
DR. CHRIS J. BENNETT

RESEARCH INTERESTS

PHYSICAL & ANALYTICAL CHEMISTRY:

- Development of novel ultra-high vacuum techniques and instrumentation · surface science · thin film preparation and characterization · ionization techniques; resonance enhanced multiphoton ionization (REMPI) and synchrotron radiation · kinetics · molecular beam generation · polymer chemistry · computational chemistry for the predication of molecular properties · interaction of charged particles and photons with matter · non-equilibrium chemistry · radical & excited state chemistry.

INSTRUMENTAL TECHNIQUES:

- FTIR spectroscopy · time-of-flight and quadrupole mass spectrometry · synchrotron photoionization · electron-, ion-, and photon-stimulated desorption · Raman spectroscopy · developing new Raman spectroscopy techniques, with biomedical applications · temperature programmed desorption · ToF-SIMS.

ASTROCHEMISTRY, ASTROBIOLOGY, AND PLANETARY SCIENCE:

- Participation in mission and instrument development (particularly Raman and time-of-flight mass spectrometers) · interaction of radiation with surfaces · space weathering of airless bodies · Kuiper belt objects · comets · icy satellites · Mercury · the Moon · chemistry in the interstellar medium · origin of amino acids, peptides, and sugars on the early Earth · origin of life.

EDUCATION

University of Hawai'i at Mānoa, Honolulu	Ph.D.	06/2007 - 05/2009	Physical Chemistry
<i>Dissertation: "An Experimental Investigation of the Effects of Irradiation on Carbon- and Oxygen-bearing Species in Interstellar Ices"</i>		<i>Advisor: Prof. Ralf I. Kaiser</i>	
University of Hawai'i at Mānoa, Honolulu	M.Sc.	08/2002 - 05/2007	Physical Chemistry
University of York, Yorkshire (England)	M.Chem.	08/1998 - 06/2002	Chemistry

PROFESSIONAL EXPERIENCE

- 2015-Present Research Scientist, Department of Chemistry & Biochemistry, Georgia Institute of Technology, Atlanta, GA
- 2012-2014 Postdoctoral Fellow, Department of Chemistry & Biochemistry, Georgia Institute of Technology, Atlanta, GA
- 2014-Present Consultant: Spectroscopy for Planetary ICes Environments (SPICE) Laboratory, NASA Goddard Space Flight Center, Greenbelt, DC
- 2015 Visiting Scientist, Jet Propulsion Laboratory, Pasadena, CA
- 2012 General Chemistry Lecturer, Department of Chemistry, University of Hawai'i at Mānoa, Honolulu, HI
- 2010 Visiting Scientist, Advanced Light Source, University of California, Berkeley, CA
- 2009-2012 Postdoctoral Fellow, NASA Astrobiology Institute, Institute for Astronomy, Honolulu, HI
- 2009 Visiting Scientist, Hefei Light Source, Hefei, Anhui (*China*)
- 2009 Visiting Scientist, Institute de Physique de Rennes, University of Rennes-1, Rennes (*France*)
- 2002-2009 Graduate Student Researcher / Teaching Assistant, Department of Chemistry, University of Hawai'i at Mānoa, Honolulu, HI
- 1999 Research assistant with Dr. David Rudd, GlaxoSmithKline, Hertfordshire (*England*)

HONORS & AWARDS

- NASA Cooperative agreement (2015) NNX15AG81A, “*Laboratory Investigations of Interstellar/Planetary/Cometary Ice Analogs*”, NASA Goddard Spaceflight Center
- Young Investigator Award (2010), Gordon Research Conference on Radiation Chemistry
- Outstanding Teaching Assistant Award (2005), ACS, University of Hawai‘i at Mānoa
- Research Assistant Fellowship (2004), NASA Astrobiology Institute, Institute for Astronomy
- Graduate Student Scholarship (2002), University of Hawai‘i at Mānoa

RECENT WORKSHOPS & SUMMER SCHOOLS ATTENDED

- NASA’s 26th Annual “Planetary Science Summer School” (PSSS), held at the Jet Propulsion Laboratory, Pasadena, California (Session II; July 14th-18th 2014).
- “Linear and Non-linear Raman Spectroscopy in the Single Molecule Limit”, Center for Chemistry at the Space-Time Limit (CASTL), University of California, Irvine, July 9th-12th 2014.

TEACHING & MENTORING

LECTURER

Department of Chemistry, University of Hawai‘i at Mānoa, Honolulu, HI

- 2012, Summer (1 section) CHEM 151 General Chemistry

TEACHING ASSISTANT

Department of Chemistry, University of Hawai‘i at Mānoa, Honolulu, HI

- 2006 (2 sections) CHEM 161L General Chemistry Laboratory I
- 2005, 2006 (4 sections) CHEM 162L General Chemistry Laboratory II
- 2006 (2 sections) CHEM 272L Organic Chemistry Laboratory I
- 2002, 2003, 2006 (6 sections) CHEM 333L Instrumental Analysis Laboratory
- 2003, 2004, 2007 (6 sections) CHEM 352L Physico-Chemical Measurements Laboratory

INVITED LECTURES & PUBLIC OUTREACH

INVITED LECTURES

- **Chris J. Bennett**, “*Radiation Chemistry from the Interstellar Medium to the Solar System*”, Solar System Exploration Seminar Series, NASA/Goddard Space Center (10/1/2014)
- **Chris J. Bennett**, “*Space Weathering of Solar System Bodies Leading to the Chemical Alteration of Surfaces and the Generation of Exospheres*”, Planetary Science Seminar, Georgia Institute of Technology (11/09/2014) and Department of Physics and Astronomy, Clemson University, SC (04/17/2015)
- Astrobiology Seminar Series, NASA Astrobiology Institute, University of Hawai‘i at Mānoa (2009-2012)

PUBLIC OUTREACH

- Presentations, demonstrations, and tours for ‘open house’, Institute for Astronomy (2004, 2008-2012)
- Instructor at the Ali‘i National Summer Teacher Workshop, Institute for Astronomy (2004)
- Remote participant in the 2014 ACCESS/DST “Habitable Planet” program, Cape Town, Africa (2014)

PROFESSIONAL AFFILIATIONS & SERVICE

ARTICLE REVIEWER:

- Icarus, Physical Chemistry Chemical Physics, Journal of Geophysical Research (JGR) – Space Physics, JGR – Planets, , Monthly Notices of the Royal Astronomical Society, Chemical Society Reviews, Journal of Physics and Chemistry of Solids, International Journal of Environmental Analytical Chemistry, and Astrophysical Journal Letters.

REVIEW PANEL PARTICIPANT:

- Planetary Astronomy (PAST), Emerging Worlds (EW), Solar Systems Workings (SSW), and Cassini Data Analysis Program (CDAP) under the NASA ROSES programs.

PROFESSIONAL MEMBERSHIPS:

- American Chemical Society (since 2011), the Planetary Society (since 2014), and the American Geophysical Union (since 2014).

CONFERENCE ORGANIZATION/PARTICIPATION:

- Discussion Leader, “*Connecting Life’s Building Blocks: The Challenges of Biopolymers*”, Gordon Research Conference on the Origin of Life, Galveston, TX (upcoming; Jan 17th - 22nd, 2016).

INTERNATIONAL CONFERENCE PRESENTATIONS

- C.J. Bennett**, “*Connecting Life’s Building Blocks: The Challenges of Biopolymers*”, Gordon Research Conference on the Origin of Life, Galveston, TX, January 17-22 (2016) [**discussion leader**]
- C.J. Bennett**, M. J., Poston, J. L. McLain, T. M. Orlando, “*The generation of surface-bound exospheres via Electron-Stimulated Desorption (and Related Phenomena): Results from Apollo samples and Hermian Regolith Simulants*”, AGU Fall, San Francisco, CA, December 15-19 (2014) [**poster**]
- Jensema, R. J.; Arias-Young, T. M.; Wilkins, A. N.; Ermakov, A.; **Bennett, C.**; Dietrich, A.; Hemingway, D.; Klein, V.; Mane, P.; Marr, K. D.; Masterson, J.; Siegel, V.; Stober, K. J.; Talpe, M.; Vines, S. K.; Wetteland, C. J. “*Core to Atmosphere Exploration of Ice Giants: A Uranus Mission Concept Study*”, AGU Fall, San Francisco, CA, December 15-19 (2014) [**poster**]
- C.J. Bennett**, M. J. Poston, A. J. DeSimone, T.M. Orlando, “*Space Weathering Processes throughout the Inner and Outer Solar System*”, DIET14, Pacific Grove, CA, October 13-17 (2014) [**oral, invited**]
- C.J. Bennett**, B. M. Jones, X. Gu, R. I. Kaiser, “*Interaction of Charged Particles with Kuiper Belt Ices and Astrobiological Implications*”, 243rd ACS National Meeting, San Diego, March 25-29 (2012) [**oral**]
- C. J. Bennett**, C. Ennis, B. M. Jones, R. I. Kaiser, “*Interaction of Charged Particles with Kuiper Belt Ices*”, PacifiChem 2010, Honolulu, HI, December 15-20 (2010) [**oral**]
- C. J. Bennett**, Y. S. Kim., C. Ennis, B. M. Jones, T. N. Chiesl, A. M. Stockton, R. A. Mathies, R. I. Kaiser, “*The Formation of Astrobiologically Important Molecules on Kuiper Belt Objects*”, Gordon Research Conference on Radiation Chemistry, Andover, NH, July 18-23 (2010) [**poster**]
- C. J. Bennett**, C. Ennis, B. M. Jones, R. I. Kaiser, “*Towards the Formation of Water in Lunar Silicates by Solar Radiation*”, AbSciCon 2010, League City, Texas, April 26-29 (2010) [**poster**]
- C. J. Bennett**, C. S. Jamieson, M. D. Lebar, Y. Osamura, A. M. Mebel, R. I. Kaiser, “*A Combined Experimental and Theoretical Study on the Charged Particle Processing of Low Temperature Ices*”, Proceedings of the 231st IAU Symposium, Pacific Grove, CA, August 29-Sept. 2 (2005) [**poster**]
- C. J. Bennett**, M. Lebar, C. S. Jamieson, R. I. Kaiser, “*Design and Operation of a Quadruply Pumped Extreme Ultra-High Vacuum Machine to Study the Formation of Astrobiologically Relevant Molecules in Extraterrestrial Ices*”, AbSciCon 2004, NASA Ames, CA, March 28-April 1 (2004) [**poster**]

PEER-REVIEWED PUBLICATIONS [**H-INDEX ~16**]

- C.J. Bennett**, J. L. McLain, M. Sarantos, R. D. Gann, A. DeSimone, T. M. Orlando, “Potential Contributions to Mercury’s Exospheric Calcium and the Loss of Hollows Surface Material: Photon-Stimulated Desorption of Calcium Neutrals from Calcium Sulfide”, *Journal of Geophysical Research: Planets*, 121, 137 (2016)
- C.J. Bennett**, C. P. Ennis, R. I. Kaiser, “Implantation of Energetic D⁺ Ions into Carbon Dioxide Ices and Implications to our Solar System: Formation of D₂O and D₂CO₃”, *the Astrophysical Journal*, 794, 57 (2014)
- C.J. Bennett**, C. P. Ennis, R. I. Kaiser, Experimental Studies on the Formation of D₂O and D₂O₂ by Implantation of Energetic D⁺ Ions into Oxygen Ices. *The Astrophysical Journal*, 782, 63 (2014)
- C.J. Bennett**, C. Pirim, T. M. Orlando, “Space Weathering of Solar System Bodies – A Laboratory Perspective”, *Chemical Reviews*, 113(12), 9086 (2013)

- 31. C.J. Bennett**, S. J. Brotton, B. M. Jones, A. K. Misra, S. K. Sharma, R. I. Kaiser, "High-Sensitivity Raman Spectrometer to Study Pristine and Irradiated Interstellar Ice Analogs", *Analytical Chemistry*, 85(12), 5659 (2013)
- 30. S.B. Morales, C.J. Bennett**, S.D. Le Picard, A. Canosa, I.R. Sims, B.J. Sun, P.H. Chen, A.H.H. Chang, V.V. Kislov, A.M. Mebel, X. Gu, F. Zhang, P. Maksyutenko, R.I. Kaiser, "A Crossed Molecular Beam, Low-Temperature Kinetics, and Theoretical Investigation of the Reaction of the Cyano Radical (CN) with 1,3-Butadiene (C₄H₆). A Route to Complex Nitrogen-Bearing Molecules in Low-Temperature Extraterrestrial Environments", *the Astrophysical Journal*, 742, 26 (2011)
- 29. B. M. Jones, C.J. Bennett**, C.S. R.I. Kaiser, "Mechanistical studies on the Production of Formamide (H₂NCHO) within Interstellar Ice Analogs", *the Astrophysical Journal*, 734:78, 1 (2011)
- 28. C. P. Ennis, C.J. Bennett**, B.M. Jones, R.I. Kaiser, "Formation of D₂-water and D₂-carbonic Acid in Oxygen-Rich Solar System Ices via D₂⁺ Irradiation", *the Astrophysical Journal*, 733:79, 1-11 (2011)
- 27. C.P. Ennis, C.J. Bennett**, R.I. Kaiser, "On The Formation of Ozone in Oxygen-rich Solar System Ices via Ionizing Radiation", *Physical Chemistry Chemical Physics*, 13, 9469 (2011)
- 26. N. L. Evans, S. Ullrich, C.J. Bennett**, R.I. Kaiser, "On the Interaction of Adenine with Ionizing Radiation at 10 K: Mechanistical Studies and Astrobiological Significance", *the Astrophysical Journal*, 730:69, 1 (2011)
- 25. Quinto-Hernandez, A. M. Wodtke, C.J. Bennett**, Y.S. Kim, R.I. Kaiser, "On the Interaction of Methyl Azide (CH₃N₃) Ices with Ionizing Radiation: Formation of Methanimine (CH₂NH), Hydrogen Cyanide (HCN), and Hydrogen Isocyanide (HNC)", *Journal of Physical Chemistry A*, 115, 250 (2010)
- 24. C.J. Bennett**, T. Hama, Y.S. Kim, M. Kawasaki, R.I. Kaiser, "Laboratory Studies on the Formation of Formic Acid (HCOOH) in Interstellar and Cometary Ices", *the Astrophysical Journal*, 727, 27 (2010)
- 23. C.J. Bennett**, B.M. Jones, E. Knox, J. Perry, Y.S. Kim, R.I. Kaiser, "Mechanistical Studies on the formation and Nature of the XCN (OCN⁻) Species", *the Astrophysical Journal*, 723, 641 (2010)
- 22. J. He, K. Gao, G. Vidali, C.J. Bennett**, R.I. Kaiser, "Formation of Molecular Hydrogen from Methane Ice", *the Astrophysical Journal*, 721, 1656 (2010)
- 21. C.J. Bennett**, S.B. Morales, S.D. Le Picard, A. Canosa, I.R. Sims, Y.H. Shih, A.H.H. Chang, X. Gu, F. Zhang, R.I. Kaiser, "A Chemical Dynamics, Kinetics, and Theoretical Study on the Reaction of the Cyano Radical (CN; X²Σ⁺) with Phenylacetylene (C₆H₄CCH; X¹A₁)", *Physical Chemistry Chemical Physics*, 12, 8737 (2010)
- 20. C.J. Bennett**, C.S. Jamieson, R.I. Kaiser, "Mechanistical studies on the formation and destruction of carbon monoxide (CO), carbon dioxide (CO₂), and carbon trioxide (CO₃) in interstellar ice analog samples", *Physical Chemistry Chemical Physics*, 12(16), 4032 (2010)
- 19. Y.S. Kim, C.J. Bennett**, L.-H. Chen, K. O'Brien, R. I. Kaiser, "Laboratory studies on the irradiation of solid ethane analog ices and implications to Titan's chemistry", *the Astrophysical Journal*, 711 (2, Pt. 1), 744 (2010)
- 18. C.J. Bennett**, C.S. Jamieson, R.I. Kaiser, "An experimental investigation of the decomposition of carbon monoxide and formation routes to carbon dioxide in interstellar ices", *Astrophysical Journal Supplement Series*, 182(1), 1 (2009)
- 17. C.J. Bennett**, C.S. Jamieson, R.I. Kaiser, "Mechanistical studies on the formation of carbon dioxide in extraterrestrial carbon monoxide ice analog samples", *Physical Chemistry Chemical Physics*, 11(21), 4210 (2009)
- 16. C.J. Bennett**, C.S. Jamieson, R.I. Kaiser, "Mechanistical Studies on the Decomposition of Carbon Suboxide in a Cometary Ice Analogue", *Planetary and Space Science*, 56, 1181 (2008)
- 15. C.J. Bennett**, R.I. Kaiser, "On the Formation of Glycolaldehyde (HCOCH₂OH) and Methyl Formate (HCOOCH₃) in Interstellar Ice Analogs", *the Astrophysical Journal*, 661, 899 (2007)
- 14. C.J. Bennett**, S.H.Chen, B.J.Sun, A.H.H. Chang, R.I. Kaiser, "Mechanistical Studies on the Irradiation of Methanol in Extraterrestrial Ices", *the Astrophysical Journal*. 660, 1588 (2007)

13. **C.J. Bennett**, R.I. Kaiser, "The Formation of Acetic Acid (CH_3COOH) in Interstellar Ice Analogs", *the Astrophysical Journal*, 660, 1289 (2007)
12. C.S. Jamieson, Y. Guo, X. Gu, F. Zhang, **C.J. Bennett**, R.I. Kaiser, "Laboratory Studies on the Formation of Carbon-Bearing Molecules in Extraterrestrial Environments – From the Gas Phase to the Solid State", *Proceedings of the NASA Laboratory Astrophysics Workshop; NASA Special Issue, CP – 2006- 214549*, 68-71 (2006)
11. **C.J. Bennett**, C.S. Jamieson, Y. Osamura, R.I. Kaiser, "Laboratory studies on the irradiation of methane in interstellar, cometary, and solar system ices", *the Astrophysical Journal*, 653, 792 (2006)
10. **C.J. Bennett**, R.I. Kaiser, "Laboratory studies on the formation of ozone (O_3) on icy satellites and on interstellar and cometary ices", *the Astrophysical Journal*, 635(2, Pt. 1), 1362 (2005)
9. **C.J. Bennett**, Y. Osamura, M.D. Lebar, R.I. Kaiser, "Laboratory studies on the formation of three $\text{C}_2\text{H}_4\text{O}$ isomers- acetaldehyde (CH_3CHO), ethylene oxide ($\text{C}_2\text{H}_4\text{O}$), and vinyl alcohol (CH_2CHOH) in interstellar and cometary ices", *the Astrophysical Journal*, 634, 698 (2005)
8. D.S. Sillars, **C.J. Bennett**, Y. Osamura, R.I. Kaiser, "Infrared spectroscopic detection of the methylsilyl (CH_3SiH_2 , X^2A') and the silylmethyl (CH_2SiH_3 , X^2A') radicals and their partially deuterated counterparts in low temperature matrices", *Chemical Physics*, 315, 41 (2005)
7. P.D. Holtom, **C.J. Bennett**, Y. Osamura, N.J. Mason, R.I. Kaiser, "A Combined Experimental and Theoretical Study on the Formation of the Amino Acid Glycine ($\text{NH}_2\text{CH}_2\text{COOH}$) and its Isomer (CH_3NHCOOH) in Extraterrestrial Ices", *the Astrophysical Journal*, 626, 940 (2005)
6. **C.J. Bennett**, C.S. Jamieson, Y. Osamura, R.I. Kaiser, "A combined experimental and computational investigation on the synthesis of acetaldehyde ($\text{CH}_3\text{CHO}(X^1A')$) in interstellar ices", *the Astrophysical Journal*, 624, 1097 (2005)
5. C.S. Jamieson, **C.J. Bennett**, A.M. Mebel, R.I. Kaiser, "Investigating the mechanism for the formation of nitrous oxide ($\text{N}_2\text{O}(X^1\Sigma^+)$) in extraterrestrial ices", *the Astrophysical Journal*, 624, 436 (2005)
4. **C.J. Bennett**, D. Sillars, Y. Osamura, R.I. Kaiser, "Infrared spectroscopic identification of the methylsilylydyne (SiCH_3 , X^2A'') and the silenyl (H_2CSiH , X^2A') radicals in methane-silane matrices", *Chemical Physics Letters*, 404, 327 (2005)
3. D. Sillars, **C.J. Bennett**, Y. Osamura, R.I. Kaiser, "First infrared spectroscopic characterization of the disilyl (Si_2H_5) and d5-disilyl (Si_2D_5) radicals in low temperature silane matrices", *Chemical Physics*, 305, 141 (2004)
2. D. Sillars, **C.J. Bennett**, Y. Osamura, R.I. Kaiser, "Infrared spectroscopic detection of the disilenyl (Si_2H_3) and d3-disilenyl (Si_2D_3) radicals in silane and d4-silane matrices", *Chemical Physics Letters*, 392, 541 (2004)
1. **C.J. Bennett**, C. Jamieson, A.M. Mebel, R.I. Kaiser, "Untangling the formation of the cyclic carbon trioxide isomer in low temperature carbon dioxide ices", *Physical Chemistry Chemical Physics*, 6, 735 (2004)