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Biocomplexity Faculty Search Committee
C/o Prof. Rob de Ruyter van Steveninck
Biocomplexity Institute
Indiana University
Swain Hall West 117
Bloomington, IN 47405-7105

January 5, 2004

Dear Search Committee,

I am pleased to recommend Dr. Armen Stepanyants for a faculty position in the Biocomplexity Institute at the Indiana University. Armen is a highly qualified scientist with a broad range of interests and a proven research record. I have no doubts that he can work successfully both in "traditional" research fields and in an interdisciplinary environment.

I have known Armen since 1995 first as an instructor in some of his graduate physics classes and, later, as his Ph.D. thesis advisor at the University of Rhode Island. Armen came to URI after completing an equivalent of M.S. program in theoretical physics at Moscow Physical and Technical University (Russian analog of MIT). All his reference letters were exceptionally good. It turned out that he was indeed an excellent student, and we were very lucky to have him in our group.

At URI, Armen took a couple of my advanced graduate physics classes in condensed matter physics. Without any doubts, he was the best student in his class.

Armen has a solid theoretical background and excellent research skills that allowed him to work successfully, while at URI, in various research areas from ultra-low temperature physics to kinetic theory to theoretical and applied solid state physics.

I was Armen's Ph.D. adviser. Most of his research at URI concerned the physics of spin-polarized quantum systems and transport and mesoscopic properties of systems with random rough boundaries. I understand that his earlier accomplishments in theoretical physics might seem irrelevant for his current career in neuroscience. The illustrations below can, nevertheless, help to understand the breadth of his research interests and the versatility of his skills.

He started from the work from the work on anomalous zero-temperature attenuation in transverse spin dynamics of polarized Fermi liquids. This effect was first predicted by our group and

observed later by two British and American groups. By the time Armen started his work, the effect was already well established, but was still considered an isolated anomalous phenomenon. Armen investigated the coupling of the underlying process to other, more traditional observable processes. He established that this effect is linked, by means of magnetic dipole-dipole interaction, to other transport and kinetic processes in spin-polarized Fermi liquids such as viscosity and sound attenuation. As a result, this anomalous transverse attenuation becomes responsible for an ultra-low temperature saturation of relaxation parameters in Fermi liquids.

His second contribution in this direction was even more revealing. Armen demonstrated that the exchange interaction between spins of conduction and ferromagnetic electrons in Heisenberg ferromagnetic metals transfers the zero-temperature attenuation from the Fermi liquid of conduction electrons to the system of localized spins. His main prediction was that the ferromagnetic magnons in Heisenberg ferromagnetic metals acquire some residual zero-temperature attenuation even in the absence of impurities. This activity on microscopic theory of Fermi liquids resulted in two publications.

Though his Ph.D. work on spin-polarized quantum systems was more than half-way completed and already resulted in several publications, Armen got interested in a completely different topic and decided to change the direction of his research to the study of transport in systems with random rough boundaries. Here we developed a new method that allows analytical and numerical analysis of the effect of surface inhomogeneities on transport in (ultra-narrow) channels with rough walls. This method turned out to be very useful for a wide variety of problems from classical transport in thin films to mesoscopic and localization consequences of scattering by random walls to a new approach to a billiard, bouncing ball, and other models. The method was based on mapping of the boundary problem on an *exactly* equivalent bulk transport problem. Armen's first step was to derive a proper transport equation for this new mapping formalism. The surprising result was that in a wide range of parameters the transport equation has an anomalous form quite different from the standard Boltzmann equation for scattering by usual bulk imperfections. Armen analyzed this equation and obtained interesting analytical and numerical results for transport coefficients. His other achievement was the first study of the effect of interwall correlation of inhomogeneities on transport in nano-channels with random rough walls. This work resulted in a couple of publications.

As a next step, Armen worked on quantum interference and localization of particles adsorbed on rough substrates. The problem is important for ultra-cold neutron systems in gravitational and magnetic traps, electrons and hydrogen states above helium films, weakly bound adsorbed states, *etc*. This work has also been published.

The final part of his Ph.D. thesis at URI was the study of the interference between scattering by boundary inhomogeneities and bulk imperfections. These interference processes, which have never been studied before, are crucial for correct understanding of the quantum size effect in ultra-thin (micro- and nano-size) systems with surface inhomogeneities of different scales. Under the certain conditions, these interference terms can even exceed the "pure" bulk contributions.
By the time Armen received his Ph.D. in 1999 he already had 16 publications.

After receiving his Ph.D. in physics, Armen worked on application of our general approach to systems with disordered boundaries to a completely different research field, namely, hydrodynamics. His work in this direction at MIT resulted in a very interesting interdisciplinary publication on diffusion and localization of surface gravity waves over irregular bathymetry. This work provided a unique example of macroscopic quantum effect in a seemingly classical system such as shallow liquid over rough bottom.

For a long time Armen wanted to try himself in basic biomedical and biophysical research. For this reason, he jumped at the opportunity to get a postdoctoral fellowship at the Cold Spring Harbor Laboratory and work in neuroscience. In just three years he published or submitted eight research papers in this field. This is a very impressive achievement for a person without prior research experience and systematic education in a completely new field. Not being an expert in biosciences, I cannot judge the scientific merits of these papers and their impact on the community. To me, as a physicist, the most interesting publications are Armen's papers on geometry and structural plasticity of synaptic connectivity patterns. I am impressed by the elegance of the underlying ideas and mathematics in these papers.

Even a mere list of Dr. Stepanyants' research accomplishments is quite impressive. Such a diversified work could be successful only because of a high level of Armen's theoretical and mathematical skills that can be applied to a wide range of problems. One of Armen's professional characteristics is almost unique these days: he is highly qualified in both analytical and computational work. On a personal level, I would like to mention that Armen is a pleasant and hardworking person. He can easily accommodate to different environments, and can work on individual and collective projects. Armen Stepanyants is a highly qualified and mature scientist, and is very thorough in his work. I strongly believe that Armen will be successful in a wide range of physics-related disciplines such as biophysics, neural and stochastic networks, *etc*. He has a sufficient research experience in current concepts and advanced biomedical methods that will allow him to become an independent leading investigator in this rapidly evolving multidisciplinary area and to nucleate a new research group in your Department.

I want to add that Dr. Stepanyants also has a positive experience in proposal preparation and search for external funding. His first grant proposal for a NIH grant received high scores and was recommended for funding. My understanding is that this, by itself, is rather unusual for young postdoc with physics background at NIH. This serves as an additional confirmation of Armen's high research potential and an exceptional quality of his work. This also indicates that Armen will be successful in securing sufficient external funding which is crucial for research work in the university environment.

In summary, I strongly recommend Dr. Armen Stepanyants for a faculty position. Armen will definitely become a valuable addition to your Institute.

Sincerely,

Alexander E. Meyerovich
Professor of Physics