9/23/11 Lecture outline (2pm WLH 2204)

⋆ **Reading for week 1 lectures: Taylor chapters 1 and 2, Arovas notes.**

• This class will go deeper into things you've seen before: Newton's laws, conservation laws (energy, momentum, angular momentum). We'll learn new ways to understand them: the principle of least action, and symmetries. Learn new problem solving methods.

• Newton's laws (1687). "First law: A body remains in uniform motion unless acted on by a force. Second law: force equals rate of change of momentum. Third law: Any two bodies exert equal and opposite forces on each other." Discussion:

• First law: Definition of inertial frames of reference, and physical result that such frames indeed always exist for isolated bodies. Rocket in deep space. Consider two frames of reference, $x = x' + x_{rel}(t)$, and what happens if there is a relative acceleration between them. Person in free falling elevator.

• Second law. Consider fixed force on two bodies and measure accelerations. Define inertial mass by $m_2/m_1 = a_1/a_2$. Find that this definition of m is an inherent property of the object itself, measuring its inertia to motion. Does not depend on type of force, or other details of the setup. Comment on $\vec{F} = m\vec{a}$ vs $\vec{F} = \frac{d\vec{p}}{dt}$. Example of uniformly moving train or rocket, with changing mass.

• Four fundamental forces. (Aside.)

• Example of force: gravity. $\vec{F} = -m\vec{g}$, or $\vec{F}_1(\vec{r}_1) = -Gm_1m_2(\vec{r}_1 - \vec{r}_2)/|\vec{r}_1 - \vec{r}_2|^3$.

• Third law. Show it in gravity.