12w5021
06/24/12–06/29/12

MEALS

*Breakfast (Buffet): 7:00–9:30 am, Sally Borden Building, Monday–Friday
*Lunch (Buffet): 11:30 am–1:30 pm, Sally Borden Building, Monday–Friday
*Dinner (Buffet): 5:30–7:30 pm, Sally Borden Building, Sunday–Thursday
Coffee Breaks: As per daily schedule, in the foyer of the TransCanada Pipeline Pavilion (TCPL)
***Please remember to scan your meal card at the host/hostess station in the dining room for each meal.**

MEETING ROOMS

All lectures will be held in the new lecture theater in the TransCanada Pipelines Pavilion (TCPL). LCD projector and blackboards are available for presentations.

SCHEDULE (MODIFIED 6/25/2012)

Sunday

16:00	Check-in begins (Front Desk - Professional Development Centre - open 24 hours)
17:30–19:30	Buffet Dinner, Sally Borden Building
20:00	Informal gathering in 2nd floor lounge, Corbett Hall Beverages and a small assortment of snacks are available on a cash honor system.

Monday

7:00–8:45	Breakfast
8:45–9:00	Introduction and Welcome by BIRS Station Manager, TCPL
9:30–10:20	Hagstrom
10:20–10:30	Coffee Break, TCPL
10:20–11:20	Jin
11:30–13:00	Lunch
13:00–14:00	Guided Tour of The Banff Centre; meet in the 2nd floor lounge, Corbett Hall
14:00	Group Photo; meet in foyer of TCPL (photograph will be taken outdoors so a jacket might be required).
14:30–15:00	Nave
15:00–15:10	Coffee Break, TCPL
15:10–15:40	Lyon
15:50–16:20	Albin
16:30–17:00	Ganesh
17:00–17:30	Discussion
17:30–19:30	Dinner

Tuesday

7:00–9:00	Breakfast
9:30–10:20	Siegel
10:20–10:30	Coffee Break, TCPL
10:30–11:20	Henshaw
11:30–13:30	Lunch
13:30–14:20	Driscoll
14:30–15:00	Chen
15:00–15:10	Coffee Break, TCPL
15:10–15:40	Leykekhman
15:50–16:20	Lau
16:30–17:30	Freeform concurrent discussions
17:30–19:30	Dinner

Wednesday

7:00–8:20	Breakfast
8:30–9:20	Melenk
9:30–10:20	Chandler-Wilde, Langdon, Spence
10:20–10:30	Coffee Break, TCPL
10:30–11:20	Costabel, Dauge
11:30–13:30	Lunch
13:30–14:00	Levadoux
14:10–14:40	Antoine
14:40–14:50	Coffee Break, TCPL
14:50–15:20	Tausch
15:30–16:00	Ovall
16:10–17:30	Freeform concurrent discussions
17:30–19:30	Dinner

Thursday

7:00–8:40	Breakfast
8:50–9:20	Wright
9:30–10:20	Sayas
10:20–10:30	Coffee Break, TCPL
10:30–11:20	Shipman, Bruno, Turc
11:30–12:50	Lunch
13:00–13:30	Nigam
13:40–14:10	Dominguez
14:10–14:20	Coffee Break, TCPL
14:20–14:50	Haslam
15:00–15:30	Betcke
17:30–19:30	Dinner

Friday

7:00–8:20	Breakfast
8:30–9:20	Monk
9:30–10:20	Gelb, Platte
10:20–10:25	Coffee Break, TCPL
10:25–10:55	Christara
11:00–11:30	Braverman
11:30–13:00	Lunch

Checkout by 12 noon.

** 5-day workshop participants are welcome to use BIRS facilities (BIRS Coffee Lounge, TCPL and Reading Room) until 3 pm on Friday, although participants are still required to checkout of the guest rooms by 12 noon. **

12w5021
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ABSTRACTS
(in alphabetic order by speaker surname)

Speaker: **Nathan Albin** (Kansas State University)
Title: *Fourier Continuation Methods for Long-Range Propagation and Transport*
Abstract: The Fourier Continuation (FC) method is a numerical technique for expressing nonperiodic functions as restrictions of rapidly converging Fourier series, thus avoiding the Gibbs phenomenon and enabling the use of Fourier-based methods to accurately evaluate derivatives of nonperiodic functions. The spectral properties of the FC derivative operator make it especially well-suited for use in numerical solvers for long-range wave propagation and transport problems. This talk will present the basic constructions underlying FC-based PDE solvers and will summarize some of the most interesting properties of these solvers, including exceptional accuracy, efficient parallelization, and optimal CFL scaling. Several applications to which FC solvers have been successfully applied, including models for ultrasound cancer therapies, scattering of chirped radar signals, and complex fluid flows, will be presented.

Speaker: **Xavier Antoine** (Université de Lorraine)
Title: *High-Order Shifted Laplace Preconditioners for Wave Equations*
Abstract: Solving linear systems arising from wave scattering is generally a difficult and challenging problem. During these last decades some preconditioning technics have been proposed to provide satisfactory convergence for iterative solvers. The aim of this talk is to propose a generalization of the so-called Shifted Laplace preconditioning methods [Erlangga & al., Appl. Numer. Math. 2004] by using operator representation combined with complex Pad approximants. We will show that the resulting High-order Shifted Laplace preconditioners are highly efficient and robust for two- and three-dimensional scattering problems that exhibit complex geometrical features (e.g. resonant structures). Furthermore, the convergence is proved to be weakly frequency dependent. The low order of this class of preconditioning method corresponds to the Shifted Laplace one in the symbolic calculus of pseudodifferential operators meaning. Some numerical examples and comparison to the Shifted Laplace methods will be presented for illustration.

Speaker: **Timo Betcke** (University College London)
Title: *Nonnormality of boundary integral operators in acoustic scattering*
Abstract: Nonnormality is a well studied subject in the context of partial differential operators. Yet, only little is known for boundary integral operators. The only well studied case is the unit ball, where the standard single layer, double layer and conjugate double layer potential operators in acoustic scattering diagonalise in a unitary basis. In this talk we present recent results for the analysis of spectral decompositions and nonnormality of boundary integral operators on more general domains. One particular application is the analysis of stability constants for boundary element discretisations. We demonstrate how these are effected by nonnormality and give several numerical examples, illustrating these issues on various domains.

Speaker: **Simon Chandler-Wilde, Steve Langdon, Euan Spence** (University of Reading and University of Bath)
Title: *Numerical-asymptotic boundary integral methods in high-frequency acoustic scattering*
Abstract: n this talk we will describe recent progress on the design and analysis of hybrid numerical-asymptotic boundary integral methods for boundary value problems for the Helmholtz equation that model time harmonic acoustic wave scattering in domains exterior to impenetrable obstacles. This work combines new results on the analysis and numerical analysis of highly oscillatory boundary integral operators and

on the high-frequency asymptotics of scattering problems. We will also address the fundamental question: Is the Helmholtz equation really sign-indefinite?

Speaker: **Yanlai Chen** (University of Massachusetts Dartmouth)
Title: *Certified fast algorithms for electromagnetic problems: reduced basis methods*
Abstract: The reduced basis method (RBM) is indispensable in scenarios where a large number of numerical solutions to a parametrized partial differential equation are desired in a fast/real-time fashion. These include simulation-based design, parameter optimization, optimal control, multi-model/scale simulation etc. Thanks to an offline-online procedure and the recognition that the parameter-induced solution manifolds can be well approximated by finite-dimentional spaces, RBM can improve efficiency by several orders of magnitudes. The accuracy of the RBM solution is maintained through a rigorous a posteriori error estimator whose efficient development is critical.

In this talk, we will discuss recent and ongoing efforts to develop RBM for various electromagnetic problems including radar cross section computation of an object whose scattered field is highly sensitive to the geometry. Time permitting, we will also introduce a new reduced basis element method (RBEM) that simulate electromagnetic wave propagation in a pipe of varying shape. RBEM is RBM coupled with domain decomposition method.

Speaker: **Christina Christara** (University of Toronto)
Title: *Adaptive and high-order PDE pricing of financial derivatives*
Abstract: Partial differential equation (PDE) methods for pricing financial derivatives are quite popular due to their global character, ability to approximate hedging parameters, such as delta and gamma, and efficiency, at least for reasonably low dimension problems. However, various techniques that are highly associated with the numerical solution of traditional PDEs, such as adaptive mesh techniques and high-order methods, have not been widely used yet for financial PDE problems. We develop space-time adaptive and high-order methods for valuing American options using a PDE approach. The linear complementarity problem arising due to the free boundary is handled by a penalty method. Both finite difference and finite element methods are considered for the space discretization of the PDE, while classical finite differences, such as Crank-Nicolson, are used for the time discretization. The high-order discretization in space is based on an optimal finite element collocation method, the main computational requirements of which are the solution of one tridiagonal linear system at each time step, while the resulting errors at the gridpoints and midpoints of the space partition are fourth-order. To control the space error, we use adaptive gridpoint distribution based on an error equidistribution principle. A time stepsize selector is used to further increase the efficiency of the methods. Numerical examples show that our methods converge fast and provide highly accurate options prices, Greeks, and early exercise boundaries.

Speaker: **Martin Costabel and Monique Dauge** (University Rennes, France)
Title: *The Cosserat eigenvalue problem*
Abstract: The Cosserat eigenvalue problem is the Dirichlet problem for the Lame equations of linear elasticity, where the bulk modulus is considered as the eigenvalue parameter. This classical problem has recently found renewed interest, mainly in fluid dynamics. It is notoriously difficult to approximate numerically, and many very simple questions are still open, like the precise value of the lowest eigenvalue for a square or a triangle. We present some recent progress on theoretical and on numerical aspects of this problem.

Speaker: **Victor Dominguez** (Dep. Ing. Matemática e Informática, Universidad Pública de Navarra, Tudela, SPAIN)
Title: *Convergence analysis of a Nyström method for 3D BIEs in acoustic scattering problems*
Abstract: Bruno and Kunyansky proposed in 2001 cf. [1, 2] a Nyström method for solving the combined Boundary Integral Equation (BIE) that arises in 3D sound-soft acoustic scattering by a smooth obstacle

S. This scheme has demonstrated to enjoy of a high order of convergence. However, no rigorous analysis could be developed up to now to prove the good properties observed in practice. Our aim in this talk is to describe such analysis and show that Nyström methods, very popular in 2D problems, are also a good alternative for BIEs in 3D and can be analysed.

The method depends heavily on having an appropriate description of the surface. In a few words, S has to be divided into a family of J smooth overlapping patches S_j of S, each of them with a smooth parameterization with domain D_j strictly contained in the unit square in $\mathbb{R}^2$. The unknown will be constructed from its pointwise values, via the parameterization, at the points of a uniform grid of the unit square lying in D_j for each j.

The integral operator is split as a sum of a regular part with smooth kernel and a singular part retaining the original singularity of the integral equation.

The regular part is approximated by means of compound rectangular rules on each patch. For smooth functions compactly supported in the unit square, this rule converges superalgebraically, supporting empirically such choice. The singular part is discretized in a different manner: polar change of variables, which cancel out the singularity, rectangular rules in the polar variables and FFT techniques for a faster evaluation of the density outside of the grid points. A very technical analysis shows that this combination of strategies gives rise to a rule which retains many of the good properties of the quadrature rules applied in the regular part.

The mathematical analysis of the method is based on recasting the original equation as a $J \times J$ system of 1-biperiodic integral equations. As discrete space we take now bivariate trigonometric polynomials on each path which interpolates the pointwise values of the unknown at the uniform grid points. This makes possible to set up as a frame for the analysis that of biperiodic Sobolev spaces and the associated pseudodifferential operators.

The stability of the method is shown to hold in L^2 norms by proving the uniform convergence of the sequence of discrete operators to the continuous one. Very well known results for approximation by trigonometric polynomials in the periodic Sobolev frame can be invoked to obtain convergence estimates in L^2 and, by using inverse inequalities, in L^∞.

References

[1] O.P. Bruno, L.A. Kunyansky, A fast, high-order algorithm for the solution of surface scattering problems: basic implementation, tests, and applications, Journal of Computational Physics, v.169 n.1, p.80-110 (2001)

[2] O.P. Bruno, L.A. Kunyansky, Surface scattering in 3-D: an accelerated high order solver. Proc. Roy. Soc. London Ser. A Comput. Phys. v. 457, p. 2921-2934 (2001).

Speaker: **M. Ganesh** (Colorado School of Mines)

Title: *A model reduction algorithm for parametrized multiple particle electromagnetic configurations.*

Abstract: We consider a parameterized multiple scattering wave propagation model in three dimensions. The parameters in the model describe the location, orientation, size, shape, and number of scattering particles as well as properties of the input source field such as the frequency, polarization, and incident direction. The need for fast and efficient (online) simulation of the interacting scattered fields under parametric variation of the multiple particle surface scattering configuration is fundamental to several applications for design, detection, or uncertainty quantification.

For such dynamic parameterized multiple scattering models, the standard discretization procedures are prohibitively expensive due to the computational cost associated with solving the full model for each online parameter choice. In this work, we propose an iterative offline/online reduced basis approach for a boundary element method to simulate a parameterized system of surface integral equations reformulation of the multiple particle wave propagation model.

The approach includes (i) a greedy algorithm based computationally intensive offline procedure to create a selection of a set of a snapshot parameters and the construction of an associated reduced boundary element basis for each reference scatterer and (ii) an inexpensive online algorithm to generate the surface current and scattered field of the parameterized multiple wave propagation model for any choice of parameters within the parameter domains used in the offline procedure. Comparison of our numerical results with experimentally measured results for some benchmark configuration demonstrate the power of our method to rapidly simulate the interaction of scattered wave fields under parametric variation of the overall multiple particle configuration.

Speaker: **Tom Hagstrom** (Southern Methodist University)
Title: *Boundary Conditions for Simulating Wave*
Abstract: The accurate, efficient, and stable approximation of boundary conditions is often the most difficult issue to deal with for simulations of waves in the time domain. In this talk we will give a brief overview of the theory of boundary conditions for hyperbolic systems, and discuss in detail the use of this theory to study:

i. Approximate radiation boundary conditions
ii. Stable boundary closures for high-resolution discretizations

Successes of the theory include the construction of optimal local conditions for isotropic waves as well as stable boundary closures for high-order difference formulas. Open problems include generalizations to anisotropic systems, a more complete understanding of any fundamental limits to one-sided differentiation formulas, and the stability of coupling procedures for disparate approximation schemes.

Speaker: **Mike Haslam** (York University)
Title: *Efficient Solvers for the Curved Wire Antenna Problem*
Abstract: We discuss our recent work concerning the evaluation of the current induced on a three dimensional curved wire antenna. Our method is based on a Chebyshev-type collocation scheme applied to the Pocklington integro-differential equation for the current. In particular, a domain decomposition is applied to the problem which gives rise to an efficient method to evaluate the integral and differential operators arising in our formulation. With Oscar Bruno (Caltech).

Speaker: **Bill Henshaw** (Lawrence Livremore National Laboratory)
Title: *High-order accurate algorithms for overlapping grids*
Abstract: This talk will give an overview of some high-order accurate finite difference and finite volume schemes that have been developed for solving partial differential equations on overlapping grids. An overlapping grid, which consists of a set of structured grids, can be used to develop efficient numerical algorithms for complex, possibly moving, geometry. Important issues in the development of such schemes include the construction of boundary conditions for high-order accurate methods and the stability of the resulting approximations in the presence of overlapping grid interpolation. A number of areas will be discussed including the incompressible Navier-Stokes equations, Maxwell's equations of electromagnetics, the elastic wave equation, multigrid elliptic solvers, and fluid-structure interaction problems.

Speaker: **Shi Jin** (Shanghai Jiao Tong University, China and University of Wisconsin-Madison,)
Title: *Asymptotic-preseving schemes for Boltzmann equation and relative problems with stiff sources*
Abstract: we propose a general framework to design asymptotic preserving schemes for the Boltzmann kinetic kinetic and related equations. Numerically solving these equations are challenging due to the nonlinear stiff collision (source) terms induced by small mean free or relaxation time. We propose to penalize the nonlinear collision term by a BGK-type relaxation term, which can be solved explicitly even if discretized implicitly in time. Moreover, the BGK-type relaxation operator helps to drive the density distribution toward the local Maxwellian, thus natually imposes an asymptotic-preserving scheme in the Euler limit. The scheme so designed does not need any nonlinear iterative solver or the use of Wild Sum. It is uniformly stable in terms of the (possibly small) Knudsen number, and can capture the macroscopic

fluid dynamic (Euler) limit even if the small scale determined by the Knudsen number is not numerically resolved. We will show how this idea can be applie to other collision opearators, such as the Landau-Fokker-Planck operator, Ullenbeck-Urling model, and in the kinetic-fluid model of disperse multiphase flows.

Speaker: **Stephen Lau** (University of New Mexico)
Title: *Sparse spectral-tau method for the three-dimensional helically reduced wave equation on two-center domains*
Abstract: We describe a multidomain spectral-tau method for solving the three dimensional helically reduced wave equation on the type of two-center domain that arises when modeling compact binary objects in astrophysical applications. We achieve sparse systems through the integration ”preconditioning” of Coutsias, Hagstrom, Hesthaven, and Torres. However, in higher dimensions further (genuine) preconditioning is still necessary to enhance convergence of the global solver (here GMRES). Our methods may prove relevant for numerical solution of other mixed-type or elliptic problems, and in particular for the generation of initial data in general relativity. This work is joint with Richard Price.

Speaker: **David Levadoux** (ONERA)
Title: *Some inherently well-conditioned formulations for time-harmonic scattering/transmission problems of electromagnetism*
Abstract: New family of source integral equations is presented, dedicated to the solution of time-harmonic Maxwell scattering and/or transmission problems. Regardless of the composition of the obstacle - metallic, full dielectric or coated with an impedance layer - we show that a general methodology is able to guide the construction of some special equations whose the foremost feature is to be well-conditioned. Indeed, all of them are free of spurious modes and appear as some compact perturbations of positive operators (when it is not the identity), leading therefore to fast iterative solutions without the help of any preconditioner. These intrinsically well-conditioned equations open the way for interesting new developments in the field of domain decomposition methods illustrated by first encouraging numerical experiments.

Speaker: **Mark Lyon** (University of New Hampshire)
Title: *Variations on Fourier Continuation Methods*
Abstract: The Fourier Continuation methods, which has been successfully applied to the solution of a variety of Partial Differential Equations (PDEs), allows for highly-accurate approximation and high-order convergence in the PDE solver. Methods based on the FC(Gram) formulation are fast (FFT speed) and exhibit minimal pollution with spectral error decay away from the boundaries and a high-order polynomial interpolation based error near the boundaries. In this talk, alternative methods for applying the FC methodology will be discussed, motivating algorithms that are both fast and are capable of spectral accuracy throughout the domain. The smoothing of Fourier Continuations will also be discussed.

Speaker: **Markus Melenk** (Vienna University of Technology)
Title: *Stability and convergence of Galerkin discretizations of the Helmholtz equation*
Abstract: We consider boundary value problems for the Helmholtz equation at large wave numbers k. In order to understand how the wave number k affects the convergence properties of discretizations of such problems, we develop a regularity theory for the Helmholtz equation that is explicit in k. At the heart of our analysis is the decomposition of solutions into two components: the first component is an analytic, but highly oscillatory function and the second one has finite regularity but features wavenumber-independent bounds.

This new understanding of the solution structure opens the door to the analysis of discretizations of the Helmholtz equation that are explicit in their dependence on the wavenumber k. As a first example, we show for a conforming high order finite element method that quasi-optimality is guaranteed if (a) the approximation order p is selected as $p = O(\log k)$ and (b) the mesh size h is such that kh/p is small.

Speaker: **Peter Monk** (University of Delaware)
Title: *The Interior Transmission Eigenvalue Problem in Acoustics and Electromagnetics*
Abstract: This is joint work with Profs. D.L. Colton, F. Cakoni (University of Delaware) and J. Sun (Michigan Tech.). As a result of studies of the far field pattern of the scattered wave for time harmonic acoustic and electromagnetics, a new class of interior problem arises termed the "Interior Transmission Problem" (ITP). The ITP is not a standard elliptic problem, and a study of the solvability of this problem gives rise to a non-standard eigenvalue problem for the ITP. The proof of existence and properties of these eigenvalues is not straightforward. I shall survey the ITP and its properties in several applications, and describe numerical schemes for computing transmission eigenvalues. Remarkably, transmission eigenvalues can be observed from far field data, and the resulting eigenvalues can be used to estimate properties of the scatterer.

Speaker: **Nilima Nigam** (Simon Fraser University)
Abstract: In this talk, we present recent progress on three unusual, conceptually simple, eigenvalue problems.

The first of these problems concerns sharp bounds on the eigenvalue of the Laplace-Beltrami operator of closed Riemannian surfaces of genus higher than one. One may ask: for a fixed genus, and a given fixed surface area, which surface maximizes the first Laplace eigenvalue?

The second of these concerns eigenvalue problems for the Laplacian, with mixed Dirichlet-Neumann data. If the Neumann and Dirichlet curves meet at an angle which is pi or larger, reflection strategies will not work.

The third problem is about the famous Hot Spot conjecture: the extrema of the 2nd Neumann eigenfunction of the Laplacian in an acute triangle will be at the vertices.

Speaker: **Jeff Ovall** (University of Kentucky)
Title: *Toward a robust and efficient hp-adaptive method for elliptic eigenvalue problems*
Abstract: We present a framework for finite element error estimation and adaptivity in the context of eigenvalue problems which is well-suited for problems in which a cluster of eigenvalues—which may include degenerate or nearly-degenerate eigenvalues—is to be approximated together with its associated invariant subspace. Though many of the more fundamental results hold in a general variational (Galerkin) setting, we focus on the use of hp finite elements, with the aim of producing an efficient algorithm which is robust with respect to singularities (and near-singularities) in the eigenfunctions, degeneracies and near-degeneracies in the spectrum, and discontinuities or other undesirable behavior in the differential operator. A range of numerical examples will serve to illustrate those points in which we feel we have been successful in our aim, and where we see room for non-trivial gains (as well as roughly how we intend to make those gains).

Speaker: **Francisco-Javier Sayas** (University of Delaware)
Title: *A fully discrete Calderón Calculus for two dimensional waves in the frequency domain*
Abstract: oundary integral techniques have been extensively used for simulation of wave propagation phenomena, including scattering by penetrable and non-penetrable obstacles. The collection of potentials and integral operators associated to a particular operator (the acoustic wave propagation at fixed frequency, for instance, leads to Helmholtz's operator) can be used to build a Calderón Calculus. This is just the mathematical understanding of a full set of rules to handle potentials and operators, leading to well posed integral operators of the first and second kind, resonance-free combined field formulations, preconditioners, etc.

In this talk, we will discuss a recently completed fully discretized Calderón Calculus for the two dimensional Helmholtz equation. This full discretization can be understood as a highly non-conforming Petrov-Galerkin discretization of the continuous calculus, based on two staggered grids, Dirac delta distributions substituting acoustic charge densities and piecewise constant functions substituting dipole densities.

This work closes a loop that originated over a decade ago with an extremely simple quadrature method for a logarithmic integral equation by Jukka Saranen and Liisa Schroderus. Two of the authors of the present work (VD & FJS), in collaboration with Ricardo Celorrio and Maria Luisa Rapún got to extend that original work to three of the integral operators associated to the Helmholtz equation on smooth closed curves. Only recently, we have been able to close the set of approximations by proving approximation properties for the fully discrete approximation of the associated hypersingular integral operator.

We will discuss how the entire system of operators can be used for very simple simulations of the scattering of waves at a given frequency by multiple obstacles with different material properties. We will finish by pointing at how the frequency-domain approximations and the convolution quadrature black-box of Christian Lubich can be joined in what is likely to be the simplest way of simulating scattering of transient waves in the plane.

Speaker: **Rodrigo Platte and Anne Gelb** (Arizona State University)
Title: *A hybrid Fourier-polynomial method for partial differential equations*
Abstract: We present a pseudospectral hybrid algorithm to approximate the solution of partial differential equations (PDEs) with non-periodic boundary conditions. Most of the approximations are computed using Fourier expansions that can be efficiently obtained by fast Fourier transforms. To avoid the Gibbs phenomenon, super-Gaussian window functions are used in physical space. Near the boundaries, we use local polynomial approximations to correct the solution. We analyze the accuracy and eigenvalue stability of the method for several PDEs. The method compares favorably to traditional spectral methods, and numerical results indicate that for hyperbolic problems a time step restriction of O(1/N) is sufficient for stability.

Speaker: **Mike Siegel** (New Jersey Institute of Technology)
Title: *A small-scale decomposition for 3D boundary integral computations with surface tension*
Abstract: An efficient, nonstiff boundary integral method for 3D interfacial flow with surface tension is presented, with an application to porous media flow. The velocity of the interface is given in terms of the Birkhoff-Rott integral, and we present a new method to compute this efficiently by Ewald summation. The stiffness is removed by developing a small-scale decomposition, in the spirit of prior work for 2D flow by Hou, Lowengrub and Shelley. In order to develop this small scale decomposition, we formulate this problem using a generalized isothermal parameterization of the free surface.

Speaker: **Grady Wright** (Boise State University)
Title: *A Radial Basis Function Partition of Unity Method for Transport on the Sphere*
Abstract: Transport (or advective) processes dominate atmospheric fluid motions on all scales. Therefore the accurate numerical solution of the transport problem is fundamentally important to all numerical methods for studying more complex atmospheric models. We present a new high-order, computationally efficient method for transport on the sphere that combines radial basis functions with a partition of unity method (RBF-PUM). Like other RBF methods, this new one does not require any mesh or grid. Furthermore, the method is completely independent of the spherical coordinate system and thus does not suffer from the notorious pole problem. Key to the implementation of the RBF-PUM for hyperbolic problems is a hyperviscosity procedure for stabilizing the computations. We discuss this procedure and present results on the RBF-PUM for several well-known test cases that probe the suitability of numerical methods for modeling transport in spherical geometries.