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Biocomplexity Faculty Search Committee
c/o Professor Rob de Ruyter van Steveninch
Biocomplexity Institute
Indiana University
Swain Hall West 117
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Dear Faculty Search Committee:

I am pleased to write this letter in support of Andy Lau's application for a position as an Assistant Professor at Indiana University. Andy has been a postdoc in the soft condensed matter theory group at the University of Pennsylvania since Sept. 2001. He has proven to be an independent and important asset to our group, and I recommend him strongly.

Andy did his graduate work at the University of California at Santa Barbara under the guidance of Phil Pincus. His thesis focused on fluctuation effects in classical electrostatics. He has written six papers on this very current topic that have been very well received. I think very highly of this work, but I will leave it to others like Phil Pincus and Sam Safran, who are more intimately familiar with it, to give it a more detailed evaluation.

Andy arrived here after spending a year at the College de France. He immediately became involved in a number of projects here, and he has become a very important part of our soft condensed matter group.

When he arrived here, Keng-Hui Lin had just finished experiments in Arjun Yodh's lab on the depletion force between two spheres in a dispersion of semi-flexible hard rods (fd virus). Her experiments did not agree with calculations based on replacing semi-flexible rods with rigid rods with a length renormalized by bend fluctuations. Andy immediately saw that an improved approximation could be obtained by replacing the semi-flexible rods with a bent rod consisting of two rigid sections meeting at an angle. The two-dimensional structure of the bent rod has rotational degrees of freedom, not present in a rigid cylindrical rod, that affect the phase space available to the rod in confined geometries. Andy conceived of and carried out all of the calculations for this model by himself.

A considerable fraction of my research efforts in the last two years has been devoted to the study of liquid crystalline elastomers. These remarkable materials, which are created by chemically crosslinking liquid crystalline polymers, combine the order of liquid crystals with the elasticity of rubber. When Andy arrived at Penn, I was working with David Lacoste, another postdoc, on a theory of lyotropic elastomers produced by embedding rigid rods in a poylacrylamide gel that can undergo enormous changes in volume in response to changes in temperature or solvent change. The contraction in volume increases the rod volume fraction and leads to an Onsager-like transition from an isotropic to a nematic state. Andy joined our collaboration and really made things work. Our theory set the stage for very interesting experiments at Penn that have actually produced lyotropic nematic elastomers, whose properties are not identical to those we predicted. Andy is currently investigating theoretical models for the more complex experimental behavior.

Andy has made every effort to interact with the many soft-matter experimentalists at Penn. He has worked closely with John Crocker, Zvonimir Dogic, and Arjun Yodh's student Dan Chen. He has often taken the lead in these interactions, suggesting experiments and working late into the night analyzing data. I have grown to rely upon him as my conduit to the experimentalists.

Inspired by experiments by John Crocker on bead tracking in living cells, Andy and I developed a theory of microrheology of systems with non-thermal noise. Microrheology experiments extract information about the complex elastic moduli of a medium by measuring either the response of colloidal particles dispersed in the medium or their fluctuations. John's fluctuation measurements in living cells do not obey the fluctuation dissipation theorem indicating to no one's surprise that living cells are not in thermal equilibrium. With minimal guidance from me, Andy was able to generalize work that I had done with Alex Levine and one- and two-point microrheology to the systems with non-thermal noise sources. His analysis was elegant in its use of clever mathematical machinery. This theory provides a framework for interpreting John's experiments, and it makes some conjectures about the origins of the ω^{-2} frequency dependence of the noise spectrum observed in these experiments. I suspect that we will be seeing considerably more about nonthermal noise in biological systems. Certain of this, Andy convinced Dan Chen to initiate rheology and microrehology experiments in baths of living bacteria, which act as a source of nonthermal noise. Preliminary results are interesting, and Andy spends a lot of time with Dan discussing them.

Andy worked closely with Zvonimir Dogic and a long list of collaborators in a study of fluctuations of polymers dispersed in a nematic solvent of fd viruses. These experiments were able to probe the polymer fluctuations via direct optical imaging. Even flexible polymers stretched out in the nematic environment. The correct theory, which none of us saw immediately, for the fluctuations of the polymer includes contributions both from intrinsic bending modes of the polymer and fluctuations of the background nematic director. Andy devised a method of calculating the polymer fluctuation spectrum from the correct model. He also spent hours working with Zvonimir to analyze the experimental data, which finally agrees very well with the theory.

Though Andy enjoys interacting with experimentalists, he maintains an interest in the more technical points of theory. He and I have begun a program to study systems in which the friction coefficient depends on position of a particle. We want, in particular, to develop the correct Langevin and associated path integral theory to describe these systems. This is a task that must immediately confront subtle concepts like the difference between Ito and Stratonovich calculus of stochastic equations. Andy has jumped into this with aplomb. He has been absolutely tenacious in his efforts to understand all aspects of this problem.

Andy is a great candidate for a junior faculty position. He has produced interesting and world-class research, and he has enormous potential for growth. He is hard working, creative, and very interactive. He definitely likes working with experimentalists, and he does it well. He has a sense of humor that should be appealing to students. His principal weakness is that his communication and writing skills could be improved. His presentations are sometimes disorganized, but they have improved significantly. He may, initially, have a difficult time teaching a large undergraduate class, but I am confident that he will work to do whatever it takes to be a good if not outstanding teacher.

I would rank Andy near the top of postdocs and graduate students we have had at Penn in recent years. His mathematical skill and physical intuition are better than those of Alex Levine, now at UMass Amherst, and he has Alex's drive, ambition, and willingness to work with experimentalists. He is not quite as deep or as broad as Ranjan Mukhopadhyay, now at Clark University, but he is more dynamic, and he projects better. He has greater depth than my former student, Corey O'Hern, now in the Department of Mechanical Engineering at Yale, but his communication skill are not as good. He is clearly superior to David Lacoste, who now has a CNRS position at the ESPCI in Paris. His depth and drive to understand are probably superior to those of Brian Didonna. If we had a position in condensed matter theory at Penn, we would certainly invite Andy for an interview to have a closer look at him, and I encourage you to do so.

Sincerely,

Tom Lubensky

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