

Preface for Volume 1

On April 4, 2014, we celebrated Cora Sadosky's life with an *afternoon in her honor*, preceded by the 13th New Mexico Analysis Seminar¹ on April 3–4, 2014, and followed by the Western Sectional Meeting of the AMS on April 5–6, 2014, all held in Albuquerque, New Mexico, USA. It was a mathematical feast, gathering more than a 100 analysts—fledgling, junior, and senior, from all over the USA and the world such as: Canada, India, Mexico, Sweden, the UK, South Korea, Brazil, Israel, Hungary, Finland, Australia, and Spain—to remember her outspokenness, her uncompromising ways, her sharp sense of humor, her erudition, and above all her profound love for mathematics.

Many speakers talked about how their mathematical lives were influenced by Cora's magnetic personality and her mentoring early in their careers and as they grew into independent mathematicians. Particularly felt was her influence among young Argentinian and Venezuelan mathematicians. Rodolfo Torres, in a splendid lecture about Cora and her mathematics, transported us through the years from Buenos Aires to Chicago and then back to Buenos Aires, from Caracas to the USA and then back to Buenos Aires, and from Washington, D.C., to California. He reminded us of Cora always standing up for human rights, Cora as president of the Association for Women in Mathematics (AWM), and Cora always encouraging and fighting for what she thought was right.

¹The 13th New Mexico Analysis Seminar and *An Afternoon in Honor of Cora Sadosky* were sponsored by National Science Foundation (NSF) grant DMS-140042, the Simons Foundation, and the Efroymsen Foundation, and the events were done *in cooperation* with the Association for Women in Mathematics (AWM). See the conference's websites:

www.math.unm.edu/conferences/13thAnalysis
people.math.umass.edu/~nahmod/CoraSadosky.html

An Afternoon in Honor of Cora Sadosky was organized by Andrea Nahmod, Cristina Pereyra, and Wilfredo Urbina. The 13th New Mexico Analysis Seminar organizers were Matt Blair, Cristina Pereyra, Anna Skripka, Maxim Zinchenko from University of New Mexico, and Nick Michalowsky from New Mexico State University.

Cora was born in Buenos Aires, Argentina, on May 23, 1940, and died on December 3, 2010, in Long Beach, CA. Cora got her PhD in 1965 at the University of Chicago under the supervision of both Alberto Calderón and Antoni Zygmund, the grandparents of the now known Calderón-Zygmund school. Shortly after her return from Chicago, she married Daniel J. Goldstein, her lifelong companion who sadly passed away on March 13, 2014, a few weeks before the Albuquerque gathering. Daniel and Cora had a daughter, Cora Sol, who is now a political science professor at California State University in Long Beach, and a granddaughter, Sasha Malena, who brightened their last years. During her life, Cora wrote more than 50 research papers, and a graduate textbook on *Interpolation of Operators and Singular Integrals: An Introduction to Harmonic Analysis* (Marcel Dekker, 1979), and she edited two volumes: one celebrating Mischa Cotlar's 70th birthday (*Analysis and Partial Differential Equations: A Collection of Papers Dedicated to Mischa Cotlar*, CRC Press, 1989) and one celebrating Alberto Calderón 75th birthday (*Harmonic Analysis and Partial Differential Equations: Essays in Honor of Alberto Calderón*, edited with M. Christ and C. Kenig, The University of Chicago Press, 1999). We have included a list as complete as possible of her scholarly work. Notable are her contributions to harmonic analysis and operator theory, in particular her lifelong very fruitful collaboration with Mischa Cotlar.

When news of Cora's passing spread like wildfire in December 2010, many people were struck. The mathematical community quickly reacted. The AWM organized an impromptu memorial at the 2011 Joint Mathematical Meeting (JMM), as reported by Jill Pipher, at the time the AWM president:

Many people wrote to express their sadness and to send remembrances. The AWM business meeting on Thursday, January 6 at the 2011 JMM was largely devoted to a remembrance of Cora.

This appeared in the March–April issue of the AWM Newsletter² which was entirely dedicated to the memory of Cora Sadosky.

An obituary by Allyn Jackson for Cora Sadosky appeared in Notices of the American Mathematical Society in April 2011.³

In June 2011, Cathy O'Neal wrote in her blog mathbabe⁴ a beautiful remembrance for Cora:

[...] Cora, whom I met when I was 21, was the person that made me realize there is a community of women mathematicians, and that I was also welcome to that world. [...] And I felt honored to have met Cora, whose obvious passion for mathematics was absolutely awe-inspiring. She was the person who first explained to me that, as women mathematicians, we will keep growing, keep writing, and keep getting better at math as we grow older [...]. When I googled her this morning, I found out she'd died about 6 months ago. You can read

²*President's Report*, AWM Newsletter, Vol. 41, No. 2, March–April 2011, p. 1. This issue was dedicated to the memory of Cora Sadosky.

³Notices AMS, Vol. 58, Number 4, April 2011, pp. 613–614.

⁴<http://mathbabe.org/2011/06/29/cora-sadosky/>.

about her difficult and inspiring mathematical career in this biography.⁵ It made me cry and made me think about how much the world needs role models like Cora.

In 2013, the Association for Women in Mathematics established the biennial AWM-Sadosky Prize in Analysis,⁶ to be awarded every other year starting in 2014. The purpose of the award is to highlight exceptional research in analysis by a woman early in her career. Svitlana Mayboroda was the first recipient of the AWM-Sadosky Research Prize in Analysis awarded in January 2014. Mayboroda is contributing a survey paper joint with Ariel Barton to this volume. We include the press release issued by the AWM on May 15, 2013, and the citation and Mayboroda's response that appeared in the March–April 2014 issue of the AWM Newsletter.⁷ As this volume goes into press, the second recipient of the award, the 2016 AWM-Sadosky Prize, was announced: Daniela da Silva, from Columbia University.

In 2015, Kristin Lauter, president of the AWM, started her report in the May–June issue of the AWM Newsletter,⁸ with a couple of paragraphs remembering Cora:

I remember very clearly the day I met Cora Sadosky at an AWM event shortly after I got my PhD, and, knowing very little about me, she said unabashedly that she didn't see any reason that I should not be a professor at Harvard someday. I remember being shocked by this idea, and pleased that anyone would express such confidence in my potential, and impressed at the audacity of her ideas and confidence of her convictions.

Now I know how she felt: when I see the incredibly talented and passionate young female researchers in my field of mathematics, I think to myself that there is no reason on this earth that some of them should not be professors at Harvard. But we are not there yet . . . and there still remain many barriers to the advancement and equal treatment of women in our profession and much work to be done.

In these two volumes, friends, colleagues, and/or mentees have contributed research papers, surveys, and/or short remembrances about Cora. The remembrances were sometimes weaved into the article submitted (either at the beginning or the end), and we have respected the format each author chose. Many of the authors gave talks in the *13th New Mexico Analysis Seminar*, in *An Afternoon in Honor of Cora Sadosky*, and/or in the special sessions of the AMS; others could not attend these events but did not think twice when given the opportunity to contribute to this homage.

The mathematical contributions naturally align with Cora's mathematical interests: harmonic analysis and PDEs, weighted norm inequalities, Banach spaces and BMO, operator theory, complex analysis, and classical Fourier theory.

Volume 1 contains articles about Cora, her mathematics and mentorship, remembrances by colleagues and friends, her bibliography according to MathSciNet, and

⁵Biographies of Women in Mathematics: Cora Sadosky <http://www.agnesscott.edu/lriddle/women/corasadosky.htm>.

⁶More details in the AWM-Sadosky Research Prize in Analysis webpage: <https://sites.google.com/site/awmmath/programs/sadosky-prize>.

⁷AWM Newsletter, Volume 44, Number 2, March–April 2014.

⁸President's Report. AWM Newsletter, Vol. 45, No. 3, May–June, p. 1.

survey and research articles on harmonic analysis and partial differential equations, BMO, Banach and metric spaces, and complex and classical Fourier analysis.

Last year (2014) saw the resolution of the two-weight problem for the Hilbert transform à la Muckenhoupt by Michael Lacey, Eric Sawyer, Chun-Yen Shen, and Ignacio Uriarte-Tuero, a problem that had been open for 40 years. This problem was solved à la Helson-Szegö by Cora Sadosky and Mischa Cotlar in the early 1980s using complex analysis and operator theory methods. In the last 15 years, a number of techniques have been developed and refined to yield this result, including stopping time arguments, Bellman functions, Lerner’s median approach, and bumped approach.

Volume 2 contains survey and research articles on weighted norm inequalities, operator theory, and dyadic harmonic analysis. The articles illustrate some of the recent techniques developed to understand weighted inequalities and more, including a survey of the two-weight problem for the Hilbert transform by Michael Lacey.

Contents of Volume 1

We now describe in more detail the contents of this first volume. Volume 1 consists of two parts, the first one devoted to remembering Cora in all her facets, and the second to mathematics which is, as we well know, a fundamental part of who Cora was.

Part I of Volume 1 contains articles about Cora, her mathematics and mentorship, as well as some remembrances by colleagues and friends. Chapter “Cora Sadosky: Her Mathematics, Mentorship, and Professional Contributions” is a written rendering of Rodolfo Torres’ Albuquerque lecture *Cora Sadosky: her mathematics, mentorship, and professional contributions*. This should help us all not to forget this amazing and strong-willed mathematician and woman and the new generations to learn about her vibrant personality. Chapter “Cora’s Scholarly Work: Publications According to MathSciNet” contains Cora’s scholarly work according to MathSciNet. Chapter “Remembering Cora Sadosky” contains remembrances from friends and colleagues, such as Steven Krantz, María Dolores (Loló) Morán, Guido Weiss, and Mike Wilson, and reproduces the article *Remembering Cora Sadosky* with contributions from Georgia Benkart, Judy Green, Richard Bourgin, and Daniel Szyld and a remembrance written collectively by Estela Gavosto, Andrea Nahmod, Cristina Pereyra, Gustavo Ponce, Rodolfo Torres, and Wilfredo Urbina, published in the AWM Newsletter Volume 41, Number 2, March–April 2011.

Part II in Volume 1 contains a survey and research articles submitted by an array of mathematicians representing one or several of the mathematical themes close to Cora’s heart. In chapter “Higher-Order Elliptic Equations in Non-Smooth Domains: A Partial Survey”, Ariel Barton and Svitlana Mayboroda present an extensive survey dealing with the theory of higher-order elliptic operators in non-smooth settings. The first section of the paper deals with mostly constant coefficient

operators, in arbitrary domains. It explains the Miranda-Agmon maximum principle and related regularity estimates, as well as the interesting extension to this setting of the Wiener test. The results explained are deep and important, and it is very useful to have the history and development detailed here. The second section deals with L^p boundary value problems for higher-order elliptic operators on Lipschitz domains. This is mainly discussed again in the constant coefficient case. This is a very rich subject, where, in spite of decades of steady progress, important problems remain open. The final section deals with variable coefficient higher-order operators. Two natural classes of such operators are discussed, and recent works by the authors are described. This is a part of the theory that is at its very beginning and where much remains to be done. The authors' recent pioneering works are explained, and also many areas of investigation that remain wide open are discussed.

Chapters "Victor Shapiro and the Theory of Uniqueness for Multiple Trigonometric Series", "A Last Conversation with Cora", and "Fourier Multipliers of the Homogeneous Sobolev Space $W^{1,1}$ " are from Cora's academic sibling Marshall Ash and dear friend and colleague Aline Bonami. Marshall Ash's paper focuses on aspects of Cantor's uniqueness theorem which states that if a trigonometric series converges to zero pointlessly everywhere, then all of its coefficients must be zero. The paper is written in the form of a survey and contains outlines of proofs, ideas and discussions, and personal experiences. Aline Bonami starts with a remembrance she titled *A last conversation with Cora*, followed by an article that studies the class of Fourier multipliers on the homogeneous Sobolev space $W^{1,1}$ which is meant to be part of this final conversation.

In chapter "A Note on Nonhomogenous Weighted Div-Curl Lemmas", Galia Dafni, Der-Chen Chang, and Hong Yue present new results concerning local versions of the div-curl lemma in \mathbb{R}^n in the context of weighted Lebesgue spaces and weighted localized Hardy spaces. Dafni and Chang were Cora's coauthors.

In chapter "A Remark on Bilinear Square Functions", Loukas Grafakos in an interesting note opens up a discussion regarding a bilinear version of a classical theorem due to Rubio de Francia on L^p -estimates for square functions based on disjoint and arbitrary (in particular, not necessarily dyadic) intervals on the real line.

In chapter "Unique Continuation for the Elasticity System and a Counterexample for Second-Order Elliptic Systems", Carlos Kenig and Jenn-Nan Wang present an interesting discussion of unique continuation for second-order elliptic systems in the plane. They discuss positive results for a class of systems of elasticity where coefficients are bounded and measurable (both isotropic and anisotropic systems) and where coefficients are Lipschitz (anisotropic system). They present an example which shows that unique continuation may fail for elliptic systems with bounded measurable coefficients in interesting contrast to the case of single equations where unique continuation results are known to hold.

In chapter "Hardy Spaces of Holomorphic Functions for Domains in \mathbb{C}^n with Minimal Smoothness", Loredana Lanzani and Eli Stein continue their program analyzing Hardy spaces on domains in several complex variables with minimal boundary smoothness. As the reviewer said, "These will be of interest to a broad cross-section of analysts. And I must note that Cora Sadosky would have been quite interested in this paper."

In chapter “On the Preservation of Eccentricities of Monge–Ampère Sections”, Diego Maldonado studies how the eccentricity of sections to solutions u to the Monge–Ampère equation behave when the right-hand side of the equation satisfies a Dini-type condition on sections. This is applied to obtain estimates of second derivatives of u in terms of the eccentricity. In addition, he uses these results to show existence of quasi-conformal solutions to Jacobian equations and also to improve recent estimates for second derivatives of solutions to the linearized Monge–Ampère equation.

In chapter “BMO: Oscillations, Self-Improvement, Gagliardo Coordinate Spaces, and Reverse Hardy Inequalities”, Mario Milman writes about BMO touching on many topics including oscillations, self improvement, Gagliardo coordinate spaces, and reverse Hardy inequalities. As the author himself says about Cora in the last section, “I know that the space BMO had a very special place in her mathematical interests and, indeed, BMO spaces appear in many considerations throughout her works. For this very reason, and whatever the merits of my small contribution, I have chosen to dedicate this note on BMO inequalities to her memory.”

In chapter “Besov Spaces, Symbolic Calculus, and Boundedness of Bilinear Pseudodifferential Operators”, Virginia Naibo and Jodi Herbert continue their work on L^p boundedness properties for bilinear pseudodifferential operators with symbols in certain Besov spaces of product type. It is useful to notice that the classes of symbols considered are extensions of some particular instance of the nowadays well-understood bilinear Hörmander classes of symbols.

In chapter “Metric Characterizations of Some Classes of Banach Spaces”, Mikhail Ostrowskii writes about metric characterization of some classes of Banach spaces; this topic is currently central in nonlinear analysis.

In chapter “On the IVP for the k -Generalized Benjamin–Ono Equation”, Gustavo Ponce surveys recent developments regarding local and global well-posedness and special properties (such as decay and regularity) of solutions of the initial value problem (IVP) associated to the Benjamin-Ono equation and k -generalized Benjamin-Ono equation.

Mayboroda, Ponce, and Torres were invited speakers to “An Afternoon in Honor of Cora Sadosky.” Dafni and Naibo gave talks in the AMS meeting in Albuquerque in April and honored there as they are doing here the life and work of Cora Sadosky. Other authors could not make it to the conference but were more than happy to contribute to this volume.

Harmonic Analysis, Partial Differential Equations,
Complex Analysis, Banach Spaces, and Operator Theory
(Volume 1)

Celebrating Cora Sadosky's life

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