

## Equations

$$\vec{r}_{\text{CM}} = \frac{\sum_{\alpha} m_{\alpha} \vec{r}_{\alpha}}{\sum_{\alpha} m_{\alpha}}$$

fixed point stable if  $|f'(x_{\text{fix}})| < 1$

$$\vec{L} = \underline{\underline{I}} \vec{\omega} \quad \text{where} \quad I_{xx} = \sum_{\alpha} m_{\alpha} (y_{\alpha}^2 + z_{\alpha}^2) \quad \text{etc. and} \quad I_{xy} = - \sum_{\alpha} m_{\alpha} x_{\alpha} y_{\alpha} \quad \text{etc.}$$

for continuous rigid bodies:

$$I_{xx} = \int \rho(\vec{r}) (y^2 + z^2) dx dy dz \quad \text{etc. and} \quad I_{xy} = - \int \rho(\vec{r}) x y dx dy dz \quad \text{etc.}$$

$$S = \int f(x, x', y, y', u) du \quad \frac{\partial f}{\partial x} = \frac{d}{du} \frac{\partial f}{\partial x'} \quad \frac{\partial f}{\partial y} = \frac{d}{du} \frac{\partial f}{\partial y'}$$

$$\mathcal{L} = T - U$$

$$\frac{d}{dt} \frac{\partial \mathcal{L}}{\partial \dot{q}_i} = \frac{\partial \mathcal{L}}{\partial q_i}$$

$$p_i = \frac{\partial \mathcal{L}}{\partial \dot{q}_i}$$

$$\mathcal{H} = \sum p_i \dot{q}_i - \mathcal{L} \quad \text{if natural coord.: } \mathcal{H} = T + U$$

$$\dot{q}_i = \frac{\partial \mathcal{H}}{\partial p_i} \quad \dot{p}_i = - \frac{\partial \mathcal{H}}{\partial q_i}$$

$$\vec{v} = \omega \times \vec{r} \quad \left( \frac{d\vec{Q}}{dt} \right)_{S_0} = \left( \frac{d\vec{Q}}{dt} \right)_S + \vec{\Omega} \times \vec{r}$$

$$\underline{\underline{M}} \ddot{\vec{q}} = - \underline{\underline{K}} \vec{q}$$