Instrumentation class, SMS 598, Fall 2012
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Group I, attenuation lab:

In this lab you will build an attenuation meter as well as use a commercial one. You will use it to measure the attenuation of food coloring (which is the same as its absorption as it is a dissolved substance that negligibly scatters).
Follow the instructions in the associated worksheet to construct a transmissometer with which you will determine the specific attenuation of a drop of food coloring. In parallel you will be using a commercial beam attenuation meter (WETLabs C-star). If time permits run filtered and total seawater sample and compare with ac-S value for the same wavelength.

Appendix: The Beer-Lambert-Bouguer law:
The law is an empirical law relating the attenuation of light to the properties of the material the light is traveling through. It states that when we shine a collimated light beam through a liquid and measure the light getting to a receiver at distance r, the intensity of the light getting to the receiver (I(r)) is a function of the light leaving the source (I_0), the concentration of the absorbing (or attenuating, for material that scatter as well as absorb) substance, [c]) the mass (or mol) specific absorption (or attenuation) by the substance, c*, and the path-length, r:

$$I(r)=I_0*\exp(-c^*\cdot[c]\cdot r). \qquad (1)$$

Beer's Law often refers to absorption by solutes while Lambert's (and Bouguer) law refers to attenuation by suspension of particles in a liquid (e.g. Shifrin, 1988, http://scienceworld.wolfram.com/physics/LambertsLaw.html, and http://scienceworld.wolfram.com/physics/BeersLaw.html).

The nondimensional quantity: $2.303\cdot c^*\cdot[c]\cdot r$ is often referred to as the 'Absorbance' when one deals with purely absorbing substances or 'Attenuance' when one deals with attenuating (absorbing+scattering) material. $2.303=\log_e(10)$.

The law fails at high concentration when either:
1. Error due to detector sensitivity become significant (absorbing materials).
2. Multiple scattering causes deviations from Equ. 1 (scattering materials).

History (From http://www.worldhistory.com/wiki/B/Beer-Lambert-law.htm):
Beer's law was independently discovered (in various forms) by Pierre Bouguer (Mathematician and hydrographer, France) in 1729, Johann Heinrich Lambert (Physicist and astronomer, Germany, other contribution to optics abound, in particular the law about reflection from surfaces) in 1760 and August Beer (Mathematician, chemist and physicist, Germany) in 1852.
While this law was discovered empirically it turns out it can be derived from theory. The statistics of interaction of light with randomly distributed molecules/particles give rise to an exponential attenuation within a substance (Kostinski, 2001).

Kostinski, A. B., 2001. On the extinction of radiation by a homogeneous but spatially correlated random medium. JOSA A, Vol. 18, Issue 8, pp. 1929-1933.

Shifrin, K. 1988. Physical Optics of Ocean Water. AIP. 285pp.