

## 13.15: Kinetic energy in terms of Euler angular velocities

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The kinetic energy is a scalar quantity and thus is the same in both stationary and rotating frames of reference. It is much easier to evaluate the kinetic energy in the rotating Principal-axis frame since the inertia tensor is diagonal in the Principal-axis frame as given in equation (13.12.14)

$$T_{rot} = \frac{1}{2} \sum_i^3 I_{ii} \omega_i^2 \quad (13.15.1)$$

Using equation (13.14.1 – 13.14.3) for the body-fixed angular velocities gives the rotational kinetic energy in terms of the Euler angular velocities and principal-frame moments of inertia to be

$$T_{rot} = \frac{1}{2} \left[ I_1 (\dot{\phi} \sin \theta \sin \psi + \dot{\theta} \cos \psi)^2 + I_2 (\dot{\phi} \sin \theta \cos \psi - \dot{\theta} \sin \psi)^2 + I_3 (\dot{\phi} \cos \theta + \dot{\psi})^2 \right] \quad (13.15.2)$$

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