G. BARRATT PARK

Department of Chemistry and Biochemistry, Texas Tech University
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EDUCATION AND RESEARCH TRAINING

2018-21: **Max Planck Institute for Biophysical Chemistry**: Project Group Leader
- Design and construction of a surface science end station for collaborative German-Chinese research at the Dalian Coherent Light Source.
- Scattering well-defined atomic beams from surfaces.

2015-18 **Max Planck Institute for Biophysical Chemistry / University of Göttingen**: Post-doc
Advisor: Alec M. Wodtke
Projects:
- State-resolved scattering of polyatomic molecules from surfaces.
- Velocity-resolved reaction kinetics at stepped metal surfaces.

2015 **Massachusetts Institute of Technology**: Ph.D., Physical Chemistry
Advisor: Robert W. Field
Thesis Title: *Dynamically motivated spectroscopy of small polyatomic molecules*
Projects:
- Development of broadband chirped-pulse Fourier-transform millimeter-wave spectroscopy and multiplexed laser/millimeter-wave double resonance techniques.
- Millimeter-wave spectroscopy as a tool for studying chemical reaction dynamics and kinetics (collaboration with Arthur Suits group).
- Observation of large amplitude motion local bending eigenstates along the acetylene↔vinylidene reaction coordinate, guided by multidimensional vibronic intensity factor calculations.
- IR-UV double resonance spectroscopy on the $\tilde{C}$ state of SO_2. Spectroscopic characterization of vibronic coupling and identification of signatures arising from conical intersection with the $\tilde{D}$ state.

2006 **Davidson College**: B.S. Chemistry (Math Minor), Magna Cum Laude, Honors in Chemistry
Advisor: Merlyn D. Schuh
Honors Thesis Research: Stability and dynamics of guest-host complexes of α-cyclodextrin with alkoxy-substituted 2-bromonaphthalene derivatives.
Summer Undergraduate Research (2004), NIST, Gaithersburg, MD
Project Title: Shock tube investigation of the kinetics of the unimolecular pyrolysis reactions of 1,4-pentadiene. (Advisors: Wing Tsang, Jeffrey Manion)

PUBLICATIONS

1. J. Quan, R. Yin, Z. Zhao, X. Yang, A. Kandratsenka, D. J. Auerbach, A. M. Wodtke, H. Guo, G. B. Park. "Highly Rotationally Excited N_2 Reveals Transition-State Character in the Thermal Decomposition of N_2O on Pd(110)" *J. Am. Chem. Soc.*, in press (2023), https://doi.org/10.1021/jacs.3c01127.
2. Z. Zhao, Y. Wang, X. Yang, J. Quan, B. C. Krüger, P. Stoicescu, R. Nieman, D. J. Auerbach, A. M. Wodtke, H. Guo, G. B. Park. "Spin-dependent reactivity and spin-flipping dynamics in O atom scattering from Graphite" *Nature Chemistry*, published online (2023), https://doi.org/10.1038/s41557-023-01204-2.
3. D. Borodin, N. Hertl, G. B. Park, M. Schwarzer, J. Fingerhut, Y. Wang, J. Zuo, F. Nitz, G. Skoulatakis, A. Kandratsenka, D. J. Auerbach, D. Schwarzer, H. Guo, T. N. Kitsopoulos, A. M. Wodtke. "Quantum effects in thermal reaction rates at metal surfaces" *Science*, **377**, 394–398 (2022).
4. S. T. Ranecky, G. B. Park, P. C. Samartzis, I. C. Giannakidis, D. Schwarzer, A. Senftleben, T. Baumert, T. Schäfer. "Detecting chirality in mixtures using nanosecond photoelectron circular dichroism" *Phys. Chem. Chem. Phys.* **24**, 2758–2761, (2022).
5. J. Quan, Y. Chang Z. Li, Y. Zhao, Z. Luo, Y. Wu, S. Zhang, Z. Chen, J. Yang, K. Yuan, X. Yang, B. C. Krüger, D. Schwarzer, A. M. Wodtke, G. B. Park. "A free electron laser-based 1+1′ Resonance-Enhanced Multiphoton Ionization scheme for rotationally resolved detection of OH radicals with correct relative intensities" *J. Mol. Spectrosc.* **380**, 111509, (2021).
6. A. Kastner, G. Koumarianou, P. Glodic, P. C. Samartzis, N. Ladda, S. T. Ranecky, T. Ring, S. Vasudevan, C. Witte, H. Braun, H.-G. Lee, A. Senftleben, R. Berger, G. B. Park, T. Schäfer, T. Baumert. "High-resolution resonance-enhanced multiphoton photoelectron circular dichroism" *Phys. Chem. Chem. Phys.* **22**, 7404, (2020).
7. K. Prozument, J. H. Baraban, P. B. Changala, G. B. Park, R. G. Shaver, J. S. Muenter, S. J. Klippenstein, V. Y. Chernyak, R. W. Field. "Photodissociation transition states characterized by chirped pulse millimeter wave spectroscopy" *Proc. Natl. Acad. Sci. USA.* **117**, 146, (2020).
8. G. B. Park, T. N. Kitsopoulos, D. Borodin, K. Golibrzuch, J. Neugebohren, D. J. Auerbach, C. T. Campbell, A. M. Wodtke. "The kinetics of elementary thermal reactions in heterogeneous catalysis" *Nat. Rev. Chem.* **3**, 723, (2019).
9. G. B. Park, B. C. Krüger, D. Borodin, T. N. Kitsopoulos, A. M. Wodtke. "Fundamental mechanisms for molecular energy conversion and chemical reactions at surfaces" *Rep. Prog. Phys.* **82**, 096401, (2019).
10. B. C. Krüger, T. Schäfer, A. M. Wodtke, G. B. Park. "Quantum-state resolved lifetime of triplet ($\tilde{a}\ ^3A_2$) formaldehyde" *J. Mol. Spectrosc.* **362**, 61, (2019) Special Issue in Honor of Anthony Merer.
11. R. J. V. Wagner, B. C. Krüger, G. B. Park, M. Wallrabe, A. M. Wodtke, T. Schäfer. "Electron transfer mediates vibrational relaxation of CO in collisions with Ag(111)" *Phys. Chem. Chem. Phys.* **21,** 1650, (2018).†
12. R. J. V. Wagner, N. Henning, B. C. Krüger, G. B. Park, J. Altschäffel, A. Kandratsenka, A. M. Wodtke, T. Schäfer. "Vibrational relaxation of highly vibrationally excited CO scattered from Au(111): Evidence for CO^- formation" *J. Phys. Chem. Lett.* **8**, 4887, (2017).
13. G. B. Park, B. C. Krüger, S. Meyer, A. M. Wodtke, T. Schäfer. "An axis-specific rotational rainbow in the direct scatter of formaldehyde from Au(111) and its influence on trapping probability" *Phys. Chem. Chem. Phys.* **19**, 19904 ,(2017).†
14. B. C. Krüger, G. B. Park, S. Meyer, R. J. V. Wagner, A. M. Wodtke, T. Schäfer. "Trapping-desorption and direct scattering of formaldehyde at Au(111)" *Phys. Chem. Chem. Phys.* **19**, 19896, (2017).
15. A. Kastner, T. Ring, B. C. Krüger, G. B. Park, T. Schäfer, A. Senftleben, T. Baumert. "Intermediate state dependence of the photoelectron circular dichroism of fenchone observed via femtosecond

resonance-enhanced multi-photon ionization." *J. Chem. Phys.* **147**, 013926, (2017).

16. G. B. Park, B. C. Krüger, S. Meyer, A. M. Wodtke, T. Schäfer. "A 1+1′ resonance-enhanced multiphoton ionization scheme for rotationally state-selective detection of formaldehyde via the $\tilde{A}\ ^1A_2 \leftarrow \tilde{X}\ ^1A_1$ transition." *Phys. Chem. Chem. Phys.* **18**, 22355–22363, (2016).
17. G. B. Park, R. W. Field. "Perspective: The first ten years of broadband chirped pulse microwave spectroscopy." *J. Chem. Phys.* **144**, 200901, (2016).
18. G. B. Park, B. C. Krüger, S. Meyer, D. Schwarzer, T. Schäfer. "The ν_6 fundamental frequency of the $\tilde{A}$ state of formaldehyde and Coriolis perturbations in the $3\nu_4$ level." *J. Chem. Phys.* **144**, 194308 (2016).
19. G. B. Park, J. Jiang, C. A. Saladrigas, R. W. Field. "Observation of b_2 symmetry vibrational levels of the SO_2 $\tilde{C}\ ^1B_2$ state: Vibrational level staggering, Coriolis interactions, and rotation-vibration constants." *J. Chem. Phys.* **144**, 144311, (2016).
20. J. Jiang, G. B. Park, R. W. Field. "The rotation-vibration structure of the SO_2 $\tilde{C}\ ^1B_2$ state explained by a new internal coordinate force field." *J. Chem. Phys.* **144**, 144312, (2016).
21. G. B. Park, J. Jiang, R. W. Field. "The origin of unequal bond lengths in the $\tilde{C}\ ^1B_2$ state of SO_2: Signatures of high-lying potential energy surface crossings in the low-lying vibrational structure." *J. Chem. Phys.* **144**, 144313, (2016).
22. A. H. Steeves, G. B. Park, H. A. Bechtel, J. H. Baraban, R. W. Field. "Communication: Observation of local-bender eigenstates in acetylene." *J. Chem. Phys.* **143**, 071101, (2015).
23. G. B. Park, C. C. Womack, A. R. Whitehill, J. Jiang, S. Ono, R. W. Field. "Millimeter-wave optical double resonance schemes for rapid assignment of perturbed spectra, with applications to the $\tilde{C}\ ^1B_2$ state of SO_2." *J. Chem. Phys.* **142**, 144201, (2015).‡
24. G. B. Park, R. W. Field. "Edge effects in chirped-pulse Fourier transform microwave spectra." *J. Mol. Spectrosc.* **312**, 54, (2015).
25. G. B. Park, J. H. Baraban, A. H. Steeves, R. W. Field "Simplified Cartesian basis model for intrapolyad emission intensities in the bent-to-linear electronic transition of acetylene." *J. Phys. Chem. A* **119**, 857, (2015).
26. J. M. Oldham, C. Abeysekera, B. Joalland, L. N. Zack, K. Prozument, I. Sims, G. B. Park, R. W. Field, A. G. Suits "A chirped-pulse Fourier-transform microwave/pulsed uniform flow spectrometer: I. The low-temperature flow system." *J. Chem. Phys.* **141**, 1545202, (2014).
27. C. Abeysekera, L. N. Zack, G. B. Park, B. Joalland, J. M. Oldham, K. Prozument, N. M. Ariyasingha, I. R. Sims, R. W. Field, A. G. Suits. "A chirped-pulse Fourier-transform microwave/pulsed uniform flow spectrometer: II. Performance and applications for reaction dynamics." *J. Chem. Phys.* **141**, 214203, (2014).
28. G. B. Park. "Full dimensional Franck-Condon factors for the acetylene $\tilde{A}\ ^1A_u$—$\tilde{X}\ ^1\Sigma_g^+$ transition. I. Method for calculating polyatomic linear—bent vibrational intensity factors and evaluation of calculated intensities for the *gerade* vibrational modes in acetylene." *J. Chem. Phys.* **141**, 134304, (2014).
29. G. B. Park, J. H. Baraban, R. W. Field. "Full dimensional Franck-Condon factors for the acetylene $\tilde{A}\ ^1A_u$—$\tilde{X}\ ^1\Sigma_g^+$ transition. II. Vibrational overlap factors for levels involving excitation in *ungerade* modes." *J. Chem Phys.* **141**, 134305, (2014).
30. K. Prozument, G. B. Park, R. G. Shaver, A. K. Vasiliou, J. M. Oldham, D. E. David, J. S. Muenter, J. F. Stanton, A. G. Suits, G. B Ellison, R. W. Field. "Chirped-pulse millimeter-wave spectroscopy for dynamics and kinetics studies of pyrolysis reactions." *Phys. Chem. Chem. Phys.* **16**, 15739, (2014).
31. J. Jiang, J. H. Baraban, G. B. Park, M. L. Clark, R. W. Field. "Laser-Induced Fluorescence Study of the S_1 State of Doubly-Substituted ^{13}C Acetylene and Harmonic Force Field Determination." *J. Phys. Chem. A* **117**, 13696, (2013).
32. K. Prozument, R. G. Shaver, M. A. Ciuba, J. S. Muenter, G. B. Park, J. F. Stanton, H. Guo, B. M. Wong,

D. S. Perry, R. W. Field. "A new approach toward transition state spectroscopy." *Faraday Discuss.* **163**, 33, (2013).

33. K. Prozument, A. P. Colombo, Y. Zhou, G. B. Park, V. S. Petrovic, S. L. Coy, R. W. Field. "Chirped-Pulse Millimeter-Wave Spectroscopy of Rydberg-Rydberg Transitions." *Phys. Rev. Lett.* **107**, 143001, (2011).
34. G. B. Park, A. H. Steeves, K. Kuyanov-Prozument, J. L. Neill, R. W. Field. "Design and evaluation of a pulsed-jet chirped-pulse millimeter-wave spectrometer for the 70-102 GHz region." *J. Chem. Phys.* **135**, 024202, (2011).
35. G. B. Park, D. M. Brown, M. D. Schuh. "Binary and Ternary Complexes Containing α-Cyclodextrin and Bromonaphthalene Derivatives: A Note of Caution in Interpreting UV Absorption Spectral Data." *J. Phys. Chem. B* **110**, 22510-22516, (2006).

†Selected for the PCCP "Hot Topics" Collection.
‡JCP Editor's Choice Award

INVITED TALKS

Department Seminar, Department of Chemistry, University of Alabama at Birmingham, USA, September 22, 2022.

Special Seminar, Department of Chemistry and Biochemistry, Florida International University, Miami, FL, USA, February 16, 2021.

Dynamics (and Kinetics) of Atomic and Molecular Processes at Surfaces, Department of Chemistry, Emory University, Atlanta, GA, USA, February 9, 2021.

Highly sensitive probes for chiral molecules, Department of Cell Biology, Microbiology, and Molecular Biology, University of South Florida, Tampa, FL, USA, February 5, 2021.

Special Seminar, Department of Chemistry and Biochemistry, Texas Tech University, Lubbock, TX, USA, January 19, 2021

Special Seminar, Department of Chemistry and Biochemistry, Auburn University, Auburn, AL, USA, January 5, 2021.

Special Seminar, Department of Chemistry, University of South Florida, Tampa, FL, USA, December 14, 2020.

Special Seminar, Department of Chemistry, Washington University, Seattle, WA, USA, December 10, 2020.

Special Seminar, Paul Scherrer Institute, Villigen, Switzerland, November 26, 2020.

From (Rotational) Rainbows to the Stars, Chemistry Seminar, Middlebury College, Middlebury, VT, USA, November 9, 2020.

Chemistry Department Seminar, Union College, Schenectady, NY, USA, October 29, 2020.

Special Seminar, Technical University of Kaiserslautern, Department of Chemistry, Kaiserslautern, Germany, October 16, 2019.

A Surface Science End-Station for VUV-FEL Experiments, 3rd Sino-German Young Scientists Symposium on Structures and Dynamics at Surfaces, Dalian, China, September 17, 2019.

Special Seminar, Argonne National Laboratory, Gas Phase Chemical Dynamics, Lemont, Illinois, USA, June 10, 2019.

Surface Scattering at VUV Free Electron Lasers, Helmholtz-Zentrum Dresden-Rossendorf, Workshop on CW-VUV-FELs, May 2, 2019.

ULTRA Research Seminar Series, Department of Experimental Physics, University of Kassel, Germany, April 25, 2018.

Department of Chemistry Seminar, Ben-Gurion University of the Negev, Beer-Sheva, Israel, March 18, 2018.

Special Seminar, Department of Chemistry and Biochemistry, University of Vermont, Burlington, VT, USA, January 25, 2018.

Special Seminar, Stanford University Physical Chemistry, Palo Alto, CA, USA, January 10, 2018.

Mode- and Axis-Specific Mechanisms for Energy Exchange Between Polyatomic Molecules and Surfaces, Dalian Institute of Chemical Physics, Dalian, China, December 19, 2017.

Special Seminar, Department of Chemistry and Biochemistry, University of Oregon, Eugene, OR, USA, December 4, 2017.

Special Seminar, Department of Chemistry, Mississippi State University, Starkville, MS, USA, November 30, 2017.

Special Seminar, Department of Chemistry, Washington University, St. Louis, MO, USA, November 25, 2017.

Three Formaldehyde Stories, Molecular Physics Seminar, Center for Free-Electron Laser Science, DESY, Hamburg, Germany, November 16, 2017.

Three stories on the dynamics of molecules on surfaces and in the gas phase, Spectroscopy of Cold Molecules Department Seminar, University of Nijmegen, The Netherlands, July 26, 2017.

Rotationally resolved scattering of formaldehyde from Au(111), 2nd German-Chinese Young Scientist Symposium on Structure and Dynamics at Surfaces, June 1, 2017.

Scattering of Formaldehyde from Au(111), Conference Retreat on the Dynamics at Surfaces, Schloss Ringberg, Bavaria, Germany, May 19, 2016.

Princesses and Peas: Are subtle dynamical features far from the "chemically interesting" region of the PES keeping molecules awake at night? MIT Physical Chemistry Department Seminar, November 22, 2014.

Chirped-Pulse Millimeter-Wave (CPmmW) Spectroscopy: Design and Chemical Application, MIT Spectroscopy Lab Conference, January 15, 2009.

CONTRIBUTED CONFERENCE PRESENTATIONS (SELECTED)

Spin-dependent reactivity and spin-flipping dynamics in O atom scattering from graphite, Texas Section of the American Physical Society Meeting, Rice University, October 14, 2022.

A 1+1′ Resonance-Enhanced Multiphoton Ionization (REMPI) scheme for state-resolved molecular beam scattering of formaldehyde, 72nd International Symposium on Molecular Spectroscopy. Champaign-Urbana Illinois, June 20, 2017.

Coriolis perturbations in the $3\nu_3$ level of the $\tilde{A}$ state of formaldehdye, 72nd International Symposium on Molecular Spectroscopy. Champaign-Urbana Illinois, June 20, 2017.

Rotationally resolved scattering of formaldehyde from Au(111), 116th General Assembly of the Bunsen Society for Physical Chemistry, May 25, 2017.

Rotationally resolved scattering of formaldehyde from Au(111), International Conference on Molecular Energy Transfer. Innsbruck, Austria, Jan 16, 2017.

Princesses and Peas: IR-UV Spectroscopy of the b_2 vibrational levels in $\tilde{C}$ ($^1B_2$) SO_2, 62nd Pacific Conference on Spectroscopy and Dynamics. Pacific Grove, CA, January 29, 2015.

A potential energy surface behaving badly, International Symposium on Molecular Spectroscopy, Urbana-Champaign, IL, June, 2014.

Full-dimensional Franck-Condon factors for the acetylene $\tilde{A}\ ^1A_u$—$\tilde{X}\ ^1\Sigma_g^+$ transition in the harmonic normal mode basis, International Symposium on Molecular Spectroscopy, Urbana-Champaign, IL,

June, 2014.

Millimeter wave-optical multiplexed double resonance: Not your grandmother's MODR, International Symposium on Molecular Spectroscopy. Columbus, OH, June, 2013.

Evidence for Perturbations in Acetylene S_1 Levels from Stimulated Emission Pumping (SEP) Spectra, International Symposium on Molecular Spectroscopy, Columbus, OH, June 21, 2011.

Development of Chirped-Pulse Millimeter-Wave Spectroscopy: Application to photolysis reactions and pure electronic Rydberg-Rydberg transitions, APS National Meeting, Portland, OR, March 17, 2010.

Chirped-Pulse Millimeter-Wave (CPmmW) Spectroscopy: Design and Chemical Application, International Symposium on Molecular Spectroscopy, Columbus, OH, June 25, 2009.

DISTINCTIONS

Poster Prize, Gordon Conference on Dynamics at Surfaces, 2017
Alexander von Humboldt Research Fellow, 2015
Rao Prize, International Symposium on Molecular Spectroscopy, 2009
MIT Dept. of Chemistry Award for Outstanding Teaching by a Graduate Student, 2007
Phi Beta Kappa, 2006
National Science Foundation Graduate Research Fellow, 2006
Barry Goldwater Scholar, 2005
Alumni Award, Davidson College, 2003
National Merit Scholar, 2002

SERVICE ACTIVITIES

Steering Committee Fellow: 2018 Exploratory Round Table Conference (Max Planck Society)

Journal Referee:
RSC Advances
The Journal of Physical Chemistry Letters
The Journal of Physical Chemistry A
The Journal of Chemical Physics
Journal of Computational Chemistry
Proceedings of the Combustion Institute
Journal of Infrared, Millimeter and Terahertz Waves

LANGUAGES

English (native speaker)
German (advanced; proficient in scientific German)
Dutch (previously fluent)
French (reading, writing, intermediate conversational)
Matlab/C++ (can hold basic conversations)