Formulas

$$U^{\mathrm{T}}U = UU^{\mathrm{T}} = 1$$

$$r = Ur' \qquad \dot{r} = \dot{U}U^{\mathrm{T}}r = A\,r$$

$$\dot{U} = A\,U$$

$$A = \begin{bmatrix} 0 & -\omega_z & \omega_y \\ \omega_z & 0 & -\omega_x \\ -\omega_y & \omega_x & 0 \end{bmatrix}$$

$$\dot{\mathbf{r}} = \boldsymbol{\omega} \times \mathbf{r}$$

$$\dot{\mathbf{a}} = \mathring{\mathbf{a}} + \boldsymbol{\omega} \times \mathbf{a}$$

$$\mathbf{F}_{\text{fict}}/m = -\boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r}) - 2\boldsymbol{\omega} \times \mathring{\mathbf{r}} - \dot{\boldsymbol{\omega}} \times \mathbf{r}$$

$$T_{\text{rot}} = \frac{1}{2}\sum_{\alpha,\beta} \omega_\alpha I_{\alpha\beta}\,\omega_\beta = \frac{1}{2}(I_1\,\omega_1^2 + I_2\,\omega_2^2 + I_3\,\omega_3^2) = \frac{1}{2}\boldsymbol{\omega}\cdot\mathbf{I}\cdot\boldsymbol{\omega}$$

$$I_{\alpha\beta} = \sum_i m_i(r_i^2\delta_{\alpha\beta} - r_{i\alpha}r_{i\beta}) \qquad \mathbf{I} = I_1\hat{\mathbf{1}}\hat{\mathbf{1}} + I_2\hat{\mathbf{2}}\hat{\mathbf{2}} + I_3\hat{\mathbf{3}}\hat{\mathbf{3}}$$

$$L_\alpha = \sum_\beta I_{\alpha\beta}\omega_\beta \qquad \mathbf{L} = \mathbf{I}\cdot\boldsymbol{\omega} = I_1\omega_1\,\hat{\mathbf{1}} + I_2\omega_2\,\hat{\mathbf{2}} + I_3\omega_3\,\hat{\mathbf{3}}$$

$$\mathbf{N} = \dot{\mathbf{L}} = \mathring{\mathbf{L}} + \boldsymbol{\omega} \times \mathbf{L}$$

$$\begin{aligned} I_1\dot{\omega}_1 &= (I_2 - I_3)\omega_2\omega_3 \\ I_2\dot{\omega}_2 &= (I_3 - I_1)\omega_3\omega_1 \\ I_3\dot{\omega}_3 &= (I_1 - I_2)\omega_1\omega_2 \end{aligned}$$

$$\dot{\boldsymbol{\omega}} = \Omega\,\hat{\mathbf{3}} \times \boldsymbol{\omega} \qquad \Omega = (I_3/I - 1)\omega_3$$

$$\dot{\hat{\mathbf{3}}} = \omega_{\mathrm{p}}\,\hat{\mathbf{L}} \times \hat{\mathbf{3}} \qquad \omega_{\mathrm{p}} = L/I$$

$$\omega_{\mathrm{p}}\hat{\mathbf{L}} = \boldsymbol{\omega} + \Omega\,\hat{\mathbf{3}}$$

$$\cos\theta = \frac{I_3\,\omega_3}{I\,\omega_{\mathrm{p}}}$$