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Undergraduate Research Program

Project Name	The interplay between glass and gel transitions in electrolyte solutions.
Campus & Location in Mexico	San Luis Potosí
Faculty	Engineering and Sciences
Research Area	Fundamental Science => Physics => Thermodynamics => Matter out-of-equilibrium => Colloids => Physics of Soft Condensed Matter
Research Responsible	José Manuel Olais Govea
Description of the Project	The interplay of the glass- and gel transition with liquid-liquid phase separation is a subject of intense debate. Recent experiments and computer simulations have revealed intriguing phenomenological fingerprints of the interference between the ordinary equilibrium gas-liquid phase transition and the non-equilibrium glass and gel transitions. We thus now know, for example, that the liquid-gas spinodal line and the glass transition loci intersect at finite temperature and density [Phys. Rev. Lett. 85, 590 (2000)], that when gel and glass meet, mechanisms for multistep relaxation emerge [Soft Matter, 10, 4800 (2014); J. Chem Phys. 142, 174503 (2015)], and that the formation of gels exhibits puzzling latency effects [J. Chem. Phys. 135, 154903 (2011)]. This project proposal intends to apply recent theoretical findings [Scientific Reports volume 9, Article number: 16445 (2019)] to the Screened Coulomb (Yukawa) charged hard-sphere binary fluid [Molecular Physics, 92:2, 211-228]. The purpose is to explore possible glassy and gel transitions in both very low densities as well as the effects of the reentrancy phenomenon at hight densities and very hight screened values.
Training Provided	In this project, the student will be involved in applying the kinetic perspective of the non-equilibrium self-consistent generalized Langevin equation (NE- SCGLE) theory of irreversible processes in liquids [Phys. Rev. E 98, 040601(R) (2018)]. From the theoretical point of view, the interested student will obtain basic knowledge concerned that theory to understand a unifying first-principles microscopic theoretical framework to describe these and other phenomena associated with spinodal decomposition, gelation, glass transition, and their combinations. The goal is to address the competition between two kinetically limiting behaviors, associated with the two distinct dynamic arrest transitions in which the liquid-glass line is predicted to bifurcate below (or really near) its intersection with the spinodal line. Depending on the level of study, in this project, the student can only apply (by means of programming tools that they know) the NESCGLE theory. The project can go beyond the application of this theory only if the student feels confident in making their own proposals framed in the general goals of this proposal. For example, applications in engineering through the fundamental knowledge of amorphous solidification processes and materials aging.

Offered during:

SUMMER		WINTER		SEMESTER	
	X				X

Student

Tasks/Responsibilities	Enable a programming code (which is already 75% complete). Perform calculations of both static and dynamic properties of a binary electrolyte (known theoretical model), by means of thta code. Periodic written reports of progress in the project objectives. Have a proposal that summarizes the results of the stay: it could be a poster, a conference article or a paper in a Q1/Q2 Journal, and submit it to a congress or journal where it is agreed to do so. Availability to offer a first research seminar in which you show your previous work. Availability to offer a first research seminar in which you show your work progress during the stay. *Possibly mobility in some other universities or research centers in Mexico (short visits).
Required Language Proficiency	English (B2) or Spanish (A2-B1) or French (A2-B1) or a mixture of them will be enough to work well.
Required Skills and Abilities	Numerical programming and analysis. Advanced mathematical methods. Ability to investigate scientific literature. Writing skills in English to prepare academic reports. Basic elements of statistical physics. Desirable but not mandatory, have knowledge of liquid theory. Ability to work both autonomously and collaboratively. Decision-making ability. Confidence and desire to explore new/different areas of study. Curiosity, patience, and ease of interacting with other colleagues.
Other Documents	2) Accumulative grade point average (GPA) 2.5 3) Official Transcript 4) 2 letters of recommendation of faculty members 5) Resume 6) Letter of intention explaining the reason why you would like to participate in the research program