

# Experimental Research on Granular Hydrodynamics

*Loyola University Chicago*

*Sigma Pi Sigma Undergraduate Research Award Final Report*

The Physics Department at Loyola University Chicago (LUC) and our SPS chapter wish to thank SPS for the 2010 Undergraduate Research Award in support of the proposal “Experimental Research in Granular Hydrodynamics” submitted by our student, Dustin Kimble. This letter is designed to serve as a final report for the award, including information on the financial use of the award as well as the progress of our chapter.

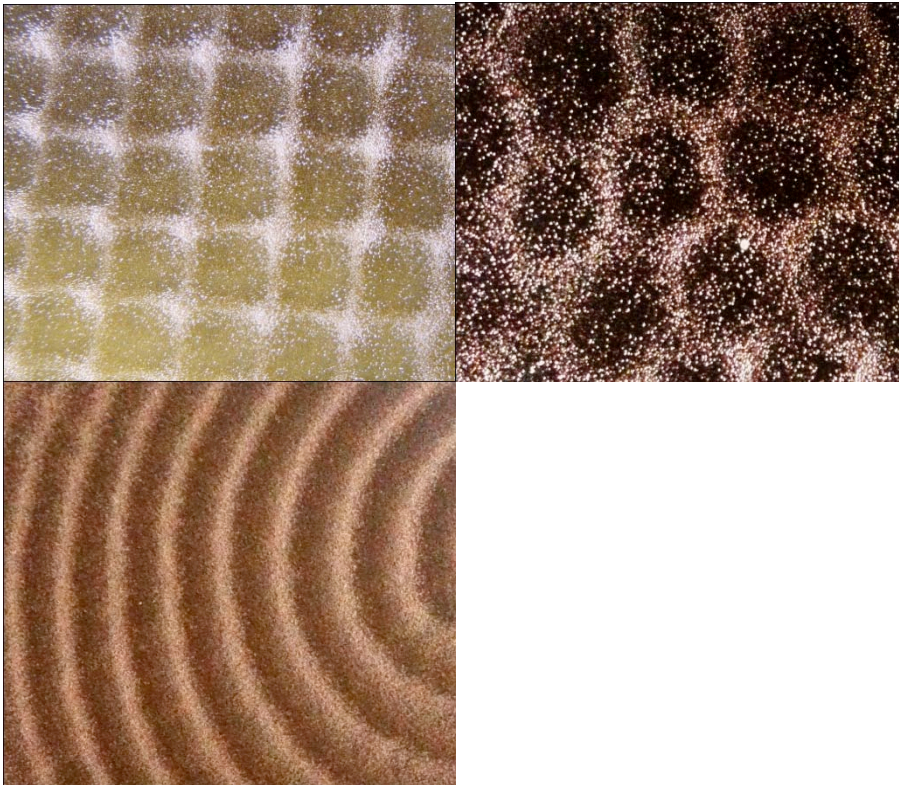
The award has been helpful to establishing experimental research in granular media at LUC, which has been a key area of investigation in a year that has been very productive for undergraduate students at Loyola. In 2010, many undergraduate students have taken part in research, and have presented their work at events including:

- Tara Hufford presented a poster at the 125<sup>th</sup> annual American Astronomical Society in Washington, DC in January. Her poster was nominated for a Chambliss student poster award.
- Dustin Kimble and Maxwell Grady presented their work at the 2010 joint national APS/AAPT meeting in Washington, DC. Dustin won an “APS/AAPT April 2010 Poster Presentation Award.”, and Maxwell was awarded an “APS/AAPT April 2010 Oral Presentation Award.”
- Several Loyola students made presentations at the Chicago Area Undergraduate Research Symposium (CAURS). Ten different projects were presented by students from the LUC Physics Department, and a poster by two students (Tara Hufford and Kyle Duckert) won the award for best poster in physics.
- Veronica Policht and Eric Wilkinson presented their research at the 2010 APS Division of Fluid Dynamics annual meeting in Long Beach, California.
- Several students have made presentations at Loyola events, including presentations at the Loyola Undergraduate Research Opportunities Program symposium.

Investigations of granular hydrodynamics have been an important part of this activity. Four of the students who presented posters (Dustin Kimble, Kyle Duckert, Veronica Policht, and Eric Wilkinson) made presentations involving granular media directly related to the SPS Undergraduate Research Award. Thus, this award has been helpful in strengthening our SPS chapter and at involving students in undergraduate research.

Here is Dustin Kimble's account of the importance of the materials supplied by the award:

Since winning the research award I have finally been able to produce patterns with grains. With the award money I bought tiny spherical bronze particles, a 212 micrometer sieve, and a 250 micrometer sieve. Using these, I filtered the particles through both the 250 and 212 micrometer sieves, and collected the particles that were caught by the 212 micrometer sieve. This allowed me to have a small range of particles sizes between 212-250 micrometers. I then used these particles to produce granular patterns with the shaker. I believe the uniformity of these new particles is what allowed me to produce patterns, which I could not achieve with salt or sand. Now that I have been able to produce patterns in grains, I am going to modify the shaker to make it very stable and able to adjust the levelness so that it can easily and repeatedly produce patterns. So far I presented a poster at the APS/AAPT national meeting in February, and also presented a poster at the Chicago Area Undergraduate Research Symposium in April. Here are some photos of the patterns I have produced thus far:



## Financial Statement:

We have used the award for the following purchases:

- \$122.04 towards purchasing bronze spheres for use in our granular shaker. (5 pounds 5657C Bronze powder and 5 pounds 68PP Bronzer Powder from AcuPowder Intenational, LLC)
- \$16.53 for a glass container for the spheres (glass locking container from Bed, Bath, and Beyond)
- \$39.27 for an aluminum tube to create an aluminum container from OnlineMetals.com
- \$20.00 for a wooden stand to support the shaker (end table from local furniture store)
- \$88.26 for two sieves from hogentogler.com
- \$1289.95 for a Casio EX-F1 digital camera and accessories (camera case, tripod, memory, etc.) This high speed camera is capable of HD video at 30 and 60 fps, and of reaching up to 1200 fps at lower resolution. This camera has allowed us to capture the dynamics of individual grains even at rapid shaking rates. Additionally, this camera will be very useful for other undergraduate research projects undertaken by the chapter.
- \$423.95 to partially cover costs for travel to a professional conference (APS Division of Fluid Dynamics meeting) for two students (Veronica Policht and Eric Wilkinson) to present results of their research. The actual cost of travel, housing, and registration for these two students was \$1,104.70. The remainder was covered by the Loyola Physics Department.

This brings the total amount spent to \$2000, or the full amount of the award.

Thank you again for your support of this project.

Sincerely,

Jonathan L. Bougie  
Assistant Professor of Physics  
Loyola University Chicago