Phys 410
Spring 2013
Lecture #26 Summary
3 December, 2013

We had a discussion of nonlinear mechanics that spanned lectures 25 and 26. The discussion focused on the driven damped pendulum, and we introduced a number of new concepts, including attractors, harmonics, sub-harmonics, period doubling bifurcations, sensitivity to initial conditions, the Lyapunov exponent, period-doubling cascade, chaos, bifurcation diagrams, state-space orbits, and the Poincaré section. The discussion is summarized on the class web site under Lecture 25.

We then turned to a discussion of Special Relativity. We began by reviewing the Galilean transformation between inertial reference frames, and showed that Newton's second law of motion holds in the same form in all inertial reference frames. This result relies on the Galilean velocity addition formula between reference frames. However, it was discovered that Galilean invariance does not apply to Maxwell's equations (which are actually Lorentz invariant) by examining the measurement of the speed of light in a moving reference frame. The Michelson-Morley experiment showed that the measured speed of light is the same in all directions for all inertial observers. Hence there must be something more going on than simple Galilean transformations between reference frames.

Einstein made two postulates:

1) If S is an inertial reference frame and if a second frame S' moves with constant velocity relative to S, then S' is also an inertial reference frame.
2) The speed of light (in vacuum) has the same value c in every direction in all inertial reference frames.

The first postulate points out that there is no "special" reference frame which is absolutely at rest and somehow 'better' than any other reference frame. It also implies that all the laws of physics (including Maxwell's equations) should take on the same form in all inertial reference frames. Again it says that there is no single inertial reference frame in which the laws of physics are simpler, or have fewer terms, than any other reference frame. The trick will be finding how to transform all of the coordinates from one inertial reference frame to another to preserve the form of the laws of physics. The second postulate codifies the results of the Michelson-Morley experiment.