Matthew F. Cain, Ph.D.

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Professional Appointments

8/20-Present	Associate Professor of Chemistry, University of Hawai‘i at Mānoa, Honolulu, HI.
7/14-7/20	Assistant Professor of Chemistry, University of Hawai‘i at Mānoa, Honolulu, HI.
1/12-5/14	Postdoctoral Researcher, Massachusetts Institute of Technology, Cambridge, MA. Research Advisor: Professor Richard R. Schrock Project: Synthesis of New TREN ligands for Mo-Catalyzed Dinitrogen Reduction

Education

7/07-12/11	Ph.D., Chemistry, Dartmouth College, Hanover, NH. Research Advisor: Professor David S. Glueck. Thesis: Cu(I)-Catalyzed P-C Bond Formation and the Synthesis of C_3- and C_1-Symmetric P-Stereogenic Triphosphine Ligands. Diploma formally received at June 2012 Commencement.
8/03-5/07	B.S. Chemistry: American Chemical Society Certified, *Magna Cum Laude*, State University of New York College at Geneseo, Geneseo, NY. Research Advisor: Professor David K. Geiger

Awards and Honors

2020	New Talent: Americas (RSC, *Dalton Transactions*)
2019	NSF CAREER Award Winner
2018	Nominated for 2018 Excellence in Teaching Award, College of Natural Sciences, University of Hawai‘i at Mānoa
2012	Hannah Croasdale Award (for academic excellence, all disciplines, Dartmouth College)
2011	ACS Division of Inorganic Chemistry Travel Award
2011	Reaxys PhD Prize Finalist
2010-2011	Department of Education Graduate Assistance in Areas of National Need (GAANN) Fellowship
2010	Selected for CENTC Summer School, “Emerging Perspectives in Catalysis”
2007	Phi Beta Kappa (National Honor Society)
2007	Gamma Sigma Epsilon (Chemistry Honor Society)
2006-2007	American Chemical Society’s Chemistry Achievement Award (Rochester, NY Section)

Awarded Research Support

From Major Funding Agencies

2022	American Chemical Society – Petroleum Research Fund (ACS-PRF), PI: Matthew F. Cain, 2 years / $110,000 “Limitations with Carbenes, Solved with Phospheniums for the Oxidative Addition of Small Molecules and Functionalization of Petroleum Relevant Substrates”
2019	NSF CAREER Award, PI: Matthew F. Cain, 5 years / $675,000 “Roadmaps for Developing Hypervalent Phosphorus-Based Main Group Catalysts and Bridging Gaps in STEM Education in Hawaii”

From Internal Sources or for Outreach Purposes

2021 American Chemical Society, PI: Matthew F. Cain, $1000
"Building a Virtual Component into ChemClub Outreach"

2019-2021 Undergraduate Research Opportunities Program (UROP), University of Hawai'i at Mānoa, PI: Matthew F. Cain, ~$5000/each
Researcher: Jazmyne Guittap (2021): "Do Benzazaphospholes Behave as Aromatics? Potential Supporting Ligands to Enhance Catalysis"
Researcher: Celeste Guiles (2020): "New Phosphorus-Based Transmetalating Agents"
Researcher: Cyrus Ma (2019): "Synthesis of a Mes-Substituted 1,2-Benzoazaphosphole as a Potential Transfer Hydrogenation Candidate"

Publications

As an Independent Researcher

18. Chinen, B.L.; Hyvl, J.; Brayton, D.F.; Riek, M.M.; Yoshida, W.Y.; Chapp, T.W.; Rheingold, A.L.; Cain, M.F. Trimerization and Cyclization of Reactive P-Functionalities Confined Within OCO Pincers. *RSC Adv.* **2021**, *11*, 28602-28613. DOI: 10.1039/d1ra05926b

17. Zhou, D.Y.; Miura-Akagi, P.M.; McCarty, S.M.; Guiles, C.H.; O'Donnell, T.J.; Yoshida, W.Y.; Krause, C.E.; Rheingold, A.L.; Hughes, R.P.; Cain, M.F. P-Alkynyl Functionalized Benzazaphospholes as Transmetalating Agents. *Dalton Trans.* **2021**, *50*, 599-611. DOI: 10.1039/D0DT01367F (special issue on New Talent: Americas, 2020).

16. Cain, M.F. 1,2-(Benz)Azaphospholes: A Slow Beginning to a Bright Future. *Comments on Inorganic Chemistry* **2020**, *40*, 25-51.

15. Nakashige, M.L.; Loristo, J.I.P.; Wong, L.S.; Gurr, J.R.; O'Donnell, T.J.; Yoshida, W.Y.; Rheingold, A.L.; Hughes, R.P.; Cain, M.F. *E*-Selective Synthesis and Coordination Chemistry of Pyridine-Phosphaalkenes: Five Ligands Produce Four Distinct Types of Ru(II) Complexes. *Organometallics* **2019**, *38*, 3338-3348.

14. Kremláček, V.; Hyvl, J.; Yoshida, W.Y.; Růžička, A.; Rheingold, A.L.; Turek, J.; Hughes, R.P.; Dostál, L.; Cain, M.F. Heterocycles Derived from Generating Monovalent Pnictogens within NCN Pincers and Bidentate NC Chelates: Hypervalency vs. Bell-Clappers vs. Static Aromatics. *Organometallics* **2018**, *37*, 2481-2490.

13. Hyvl, J.; Yoshida, W.Y.; Moore, C.E.; Rheingold, A.L.; Cain, M.F. Unexpected Detours and Reactivity Encountered During the Planned Synthesis of Hypervalent 10–Pn–3 Species (Pn = P or As). *Polyhedron* **2018**, *143*, 99-104 (special issue on pincer ligands).

12. Hyvl, J.; Yoshida, W.Y.; Rheingold, A.L.; Hughes, R.P.; Cain, M.F. A Masked Phosphinidene Trapped in a Fluxional NCN Pincer. *Chem. Eur. J.* **2016**, *22*, 17562-17565.

11. Miura-Akagi, P.M.; Nakashige, M.L.; Maile, C.K.; Oshiro, S.M.; Gurr, J.R.; Yoshida, W.Y.; Royappa, A.T.; Krause, C.E.; Rheingold, A.L.; Hughes, R.P.; Cain, M.F. Synthesis of a Tris(phosphaalkene)phosphine Ligand and Fundamental Organometallic Reactions on Its Sterically Shielded Metal Complexes. *Organometallics* **2016**, *35*, 2224-2231. This article was highlighted in the July 18, 2016 issue of Chemical & Engineering News.

10. Magnuson, K.W.; Oshiro, S.M.; Gurr, J.R.; Yoshida, W.Y.; Gembicky, M.; Rheingold, A.L.; Hughes, R.P.; Cain, M.F. Streamlined Preparation and Coordination Chemistry of Hybrid Phosphine-Phosphaalkene Ligands. *Organometallics* **2016**, *35*, 855-859.

As a Postdoctoral/Graduate Researcher

9. Gibbons, S.K.; Valleau, C.R.D.; Peltier, J.L.; Cain, M.F.; Hughes, R.P.; Glueck, D.S.; Golen, J.A.; Rheingold, A.L. Diastereoselective Coordination of P-Stereogenic Secondary Phosphines in Copper(I) Chiral Bis(phosphine) Complexes: Structure, Dynamics, and Generation of Phosphido Complexes. *Inorg. Chem.* **2019**, *58*, 8854-8865.

8. Xu, Z.; Cain, M.F.; Rupert, A.V.; Glueck, D.S.; Golen, J.A.; Rheingold, A.L. Selective Formation of a C_3-Symmetric P-Stereogenic Tris(phosphine) via Platinum-Catalyzed Asymmetric Alkylation of a Tris(Secondary Phosphine). *Tetrahedron: Asymmetry* **2015**, *26*, 1459-1468.

7. Emerson, E.W.; Cain, M.F.; Sanderson, M.D.; Knarr, C.B.; Glueck, D.S.; Ahern, J.C.; Patterson, H.E.; Rheingold, A.L. Synthesis, Structure, and Luminescence of the "Octahedral" Cluster Cu_4I_4(*rac*-IsMePCH$_2$PMeIs)$_2$ (Is = 2,4,6-(*i*-Pr)$_3$C$_6$H$_2$). *Inorg. Chim. Acta* **2015**, *427*, 168-172.

6. Cain, M.F.; Forrest, W.P.; Peryshkov, D.V.; Schrock, R.R.; Müller, P. Synthesis of a TREN in Which the Aryl Substituents are Part of a 45 Atom Macrocycle. *J. Am. Chem. Soc.* **2013**, *135*, 15338-15341.

5. Cain, M.F.; Glueck, D.S.; Golen, J.A.; Rheingold, A.L. Asymmetric Synthesis and Metal Complexes of a C_3-Symmetric P-Stereogenic Triphosphine, (*R*)-MeSi(CH$_2$PMe(*t*-Bu))$_3$ (MT-Siliphos). *Organometallics* **2012**, *31*, 775-778.

4. Cain, M.F.; Reynolds, S.C.; Anderson, B.J.; Glueck, D.S.; Golen, J.A.; Moore, C.E.; Rheingold, A.L. Synthesis, Structure and Spectroscopic Properties of 2,3-bis(diphenylphosphino)quinoxaline (dppQx) and Its Copper(I) Complexes. *Inorg. Chim. Acta* **2011**, *369*, 55-61 (special issue in honor of Robert G. Bergman).

3. Seibert, A.R.; Cain, M.F.; Glueck, D.S.; Nataro, C. Electrochemistry of P(CH$_2$Fc)$_3$ and Derivatives. *J. Organomet. Chem.* **2011**, *696*, 2259-2262.

2. Cain, M.F.; Hughes, R.P.; Glueck, D.S.; Golen, J.A.; Moore, C.E.; Rheingold, A.L. Synthesis and Structure of Intermediates in Copper-Catalyzed Alkylation of Diphenylphosphine. *Inorg. Chem.* **2010**, *49*, 7650-7662 (cover picture).

1. Pet, M.A.; Cain, M.F.; Hughes, R.P.; Glueck, D.S.; Golen, J.A.; Rheingold, A.L. Synthesis and Structure of Ferrocenylmethylphosphines, Their Borane Adducts, and Some Related Derivatives. *J. Organomet. Chem.* **2009**, *694*, 2279-2289.

Invited Lectures

As an Independent Researcher

9. "Progress toward Isolable 10–P–3 Species: A Long Detour into New PN Heterocycles" Department of Chemistry – Ångström Laboratories, Uppsala University, Uppsala, Sweden, May 26, 2021 via Zoom.

8. "Progress toward Isolable 10–P–3 Species: A Long Detour into New PN Heterocycles" Department of Chemistry, Case Western Reserve University, Cleveland, OH, April 1, 2021 via Zoom.

7. "Progress toward Isolable 10–P–3 Species: A Long Detour into New PN Heterocycles" Department of Chemistry and Biochemistry, Texas Tech University, Lubbock, TX, October 28, 2020 via Zoom.

6. "1,2-Benzazaphospholes as Transition Metal Surrogates" Department of Chemistry, University of Idaho, Moscow, ID, October 29, 2019.

5. "1,2-Benzazaphospholes as Transition Metal Surrogates" Department of Chemistry, Washington State University, Pullman, WA, October 28, 2019.

4. "1,2-Benzazaphospholes as Transition Metal Surrogates" Department of Chemistry and Biochemistry, University of Oregon, Eugene, OR, October 25, 2019.

3. "All Things P: New Investigations into Multidentate, Non-Innocent, and/or Chiral Phosphine- and Phosphaalkene-Based Ligands" American Chemical Society - Hawai'i Chapter, Kapi'olani Community College, Honolulu, HI, November 2014 (Keynote Speaker).

As a Postdoctoral Researcher

2. "Synthesis and Development of New Multidentate Ligands for Challenging Catalytic Processes" Department of Chemistry, University of New Hampshire at Durham, Durham, NH, December 2013 (Junior Faculty Candidate Seminar).

1. "Synthesis and Development of New Multidentate Ligands for Challenging Catalytic Processes" Department of Chemistry, University of Hawai'i at Mānoa, Honolulu, HI, December 2013 (Junior Faculty Candidate Seminar).

Contributed Presentations

As an Independent Researcher

17. Oral: Cain, M.F.; Zhou, D.Y.; Miura-Akagi, P.M. 2021 International Chemical Congress of Pacific Basin Societies, Pacifichem 2021 (Virtual), Honolulu, HI, December 16-21, **2021**. P-Alkynyl Functionalized Benzazaphospholes as Transmetalating Agents.

16. Poster: Cain, M.F.; Hyvl, J.; Riek, M.M.; Chinen, B.L.; Rheingold, A.L. 2021 International Chemical Congress of Pacific Basin Societies, Pacifichem 2021 (Virtual), Honolulu, HI, December 16-21, **2021**. Progress toward Stabilizing 10–P–3 Species Utilizing NCN and OCO Pincers.

15. Poster: Cain, M.F. Gordon Research Conference: Organometallic Chemistry, Newport, RI, July 7-12, **2019**. 1,2-Benzoazaphospholes as Transition Metal Surrogates.

14. Oral: Cain, M.F. The 13th International Conference on Heteroatom Chemistry (ICHAC 2019), Prague, Czech Republic, June 30-July 5, **2019**. 1,2-Benzoazaphospholes as Transition Metal Surrogates.

13. Oral: Cain, M.F.; Miura-Akagi, P.M. 257th ACS National Meeting, Orlando, Fl, March 31-April 4, **2019**. INOR-0081: 1,2-Benzoazaphospholes as Transition Metal Surrogates.

12. Oral: Cain, M.F.; Nakashige, M.L. 257th ACS National Meeting, Orlando, Fl, March 31-April 4, **2019**. INOR-0595: Synthesis and Coordination Chemistry of Pyridine-Phosphaalkene Ligands: An Entry Point into New Dearomatized Ru(II) Complexes?

11. Oral: Cain, M.F. The 12th International Conference on Heteroatom Chemistry (ICHAC–12), Vancouver, British Columbia, Canada, June 11-16, **2017**. Hypervalency and Bell-Clappers: Recent Developments in Stabilizing Singlet Phosphinidenes and Hypervalent Nitrogen Species.

10. Oral: Cain, M.F. The International Chemical Congress of the Pacific Basin Societies 2015, Pacifichem 2015, Honolulu, HI, December 15-20, **2015**. INOR-2026: All Things P: New Investigations into Multidentate, Non-Innocent, and/or Chiral Phosphine- and Phosphaalkene-Based Ligands.

As a Postdoctoral/Graduate Researcher

9. Poster: Cain, M.F.; Hughes, R.P.; Glueck, D.S.; Golen, J.A.; Rheingold, A.L. 14th Asian Chemical Congress, Bangkok, Thailand, September 5-8, **2011**. Reaxys Prize Poster Session: Synthesis of C_3- and C_1-Symmetric Tripodal Triphosphines as Potential Ligands for Cu(I)-Catalyzed Asymmetric P-C Bond Formation.

8. Oral: Cain, M.F.; Glueck, D.S.; Golen, J.A.; Rheingold, A.L. 242nd ACS National Meeting, Denver, CO, August 28-September 1, **2011**. INOR-496: Synthesis of C_3-Symmetric P-Stereogenic Triphosphine Ligands.

7. Poster: Cain, M.F.; Hughes, R.P.; Glueck, D.S.; Golen, J.A.; Rheingold, A.L. 242nd ACS National Meeting, Denver, CO, August 28-September 1, **2011**. INOR-443: Synthesis of C_3- and C_1-Symmetric Tripodal Triphosphines as Potential Ligands for Cu(I)-Catalyzed Asymmetric P-C Bond Formation.

6. Poster: Cain, M.F.; Glueck, D.S. Gordon Research Conference: Organometallic Chemistry, Newport, RI, July 9-15, **2011**. Synthesis of C_3- and C_1-Symmetric Tripodal Triphosphines as Potential Ligands for Cu(I)-Catalyzed Asymmetric P-C Bond Formation.

5. Poster: Cain, M.F.; Reynolds, S.C.; Glueck, D.S.; Golen, J.A.; Rheingold, A.L. 240th ACS National Meeting, Boston, MA, August 22-26, **2010**. INOR-561: Synthesis, Structure, and Spectroscopic Properties of 2,3-bis(diphenylphosphino)quinoxaline (dppQx) Cu(I) Complexes

4. Poster: Cain, M.F.; Glueck, D.S. 240th ACS National Meeting, Boston, MA, August 22-26, **2010**. INOR-234: Approaches to the Synthesis of C_3-Symmetric P-Stereogenic Triphosphine Ligands

3. Poster: Cain, M.F.; Hughes, R.P.; Glueck, D.S.; Golen, J.A.; Moore, C.E.; Rheingold, A.L. 240th ACS National Meeting, Boston, MA, August 22-26, **2010**. INOR-232: Synthesis and Structure of Intermediates in Copper-Catalyzed Alkylation of Diphenylphosphine

2. Poster: Cain, M. F.; Pet, M.A.; Hughes, R.P.; Glueck, D.S.; Golen, J.A.; Rheingold, A.L. 237th ACS National Meeting, Salt Lake City, UT, March 22-26, **2009**. INOR-549: Synthesis and Structure of Ferrocenylmethylphosphines and Their Borane Adducts

1. Poster: Cain, M.F.; Glueck, D.S.; Golen, J.A.; Rheingold, A.L. 237th ACS National Meeting, Salt Lake City, UT, March 22-26, **2009**. INOR-553: Cationic Cu(I) Complexes of Primary and Secondary Phosphines: Potential Precursors to Phosphido Complexes

Teaching Experience

Spring 2020 **Assistant Professor of Inorganic Chemistry**, University of Hawai'i at Mānoa
Spring 2018 Chem 161, General Chemistry I
Fall 2015-2017 *The most fundamental aspects of chemistry were explained. Atoms, Elements and Molecules, Stoichiometry, the Ideal Gas Law, Thermochemistry, Quantum Mechanical Model of the Atom, Periodic Trends, Lewis Structures, Molecular Shapes, VSEPR and MO Theory, Intermolecular Forces and the Solid State*
Overall Rating: 3.79 / 5 (2020, Online), 4.17 / 5 (2018), 4.40 / 5 (2017), 4.04 / 5 (2016), 3.77 / 5 (2015)

Fall 2018-2021 **Assistant/Associate Professor of Inorganic Chemistry**, University of Hawai'i at Mānoa
Spring 2016 Chem 425/427, Advanced Inorganic Chemistry
Spring 2015 *The fundamentals of coordination chemistry were introduced. Bonding and molecular orbital theory, coordination number and geometry, isomerism and chirality, reaction mechanisms and kinetics, the effect of ligands, organometallic processes, and catalysis were among the topics*

discussed. A primary focus was centered on understanding the "hows and whys" of inorganic and organometallic chemistry with the ultimate goal of comprehending published research.
Overall Rating: 4.84 / 5 (2021), 4.57 / 5 (2020, Online), 5.0 / 5 (2019), 5.0 / 5 (2018), 4.89 / 5 (2016), 4.88 / 5 (2015)

Spring 2019 **Assistant Professor of Inorganic Chemistry**, University of Hawai'i at Mānoa
Spring 2017 Chem 622, Organometallics I
Fall 2014 *The structure, reactivity, and bonding of Main Group Compounds and Transition Metal Complexes were discussed with a dual emphasis placed on the fundamental principles and application to new and relevant literature.*
Overall Rating: 5.0 / 5 (2019), 4.50 / 5 (2017), 3.83 / 5 (2014)

Fall 2017-2020 **Assistant/Associate Professor of Inorganic Chemistry**, University of Hawai'i at Mānoa
Chem 425L, Preparation and Analysis of Inorganic Compounds
The laboratory component of the Chem 425/427 sequence, involving the synthesis of several organometallic species and their subsequent characterization by NMR and IR spectroscopy.

2007-2009 **Teaching Assistant**, Dartmouth College
Supervised and evaluated undergraduates in the laboratory, graded their data sheets, formal lab reports, and exams in four different courses: General I, General II, Honors General, and Inorganic Chemistry

2005-2007 **Undergraduate Teaching Assistant**, SUNY Geneseo
Supervised and evaluated undergraduates in the laboratory, graded their data sheets and formal lab reports in General Chemistry I and II

2002-2004 **Private Tutor**, Congers, NY
Tutored high school students for the NYS Chemistry Regents Exam; all passed with above-average grades

Outreach Efforts

2022 Partnering with Hawaii Baptist Academy (Private high school)
2021-Present Partnering with SparkYou, LLC (Science Summer Camp/Enrichment Program)
2/2019-20 Honolulu District Science and Engineering Fair: Chemistry Judge
12/2018-19 Niu Valley Middle School Science Fair: Chemistry Judge
11/2018 Center for Tomorrow's Leaders: Guest Speaker
11/2018-19 Pearl City High School College and Career Fair: STEM Guest Speaker
Fall 2016-Present University of Hawai'i at Mānoa Chemistry Club Advisor
2015-Present Chemistry Department Liaison for the Mānoa Experience, the University Preview Day