"Granular Patterns"

Project Outline

Goals

1. Assemble a new setup to observe standing wave patterns in vertically vibrated fine metal grains.
2. Find onset conditions for different surface patterns and localized excitations (oscillons).
3. Create software to process experimental data

Specific Safety Issues

1. Working with vibrating metal grains may under some conditions require a mask and goggles.
2. Tuning frequency and amplitude of the driving force, the shaker must be treated with care to not permit destroying it under resonance condition

Granular Patterns

Granular patterns can be treated as Faraday waves in a layer of solid particles. They become a result of a parametric resonance when the standing wave frequency becomes equal to ½ of the driven frequency

Oscillons

Oscillon is a peak or a crater that appears, grows, moves around and disappears on the surface of a thin layer of fine particles undergoing vertical forced vibrations. Scientifically saying, the oscillon is a localized subharmonic excitation that has its own oscillating frequency equal to ½ of the driven frequency. The approximate values for parameters of this process are:

- the particles' diameter is about tenths of a millimeter;
- thickness of the layer of particles is slightly above 1 cm;
- frequency of vibrations is in the range of 10-30 Hz;
- lifetime of an oscillon is about several minutes.

Oscillons are of great interest because their properties are not yet understood and explained theoretically. It was experimentally found that under some conditions the peaks and the craters interact like oppositely charged particles. Other standing wave patterns produced in the vertically vibrating layer of particles can transform into oscillons under specific conditions.

Expected Schedule

1. Assemble the new setup with a shaker, a signal generator, an oscilloscope, a camera and a vessel for grains. Test the setup and observe pattern formation in a layer of grains.
2. Study the published results for surface pattern formation and localized excitations (oscillons) in a vertically vibrating layer of fine grains
3. Study results of SURF projects of 2010 and 2011
4. Set up sources of visualization of the surface and behavior of grains in a vibrating layer
5. Select the ranges of driven frequency, the driving force amplitude, the layer of grains thickness and the diameter of bronze grains to study the onset conditions for observing stripes, squares, hexagons and oscillons. Perform series of experiments and draw the phase diagram for onset conditions for the above mentioned patterns
6. Introduce parameters being used in theory of condensed matter and particularly in theory of crystals into qualitative and quantitative description of the granular patterns
7. Prepare materials of the project for a handout of the new experiment in Advanced Physics Laboratory and for a report to 2012 CUPC (Canadian Undergraduate Physics Conference)