NONLINEAR WAVES
SIO 211B Spring 2015
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SYLLABUS[2]

1. Review of linear waves

2. Nonlinear shallow water wave theory
   - method of characteristics
   - wave steepening & breaking

3. Introduction of the effects of linear dispersion with nonlinearity
   - Derivation of the Korteweg de Vries (KdV) equation
   - Solitary wave solutions
   - Cnoidal wave solutions
   - Stokes expansion for KdV equation
   - Stokes expansion for deep water waves

4. Derivation of the nonlinear Schrödinger equation NLSE (O.M. Phillips' derivation)
   - Stokes expansion solution
   - Benjamin-Feir instability
   - Laboratory data on BF instability -> breaking
   - 3D instabilities, reference to literature and experiments
   - Solitary wave groups
   - Higher-order Dysthe's equation

5. Resonant wave interactions
   - 3-wave interactions
   - 4-wave interactions
   - Use in numerical models of wind-wave prediction (see 9 below)

6. Long Nonlinear Internal Waves
   - forced extended KdV equation in 2-layer fluid
   - flow over bottom topography
   - solitary wave solutions, polarity
   - solitary wave generation
   - propagation into shallow water
   - nonlinear long waves with weak rotation
   - nonlinear Kelvin waves, stability

[1] No set office hours. Just contact me for individual or group appointments.
[2] Since this course is still developing there may be some changes to the syllabus during the quarter as the pace of working through the material is adjusted. E.g. We may just have time for snippets of Sections 8-10.

7. Geometrical optics – wave action conservation
    - Wave-current interaction
    - Long-wave-short-wave interaction
8. Langmuir circulations
    - Stokes drift
    - The mean vorticity equation, Kelvin's circulation theorem
    - Craik-Leibovich instability
    - Observations and numerical modeling

9. Wind wave modeling
    - wind input
    - nonlinear wave-wave interactions
    - dissipation & breaking
    - - OMPs equilibrium theory

10. Wave breaking in deep water
    - laboratory experiments
    - Phillips' theory for wave breaking statistics
    - Field measurements of breaking statistics
    - Romero et al (2012) measurements of spectral dissipation

Homework and Grades

Grades will be given based on 6 homework sets during the quarter.
Due to the construction of a new wave channel in the Hydro Lab there will be no physical laboratory experiments this year. Instead, three of the homework assignments will be based on "synthetic lab sessions" using numerical simulations and archived lab data from previous years. Synthetic lab sessions will take 1-1.5 hrs.