Department of Chemical Engineering
Department of Chemistry, Division of Biol. Eng.

Massachusetts Institute of Technology
77 Massachusetts Avenue, Room 66-546
Cambridge, Massachusetts 02139-4307

Name
Arup K. Chakraborty
Robert T. Haslam Professor

Phone 617.253-3890
Fax 617.258-5766
Email arupc@mit.edu

November 10, 2005

Jeremy Bennett
Faculty Search Coordinator
Department of Biology
Indiana University
1001 East 3rd Street
Jordan Hall 127
Bloomington, IN 47405-3700

Dear Prof. Bennett:

It is a great pleasure to write in support of Dr. Jayajit Das' application for a junior faculty position in your department. Right at the outset, let me say that Jayajit is a very talented researcher, and I think that he will be a successful faculty member. Jayajit's early scientific work focused on theoretical condensed matter physicist with special emphasis on non-equilibrium statistical mechanics. He came to my group to work on problems that involved developing and using statistical mechanical methods to shed light on practical problems. His work with me has had two phases. The first phase is one where he worked on problems in polymer science and engineering in close collaboration with the experimental laboratories of Profs. Balsara and Frechet (at Berkeley). The second phase of his work has been focused on T cell biology, and is closely collaborative with experiments carried out in Prof. Shaw's laboratory (Washington University Medical School). Jayajit's postdoctoral work has been a success, and he is ready to embark on an independent career. His efforts on T cell biology presage the majority of his future research plans on understanding the biology of NK-cells. These proposals are very well-crafted, and are harbingers of future successes as an independent academic researcher. Below, I briefly describe some of Jayajit's successes during the time he has spent in my research group.

Jayajit's first research project in my group concerned understanding the phase behavior of crosslinked block copolymers. This work was a collaboration between my group and Prof. Balsara's experimental group. Crosslinked block copolymers are being considered by the Balsara group as possible constituents of artificial muscles. Jayajit carried out a very difficult replica field-theoretic calculation to study how the crosslink density controls the order-disorder transition. In carrying out this calculation, Jayajit included an *ansatz* that was developed earlier by physicists at Illinois. Jayajit's theory was very useful in helping the interpretation of experiments. However, Jayajit also demonstrated that the *ansatz* developed by the Illinois physicists is just wrong under certain common experimental situations! He was able to do this because he focused on understanding the experiments as well as the mathematics, and because he is an extremely careful researcher. His paper on this subject will be very helpful as it will prevent others from using similar theoretical methods without modification. His collaborative work with Prof. Nitash Balsara's group has led to other successes, but I leave it up to Nitash to highlight these studies in his letter.

The above project was a "warm-up" effort that prepared Jayajit to carry out extremely successful studies on dendronized polymers. These macromolecules consist of a simple homopolymer backbone from which emerge branches that are dendrimers. By tuning architectural features of dendronized polymers, their properties can be varied from that of a flexible coil to rigid nano objects. In collaboration with Prof. Frechet's group, Jayajit has been developing theoretical and computational methods to guide the design of dendronized polymers that are constituents of nanostructures that can carry out stimuli-responsive biomimetic tasks (e.g., those that can function as selective transport channels). So far, Jayajit has had two successes. The first one is an interesting fundamental advance. Jayajit has shown that as the number of generations of a single dendronized polymer increases, it undergoes a "glass transition". Thus, Jayajit has helped discover a new form of molecular matter that was once imagined by deGennes – a single molecule glass. Over the preceding two decades, there has been enormous interest in understanding whether the glass transition has a thermodynamic or purely dynamic origin. The controversy has largely been abstract in nature because it is impossible to experimentally test purely dynamic theories by changing temperature. Jayajit's discovery that dendronized polymers can undergo a purely dynamical phase transition as architecture (not temperature) is tuned offers the possibility of testing purely dynamic theories of the glass transition.

The second project on dendronized polymers that Jayajit has completed is motivated by practical concerns. He has developed a field-theoretic computational method (related to those due to Fredrickson and Schick) that can predict the ordered microstructures of dendronized polymers in solution and in the molten state. The purpose of these computations is to discover chemistries and architectures that will lead to self-assembled nanostructures that are important in advanced engineering applications. Jayajit has already discovered conditions that lead to self-assembled nanostructures that could be useful as selective transport channels. The paper on this topic will soon be completed, and current synergistic synthetic research being carried out by members of Prof. Frechet's group is developing these ideas further.

In his most recent efforts, Jayajit has turned his attention to immunology. T lymphocytes (T cells) are the orchestrators of the adaptive immune response. Over the last six years, my research group has focused on understanding various aspects of how T cells get activated in response to pathogen invasion. One such effort aims to elucidate the function of the immunological synapse, a spatially organized collection of membrane proteins that forms at the junction between T cells and antigen presenting cells displaying molecular signatures of the pathogen. This work is closely collaborative with Prof. Andrey Shaw's laboratory at Washington University Medical School. Jayajit has been the key theoretical researcher on our most recent work in this area. He developed both continuum and stochastic approaches to study signaling in T cells in the spatially organized environment of the immunological synapse. He showed that, for good antigens, the role of the immunological synapse is largely to downregulate signaling, while for weaker antigens, the synapse can enhance signaling and downregulation. Experiments carried out in Andrey's lab. Show that, consistent with these ideas, a antigenic molecule that does not stimulate synapse formation can lead to more robust stimulation, while others cannot elicit such a response. The paper based on this work is currently in review at *Nature Immunology*.

Jayajit revels in collaborations with experimentalists focused on applications and he can think seamlessly from the molecular to macroscopic scales. He proposes to work on problems focused on immunology and one problem on synthetic nanostructures. These are exciting areas, and Jayajit's track record suggests that he will contribute to these areas in a significant way. His knowledge of immunology is still developing, but the slope of the learning curve is high.

Jayajit is very patient, and has been a good mentor for younger students in my group. Thus, I believe he will be a very good educator.

In summary, I believe that Jayajit Das is a deep thinker, a careful researcher, and a great colleague. He wants to develop a research program that intertwines sophisticated theory and synergistic experiments (with collaborators) to study important problems in immunology and soft material science. Among recent members of my group who have gone on to academic positions, I rate him to be in the middle of the pack. This is actually quite impressive as I rate him to be better than Simcha Srebnik (Technion), as good as S. Raychaudhuri (UC Davis) and M.O. – Coppens (RPI), and below Bernhardt Trout (MIT), Vijay Pande (Stanford), and Aaron Dinner (U. Chicago). I think he will be successful as a faculty member. Please do not hesitate to contact me if I can be of further assistance.

Sincerely,

Arup K. Chakraborty
Robert T. Haslam Professor of Chemical Engineering
Professor of Chemistry, and Professor of Biological Engineering