

University of Colorado at Boulder

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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 47405-7105

To Whom It May Concern,

It is my sincere pleasure to recommend for Hugh MacMillan for the position you have open. I have known Hugh since he came to Boulder to pursue graduate studies, and I have nothing but the highest regard for him.

Hugh received his Ph. D. here in the Department of Applied Mathematics at the University of Colorado at Boulder in the spring of 2001, and I was fortunate to have served as his co-advisor in that capacity. Hugh is one of the best students with whom I have ever had the pleasure of working. I would rate him in the top 1% of all of the graduate students whom I have known over my 30-year career. He is truly exceptional and I therefore give him my highest recommendation.

My comments here are focused on Hugh's thesis since most of my professional contact has been in that regard. The aim of his thesis is to apply first-order system least squares (FOSLS) to inverse problem. Least-squares methods provide a very effective methodology for solving a wide variety of partial differential equations. Some of the benefits of these methods include realization of a well-posed minimization principle, facilitation of accurate and efficient finite element discretization methods and multigrid solvers, and availability of sharp error estimates. Least-squares methods offer a natural framework for inverse problems, but they had yet to be developed for this important application area.

Hugh's thesis forges the way to applying FOSLS to inverse problems by tackling electrical impedance tomography (EIT). EIT involves recovering the unknown coefficient of an elliptic equation given over-determined boundary data for various states of the system. The primary difficulty with EIT, as with many inverse problems, is that it is ill posed in the sense that small changes in the data create large changes in the solution. It is important to realize that this sense of ill-posedness depends on the norms used, and it reflects the real limitations of the physics. While the explicit aim of Hugh's research is to provide a FOSLS formulation for EIT, an underlying theme is to determine appropriate norms in which the formulation is well posed. Achieving this ambitious goal is tantamount to determining which solution components can be retrieved from the physics. It would obviate

the need for generic regularization schemes and enable accurate and efficient methods that are limited only by physical considerations.

Hugh was not only able to formulate FOSLS for EIT and prove well-posedness in norms that he devised, but he also extended his theory to other variational formulations and exploited it in the development of an effective numerical scheme. The remarkable results that he obtained answers the question for EIT that is central to inverse problems in general: it characterizes the components of the solution that we can rightfully expect to reconstruct given the constraints imposed by the physics.

Hugh has demonstrated exceptional research skills in his pursuit of these results. He has a keen mind that penetrates central issues, an intellectual and investigative attitude that leads to his broad knowledge of the field, and a professional and personal maturity that is well beyond his years. His ability to pursue his own initiatives as well as collaborate with colleagues makes him a real asset in a team research setting. Evidence of his excellence is the prestigious Sloan/DOE Fellowship he was awarded to pursue research in computational molecular biology at the University of San Diego.

While I have not observed Hugh's classroom activities directly, I understand from the many positive comments from students and others who observed him in class that he is an exceptional teacher. I have, however, seen several of his research lectures, and he is consistently well prepared, in control of the subject and ensuing discussions, and very clear in his delivery. His passion for mathematics and science comes through in his spirited but comfortable lecture style.

Hugh is an exceptional scientist, and he would make an excellent choice for the position in your department. I therefore recommend him most highly and without reservation.

Sincerely,



Steve McCormick
Professor