

Lagrangian Mechanics

Pugazharasu A D

August 21, 2020

Bibliography & Image Credits



The Theoretical Minimum: What You Need to Know to Start Doing Physics

Susskind, Leonard, and George Hrabovsky

New York: Basic Books, 2014



No-Nonsense Classical Mechanics: a Student-Friendly Introduction

Schwichtenberg, Jakob

Karlsruhe, Germany: No-Nonsense Books, 2020



Classical Dynamics of Particles and Systems

Bradley W. Carroll and Jerry B. Marion

Addison Wesley Publishing Company



Physics from Symmetry

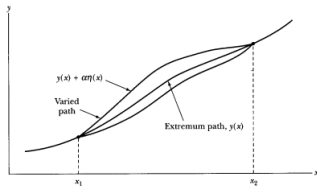
Schwichtenberg, Jakob

Springer International Publish, 2018

Intro/Motivation

Hamilton's Principle

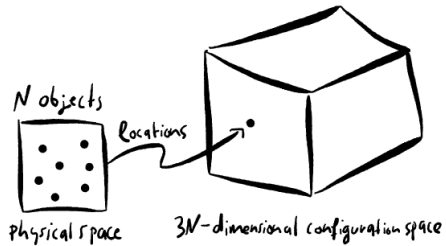
Euler-Lagrange Equation



Toy-Model

Generalized Coordinates

Configuration Space



Rewriting Lagrange's Equations

Lagrange's Equations require the following two conditions:

- The forces acting on the system (apart from any forces of constraint) must be derivable from potentials
- The equations of constraint must be relations that connect the coordinates of the particles and may be functions of the time

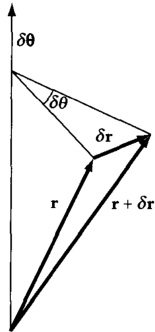
Lagrangian Mechanics = Newtonian Dynamics

Essence of Lagrangian Dynamics

Conservation Theorems Revisited

Conservation of Momentum

Conservation of Angular Momentum



Conservation of Angular Momentum

Conservation of Energy

Conservation of Energy

- The equations of the transformation connecting the rectangular and generalized coordinates must be independent of the time, thus ensuring that the kinetic energy is a homogeneous quadratic function of the \dot{q}_i
- The potential energy must be velocity independent, thus allowing the elimination of the terms $\partial U / \partial \dot{q}_i$ from the equations for H .

Summary of Conservation Principles

Characteristic of Inertial Frame	Property of Lagrangian	Conserved Quantity
Time homogeneous	Not explicit function of time	Total energy
Time homogeneous	Invariant to translation	Linear momentum
Space isotropic	Invariant to rotation	Angular momentum

Field Theories