



Nov. 15, 2004

Biocomplexity Faculty Search Committee
c/o Prof. Rob de Ruyter van Steveninck
Department of Physics
Indiana University

Dear Prof. de Ruyter van Steveninck

I am writing in support of Dr. Joe Reiner's application for a faculty position at your institution. I am a theorist in quantum optics, and was on Joe's thesis committee, and we have published two papers together. I worked quite closely with Joe over a four year period on various problems in cavity quantum electrodynamics. His experimental work initially involved a small cavity with a few atoms at a time inside, driven by a weak probe. The initial goal was to observe photon antibunching and other nonclassical behavior, which was accomplished. To model the system, Joe became quite proficient in the methods of open quantum systems, or quantum statistical mechanics. This includes density matrix formulations as well as quantum trajectories (or quantum Monte Carlo wavefunction simulations). I was very impressed by Joe's theoretical abilities. He could easily be a successful theorist, he has a great intelligence, learns quickly, and is able to figure out what is significant. He was not content to get a match between theory and experiment curves, but worked very hard to understand why the curves did what they did. He has a great physical insight, intense curiosity, and an extraordinary work ethic.

After the preliminary work on photon statistics, Joe went on to contribute to ground breaking experiments in quantum feedback, where a control signal is sent back to the drive of a quantum system. This represented the first truly "real world" application of quantum feedback and control, and was featured on a variety of science news sites. Joe also contributed to the theory here, along with Howard Wiseman and Luis Orozco. Also Joe contributed to measurements of a new type of correlation function, as well as the theory. This is a homodyne measurement conditioned on detection of a photon, and it allows one to make a simultaneous measurement of wave and particle properties of light. Obviously you don't get complete information about both aspects, but in a very real sense, these experiments measured the electric field of a single photon. Joe was one of the authors on an extensive paper that appeared in the Progress In Optics series, and his contributions to that article were quite significant. Also, Joe, along with Howard Wiseman and Hideo Mabuchi proposed a feedback scheme for an atomic system; this was an outgrowth of his visit to Howards group in Australia. It once again demonstrates that he is at home with theory as he is with experiment, and the breadth of his interests and abilities.

I have visited with Joe at NIST several times, and have heard his talks on the work he is doing with optical tweezers with Kris Helmerson. This is a very different area for Joe, but he has, in my opinion, made significant progress in identifying interesting problems.

Joe Reiner has the capability to be a truly great physicist. I will let others speak to his lab skills more fully, but he compares well with the best students in the Orozco group (which has had several NRC fellows), as well as the best in the group of H. J. Kimble at Cal Tech, another pioneer in quantum optics, whose group I have spent time with. He has the needed technical abilities in the lab and with theory, and more importantly he has a passion for physics and the ability to identify truly fundamental questions, and find ways to answer them. I think he would be a wonderful addition to your faculty, and recommend him to you most highly. He will also make a wonderful teacher as he is outgoing, and has great communication skills. At his defense, his entire family was there. A committee member asked him one final question: "After all this technical stuff, explain to your family in 2 minutes what you have done the last 5 years". This would throw many graduate students off, but Joe compared quantum feedback to cruise control in an automobile, and pointed out the differences in a quantum system.

He is a fine person, a great colleague, and a first class physicist with potential to do truly amazing things.

Sincerely,



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