

## 7.5: Cyclic Coordinates

Translational and rotational invariance occurs when a system has a cyclic coordinate  $q_k$ . A *cyclic coordinate* is one that does not explicitly appear in the Lagrangian. The term cyclic is a natural name when one has cylindrical or spherical symmetry. In Hamiltonian mechanics a cyclic coordinate often is called an *ignorable coordinate*. By virtue of Lagrange's equations

$$\frac{d}{dt} \frac{\partial L}{\partial \dot{q}_k} - \frac{\partial L}{\partial q_k} = 0 \quad (7.5.1)$$

then a cyclic coordinate  $q_k$ , is one for which  $\frac{\partial L}{\partial q_k} = 0$ . Thus

$$\frac{d}{dt} \frac{\partial L}{\partial \dot{q}_k} = \dot{p}_k = 0 \quad (7.5.2)$$

that is,  $p_k$  is a constant of motion if the conjugate coordinate  $q_k$  is cyclic. This is just Noether's Theorem.

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