Celková kinetická energie tuhého tělesa

$$W_k = \sum_\alpha \frac{1}{2} m_\alpha v_\alpha^2 \qquad \vec{v}_\alpha = \vec{V} + \vec{\omega} \times \vec{r}'_\alpha$$

$$W_k = \sum_\alpha \frac{1}{2} m_\alpha (\vec{V} + \vec{\omega} \times \vec{r}'_\alpha)^2 = \sum_\alpha \frac{1}{2} m_\alpha (\vec{V} + \vec{\omega} \times \vec{r}'_\alpha) \cdot (\vec{V} + \vec{\omega} \times \vec{r}'_\alpha) =$$

$$= \sum_\alpha \frac{1}{2} m_\alpha \left(V^2 + 2\vec{V} \cdot \vec{\omega} \times \vec{r}'_\alpha + \left| \vec{\omega} \times \vec{r}'_\alpha \right|^2 \right) =$$

$$= \sum_\alpha \frac{1}{2} m_\alpha V^2 + \vec{V} \cdot \vec{\omega} \times \sum_\alpha m_\alpha \vec{r}'_\alpha + \sum_\alpha \frac{1}{2} m_\alpha \left| \vec{\omega} \times \vec{r}'_\alpha \right|^2$$

$$W_k = \frac{1}{2} M V^2 + \frac{1}{2} J \omega^2 = W_{kp} + W_{kr}$$