The Pendant Drop Method for Measuring Interfacial Tension

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Overview of Proposed Work

Over the last decade, computers have continued following a Moore's Law trend and have increased in computational power tremendously. Following this increase in computational power was the subsequent boom in the levels of complexity of various computer softwares, whether originating from the gaming industry or from the private sector and manufacturing companies with design and modeling programs. The power of these programs in recent years has allowed the average household user to process high quality data at a level comparable to today's industry standards. Specifically, programs like MATLAB have enabled users to model, design, and analyze high quality renderings of data with real application value.

In Physics, the studies of the most fundamental interactions of matter in the universe have taken on great interest by scientists from all over the world. At the microscopic level, it is in fact not gravity that dominates interactions, but rather surface tension that has the most influence over the micro-world. Classically, proposed methods to analyze the interfacial tension between two interfaces have relied on approximative methods and iterative numerical computations with limited understanding of the physics that fundamentally defines these interactions. Using the power of today's technology, the proposed research will analyze the Young-Laplace Equation in its association with the interfacial tension between different interfaces using a computer program written in MATLAB.

Objectives for Next Semester Research

Continuing research of the previous semester conducted in the Fernandez-Nieves Soft Condensed Matter Lab at Georgia Tech under the direction of Dr. Alberto Fernandez de las Nieves and with the help of co-mentor graduate student, Ekapop Pairam, on the understanding of the second order partial differential Laplace Equation in its physical application to the Pendant Drop Method to measure interfacial tension sets the framework for next semester's research. The main objective of next semester's research will be to use MATLAB computational software to create a user-friendly program that takes in an image of a pendant drop of any fluid immersed in any another fluid and outputs a reading of the interfacial tension between the two immiscible interfaces at any given time, thereby employing the power of modern technology.

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Methods/Techniques

Using IC Capture imaging software, the research will receive an inputted image of a pendant drop from a CCD super-high quality camera and then apply filtering and contrast the image to find just the interface surface of the immersed liquid. Once the interfacial surface contour has been developed, the research will use MATLAB to first correct for any shifting in the axis of the pendant drop. The next step would be to find the radius of curvature, $\Re$, of the pendant drop at the apex of the drop. Once the radius of curvature is found, the form factor constant, β, which defines the shape of all possible shapes of drops of any fluids in the universe under the presence of an applied gravity field, can be found. Once the fundamental properties of the fluids' interface are calculated and analyzed, the program will employ the Young-Laplace Equation to determine interfacial tension:

$$\Delta p = \rho g h - \gamma \left(\frac{1}{R_1} + \frac{1}{R_2} \right) \longleftrightarrow \gamma = \frac{\Delta \rho g R^2}{\beta}$$

Young-Laplace Equation

Interfacial Tension Equation

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