2011-2012 Annual Report

CRG in Applied and Computational Harmonic Analysis

Here is a short summary of all CRG activities:

1. Joint Alberta-British Columbia seminar, August 7-10, 2012 at University of British Columbia.

2. New and continuing PIMS CRG PDFs and graduate students.

3. List of PIMS visitors in 2012.

4. Collaborations and research activities of CRG members and their students and PDFs.

5. Some publications in 2012.

1. One Major Event of CRG in 2012: Joint Alberta-British Columbia Seminar, August 7-10, 2012 at the University of British Columbia in Vancouver.

The main objective of this workshop is that it serves as a platform where CRG members can present their recent research, interact, and start new collaborations. For this purpose, we invited CRG members and their graduate students and PDFs. This gave everyone the opportunity to talk on their research. This particularly provided valuable experience to the junior participants (graduate students and PDFs) and exposed them to cutting edge research directions in the field. Furthermore, some new interactions have been initiated during the workshop between CRG members. This joint seminar has total 22 participants:

Arman Ahmadieh (student), Menglu Che (student), Elena Braverman,
Jiang Deng* (student), Tom Duchamp*, Mpafareleni, Rejoyce Gahvi* (PDF),
Navid Ghadermarzy* (student), Sinan Gunturk, Brock Hargreaves (student)
Bin Han*, Rong-Qing Jia*, Hassan Mansour* (PDF),
Rayan Saab* (PDF), Kun Wang* (PDF), Xin Wang* (PDF),
Yang Wang*, Yau Shu Wong, Jie Yan* (student),
Enrico Au-Yeung* (PDF), Ozgur Yilmaz, Zhenpeng Zhao* (student),
Xiaosheng Zhuang* (PDF)

Note: * indicates speakers in the joint Alberta-BC seminar.

2. PIMS PDFs and Graduate Students:

One New PIMS CRG PDF: Dr. Yi Shen is jointly hosted by Elena Braverman at University of Calgary and by Bin Han at University of Alberta. Dr. Yi Shen came to UA in September 2012. He received his PhD in Mathematics at Zhejiang University in 2010. Before coming to UA, he has been working on wavelet analysis and compressive sensing. Currently, Dr. Shen is working with Bin Han and Elena Braverman on directional sparse representations and their applications in image denoising. He is currently exploring the applications of combining directional framelets and sparse representations with optimization techniques on image denoising problem.

One New PIMS MITAC industrial PDF: Dr. Xiaosheng Zhuang (July 2012-December 2012) at the University of Alberta, jointly hosted by Yau Shu Wong and Bin Han at the University of Alberta. Besides PIMS's support, Dr. Zhuang is supported in part by MITACS Accelerate Internship programs sponsored by a local Alberta Geophysical Ltd to investigate image decomposition in geophysical applications using mesh fitting and contour method. He is currently exploring the applications of wavelet methods and mesh fitting methods for the image decomposition problem of magnetic field data.

Continuing PIMS CRG PDFs:

1. Dr. Enrico Au-Yeung, at the University of British Columbia, hosted by Ozgur Yilmaz. In collaboration with Ozgur Yilmaz, Dr. Enrico Au-Yeung has been studying the use of certain classes of measurement matrices that are obtained by special random restrictions of discrete Fourier transform matrices. These restrictions correspond to obtaining irregular samples of the original signal on a "jittered" set of points---a practicable scenario with the potential of improving the quality of the recovered signal without increasing the effective sampling rate. This is a mathematically difficult problem as the usual proof techniques used in the case of sub-Gaussian matrices do not apply (as they are based on measure concentration). Significant progress in this project has been made. Collaborating with Ozgur Yilmaz, he proved an important theorem on the recovery guarantees in compressed sensing when the so-called "jitter sampling" based Fourier sampler matrices are used for collecting the measurements.

2. Dr. Kun Wang, at the University of Alberta, jointly hosted by Rong-Qing Jia and Yau Shu Wong. Dr. Kun Wang came to UA in February 2012. He has been working on topics in numerical analysis and scientific computing. Kun presented a series of talks on his work related to Navier-Stokes equation during the Fall term 2012. He has written a paper on: Error correction method for the Navier-Stokes equations with high Reynolds numbers, in which he proposes an error correction method to improve the convergence rate of the Oscen's scheme, and also demonstrates that the use of the correction method could extend the capability of the Oscen's scheme for application to higher range of Reynold numbers. The paper is being revised and he hopes to submit for journal publication by the end of 2012. Kun's also study the numerical solutions for 1D Helmholtz equation, and extended the early work of Wong & Li to inhomogeneous cases and also for problems with varying wavenumbers. Theoretical analysis of the new differencing methods has demonstrated the effectiveness of the schemes. The results will be submitted to a journal paper early next year. Kun will be staying for another year to focus on extending the work on Helmholtz equation to the multidimensional case.

Graduate students and other PDFs in 2012 at UA:

1. Menglu Che, MSc student, co-supervised by Yau Shu Wong and Bin Han, participated in joint Alberta-BC seminar. Currently working on construction of directional tight framelet filter banks.

2. Jian Deng, PhD student, supervised by Yau Shu Wang. Participated in joint Alberta-BC seminar and presented a talk on his work, currently working on numerical analysis.

3. Li Zhang, PhD student, co-supervised by Peter Minev and Bin Han. Currently working on splitting methods in numerical analysis.

4. Y. Zhang, PhD student, supervised by Yau Shu Wong.

5. Zhenpeng Zhao, PhD student, co-supervised by Yau Shu Wong and Bin Han. Participated in joint Alberta-BC seminar and presented a talk on his work. Currently working on applications of directional framelets in image processing.

6. Mpafareleni Rejoyce Gahvi, NRF PDF, hosted by Bin Han, fully supported by National Research Foundation in South Africa. Participated in joint Alberta-BC seminar and presented a talk. Currently working on subdivision schemes.

Note: PhD students J. Deng and Z. Zhao and one M.Sc student M. Che are supported are supported in part by MITACS Accelerate Internship programs sponsored by a local Alberta Geophysical Ltd to investigate inverse electromagnetic scattering and signal/ image decomposition in geophysical applications.

Graduate students in 2012 and other PDFs at UBC:

1. Navid Ghadermarzy, MSc student, co-supervised by Ozgur Yilmaz, working on various problems in sparse approximations and compressed sensing.

2. Brock Hargreaves, MSc student, co-supervised by Ozgur Yilmaz, working on various problems in sparse approximations and compressed sensing.

3. Kateryna Melnykova, co-supervised by Ozgur Yilmaz, PhD student, just started.

4. Arman Ahmadieh, co-supervised by Ozgur Yilmaz, PhD Student, just started.

5. Hassan Mansour, PDF (continuing -- starting at MERL (Mitsubishi Electric Research Laboratories) in March 2013 as a member of research staff), hosted by Ozgur Yilmaz, obtained various important results in the theory of compressed sensing and its applications, especially in seismic exploration.

Graduate students in 2012 at UC:

1. Johnwill Keating, PhD student, supervised by Elena Braverman, working with E. Braverman, he developed a new direction splitting algorithm for computation of particulate flows which allows to resolve directly and with high accuracy such flows involving two different scales.

Graduate students in 2012 at UV:

1. Xiao Ma, MSc student, supervised by Michael Adams.

2. Seyed Ali Mostafavian, Ph.D. student, supervised by Michael Adams.

3. Xiao Feng, MSc student, supervised by Michael Adams.

4. Badr El Marzouki, MSc student, supervised by Michael Adams.

5. Dan Han, MSc student, supervised by Michael Adams.

Note: None of these students have yet started into their research projects in any depth yet, but they will be working on projects that relate to triangle-mesh representations of images (e.g., mesh generation and mesh coding).

6. Ping Li, MSc student, supervised by Michael Adams, completed degree in 2012, now working as Firmware Engineer for Qualcomm in Toronto.

7. Xi Tu, MSc student, supervised by Michael Adams, completed degree in 2012, now working as Software Development Engineer for Amazon in Seattle.

3. PIMS Visitors:

1. Sinan Gunturk, Courant Institute, Aug 6-11, 2012, hosted by Ozgur Yilmaz at UBC, participated in the Joint Alberta-British Columbia Seminar.

2. Ben-qi Guo, University of Manitoba, hosted by Yau Shu Wong at UA, presented a PIMS-AMI seminar talk.

3. Yinnian He, Xi'an Jiaotong University, hosted by Yau Shu Wong at UA, presented a PIMS-AMI seminar talk.

4. Hong Jiang, Bell Labs, Murry Hill, hosted by Yau Shu Wong at UA, presented a PIMS-AMI seminar talk.

5. Chi-Kun Lin, National Chiao-Tung University, hosted by Yau Shu Wong at UA, presented a PIMS-AMI seminar talk.

6. Qun Mo, Zhejiang University, September 14-Novermber 30, 2012, hosted by Bin Han at UA, also presented a PIMS-AMI seminar talk.

7. Krishnaswamy Nandakumar, Louisiana State University, hosted by Yau Shu Wong at UA, presented a PIMS-AMI seminar talk.

8. Amos Ron, University of Wisconsin-Madison, April 3-6, 2012, hosted by Bin Han at UA, also presented a PIMS-AMI departmental colloquium talk.

9. Rayan Saab, Duke, Aug 6-11, 2012, hosted by Ozgur Yilmaz at UBC, participated in the Joint Alberta-British Columbia Seminar.

10. Yang Wang, Michigan State, Aug 6-9, 2012, hosted by Ozgur Yilmaz at UBC, participated in the Joint Alberta-British Columbia Seminar.

11. X. Wang, Shanghai University, May 2012 – August 2012, research scientist, hosted by Yau Shu Wong at UA.

4. Collaborations and Research Progresses of CRG members and their students and PDFs:

Michael Adams at the University of Victoria:

My research group has been working on triangle-mesh representations of images. This work has involved: 1) developing new mesh models for images; 2) devising effective methods for the selection of the parameters for these models for a given image (the mesh-generation problem); and 3) technique for efficiently encoding these models (the data compression problem).
Xi Tu worked on mesh models of images that explicitly represent image discontinuities and the corresponding techniques for selecting the parameters of these models for a given image (i.e., the mesh-generation problem). His proposed models are based on constrained Delaunay triangulations. Ping Li worked on mesh-generation techniques for mesh representations of images based on data-dependent triangulations. My work has focused on mesh representations of images based on Delaunay triangulations as well as the coding of such representations.

Elena Braverman at the University of Calgary:

During the past year Lyudmila Korobenko obtained some important results in the area of elliptic PDE's. Together with Prof. Cristian Rios (U of C) she investigated hypoellipticity of second order infinitely degenerate elliptic operators. It is well known, that if second order operator is elliptic, it is subelliptic. More precisely, every weak solution $u \in W^{1,2}(\Omega)$ to an equation L*u*=*f* with $f \in L^{\infty}(\Omega)$ is Hölder continuous, i.e. $u \in C^{\alpha}(\Omega)$. In the case when the operator degenerates to an infinite order, i.e. the determinant of the coefficient matrix vanishes on a hyperplane together with all its derivatives, the operator cannot be subelliptic. Hypoellipticity is yet a weaker property of a second order operator L, when $Lu \in C^{\infty}(\Omega)$ implies $u \in C^{\infty}(\Omega)$ for every $u \in W^{1,2}(\Omega)$. L. Korobenko was able to prove hypoellipticity of a certain class of *linear* infinitely degenerate elliptic operators, and establish continuity of weak solutions to *quasilinear* infinitely degenerate elliptic equations. Hypoellipticity of a certain class of such operators has been recently shown by Rios, Sawyer and Wheeden in the a priori assumption of continuity of weak solutions. Thus, the two results of L. Korobenko and C. Rios together provide a complete answer to the question of hypoellipticity in this setting. The proof of continuity relies on the subunit metric approach and the properties of subunit metric balls. This approach turns out to be very powerful, and some criteria of subellipticity of second order operators have been obtained in terms of associated metric spaces. One of the important features of our result is that it does not rely on a doubling property of the corresponding subunit metric. Doubling condition $|B(x,2r)| \leq C|B(x,r)|$ provides a structure for so-called homogeneous spaces, and there is a vast body of results established for this type of spaces. In the non-doubling case very little theory have been established, and moreover, many results rely on a "geometric doubling" condition which is not assumed in the research of L. Korobenko and C. Rios. Further, establishing such fundamental results as a theory of Ap-weights, John-Nirenberg inequality, and Sobolev-Poincare inequalities would be a significant contribution to the metric measure theory and harmonic analysis.

Tom Duchamp at University of Washington:

Working with Thomas Yu and Gang Xie, we are studying manifold-valued subdivision schemes modeled on linear subdivision schemes, with particular attention to their smoothness properties. These schemes are modeled on linear subdivision schemes. It is known that the nonlinear scheme yields C^k curves provided it satisfies a C^k -proximity condition to the linear model. In the paper described below, we showed that for an important class of schemes introduced by Donoho, the proximity conditions can only be satisfied by a restricted class of manifolds. Yu and his students have given numerical evidence that the proximity conditions are actually necessary for C^k -smoothness. The current project with Yu and Xie is to develop general necessary and sufficient smoothness conditions for a large class of non-linear schemes. We made some progress on this project in the summer of 2011 at the Edmonton conference sponsored by our PIMS CRG. I reported on some of our results at our workshop in UBC this summer. This project is nearing completion, and we expect to complete a paper describing our results within the next few months. In an accepted paper, we establish smoothness results for a class of nonlinear subdivision schemes, known as the *single basepoint manifold-valued subdivision schemes*, which show up in the construction of wavelet-like transform for manifold-valued data. This class includes the (single basepoint) Log-Exp subdivision scheme as a special case; and the class is defined base on replacing the exponential map by a so-called retraction map *f*. It is known that any choice of *f* would yield a scheme that C^2as long as the underlying linear scheme is C^2. However it was found by Navayazdani and Yu that a specific condition on *f* has to be imposed in order to guarantee the next higher order, i.e. C^3, equivalence. Underlying this condition is a certain tensor P_f associated with *f*, and the condition is that this tensor vanishes. It was also shown that, in a symmetric space setting, the exponential map always satisfies this condition. The paper includes a geometric interpretation of this tensor. We show that any retraction map f defines a torsion-free affine connection, which in turn defines an exponential map. The condition P_f =0 is shown to be equivalent to the condition that *f* agrees with the exponential map of the connection up to the 3rd order. In particular, when *f* is, itself, the exponential map of a connection, one recovers the original connection. It then follows that the condition P_f =0 is satisfied in a setting much more general than symmetric space. We also prove that, under the additional assumption that the subdivision rule satisfies a *time-reversal symmetry*, C^4 equivalence holds without any constraint on the fourth order behavior of *f*.

CRG members at the University of Alberta:

In the paper [R. Q. Jia, Unconditional convergence and unconditional bases in Hardy spaces, Analysis and Applications, accepted], Jia showed that a system of wavelets forms an unconditional basis for the Hardy space, provided the dual wavelet is continuous. This result is much stronger than the corresponding result of Y. Meyer on unconditional bases.

The research collaborations between Rong-Qing Jia, Yau Shu Wong and their PIMS PDF have already been described in the category of PIMS PDFs. The research collaborations between Yau Shu Wong and Bin Han and their PIMS-MITACS industrial PDF Xiaosheng Zhuang on the industrial project of image decomposition has been described in the category of PIMS PDFs. The research collaborations between Elena Braverman and Bin Han and their PIMS PDF Yi Shen have been described in the category of PIMS PDFs.

During the visit of PIMS visitor Amos Ron, Bin Han has been initiating collaboration with A. Ron on sparse high-dimensional dual wavelet frames for processing high dimensional data.

Currently Bin Han and his group have been working on directional tight framelets with applications on image processing. Xiaosheng Zhuang and Bin Han have been working on shearlets with refinable structures. This not only provides a comprehensive theory for shearlets, but also provide for the first time refinable structure which enables us to implement shearlet transform using filter banks. We expect that the results will be summarized in a forthcoming paper soon. Visitor Qun Mo, Zhenpeng Zhao, and Bin Han have been working on several interesting problems on one-dimensional tight wavelet frames, which are of particular interest for their applications in image denoising. Currently, Qun Mo and Bin Han are writing a paper on tight wavelet frames having interpolation property.

Bernie Shizgal at the University of British Columbia:

The main thrust of the research is directed towards the development of numerical algorithms in scientific computing based on spectral methods with grids defined by nonclassical polynomials, as well as with Fourier series, splines and wavelets. The numerical methods are applied to the solution of kinetic equations such as the Boltzmann, Fokker-Planck, and Schroedinger equations. These formalisms form the basis for numerical simulations for a large number of physical phenomena in chemistry, physics, astronomy, engineering as well mathematical biology. A brief overview of several research endeavors is discussed below:

1. *Fourier methods in the solution of the Vlasov equation in ionospheric physics*: The evolution of an ensemble of charged particles is given by the Vlasov equation with a steady uniform magnetic field and a perpendicular electric field that oscillates in space and time. The Vlasov equation is solved with a Fourier-Hermite spectral method and a particle simulation, and the energization of ions in a geophysical context is studied. We are currently involved with the inclusion of the altitude dependence of the distribution function and a study of the formation of "conics" in the terrestrial ionosphere in conjunction with the upcoming ePOP satellite mission (http://mertensiana.phys.ucalgary.ca/) scheduled for launch in March-May 2013. Dr. Gibelli of the Dipartimento di Matematica of the Politecnico di Milano is an international collaborator on this project and will visit UBC in August 2013. This study with a direct numerical solution based on spectral methods in comparison with Monte Carlo simulations is ongoing.

2. *A spectral and Fourier analysis of the nonlinear and linearized Boltzmann equations*.
The research work on spectral methods of solution of the Boltzmann equation is ongoing. A study of the approach to equilibrium in electron-atom and atom-atom systems with the use of entropy functionals was reported in two papers. Energetic oxygen atoms are produced in the terrestrial atmosphere as products of the dissociative recombination reaction. The characterization of the energy distribution of atoms versus altitude is determined from the linear Boltzmann equation at low altitudes and the nonlinear Boltzmann equation at high altitudes. A comparison of the solutions of the linear and nonlinear equations is of fundamental interest independent of this particular application. The methods of solution employed include spectral methods involving the expansion of the speed or Laguerre polynomials. This work is carried out in collaboration with Dr. Reinel Sospedra-Alfonso, a postdoctoral fellow at UBC and is also related to the ePOP satellite mission. The ongoing progress in this area has been reported at the European Geophysical Union and the American Geophysical Union meetings.

3. *Splines and wavelets in kinetic theory*. Solutions of the Boltzmann equation using splines have been used and reported recently by Khurana and Katchuk at UBC in collaboration with Bernie Shizgal. A detailed study of the approach to equilibrium for atom-atom relaxation in one-component systems was reported recently. There have been numerous publications on a

Fourier method of solution of the nonlinear Boltzmann equation and the work in this paper will be compared with these other methods of solution.

4. *Resolution of Gibbs' phenomena*. Images in science and engineering are often stored as Fourier data. The reconstruction of the original data or images from such Fourier data is contaminated by Gibbs phenomena (Gottlieb, Jung and Kim, Commun. Computat. Phys. 9 (2011) 497-519). It arises owing to the lack of convergence of the Fourier series of nonperiodic functions at discontinuous points and does not disappear if the terms in the series are increased. A new method for the resolution of Gibbs phenomena referred to as the Inverse Polynomial Reconstruction Method (IPRM) was developed by Shizgal and Jung (J. Comp. Appl. Math. 161 (2003) 41-65). This research effort is ongoing.

Ozgur Yilmaz at University of British Columbia:

The research collaboration between Ozgur and his PIMS PDF Enrico Au-Yeung has been described in the category of PIMS PDFs.

5. Some publications in 2012:

Michael Adams at the University of Victoria:

1. M. D. Adams, A flexible Incremental/decremental Delaunay mesh-generation framework for image representation, *Signal Processing*, accepted for publication September 2012. To appear. doi:10.1016/j.sigpro.2012.09.017.

2. Xi Tu and Michael D. Adams, Improved mesh models of images through the explicit representation of discontinuities, submitted to *IEEE Canadian Journal of Electrical and Computer Engineering*, 9 pages, July 2012.

3. Ping Li and Michael D. Adams, An effective mesh-generation strategy for image representation using data-dependent triangulation, *IEEE Transactions on Image Processing*, Aug. 2012, 30 pages, submitted

4. Xi Tu, Image Representation with explicit discontinuities using triangle meshes, MSc. thesis.

5. Ping Li, A flexible mesh-generation strategy for image representation based on data-dependent triangulation, MSc. thesis.

Elena Braverman at the University of Calgary:

1. (Monograph) R.P. Agarwal, L. Berezansky, E. Braverman and A. Domoshnitsky, Nonoscillation Theory of Functional Differential Equations with Applications, Springer, New York, 2012. xvi+520 pages.

2. E. Braverman and B. Karpuz, On stability of delay difference equations with variable coefficients: successive products tests, *Advances in Difference Equations*, (2012), doi: 10.1186/1687-1847-2012-177

3. E. Braverman and I. Karabash, Bohl-Perron type stability theorems for linear difference equations with infinite delay, *J. Difference Equ. Appl*., **18** (2012), 909-939.

4. E. Braverman and E. Liz, On stabilization of equilibria using predictive control with and without pulses, *Computers & Mathematics with Applications*, **64** (2012), 2192-2201.

5. E. Braverman and A. Rodkina, On difference equations with asymptotically stable 2-cycles perturbed by a decaying noise, *Computers & Mathematics with Applications*, **64** (2012), 2224-2232.

6. L. Berezansky, E. Braverman and L. Idels, The Mackey-Glass model of respiratory dynamics: review and new results, *Nonlinear Analysis TMA*, **75** (2012), 6034-6052.

7. E. Braverman and B. Karpuz, Uniform exponential stability of first-order dynamic equations with several delays, *Appl. Math. Comput*., **218** (2012), 10468-10485.

8. L. Korobenko and E. Braverman, On permanence and stability of a logistic model with harvesting and a carrying capacity dependent diffusion, *Nonlinear Anal. Real World Appl*. **13** (2012), 2648--2658.

9. E. Braverman and B. Karpuz, On monotonicity of nonoscillation properties of dynamic equations in time scales, *Zeitschrift fur Analysis und ihre Anwendungen* **31** (2012), 203-216.

10. L. Berezansky and E. Braverman, Stability and linearization for differential equations with a distributed delay, *Functional Differential Equations* **19** (2012), 27-43.

11. E. Braverman and S. Zhukovskiy, Absolute and delay-dependent stability of equations with a distributed delay, *Discrete and Continuous Dynamical Systems A* **32** (2012), 2041-2061.

12. L. Berezansky and E. Braverman, On the existence of positive solutions for systems of differential equations with a distributed delay, *Computers & Mathematics with Applications*, **63** (2012), 1256--1265.

13. L. Berezansky and E. Braverman, On nonoscillation and stability for systems of differential equations with a distributed delay, *Automatica* **48** (2012), 612--618.

14. E. Braverman and B. Karpuz, On global asymptotic stability of nonlinear higher-order difference equations, *J. Comput. Appl. Math.* **236** (2012), 2803-2812.

15. E. Braverman and E. Liz, Global stabilization of periodic orbits using a proportional feedback control with pulses, *Nonlinear Dynamics* **67** (2012), 2467-2475.

Tom Duchamp at the University of Washington:
1. Tom Duchamp, Thomas Yu and Gang Xie, Single basepoint schemes for manifold-valued data: time-symmetry without space-symmetry, *Journal of Foundations of Computational Mathematics*, accepted.

Bin Han at the University of Alberta:
1. B. Han, Nonhomogeneous wavelet systems in high dimensions, *Applied and Computational Harmonic Analysis*, **32** (2012), 169-196.

2. C. K. Chui, B. Han, and X. Zhuang, A dual-chain approach for bottom-up construction of wavelet filters with any integer dilation, *Applied and Computational Harmonic Analysis*, **33** (2012), 204-225.

3. B Han and X. Zhuang, Algorithms for matrix extension and orthogonal wavelet filter banks over algebraic number fields, *Mathematics of Computation*, accepted.

Rong-Qing Jia at the University of Alberta:
1. Rong-Qing Jia, Unconditional convergence and unconditional bases in Hardy spaces, *Analysis and Applications*, accepted.

Peter Minev at the University of Alberta:
1. J.L. Guermond, P. Minev, A. Salgado, Convergence Analysis of a Class of Massively Parallel Direction Splitting Algorithms for the Navier-Stokes Equations in simple Domains. *Math. Comp*. **81** (2012), 1951-1977.

2. J.L. Guermond and P. Minev, Start-up ow in a three-dimensional lid-driven cavity by means of a massively parallel direction splitting algorithm. *Int. J. Numer. Meth. Fluids*, **68** (2012), 856-871.

3. Ph. Angot, J. Keating, P. Minev, A Direction Splitting Algorithm for Incompressible Flow in Complex Geometries. *Comp. Meth. Appl. Mech. Engng*. **217** (2012), 111-120.

Bernie Shizgal at the University of British Columbia:

1. Reinel Sospedra-Alfonso and Bernie D. Shizgal. Kullback-Leibler entropy in the electron distribution shape relaxation for electron-atom thermalization, *Phys. Rev*. **E84**, (2011), 041202.

2. Reinel Sospedra-Alfonso and Bernie D. Shizgal, Henyey-Greenstein Model in the Shape Relaxation of Dilute Gas Mixtures, *Trans Th. Stat. Phys*. **41**, (2012), 368-388.

3. B. Shizgal, R. Sospedra-Alfonso and A. Yau, Energetic Oxygen in the Terestrial Exosphere, *Geophys. Res. Abstracts*, **14** (2012), EGU2012-6182-2.

4. Bernard Shizgal and Reinel Sospedra-Alfonso, Energetic Atomic Oxygen in the Region of the Terrestrial Exobase, *American Geophysical Union*, San Francisco, Dec 3-7, (2012) P13B-1944.

5. S. Khurana and M. Thachuk, A numerical solution of the linear Boltzmann equation using cubic B-splines, *J. Chem. Phys*. **136**, 094103 (2012) with an acknowledgement to Bernie Shizgal.

6. Reinel Sospedra-Alfonso and Bernie D. Shizgal, Hot Atom Populations in the Terrestrial Atmosphere; A Comparison of the Nonlinear and Linearized Boltzmann Equations, *Rarefied Gas Dynamics, AIP Conf. Proc*. (in press, 2013).

Yau Shu Wong at the University of Alberta:

1. C. Anton, J. Deng, and Yau Wong, Hopf bifurcation analysis of an aeroelastic model using stochastic normal form, *Journal of Sound and Vibriance*, **331** (2012) 3866-3886.

2. C. Anton, Yau Wong, and J. Deng. Symplectic numerical schemes for stochastic Hamiltonian equations. *Proccedings of the Fifth Conference on Numerical Analysis and Applications*, Bulgaria. 2012, to appear in Lecture Notes in Computer Science series, Springer.

Ozgur Yilmaz at the University of British Columbia:

1. H. Mansour, F. Herrmann, and O. Yilmaz. Improved wavefield reconstruction from randomized sampling via weighted one-norm minimization, Submitted (2012).

2. Y. Wang, O. Yilmaz, and Z. Zhou. Phase aliasing correction for robust blind source separation using DUET. Submitted (2012).

3. S. Gunturk, M. Lammers, A. Powell, R. Saab, and O. Yilmaz. Sobolev duals for random frames and sigma-delta quantization of compressed sensing measurements. Foundation of Computational Computational Mathematics, In press (2012).

4. F. Herrmann, M. Friedlander, and O. Yilmaz. Fighting the curse of dimensionality: compressive sensing in exploration seismology. *IEEE Signal Processing Magazine*,**29** (2012) 88–100.

5. M. Friedlander, H. Mansour, R. Saab, and O. Yilmaz. Recovery of compressively sampled signals using partial support information. *IEEE Transaction on Information Theory*, **58** (2012), 1122-1134.

6. A.M.Powell, J.Tanner, Y.Wang, and O.Yilmaz. Coarse quantization for random interleaved sampling of bandlimited signals. *ESAIM Mathematical Modelling and Numerical Analysis*, **46** (2012), 605- 618.

7. A.M. Powell, R. Saab, and O. Yilmaz, Quantization and Finite Frames, Chapter 8 (pages 267-302) in "Finite frames: Theory and Applications" (edited by P. Casazza and G. Kutyniok), Birkhauser, Boston, 2012.

8. H. Mansour and O. Yilmaz. Support driven reweighted 1-norm minimization. *Proceedings of International Conference on Acoustics, Speech*, and Signal Processing (ICASSP), 2012.

9. H. Mansour and O. Yilmaz. Adaptive compressed sensing for video acquisition. *Proceedings of International Conference on Acoustics, Speech, and Signal Processing* (ICASSP) 2012