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Biocomplexity Faculty Search Committee
c/o Prof. Rob de Ruyter van Steveninck
Department of Physics
Indiana University
Swain Hall West 117
Bloomington IN, 47405-710509-1120

Dear Selection Committee:

It is a pleasure to recommend **Dr. Roya Zandi** for a faculty position in your department. I have followed Roya's work since she was a graduate student at UCLA, and have interacted with her closely while she was a UC Presidential (postdoctoral) Fellow. During the latter period (Fall 2002–2004) she was also a visiting postdoctoral fellow in my group at MIT. We have collaborated on a wide range of topics from superfluid helium to polymer knots. Based on these interactions I have formed a very high opinion of Dr. Zandi: she is hard working, meticulous, cognizant of both details and the overall goals of a project. She is not afraid of tackling completely new problems, indeed she seems to relish the challenge of learning a new topic and novel tools. This makes her ideally suited for her chosen interdisciplinary field of biophysics, and I can recommend her selection with utmost enthusiasm.

I first heard about Roya's work through a former student, *Dr. Ramin Golestanian* who had taken up a postdoctoral position at the Institute for Theoretical Physics (ITP) at UC Santa Barbara. Along with Professor Rudnik, they studied the end-to-end probability distribution of a charged polymer. While this initially appears as a straightforward problem, there are in fact many subtleties associated with the non-linear constraints and the long-range interaction. Indeed they uncovered some novel features associated with the bending of charged semi-flexible polymers, which has lead to a stream of publications. The initial set up of the problem was due to her senior collaborators, with Roya set in charge of the numerical studies. However, it was her persistent questioning of the results that lead to the uncovering of the unusual aspects of bending and buckling in semi-flexible polyelectrolytes.

My initial direct contact with Roya was in the spring of 2001, while I was on sabbatical at the ITP. Roya and Prof. Rudnik drove to Santa Barbara, and we had a very productive day discussing their ongoing research, both on bending of polyelectrolytes, and on the mechanical constraints encountered by DNA bending around a histone. The latter is a beautiful application of the theory of elasticity involving the interplay of bend and twist. I came away from this meeting with great appreciation for the technical abilities of Roya. These impressions were reinforced when I later visited UCLA in the spring of 2002. By that time Roya had finished her doctoral studies, and awarded the prestigious UC presidential fellowship. This postdoctoral fellowship is quite flexible, providing her with the opportunity for extensive travel in pursuit of research. Roya inquired about taking advantage of this opportunity to initiate a collaboration with me at MIT. Naturally, I was delighted with such a possibility, and arranged for her appointment to a visiting postdoctoral position at MIT. Due to family commitments in LA, Roya could only make short visits (typically one week in length) every couple of months to Boston. Along with exchanges by Email, this has been our mode of collaboration for the past few years.

Her first visit to MIT in the Fall of 2002 coincided with that of my longtime collaborator, *Prof. Yacov Kantor* of Tel Aviv University. At that time, the subject of our research was the configurations of knotted polymers, and Roya expressed interest in working on this topic. In particular, we were interested in finding out how topological constraints (such as knots) modify the number of configurations (hence entropy) of a polymer. (Does a knot have more configurations than a loop?) As a numerical means for answering this question, we devised a method, which we called entropic competition, in which polymers with different constraints were allowed to exchange monomers– the histogram for the number of monomers in each segment then provides a measure of their relative entropy. In the short span of a week, we settled upon how to study this problem, and Roya learned and wrote a Monte Carlo program for its execution. (She had some expertise with a very different method, Molecular Dynamics, for numerical studies of polymers.) The method of entropic competition has since been employed by another group for the study of knots. We recently used it for a numerical study of the (apex) scaling exponents describing the interaction of a polymer with a probe.

This was the pattern for all of Roya's visits to MIT: she would arrive with a set of things to do and questions to ask, would devote every available second to getting answers, absorbing information, and planning new things to do while in LA. Indeed, given her enthusiasm and dedication, I would feel bad if I could not devote my entire time to our interactions during her brief visits.

At Roya's insistence to explore directions orthogonal to her previous research, I suggested that she examine the thinning of helium films at the superfluid transition. This phenomenon was experimentally observed a few years ago, and attributed to fluctuations of the superfluid order (a so-called Casimir interaction). However, the observed change of thickness is larger than can be accounted for by theoretical estimates of the Casimir force. My original suggestion was for Roya to quantify the hitherto neglected quantum contributions to the force; she quickly concluded that these corrections are negligible. To arrive at this conclusion, Roya had to master a whole new formalism (path integral calculations) in a different realm of physics. More impressively, she did not quit when quantum corrections failed to account for experimental observations, but explored other possibilities. In particular, after teaching herself the phenomenology of superfluid hydrodynamics, she suggested that the so-called third sound (due to surface fluctuations of the film) could be relevant. I was initially skeptical that surface effects could influence the bulk thickness of the film. Roya convinced me otherwise, pointing out that the dispersion of surface modes actually depends on the film thickness. Furthermore, her analytical computations showed that the force resulting from the third sound modes was almost twice as large as the forces calculated earlier, and that the combination was consistent with the experimental observations. I was quite impressed with Roya's persistence and creativity in pursuit of this puzzle. (The final results were published recently in Physical Review Letters.) We are hoping to extend the results to understanding the large dip observed in the thickness right at the superfluid transition.

In addition to the above topics, Roya has pursued other projects with her collaborators at UCLA. I am quite familiar with her work on translocation (passage through a pore) of stiff polymers, which I discussed with her on several occasions. In this work (published in the PNAS), a combination of analytical methods (calculation of equilibrium free energies) and numerical simulations (molecular dynamics) is employed to address how adsorption of proteins on a stiff polymer assists its passage through a pore in a vesicle. An earlier model, based on Brownian ratchets, assumes that particles irreversibly attach to the chain, preventing its retraction once inside the vesicle. The numerical simulations of Roya, which allow for reversible detachment of particles, elucidate the limitations of the previous model; the comparisons with equilibrium free energies enable them to place limits on the force exerted on the chain. Yet another project pertains to the self-assembly and shapes of viruses. In fact, I learned about this beautiful topic only through an enjoyable seminar from one of her collaborators (Robjin Bruinsma). Currently Roya has embarked on yet another direction, related to nucleation, with Prof. Howard Reiss in the Chemistry department. I will have to leave it to her collaborators to comment on her contributions in these diverse projects.

In summary, Roya has worked on a broad range of problems in statistical and biological physics, employing a wide variety of numerical and analytical tools. She relishes the challenge of tackling new projects, which she attacks with hard work and determination. In each case, she has obtained innovative results, in some instances overturning commonly accepted beliefs. Her scientific courage and integrity, persistence and devotion, and qualities that shall no doubt serve her well in an academic and research setting. I recommend her for a faculty position in your department in the strongest terms.

Sincerely yours,

Mehran Kardar
Professor of Physics