SMS-303: Integrative marine sciences III.

Lab 4, Waves.

Purpose of the lab: familiarize the students with waves. Students generate seich, observe particles in waves and generate internal waves. The students observe the development of mean circulation by periodic forcing. Concepts such as wavelength, frequency, period, amplitude, resonance are all emphasized.

Class demo: ‘dead-water’ – famous oceanographic problem- boat in stratified fluid can encounter large resistance. Many different explanations until Ekman (1904) provided the correct one. See: Ekman V. W., 1904. On dead water. Sci.Results Norw. North Polar Expedi. 1893-1896, 5(15).

In-class exercise: You are about to measure the period of wave sloshing back and forth in a small tank (this is the seich). Q: Which do you expect to propagate faster: a wave in a tank with little water or that where the water is deeper?

Have one student raise one side of the tiny aquarium and another be the timer. Measure (using a stopwatch) how many sloshing back and forth you get in a tank with little water (1.5cm) and one with 4 times the depth (6cm) within a period of 5seconds. How much faster is one from the other? Please record this data as you will need it for your homework.

Station I.
Buoyancy oscillations:
In two tall cylinders with salty water on the bottom and fresh water on top you have a floating object parked between the fluids.
Q: What will happen if you push the floating object down? Why?
How will the period of the oscillation change if the water is more/less stratified?
Compare the period in the two cylinders. Which do you think is more stratified? Why?
Note the periods you observed on the board and compare to previous groups. Is there a change in period as function of time? Why?

Station II.
Large tank with paddle.
A power supply is attached to the paddle allowing us to change the frequency of the forcing.

a. Q: How do you think the wave amplitude will change with the frequency of the paddle?

Change the voltage from 12→17V in increment of 1V and plot the change in the wave height of the along channel velocity as function of voltage. How do you explain your observations?

b. Observe particles within the fluid. How are they distributed? Why?

c. Observe the behavior at the beach as you change the forcing. What can explain it?

d. Observe some particles floating on the water or suspended at depth. Are they simply oscillating or can they be observed drifting in a given direction? Can a periodic forcing force a current (that has a none zero mean velocity)?

Station III:
Wave classification- use a slinky to make a transverse wave (where the wave motion is at 90 to that of the particles) and a longitudinal wave (where the wave and particles move in the same direction). Classify sound, light, and gravity waves as transverse of longitudinal. Use the two computers supplied to you to explore longitudinal and transverse waves.

For longitudinal waves:
http://www.surendranath.org/Applets/Waves/Lwave01/Lwave01Applet.html
Vary amplitude and frequency and observe the changes you see. Explore the different waves (pulse, progressive, open at both ends etc') for different conditions.

For transverse waves:
http://www.surendranath.org/Applets/Waves/Twave01/Twave01Applet.html
Vary amplitude and frequency and observe the changes you see. Explore the different waves (pulse, progressive, fixed at both ends etc') for different conditions.

Station IV.
Internal waves:
You have a small tank with a partition in the middle. Fill one side of the partition with cold fresh water and the other with hot and fresh or cold and salty water. Q: What will happen when you raise the partition between the fluids?

Remove the partition. What is happening? How does the speed of the perturbation compare with those in St. 1? If you used the hot cold combination, put your finger in, can you feel the different waters?

Station V.
You have a large aquarium with a 2-layered stratified fluid. Use a plastic container to excite waves within the tank. Can you excite the internal gravity waves without exciting the surface gravity waves? Which has a higher frequency? Try to match the frequency of the wave you want to excite with the motion of the container.

Station VI.
Wave applets (four computers each with a different applet).
Doppler:
Source moving:

http://www.surendranath.org/Applets/Waves/Doppler/DopplerSMApplet.html
Observe the difference in the wavelength of the wave generated by the moving source relative to a stationary source. How would that affect the measured period a the right wall?
2D Wave generation by moving source:
http://www.surendranath.org/Applets/Waves/Doppler/DopplerApplet.html
Observe the pattern of wave propagation in front and back of moving source as you change the ratio of velocity of source and wave speeds. Where is the wavelength (period) larger, in the direction of motion or at the rear of the source?

Superposition of waves.
Additions of waves result in very interesting patterns:
Observe beating (also needed for you homework) using:
http://www.surendranath.org/Applets/Waves/Beats/BeatsApplet.html
Add waves of the almost the same frequency. Do you observe an oscillation at a much longer frequency?
Add waves one which is about half the frequency of the other. Have you seen such patterns before?

Harmonic (seichs):
There are a lot of similarities between acoustics and water waves. Here you explore how superposition of different resonant modes result in the observed waves. Using:
http://www.surendranath.org/Applets/Waves/Harmonics/HarmonicsApplet.html
explore how the superposition of modes comes about. Select only the fundamental mode and then add overtones. Observe how changing the boundary conditions (bottons on top) change the structure of the wave. Same is true for seich in channel (or bay of fundy) when one side is open compared to seich in a lake.

This page was last edited on 10/28/2010