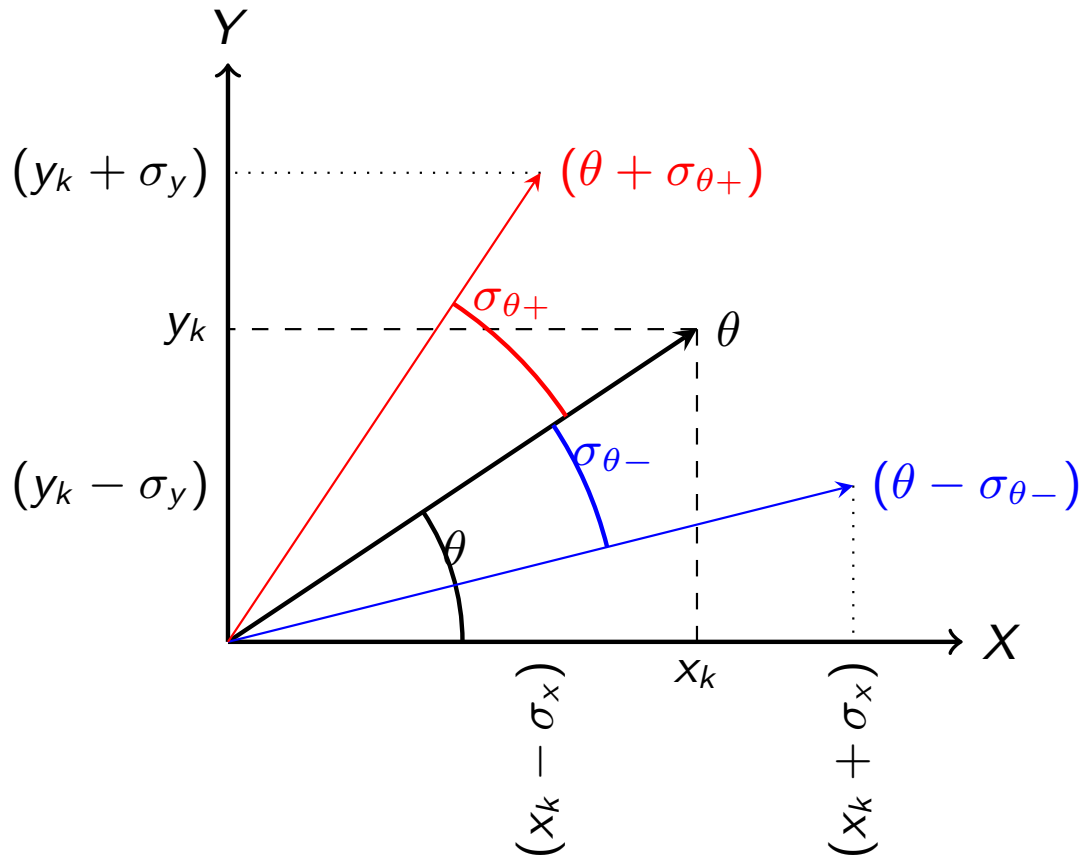

Y
y_k
θ
θ
X
x_k


Y
y_k
θ
θ
X
x_k
$(x_k - \sigma_x)$
$(x_k + \sigma_x)$

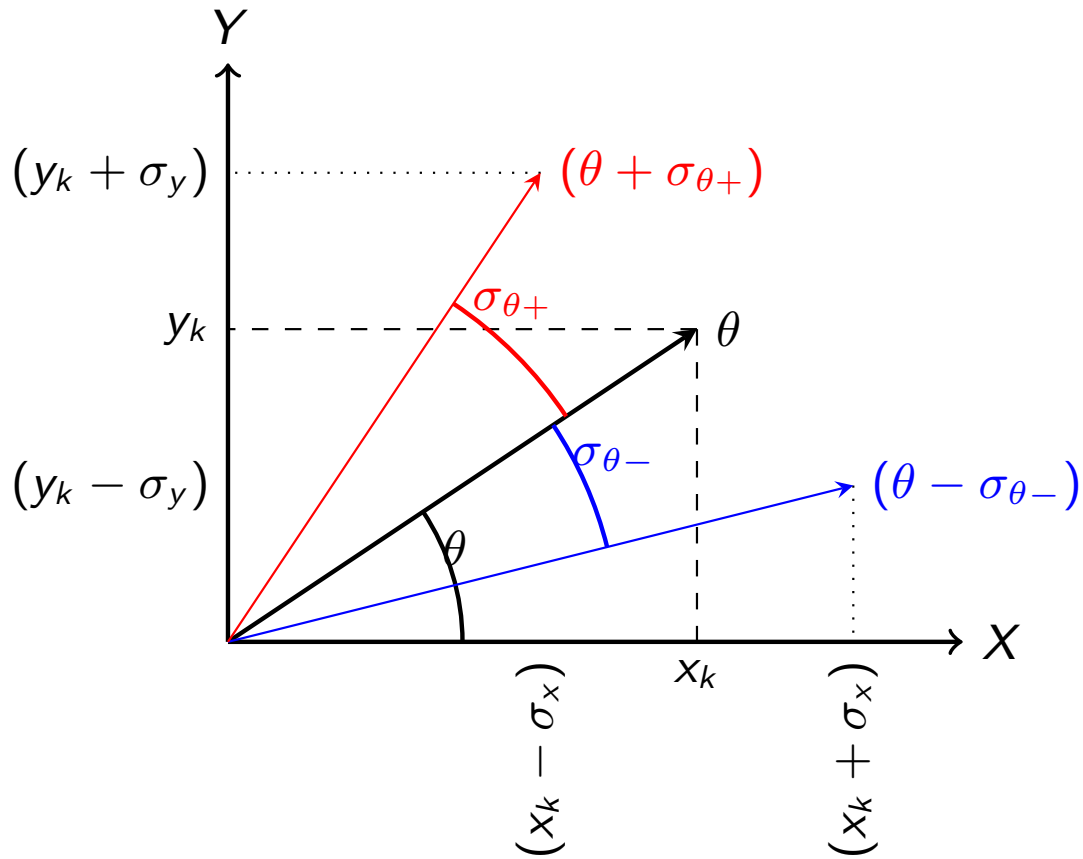

Y
$(y_k + \sigma_y)$
y_k
$(y_k - \sigma_y)$
θ
θ
X
x_k
$(x_k - \sigma_x)$
$(x_k + \sigma_x)$


Y
$(y_k + \sigma_y)$
y_k
$(y_k - \sigma_y)$
θ
$\sigma_{\theta-}$
$(\theta - \sigma_{\theta-})$
θ
X
x_k
$(x_k - \sigma_x)$
$(x_k + \sigma_x)$


Y
$(y_k + \sigma_y)$
$(\theta + \sigma_{\theta+})$
$\sigma_{\theta+}$
y_k
θ
$\sigma_{\theta-}$
$(y_k - \sigma_y)$
$(\theta - \sigma_{\theta-})$
θ
X
x_k
$(x_k - \sigma_x)$
$(x_k + \sigma_x)$



$$(\theta_z - \sigma_{\theta-}) = \arctan \frac{y_k - \sigma_y}{x_k + \sigma_x}, \quad (\theta_z + \sigma_{\theta+}) = \arctan \frac{y_k + \sigma_y}{x_k - \sigma_x} \tag{6}$$



$$(\theta_z - \sigma_{\theta-}) = \arctan \frac{y_k - \sigma_y}{x_k + \sigma_x}, \quad (\theta_z + \sigma_{\theta+}) = \arctan \frac{y_k + \sigma_y}{x_k - \sigma_x} \tag{6}$$

$$\sigma_k = (\sigma_{\theta+} + \sigma_{\theta-}) = \arctan \frac{y_k + \sigma_y}{x_k - \sigma_x} - \arctan \frac{y_k - \sigma_y}{x_k + \sigma_x} \tag{7}$$