Titles and Abstracts
15th New Mexico Analysis Seminar
(Speakers listed alphabetically)

Speaker/Affiliation: Keshav Acharya, Embry Riddle Aeronautical University
Title: Action of Symplectic Matrices on Siegel half space
Abstract: We will discuss the action of symplectic matrices on Siegel space and introduce the metrics on the space. In our attempt to show that the action of sympletic matrices on Siegel space is distance decreasing, we show that the projection map from the Siegel space onto a complex plane is distance decreasing.

Speaker/Affiliation: Timur Akhunov, University of Rochester
Title: On hypoellipticity of degenerate elliptic operators
Abstract: Solution of the laplace equation is smooth in the interior of the domain. This property is inherited by the uniformly elliptic operators. However, if the elliptic operator is degenerate in some directions, would solutions still be smooth? Hormander's bracket condition is a powerful sufficient condition, but a necessary condition is an open problem. Ellipticity is such a powerful effect, that even a pointwise vanishing that is faster than any polynomial rate may exclude non-smooth solutions. We investigate a wide class of such degenerate operators in this talk.

Speaker/Affiliation: Tess Anderson, University of Wisconsin
Title: What the A_2 theorem has taught us about singular integrals
Abstract: I'll discuss how one can bound certain singular integrals by really simple positive dyadic ones. This was done by Andrei Lerner, and extended by myself and Armen Vagharshakyan. It had powerful and surprising consequences and generalizations. Come and find out what they are.

Speaker/Affiliation: Hussein Awala, Temple University
Title: Mellin Transform Techniques for the Mixed Problem in Two Dimensions
Abstract: In this talk I will discuss the boundary value problem with mixed Dirichlet and Neumann boundary conditions for the Laplacian and the Lame system in infinite sectors in two dimensions. Using a potential theory approach the problem is reduced to inverting a singular integral operator (SIO) naturally associated with the problem on appropriate function spaces. Mellin transform techniques are then employed in the study of the spectrum of the aforementioned SIO.

Speaker/Affiliation: Chandan Biswas, University of Wisconsin, Madison
Title: Extremals of the convolution operator with the arc length measure on the moment curve
Abstract: The operator defined by convolution with the affine arclength measure on the moment curve parametrized by $h(t) = (t, t^2, ..., t^d)$ is a bounded operator from L^p to L^q if $(1/p, 1/q)$ lies on the line segment joining the points $(2/(d+1), 2(d-1)/d(d+1))$ and $(1-2(d-1)/d(d+1), 1-2/(d+1))$. We prove that there exist functions which extremize the associated inequality and any extremizing sequence is pre compact modulo the action of the symmetry group.

Speaker/Affiliation: Yaiza Canzani, Harvard University
Title: Topology and nesting of the components of the zero set of monochromatic random waves
Abstract: There are several questions about the zero set of Laplace eigenfunctions that have proved to be extremely hard to deal with and remain unsolved. Among these are the study of the size of the zero set, the study of the number of connected components, and the study of the topology of such components. A natural approach is to randomize the problem and ask the same questions for the zero sets of random linear combinations of eigenfunctions (known as monochromatic random waves). In this talk I will present some recent results in this direction related to the study of the topology and the nesting of the components of the zero sets of these monochromatic random waves. The results I'll present are based on joint works with Boris Hanin and Peter Sarnak.

Speaker/Affiliation: Erin Compaan, University of Illinois Urbana-Champaign
Title: Dynamics of the Periodic Majda-Biello System
Abstract: This talk will focus on smoothing and dynamical properties of the periodic Majda-Biello system, a dispersive system consisting of two KdV-type equations coupled through the nonlinearity. First, given initial data in a Sobolev space, we show that the difference between the linear and the nonlinear evolution almost always lives in a smoother space. The smoothing, and the precise meaning of "almost always" depends on arithmetic properties of coupling parameter in the system, which controls the resonant sets. Similar smoothing results hold for the forced and damped version of the system; these results imply the existence of a global attractor in the energy space. Finally, we mention progress on similar results for higher-dimensional dispersive systems.

Speaker/Affiliation: Andres Contreras, New Mexico State University
Title: Harmonic maps in vector-valued singular problems
Abstract: We prove the existence of defect solutions in a wide class of functionals of Ginzburg-Landau type under minimal, physically meaningful assumptions. A blow-up analysis leads to the study of topologically nontrivial minimizers in entire space with good mapping properties for an associated linear problem. In bounded domains, a variational reduction yields existence of solutions with singularities that approach harmonic maps with defects in the London limit. This is joint work with Xavier Lamy.

Speaker/Affiliation: Blair Davey, City College of New York
Title: Recent progress on Landis' conjecture
Abstract: In the late 1960s, E.M. Landis made the following conjecture: If u and V are bounded functions, and u is a solution to $\Delta u = Vu$ in $\mathbb{R}^n$ that decays like $|u(x)| \leq c \exp(-C|x|^{1+})$, then u must be identically zero. In 1992, V. Z. Meshkov disproved this conjecture by constructing bounded functions $u, V : \mathbb{R}^2 \to \mathbb{C}$ that solve $\Delta u = Vu$ in $\mathbb{R}^2$ and satisfy $|u(x)| \leq c \exp(-C|x|^{4/3})$. The result of Meshkov was accompanied by qualitative unique continuation estimates for solutions in $\mathbb{R}^n$. In 2005, J. Bourgain and C. Kenig quantified Meshkov's unique continuation estimates. These results, and the generalizations that followed, have led to a fairly complete understanding of the complex-valued setting. However, there are reasons to believe that Landis' conjecture may be true in the real-valued setting. We will discuss recent progress towards resolving the real-valued version of Landis' conjecture in the plane.

Speaker/Affiliation: Boris Hanin, Massachusetts Institute of Technology
Title: Scaling Limit of Spectral Projector for the Laplacian on a Compact Riemannian Manifold
Abstract: Let (M, g) be a compact smooth Riemannian manifold. I will give some new off-diagonal estimates for the remainder in the pointwise Weyl Law. A corollary is that, when rescaled around a non self-focal point, the kernel of the spectral projector of the Laplacian onto the frequency interval $(\lambda, \lambda + 1]$ has a universal scaling limit as λ goes to infinity (depending only on the dimension of M). This is joint work with Y. Canzani.

Speaker/Affiliation: Jongchon Kim, University of Wisconsin-Madison
Title: Endpoint bounds for a class of spectral multipliers on compact manifolds
Abstract: We will present some old and new L^p estimates for spectral multipliers of elliptic self-adjoint pseudo-differential operators on compact manifolds.

Speaker/Affiliation: Damir Kinzebulatov, Indiana University
Title: A new approach to the L^p-theory of $-\Delta + b \cdot \nabla$, and its applications to Feller processes with general drifts
Abstract: We develop a detailed regularity theory of $-\Delta + b \cdot \nabla$, $b : R^d \to R^d$ $(d \geq 3)$, in L^p for a wide class of vector fields b combining, for the first time, critical point and critical hypersurface singularities, and not reachable by the standard techniques of perturbation theory. We use the L^p-theory to construct a Feller process associated with $-\Delta + b \cdot \nabla$ (a "Brownian motion perturbed by a singular drift b'), strengthening and unifying a number of classical results in the field, towards completion of Kolmogorov program for $-\Delta + b \cdot \nabla$. arXiv:1502.07286

Speaker/Affiliation: Lyudmila Korobenko, McMaster University
Title: Sobolev inequalities on non doubling metric spaces and application in Moser iteration scheme
Abstract: The method of Moser iteration is a powerful tool in the regularity theory of elliptic and parabolic PDE's. It plays off a Sobolev inequality, that holds for all compactly supported functions, against a Caccioppoli inequality, that holds only for subsolutions or supersolutions of the equation. If ellipticity fails to infinite order and the operator becomes degenerate, one is forced to work on a non doubling metric space. I will first talk about failure of a (q, p) Sobolev inequality for any $q > p$. I will then introduce a weaker Sobolev inequality with Orlicz bump rather than a power bump, which can be shown to hold on certain non doubling metric spaces and successfully implemented in Moser iterations.

Speaker/Affiliation: Joseph D. Lakey, New Mexico State University
Title: Frames for Duration and Bandwidth Limiting
Abstract: That the prolate spheroidal wave functions are eigenfunctions of an operator that first limits a function to a finite time interval then bandlimits the resulting function was observed by Slepian and Pollak in 1960. Since 2000 much progress has been made involving numerical analysis using the prolates. Here we will focus on some new results in frame theory. Specifically, certain normalizations of shifted prolates form tight frames for the Paley-Wiener space. A corresponding result applies to what we call bandpass prolates which generate wavelet frames. These are eigenfunctions of time limiting then bandpass limiting. Methods to compute prolate-shift frame expansions will be discussed and applications will be outlined.

Speaker/Affiliation: Ruomeng Lan ,Texas A&M University
Title: Spectral Stability of the nonlinear Dirac equation in the plane and the Evans function factorization technique
Abstract: We consider the spectral stability of the solitary wave solutions to the nonlinear Dirac equation in the plane for the Soler model. We develop the Evans function factorization technique, which is based on finding the minimal invariant subspaces of the linearized equation. The technique is used to compute point spectrum of the operator corresponding to the linearized equation numerically.

Speaker/Affiliation: Xin Yang Lu, McGill University
Title: Grain Boundary Characteristic Distribution
Abstract: Many useful materials are composed of myriads of monocrystalline grain cells separated by grain boundaries. One evolution model, proposed by Mullins in the 1950s, is the (highly non-local) curvature driven evolution. Predicting the evolution of such systems is difficult, yet desirable. The theory of Grain Boundary Characteristic Distribution (GBCD) was proposed by Kinderlehrer et al. as predictive theory for grain network evolutions. The GBCD is a relative distribution of certain quantities, generally difficult to identify, whose evolution follows a predictable pattern. The mathematical formulation of the theory of GBCD heavily relies on optimal transport theory. In this talk we present a rigorous derivation of the GBCD theory in 2D. Joint work with David Kinderlehrer.

Speaker/Affiliation: Ramesh Manna, Harish-Chandra Research Institute
Title: Maximal averages associated with families of finite type surfaces
Abstract: In this talk, we will discuss the boundedness problem for maximal operators M associated to averages along families of hypersurfaces "S" of "finite type" in R^n. In the paper, we show that if the surface S, is a finite type hypersurface which is of finite type k at a_0, then the associated maximal operator is bounded on $L^p(R^n)$ for $p > k$. In this paper, we shall also consider a variable coefficient version of maximal theorem and we obtain the same L^p-boundedness result for $p > k$.

In this talk, we will also discuss the consequence of this result. In particular, we will discuss the connection between the decay rate of the Fourier transform of the surface measure on S and the L^p-boundedness of the associated maximal operator M.

References:
1) Ramesh Manna, Maximal averages associated to families of finite type surfaces, arXiv 1510.08649.

2) Iosevich, A., Maximal operators associated to families of flat curves in the plane, Duke Math. J., 76 (1994), no. 2 pp. 633-644.

3) Sogge, C. D., Maximal operators associated to hypersurfaces with one nonvanishing principal curvature, Miraflores de la Sierra, Spain, 1992, pp. 317-323.

Speaker/Affiliation: Pei Pei, Earlham College
Title: Existence and stability for wave equations of p-Laplacian type with supercritical sources.
Abstract: This paper investigates a quasilinear wave equation with Kelvin-Voigt damping, $u_{tt} - \Delta_p u - \Delta u_t = f(u)$, in a bounded domain $\Omega \subset \mathbb{R}^3$ and subject to Dirichlét boundary conditions. The operator Δ_p, $2 < p < 3$, denotes the classical p-Laplacian. The nonlinear term $f(u)$ is a source feedback that is allowed to have a *supercritical* exponent, in the sense that the associated Nemytskii operator is not locally Lipschitz from $\mathrm{W}_0^{1,p}(\Omega)$ into $L^2(\Omega)$. Under suitable assumptions on the parameters, we prove existence of local weak solutions, which can be extended globally provided the damping term dominates the source in an appropriate sense. Moreover, a blow-up result is proved for solutions with negative initial total energy. This is a joint work with Mohammad Rammaha and Daniel Toundykov.

Speaker/Affiliation: Robert Rahm, Georgia Institute of Technology
Title: Entropy Bump Conditions for Fractional Maximal and Fractional Integral Operators
Abstract: We investigate weighted inequalities for fractional maximal and fractional integral operators. We approach the problem from a dyadic point of view and dyadic and sparse operators play a central role. Using the innovative framework of "entropy bounds", introduced by Treil-Volberg, and the techniques developed by Lacey-Spencer, we are able to deduce the weighted inequalities. In particular, we give conditions on two weights, w and σ to ensure that $\|T(\sigma\cdot) : L^p(\sigma) \to L^q(w)\|$ is finite, where T is either the fractional maximal or fractional integral operator. This is joint work with Scott Spencer.

Speaker/Affiliation: Jacob Shapiro, Purdue University
Title: Semiclassical resolvent bounds in dimension two
Abstract: We give an elementary proof of resolvent bounds for semiclassical Schrödinger operators in dimension two. We require mild decay conditions on the potential. The resolvent norm grows exponentially in the inverse semiclassical parameter, but near infinity it grows linearly. This result builds from the works of several authors, including Burq, Cardoso, Datchev and Vodev.

Speaker/Affiliation: Christopher Sogge, Johns Hopkins University
Title: Global Harmonic Analysis and the Concentration of Eigenfunctions
Abstract: We shall go over several problems related to the concentration of eigenfunctions. The study of eigenfunction concentration naturally arises in analysis, number theory and mathematical physics. The tools that we use to analyze these problems are based on microlocal and harmonic analysis, as well as Riemannian geometry. More specifically, we shall show how classical results from the propagation of singularities, bilinear oscillatory integral estimates and the Cartan-Hadamard theorem as well as comparison theorems from geometry play a natural role in the analysis of this phenomena. We shall show that, even though extreme concentration occurs on manifolds of positive curvature, it cannot occur on manifolds of negative curvature.

Speaker/Affiliation: Eric Stachura, Temple University
Title: Boundary Value Problems for the Anisotropic Maxwell System
Abstract: Boundary value problems for the time-dependent, anisotropic Maxwell system are analyzed in a bounded, Lipschitz domain in $\mathbb{R}^3$. The permittivity ε and the permeability μ are parameters which determine the propagation of radiation in a material, and here are assumed to be 3×3 matrices depending on position. Motivated by an inverse problem in Electrical Impedance Tomography, solutions are obtained with general boundary data and under general assumptions on the material parameters.

Speaker/Affiliation: Pablo Raúl Stinga, Iowa State University
Title: The parabolic Calderón-Zygmund estimates revisited and novel applications
Abstract: The Calderón-Zygmund estimates for parabolic equations are revisited under the light of the language of semigroups. One of the main features of this novel point of view is that it avoids the heavy use of the symmetries of the Fourier transform. Instead, our method takes advantage of semigroup kernel estimates. Although parabolic differential operators are not positive, we manage to overcome this difficulty and define their negative powers by using complex variable. Then the derivatives of solutions are obtained by taking derivatives of the negative powers of the parabolic operator. By using this idea, new global a priori Sobolev estimates in space and time for the harmonic oscillator evolution equation as well as for the corresponding Cauchy problem are obtained. Convergence results to initial data and mixed norm Sobolev estimates are also deduced. As a test of our method, we recover the classical parabolic Sobolev estimates, though some new results for the heat equation are also proved. This is joint work with L. Ping (Wuhan University, China) and J. L. Torrea (Universidad Autnoma de Madrid, Spain).

Speaker/Affiliation: Edgar Tchoundja, Washington University in St. Louis / University of Yaounde I
Title: Duality for Bergman-Orlicz spaces and Hankel operators
Abstract: Let $\mathbb{B}^n$ be the unit ball of $\mathbb{C}^n$. The holomorphic Bergman-Orlicz spaces are generalizations of the classical Bergman spaces in the unit ball of $\mathbb{C}^n$. In this talk, we characterize the dual of large Bergman-Orlicz spaces and use it to characterize the boundedness of the (small) Hankel operator, with holomorphic symbols, between two Bergman-Orlicz spaces in the unit ball of $\mathbb{C}^n$. Our characterization is in terms of the symbols belonging to some weighted Lipschitz spaces. This talk is based on joint work with B. Sehba.

Speaker/Affiliation: Wilfredo Urbina, Roosevelt University
Title: New real variable methods in H summability of Fourier series
Abstract: In this presentation we shall be concerned with H_α summability, for $0 < \alpha \leq 2$ of the Fourier series of arbitrary $L^1([-\pi, \pi])$ functions. The methods to be employed here are a refinement of the real variable methods introduced by Marcinkiewicz. In addition, we introduce maximal theorems with respect to the Lebesgue measure and A_1 weights.

Speaker/Affiliation: Ignacio Uriarte-Tuero, Michigan State University
Title: Two weight norm inequalities for singular and fractional integral operators in R^n
Abstract: I will report on recent advances on the topic, related to proofs of T1 type theorems in the two weight setting for Calderón-Zygmund singular and fractional integral operators, with side conditions, and related counterexamples. Joint work with Eric Sawyer and Chun-Yen Shen.

Speaker/Affiliation: John Villavert, University of Texas – Rio Grande Valley
Title: Integral systems related to sharp geometric inequalities
Abstract: In this talk, we introduce a family of integral systems and closely related elliptic partial differential equations (PDEs). This family arises in the context of important problems from geometric analysis. This includes problems on finding the best constants in geometric inequalities, e.g., the Sobolev and Hardy-Littlewood-Sobolev inequalities. The PDEs also appear in problems from conformal geometry such as the Yamabe and prescribing scalar curvature problems. The first part of the talk will quickly introduce some of these motivating problems then connect them to the study of the quantitative and qualitative properties of solutions for the integral systems. Particularly, we will discuss some recent results on the existence, non-existence, and the classification of positive solutions for the class of integral systems.

Speaker/Affiliation: Daniel Wang, Sam Houston State University
Title: Variable A_p weights
Abstract: The variable L^p spaces allow the exponent p to be a function with values between 1 and infinity. A sizable theory has been developed on these spaces, such as the boundedness of maximal and singular integral operators on these spaces. A natural development is adapting the classical A_p weights to the variable setting. In this talk, we contrast the classical weights and variable weights, and see what properties hold in the variable case. In particular, we have a "reverse factorization" result that allows us to construct variable weights. This is joint work with David Cruz-Uribe (University of Alabama).

Speaker/Affiliation: David Weirich, University of New Mexico
Title: A Good Bellman Function Lemma for Spaces of Homogeneous Type
Abstract: We generalize a lemma originally by used D. Chung, the so called 'Good Bellman Function Lemma.' Using this lemma, we can very easily extend many theorems proved by the Bellman function technique from the real numbers to spaces of homogeneous type. We will also present some examples.

Speaker/Affiliation: Yakun Xi, Johns Hopkins University
Title: On Kakeya-Nikodym Maximal Inequalities.
Abstract: In this talk, I will discuss some recent results related to the Kakeya-Nikodym problem. The main result is that for any dimension $d \geq 3$, one can obtain Wolff's $L^{(d+2)/2}$ bound on Kakeya-Nikodym maximal function in $\mathbb{R}^d$ for $d \geq 3$ without the induction on scales argument. The key ingredient is to reduce to a 2-dimensional L^2 estimate with an auxiliary maximal function. A similar argument can be applied to show that the same $L^{(d+2)/2}$ bound holds for Nikodym maximal function for any manifold (M^d, g) with constant curvature, which generalizes Sogge's results for $d = 3$ to any $d \geq 3$.

Speaker/Affiliation: Xiang Xu, Old Dominion University
Title: Eigenvalue preservation for the Beris-Edward system modeling nematic liquid crystals
Abstract: We consider an incompressible Navier-Stokes and Q-tensor system modeling liquid crystal flows of nematic type. The main aim is to prove the eigenvalue preservation property for solutions to the coupled system in 3D. More precisely, we prove that if all eigenvalues of the initial data stay in a specified small interval, then the range of the eigenvalues of Q(t) will keep the same as time evolves.

Speaker/Affiliation: Kazuo Yamazaki, Washington State University
Title: Global martingale solution for the stochastic Boussinesq system with zero dissipation
Abstract: In this talk we study the two-dimensional stochastic Boussinesq system with zero dissipation and multiplicative noise. We prove the existence of a martingale solution by a priori estimates using stochastic calculus, and applications of Prokhorov's, Skorokhod's and Martingale Representation theorems. Due to the lack of dissipation, the proof requires higher regularity estimates, taking advantage of the structure of the nonlinear term. Moreover, we obtain the existence of the pressure term via an application of de Rham's theorem for processes. Finally, we discuss open problems as an extension of this result, which raises interesting gaps between the deterministic and stochastic analysis of these PDE in fluid in general.

Speaker/Affiliation: Jiuyi Zhu, Johns Hopkins University
Title: Nodal geometry of Steklov eigenfunctions
Abstract: In this talk, we consider the Steklov eigenvalue problem with its spectral parameter at the boundary of a compact Riemannian manifold. Recently the study of Steklov eigenfunctions has been attracting much attention. We can ask Yau's type conjecture for the Hausdorff measure of nodal sets of Steklov eigenfunctions on the boundary and interior of the manifold. I will describe some recent progress about this challenging direction. Part of work is joint with Chris Sogge and X. Wang.