Carlos H. Borca | Curriculum Vitæ

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Summary

- Pragmatic theoretical chemist that enjoys doing collaborative basic science research, engaging real-life problems, and developing original scientific software solutions.
- Interested in developing theory and software to be applied on problems of broad chemical scope: intermolecular interactions, pharmaceutical formulations, machine learning descriptors, biomolecular structure, and materials design.
- 10 years of research and teaching experience in academic institutions and national laboratories in the U.S.
- 8 articles published in peer-reviewed scientific journals, 2 invited and 15 contributed oral presentations, 16 poster presentations.
- More than $25,000 in scholarships, travel grants, and awards.

Education

Postdoctoral Fellowship 2017 - Present
Georgia Institute of Technology - School of Chemistry and Biochemistry - Atlanta, GA, USA

Ph.D. in Chemistry 2012 - 2017
Purdue University - Department of Chemistry - West Lafayette, IN, USA

Applied Management Principles Mini-MBA 2016 - 2016
Purdue University - Krannert School of Management - West Lafayette, IN, USA

Professional (5-Year) Degree in Chemistry | Honors mention for meritorious research thesis 2004 - 2009
Universidad del Valle - School of Natural and Exact Sciences - Cali, Colombia

Experience

Research

Georgia Institute of Technology - Atlanta, GA, USA | Adviser: Prof. C. David Sherrill 2017 - Present
- Development of software and theoretical methods to compute properties of molecular crystals
- Generation benchmark-level databases of lattice energies of molecular crystals
- Atomistic molecular dynamics of self-assembling non-covalently bonded polymers
- Benchmarking of interaction energies in systems with halogen-polarized C-H and aromatic rings

Purdue University - West Lafayette, IN, USA | Adviser: Prof. Lyudmila V. Slipchenko 2012 - 2017
- Timescale separation of energy contributions in the Effective Fragment Potential molecular dynamics
- Determination of the melting temperature of ice with the Effective Fragment Potential method
- Computationally-aided mechanistic design of polymers with applications on pharmaceutics
- Molecular modeling of crystallization inhibition properties of bile salts
- Photochemical degradation process of isoprene carbonyl nitrates in the atmosphere
- Charge-transfer in carbon nanopore models via ground-state density functional theory

Northwestern University - Evanston, IL, USA | Collaborators: Dr. Martín A. Mosquera, Prof. Mark A. Ratner, and George C. Schatz 2015 - 2016
- Development of long-rang corrected local density functionals for excitation energies
- Impact of spherical deformations in the electronic structure of polyaromatic hydrocarbons

Lawrence Livermore National Laboratory - Livermore, CA, USA | Advisers: Dr. Alfredo A. Correa and Dr. Xavier I. Andrade 2015
- Modular implementation of the Tkatchenko-Scheffler model for van der Waals interactions

Universidad Icesi - Cali, Colombia | Adviser: Prof. Carlos A. Arango 2011 - 2012
- Atomistic molecular dynamics of water absorbent materials at the nano-scale

Universidad del Valle - Cali, Colombia | Adviser: Prof. Julio C. Arce 2007 - 2009
- Computational study of interactions of single-wall carbon nanotubes/DNA hybrids and small molecules relevant to chemical sensing applications

Teaching

Graduate Teaching Assistant | Purdue University - West Lafayette, IN, USA — 2012 - 2015
- CHM 57900: Computational Chemistry - Spring 2015
- CHM 11100: General Chemistry - Fall 2012, Fall 2013, Fall 2014
- CHM 11500: General Chemistry - Spring 2013

Laboratory Lecturer | Universidad Icesi - Cali, Colombia — 2009 - 2011
- Physical Chemistry I - 2010-I, 2010-II, 2011-I
- Physical Chemistry II - 2010-II
- General Chemistry - 2009-II, 2010-I, 2010-II

Mentoring

Postgraduate Mentor | Georgia Institute of Technology - Atlanta, GA, USA — 2017 - Present
Asem Alenaizan - *Graduate Student Researcher in Chemistry*
Donna Odhiambo - *Undergraduate Student Researcher in Chemistry*

Graduate Mentor | Purdue University - West Lafayette, IN, USA — 2015 - 2017
Jennifer Werner - *Undergraduate Student Researcher in Chemistry*
Yifan Wang - *Undergraduate Student Researcher in Chemistry*

Honors and Awards

National Science Foundation Travel Award to attend the CMU-GT Symposium on Machine Learning in Science and Engineering — 2018
Carnegie Mellon University - Pittsburgh, PA, USA

Materials Computational Center Travel Award to attend the 7th TDDFT School and Workshop — 2016
University of Illinois - Urbana-Champaign, IL, USA

Colombian Students Association at Purdue University (CSAP) Travel Grant Award — 2015
Purdue University - West Lafayette, IN, USA

LLNL Students Poster Symposium Outstanding Accomplishment Award — 2015
Lawrence Livermore National Laboratory - Livermore, CA, USA

Eli Lily Scholarship — 2014
Purdue University - West Lafayette, IN, USA

Young Scientist and Innovator Scholarship of 2011 — 2011
Administrative Department of Science, Technology, and Innovation of the Colombian Government (Colciencias) and Universidad Icesi - Cali, Colombia

Honors graduation with a mention for meritorious research thesis — 2009
Universidad del Valle - Cali, Colombia

Top-5-in-class Scholarship: six out of eight semesters, including two first places — 2008
Universidad del Valle - Cali, Colombia

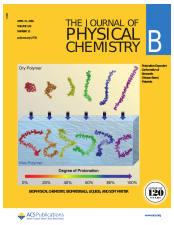
11^{th} National ICFES Average Score (Colombian ICFES is analogous to the SAT in the USA) — 2004
Ministry of Education of the Colombian Government - Bogotá, Colombia

Andrés Bello Departmental Award for the best Biology score in the ICFES — 2004
Ministry of Education of the Colombian Government - Bogotá, Colombia

Peer-reviewed Articles

Published

- Martín A. Mosquera, **Carlos H. Borca**, Mark A. Ratner, and George C. Schatz. Connection Between Hybrid Functionals and Importance of the Local Density Approximation. *The Journal of Physical Chemistry A*, **2016**, *120* (9), pp 1605–1612. DOI: 10.1021/acs.jpca.5b10864
- **Carlos H. Borca** and Carlos A. Arango. Molecular Dynamics of a Water-absorbent Nano-scale Material Based on Chitosan. *The Journal of Physical Chemistry B*, **2016**, *120* (15), pp 3754–3765. DOI: 10.1021/acs.jpcb.5b11230
  Featured in the cover art.



- Fulizi Xiong, **Carlos H. Borca**, Lyudmila V. Slipchenko, and Paul B. Shepson. Photochemical Degradation of Isoprene-derived 4,1-Nitrooxy Enal. *Atmospheric Chemistry and Physics*, **2016**, *16*, pp 5595–5610. DOI: 10.5194/acp-16-5595-2016
- Laura I. Mosquera-Giraldo, **Carlos H. Borca**, Xiangtao Meng, Kevin J. Edgar, Lyudmilla V. Slipchenko, and Lynne S. Taylor. Mechanistic Design of Chemically Diverse Polymers with Applications in Oral Drug Delivery. *Biomacromolecules*, **2016**, *17* (11), pp 3659–3671. DOI: 10.1021/acs.biomac.6b01156
- **Carlos H. Borca**, Lyudmila V. Slipchenko, and Adam Wasserman. Ground-State Charge Transfer: Lithium-Benzene and the Role of Hartree-Fock Exchange. *The Journal of Physical Chemistry A*, **2016**, *120* (41) pp 8190–8198. DOI: 10.1021/acs.jpca.6b09014
- Na Li, Laura I. Mosquera-Giraldo, **Carlos H. Borca**, James D. Ormes, Michael Lowinger, John D. Higgins, Lyudmilla V. Slipchenko, and Lynne S. Taylor. A Comparison of the Crystallization Inhibition Properties of Bile Salts. *Crystal Growth & Design*, **2016**, 16 (12) pp 7286–7300. DOI: 10.1021/acs.cgd.6b01470
- Joel D. Rindelaub, **Carlos H. Borca**, Matt A. Hostetler, Mark A. Lipton, Lyudmila V. Slipchenko, and Paul B. Shepson. The Acid-Catalyzed Hydrolysis of an α-Pinene-Derived Organic Nitrate: Kinetics, Products, Reaction Mechanisms, and Atmospheric Impact. *Atmospheric Chemistry and Physics*, **2016**, 16, pp 15425–15432. DOI: 10.5194/acp-2016-726
- Sarah F. Tyler, Eileen C. Judkins, Dmitry Morozov, **Carlos H. Borca**, Lyudmila V. Slipchenko, and David R. McMillin. To Be or Not to Be Symmetric: That is the Question for Potentially Active Vibronic Modes. *The Journal of Chemical Education*, **2017**, 94 (9), pp 1232–1237. DOI: 10.1021/acs.jchemed.7b00289

Under Review

- Naila A. Mugheirbi, Laura I. Mosquera-Giraldo, **Carlos H. Borca**, Lyudmila V. Slipchenko, and Lynne S. Taylor. Phase Behavior of Solid Dispersions Produced using Various Solvent Systems: Mechanistic Understanding of the Role of Polymer using Experimental and Theoretical Methods. *Under review*, **2018**.

In Preparation (Draft available)

- Laura I. Mosquera-Giraldo, **Carlos H. Borca**, Andrew S. Parker, Yifan Dong, Kevin J. Edgar, Stephen P. Beaudoin, Lyudmila V. Slipchenko, and Lynne S. Taylor. Crystallization Inhibition Properties of Cellulose Ester and Ethers for a Group of Chemically Diverse Drugs - Experimental and Computational Insight. *Manuscript in Preparation*, **2018**.
- **Carlos H. Borca** and Lyudmila V. Slipchenko. Exploiting the Timescale Separation between Energy Contributions to Accelerate Molecular Dynamics in the Effective Fragment Potential. *Manuscript in Preparation*, **2018**.
- **Carlos H. Borca**, Brandon W. Bakr, Lori A. Burns, and C. David Sherrill. CrystaLattE: Automated Computation of Benchmark-level Lattice Energy of Molecular Crystals. *Manuscript in Preparation*, **2018**.

Scientific Events

Events Organized

Second Annual Academic Event of the Colombian Student Association at Purdue University - West Lafayette, IN, USA 10/2016
Head of the Academic Event Organization Committee

Invited Talks

Academic Presentations of the Colombian Student Association at Purdue University - West Lafayette, IN, USA 9/2015
Developing Software to Model van der Waals Interactions in Materials

Special Guest Talk at the Graduate Physical Chemistry Seminar at Universidad del Valle - Cali, Valle del Cauca, Colombia 5/2014
Charge Distribution in Carbon Nanopores Via Density Functional Theory

Contributed Talks

Machine Learning in Science and Engineering Conference - Pittsburgh, PA, USA 6/2018
CrystaLattE: Automated Computation of Benchmark-level Lattice Energies of Molecular Crystals

North Carolina State University Building Faculty of the Future Program - Raleigh, NC, USA 3/2018
CrystaLattE: Automated Computation of Benchmark-level Lattice Energies of Molecular Crystals

Meeting of the Southeastern Theoretical Chemistry Association (SETCA 2017) - Oxford, MS, USA 5/2017
CAM-LDA0: Reincarnating the Local Density Approximation

Graduate Physical Chemistry Seminar - West Lafayette, IN, USA 11/2016
Molecular Dynamics with the Effective Fragment Potential Method

252th National Meeting & Exposition of the American Chemical Society (ACS 2016) - Philadelphia, PA, USA 8/2016

- *CAM-LDA0: The Reincarnation of the Local Density Approximation*
- *Timescale Separation between Energy Contributions in the Effective Fragment Potential*
- *Molecular Dynamics of Water-Absorbent Nanoscale Materials Based on Chitosan*

48th Midwest Theoretical Chemistry Conference (MWTCC 2016) - Pittsburgh, PA, USA 6/2016
Exploiting the Timescale Separation between Energy Contributions to Accelerate Molecular Dynamics in the Effective Fragment Potential

Academic Presentations of the Colombian Student Association at Purdue University - West Lafayette, IN, USA 6/2016
Molecular Dynamics of a Water-Absorbent Nanoscale Material Based on Chitosan

250th National Meeting & Exposition of the American Chemical Society (ACS 2015) - Boston, MA, USA 8/2015
- *Charge Transfer in the Lithium-Benzene Complex via Density Functional Theory*
- *Developing materials-modeling software for electron dynamics with van der Waals interactions*
- *Determining the Melting Point of Ice with the Effective Fragment Potential*

V National Meeting of Theoretical and Computational Chemists (V ENQTC) - Guatapé, Antioquia, Colombia 5/2014
Charge Distribution in Carbon Nanopores Via Density Functional Theory

IX National Congress of Pure and Applied Chemistry Students (IX CONEQ) - Cali, Valle del Cauca, Colombia 10/2009
Computational Study of the Interactions between Carbon Nanotube/DNA Hybrids and Simple Molecules Relevant in Chemical Sensing

III National Symposium of Nanotechnology (NANOCOLOMBIA 2009) - Bogotá, D.C., Colombia 4/2009
Electronic Properties of Chemical Transducers Based on Carbon Nanotubes Functionalized with Homo-DNA polynucleotides

Posters

Institute for Data Engineering and Science Industry Day - Atlanta, GA, USA 3/2018
CrystaLattE: Automated Computation of Benchmark-level Lattice Energies of Molecular Crystals

49th Midwest Theoretical Chemistry Conference (MWTCC 2017) - East Lansing, MI, USA 6/2017
CAM-LDA0: Reincarnating the Local Density Approximation

7th Time-Dependent Density-Functional Theory: Prospects and Applications (7th TDDFT) - Benasque, Aragón, Spain 9/2016
CAM-LDA0: The Reincarnation of the Local Density Approximation

IX Congress of the International Society for Theoretical Chemical Physics (IX ISTCP 2016) - Grand Forks, ND, USA 7/2016
Exploring the Temporal Evolution of the Energy Components in the Effective Fragment Potential Molecular Dynamics

2016 Conference on Excited State Processes (ESP 2016) - Santa Fe, NM, USA 6/2016
Charge Transfer in the Lithium-Benzene Complex: Understanding the Role of the Hartree-Fock Exchange

First Annual Academic Event of the Colombian Student Association at Purdue University - West Lafayette, IN, USA 11/2015
Developing Materials-modeling Software for Electron Dynamics with van der Waals Interactions

Lawrence Livermore National Laboratory Student Poster Symposium - Livermore, CA, USA 7/2015
Developing Materials-modeling Software for Electron Dynamics with van der Waals Interactions

Meeting of the Southeastern Theoretical Chemistry Association (SETCA 2015) - Orlando, FL, USA 5/2015
Charge Transfer in Lithium-Benzene via Density Functional Theory

248th National Meeting & Exposition of the American Chemical Society (ACS 2014) - San Francisco, CA, USA 8/2014
Charge Transfer in Lithium-Benzene via Density Functional Theory

46th Midwest Theoretical Chemistry Conference (MWTCC 2014) - Evanston, IL, USA 7/2014
Charge Transfer in Lithium-Benzene via Density Functional Theory

VIII National Meeting of Neuroscience - Bogotá, D.C., Colombia 6/2012
Computational Study of Glycosylation and Phosphorylation of Proteins Involved in Neurodegeneration

IV National Meeting of Theoretical and Computational Chemists (IV ENQTC) - Cali, Valle del Cauca, Colombia 5/2012
Molecular Modelling of Water Absorbent Nanoscale Materials

Fourth Research Socialization Day at Universidad Icesi 2011 - Cali, Valle del Cauca, Colombia 3/2011
Molecular Mechanics Study of Hydrogel-type Biopolymers at the Nanoscale

III National Meeting of Theoretical and Computational Chemists (III ENQTC) - San Gil, Santander, Colombia 4/2010
Electronic Response of Chemical Transducers Constituted by Carbon Nanotubes Functionalized with DNA Homopolynucleotides

XXXV Congress of Theoretical Chemists of Latin Expression (QUITEL 2009) - San Andrés Islas, Colombia 9/2009
Electronic Response of Chemical Transducers Constituted by Carbon Nanotubes Functionalized with DNA Homopolynucleotides

II National Meeting of Theoretical and Computational Chemists (II ENQTC) - Calarcá, Quindio, Colombia 4/2010
Computational Study of the Interactions between Carbon Nanotube/DNA Hybrids and Simple Molecules Relevant in Chemical Sensing

Participations

Cell Press LabLinks Meeting on Machine Learning in Material and Chemical Sciences at Harvard University 5/2018
Cambridge, MA, USA

PSI4 World Wide Developers Conference 2017 (PSI4 WWDC 2017) 11/2017
Blacksburg, VA, USA

7th Time-Dependent Density-Functional Theory: Prospects and Applications School and Workshop (7th TDDFT) 9/2016
Benasque, Aragón, Spain

2015 Computational Chemistry and Materials Science Summer Institute (CCMS 2015) 6/2015
Livermore, CA, USA

Sustainable Software Innovation Institute for Computational Chemistry and Materials Modeling ((SICM)^2) 7/2014
Stony Brook, NY, USA

II Colombian School on Theory and Computation in Molecular Sciences (II ECTCCM) 5/2014
Guatapé, Antioquia, Colombia

246th National Meeting & Exposition of the American Chemical Society (ACS 2013) 8/2013
Indianapolis, IN, USA

45th Midwest Theoretical Chemistry Conference (MWTCC 2013) 7/2013
Urbana-Champaign, IL, USA

IX International Seminar of Neuroscience 6/2012
Bogotá, D.C., Colombia

I Colombian School on Theory and Computation in Molecular Sciences (I ECTCCM) 5/2012
Cali, Valle del Cauca, Colombia

Outreach Education Programs and Initiatives

Interchange Program 2016 - West Lafayette, IN, USA 7/2016
Theoretical and Computational Chemistry Science Club

Clubes de Ciencia - Colombia 2015 - Puerto Triunfo, Antioquia, Colombia 10/2015
Computational Chemistry Science Club Designer and Instructor

Interchange Program 2015 - Medellín, Antioquia, Colombia 9/2015
Chemistry and Biology Instructor

Professional Affiliations

Member of the American Chemical Society (ACS) 7/2013 - Present

Member of the Colombian Student Association at Purdue University (CSAP) 7/2012 - Present

Member of the Professional Chemists Council of Colombia (CPQ) 2/2010 - Present
Professional Card No.: PQ-3170

Jesuit Alumni Association of Cali, Colombia (A.S.I.A. Santiago de Cali) 5/2004 - Present
Member of the Board (2008-2012)

Languages

Spanish:	Native speaker.	
English:	Fluently spoken and written.	*Live and work in the United States since 2012.*
Portuguese:	Intermediate proficiency.	

Computer Skills

Chemistry: LibEFP/EFPMD, GROMACS, NAMD, PSI4, Q-Chem, Octopus, GAMESS, HyperChem, Gaussian, MOPAC, NWChem, VMD, IQmol, GaussView, Gabedit, Avogadro, Molden, ChemBioOffice.

OS:	Linux | Ubuntu, Red Hat, SUSE, CentOS, Cygwin. Windows | 98, XP, Vista, 7, 8, 10.
Basic programing:	Python, HTML, C/C++.
Others:	LaTeX, gnuplot, GIMP, Git, Bash, Origin, Inkscape, Office, LibreOffice, Jupyter.

References

Prof. C. David Sherrill | *Postdoctoral Adviser* 8/2017 - Present
Professor - Department of Chemistry - Georgia Institute of Technology
Email: sherrill@gatech.edu | Office Phone: +1 (404) 894-7452

Prof. Lyudmila V. Slipchenko | *Doctoral Adviser* 8/2012 - Present
Associate Professor - Department of Chemistry - Purdue University
Email: lslipchenko@purdue.edu | Office Phone: +1 (765) 494-5255

Prof. Lynne S. Taylor | *Research Collaborator* 8/2014 - 5/2018
Retter Professor of Pharmacy - Department of Industrial and Physical Pharmacy - Purdue University
Email: lstaylor@purdue.edu | Office Phone: +1 (765) 496-6614

Prof. Adam Wasserman | *Committee Member* 8/2012 - 5/2017
Associate Professor - Department of Chemistry - Purdue University
Email: awasser@purdue.edu | Office Phone: +1 (765) 494-2348

Interests

- Computer repair and upgrade.
- LEGO®.
- Aircraft modeling and simulation.
- Automobile mechanics.