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Dear colleagues:

I am writing to enthusiastically recommend Julio Castrillon for a position in your department. I have known Julio for about two years and had a chance to read some of his recent work.

The bulk of Julio's research has been in application of surface wavelets to signal processing and numerical solution of differential equations. Traditional wavelets form an orthogonal basis for L^2 in one dimension and their extension to two and three dimensions requires uniform tensor product grids. In the last decade, several attempts have been made to use wavelets in lieu of polynomial shape functions to solve PDE's, primarily by W. Dahmen and A. Kunoth in Germany. The motivation is the natural multiresolution structure of the bases that leads to improved algebraic efficiency. The disadvantages are dense stiffness matrix (orthogonality is with respect to L^2, not the energy inner product) and uniform grids. As a result, traditional wavelets cannot be deemed as viable general-purpose discretization tool for PDE's.

Julio's work is concerned with a type of wavelets (called 2nd generation) that do not posses traditional wavelet properties such as shift and scale invariance. In addition, 2nd generation wavelets are only approximately orthogonal. However, they can be defined on arbitrary domains and retain localization, fast transform and de-correlation properties. This makes them a better choice if one wants to solve PDE's.

The novel aspect in Julio's research is application of 2nd generation wavelets to the numerical solution of PDE's. These wavelets are used predominantly in 3D computer graphics; however, Julio has realized that they are much better suited to solve PDE's numerically than conventional wavelets. This gives his approach a definite practical edge over the work of Dahmen and Kunoth.

Julio's approach is based on a variant of 2nd generation wavelets called "surface wavelets". These are defined on, e.g., boundaries of 3D regions. To address physical, rather than computer graphics applications, he places the emphasis on the accuracy of the bases. To solve a PDE by surface wavelets the problem is recast into an equivalent integral equation of the second kind. After Galerkin procedure one gets a dense linear system. The matrix of this

system can be simplified by using the decaying property of the integral equation kernel, a fact that is routinely exploited by people who solve integral equations (matrix entries decay as the distance between source and evaluation point increases).

Some of the most interesting aspects of Julio's work concern the proper compression of the discretization matrix. His main results were to

   a) Estimate rate of decay of kernel coefficients for surface wavelet discretizations;

   b) Estimate rate of convergence of the surface wavelet scheme using the full matrix

   c) Establish the compression threshold that will guarantee a match in convergence rates

      with a compressed matrix.

He has shown that surface wavelets give a faster decay rate than a single scale discretization and that approximately $O(\log(N)^{(7/2)N})$ entries are sufficient to retain the convergence rate of the full problem.

After earning his PhD, Julio was awarded a prestigious postdoctoral fellowship at ICES, a leading institution in applied and computational mathematics and high performance scientific computing. His research in computational biology and scientific visualization is highly relevant. I am very impressed by how fast Julio was able to enter this new research field, and the rapid progress he has made in his work.

Overall, Julio has solid mathematical competence and excellent command of his core research area. His interests and background strike me as unusually broad for someone less than two years after a PhD and he will fit nicely in a wide range of settings. As a result, I would give his application a very serious consideration for this position. As a comparison, Julio's record would have easily placed him on the short list for the prestigious Von Neumann scholarship offered by the Sandia National Laboratories. Finally, yet importantly, Julio's pleasant personality and outgoing character make him an excellent colleague.

Please do not hesitate to contact me at 505.844.1990 should you have any further questions about Julio.

Sincerely
Pavel Bochev