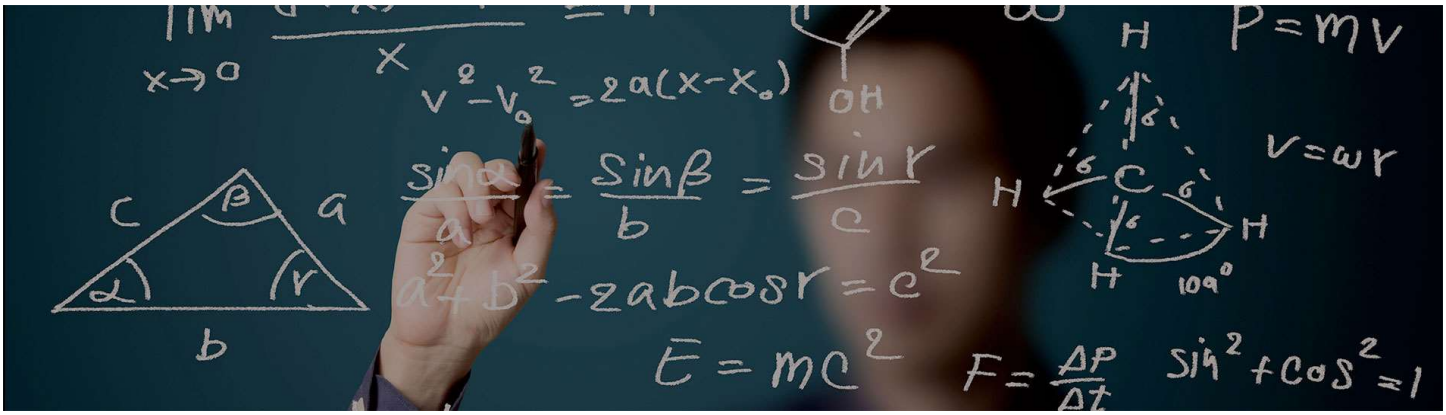

Spring 2023

RENSSELAER POLYTECHNIC INSTITUTE

DEPARTMENT OF MATHEMATICAL SCIENCES COLLOQUIUM

Guglielmo Scovazzi (Duke University)

March 13, 2023 at 4pm

TROY 2012

The Shifted Boundary / Shifted Fracture Method for Computational Mechanics

Embedded/immersed/unfitted boundary methods obviate the need for continual re-meshing in many applications involving rapid prototyping and design. Unfortunately, many finite element embedded boundary methods (cutFEM, Finite Cell Method, etc.) are also difficult to implement due to: (a) the need to perform complex cell cutting operations at boundaries, (b) the necessity of specialized quadrature formulas, and (c) the consequences that these operations may have on the overall conditioning/stability of the ensuing algebraic problems.

We present a new, stable, and simple embedded boundary method, named “Shifted Boundary Method” (SBM), which eliminates the need to perform cell cutting. Boundary conditions are imposed on a surrogate discrete boundary, lying on the interior of the true boundary interface. We then construct appropriate field extension operators by way of Taylor expansions, with the purpose of preserving accuracy when imposing the boundary conditions. We demonstrate the SBM in applications involving solid and fracture mechanics; thermomechanics; CFD and porous media flow problems.

In the specific case of fracture mechanics, the SBM takes the name of Shifted Fracture Method (SFM), which can be thought of a method with the data structure of classical cohesive fracture FEM but with the accuracy and mesh-independence properties of XFEM. We show how the SFM has superior accuracy in capturing the energy released during the fracture process and how the method can be combined with phase-field approaches to simulate crack branching and merging.

Refreshments served at 3:30pm 4th floor Lounge

Biographical Sketch

Guglielmo Scovazzi is Professor of Civil & Environmental Engineering and Mechanical Engineering & Materials Science at Duke University. His interests are in the general area of computational mechanics, and specifically in CFD, computational solid mechanics, fluid/structure interaction, computational geomechanics, flow through porous media.

He earned B.S./M.S. Degrees in Aerospace Engineering at Politecnico di Torino in 1998. He received a M.S. in 2001 and a Ph.D. in 2004, both from the Mechanical Engineering Department at Stanford University. Between 2004 and 2012, he held a position as Senior Member of the Technical Staff at Sandia National Laboratories, Albuquerque (New Mexico).

Guglielmo Scovazzi is a recipient of the 2014 Early Career Award from the Office of Science of the US Department Of Energy (ASCR program), and the 2017 Presidential Early Career Award for Scientists and Engineers (PECASE). In February 2018, he was named Kavli Fellow by the National Academy of Sciences and the Kavli Foundation. The Kavli Fellowship acknowledges contributions of U.S. scientists under the age of 45. He was also named Distinguished Adjunct Professor at POSTECH (Pohang University of Science and Technology, South Korea).

He is an associate editor of the “Journal of Computational Physics” (Elsevier) and in the editorial board of "Computer Methods in Applied Mechanics and Engineering" (Elsevier), the "International Journal on Numerical Methods for Fluids" (Wiley), "Engineering with Computers" (Springer), and “Advances in Computational Science and Engineering” (American Institute of Mathematical Sciences). He is a member of USACM, IACM, SIAM, ASCE, and ASME.

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