Sandia National Laboratories

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Biocomplexity Faculty Search Committee
c/o Prof. Rob de Ruyter
Department of Physics
727 East Third Street
Indiana University
Bloomington, IN 47405-7105

Dear Sir/Madam,

I am pleased to write a letter of recommendation on behalf of Leo Silbert who has applied for a faculty position in your department. Leo worked closely with me on modeling granular materials while a postdoctoral research associate at Sandia National Laboratories before moving to the University of Chicago. He has made a number of significant contributions to our understanding of flow and packing of particulate systems and will make a strong addition to your department.

After completing his Ph.D., Leo came to Sandia as a postdoctoral associate in February 1999. I had recently moved to Sandia and was starting a new program on the modeling of granular materials. Leo was the main person working on this project with me. Leo's first task was to write a three dimensional molecular dynamics code for granular materials. The code is similar to molecular dynamics codes for liquids in that each granular particle is followed explicitly, however unlike ordinary liquids, one must include rotational degrees of freedom. In addition to the normal forces between grains, frictional forces between particles in contact and energy dissipation due to plastic deformation are also included. After writing and testing his own scalar code, Leo worked closely with Steven Plimpton at Sandia to develop a highly parallel version of the code based on message passing instructions. This code runs on any parallel computer and is the mainstay of our simulation work today. With this code Leo was able to study a range of problems previously not accessible to simulations. The first problem Leo studied was gravity driven flow down an inclined plane. Previously studies of this problem had been either for very thin piles or had not been simulated long enough to reach steady state. Working in collaboration with Thomas Halsey and Deniz Ertas from ExxonMobil and Dov Levine from the Technion, Leo carried out a detailed study of flow in this geometry. One of the most important finding is that for an intermediate range of angle, there is a steady state regime where the energy dissipation due to collisions balances the energy input from gravity. For low angles, the system does not flow while for large inclination angle, the system is unstable and continues to accelerate. In this intermediate range of angles, the density is constant independent of the height of the pile and the velocity and shear stresses obey a simple scaling law. When the base of the system is ordered, Leo observed a new flow-induced, self-organized state in which the system forms layers. For some angles, the system even oscillates between the ordered, layered state and a disordered state.

Leo also studied the role of particle packing such as one pours particles into a container or die. He was particularly interested in the effect of particle-particle friction on the packing. It is well known that hard, frictionless spheres have a maximum dense random packing at approximately 64% volume fraction and the number of nearest neighbor contact is six. This is also the minimum number of contacts for a solid to be stable. With friction, the minimum number of contacts for a system to be stable is reduced to four. However no one has ever been able to create stable packings with such few contacts. To clarify this issue, Leo carried out a series of simulations starting from a dilute system of particles and letting them fall under the influence of gravity. By varying the normal force between particles over six orders of magnitude as well as the coefficient of restitution, which controls how fast the energy is dissipated due to collisions, Leo produced stable packings which approached the theoretical limit and carried out detailed analysis of the distribution of forces and network of force chains on the resulting packings.

After completing his postdoc at Sandia, he moved to the University of Chicago to work with Sid Nagel and Andrea Liu on the properties of dense random packings. His recent work has clarified the number of low energy modes as one approaches the jamming transition. He has established himself in the area of granular and colloidal modeling and simulation and is in a position to move into new areas to model other complex phenomena. I expect him to do well in the future and strongly recommend him for a position in your department.

Sincerely yours,

Gary S. Grest