RMSM REU - Aggregation Dynamics of Active Shifted-Dipole Particle Suspensions [1]

Submitted by Angel Christian González Martell [2] on 26 June 2015 - 3:25pm

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My name is Angel González and I am a student of mechanical engineering at UPRM. At this time I am just 9 credits from my degree and graduate school seems like will be the next step in my career. This is why I decided to apply to the Reconfigurable & Multifunctional Soft Materials REU, to explore the areas of research at my alma mater and acquire skills that will help me through my professional development. So far, one month into the program, I've got the opportunity to learn things that will not only help me during grad school, but throughout my entire life thanks to the seminars and all the activities that our REU managers have arranged for us in addition to the hands on experience that we get on research.

During this summer I am working with Brownian dynamics simulations of suspended magnetic particles to understand their behavior from a mathematical and theoretical point of view. These simulations are important because experimental approaches could be rather expensive or difficult to achieve, making the simulation approach a good option to predict the behavior of different types of particles under endless possible conditions. The particles that I've been working with are paramagnetic (they are able to aggregate even without the presence of a magnetic field) and have a self-propulsion force acting on their main dipole direction, which is governed by their Brownian rotary motion (random motion of suspended particles resultant from their collisions with the fluid molecules). Simulating these particles we can observe how they aggregate under different magnitudes of magnetic fields, self-propulsion forces and dipole-dipole interaction forces. For example, from these simulations we can now that particles with a centered dipole will aggregate in linear chains when the applied magnetic field is bigger than the self-propulsion forces. Now, what my project seeks, is to add in these simulations particles with a magnetic dipole moment shifted out from the center of mass towards the particle surface, which is often referred to as a shifted-dipole. From previous works we know that these particles tend to aggregate in staggered chains (zipper or zigzag like chains) in the presence of a magnetic field because of their off-center dipole-dipole interaction. If these particles are still being self-propelled as before, an increase in the rate of aggregation and longer staggered chains are expected with a self-propulsion force smaller than the dipole-dipole interaction force. On the other hand, at self-propulsion forces higher than the dipole-dipole force, disaggregation is expected to occur. In order to study this behavior, a computational study af these simulations with particles suspended in the dilute limit (low volume fraction), neglecting the particle inertia and subjected to a uniform magnetic field was proposed in order to measure the chain formation's length and the number of particles per chain.

Beside this, I've been able to meet new cultures being in my own country, and at just 15 minutes from my home town, spending my days and weekends with foreign students. I've even been able to visit places in my island that I've never visited and done things that I've never done before trying to make their stay here the most culturally enriching as possible outside the program.

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