

## Mohamed Oudah

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Address: Stewart Blusson Quantum Matter Institute (SBQMI), 2355 E Mall, Vancouver, BC V6T 1Z4

### EDUCATION

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- PhD in Physics at the Kyoto University, Japan, Highest Honors (2015-2018)  
Thesis: "Superconductivity in Antiperovskite Oxide  $\text{Sr}_{3-x}\text{SnO}$ " Supervisor: Yoshiteru Maeno
- MSc in Chemistry-Nanotechnology at the University of Waterloo, Canada (2013-2014)  
Thesis: "Optimization of Thermoelectric Chalcogenides" Supervisor: Holger Kleinke
- BAS in Chemical Engineering, University of Ottawa, Canada (2006-2012)  
Thesis: "Ammonia electro-oxidation on alloyed PtIr nanoparticles" Supervisor: Elena Baranova

### EMPLOYMENT & RESEARCH POSITIONS

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#### **Senior Scientist – SBQMI – University of British Columbia, 100% Research (January 2021-Current)**

Area of Focus: Growth and low temperature measurements of intermetallics and high-entropy oxides with topology, superconductivity and magnetism, and muon spin relaxation studies.

#### **SBQMI & UBC-MPI-UTokyo Fellow –University of British Columbia (June 2018 - January 2021)**

Advisors: Doug Bonn, George Sawatzky

Area of Focus: Single crystal growth and low temperature measurements of semimetallic superconductors

#### **Visiting Fellow – Max Planck Institute, Stuttgart (June-December 2018, July-August 2019)**

Advisors: Bernhard Keimer, Hidenori Takagi

Area of Focus: High-pressure synthesis of novel oxides and chalcogenides and crystal growth of oxides

#### **Visiting Fellow – Princeton University (May-July 2019)**

Advisors: Leslie Schoop

Area of Focus: Crystal growth and exploration of new topological square-net materials

#### **Physics PhD Candidate – Kyoto University (April 2015 – March 2018)**

Advisor: Yoshiteru Maeno

Area of Focus: Discovery of superconductivity in the antiperovskite oxides with topological semimetallicity

#### **Research Assistant – University of Waterloo (January 2013 – March 2015)**

Advisor: Holger Kleinke

Area of Focus: Improving the thermoelectric performance of copper chalcogenides for clean energy

#### **Research Intern – NTT BRL, Japan, 100% Research (September 2010 – September 2011)**

Advisor: Yasuyuki Kobayashi

Area of Focus: Characterization of freestanding III-V heterostructure thin-film

### AWARDS & FELLOWSHIPS

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- QuantEmX Exchange Award (2023)
- Best Poster Prize at Conference on Strongly Correlated Electron Systems (SCES), 1st Place (2022)
- SBQMI & MPI-UBC-UTokyo Fellowship (2018-2021)
- MEXT Research Scholarship, Full Scholarship to Study in Japan (2015-2018)
- University of Waterloo Special Graduate Scholarship (2014)
- Andrew Moffitt Memorial Scholarship and University of Ottawa Engineering Scholarships (2009, 2012)
- Wilfrid Brisson Undergraduate Memorial Scholarship and McLimont Scholarship (2009)
- Ontario Professional Engineers Foundation for Education Scholarships (2009)
- Queen Elizabeth Aiming for the Top Scholarship (2006-2009)

## TEACHING & SUPERVISION

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- Leading and teaching seminars on X-ray diffraction and crystal structures at UBC for Quantum Pathways undergraduate students from underrepresented groups in physics (2020-2021)
- Supervision of six undergraduate and seven graduate students at UBC (2019-2024)
- Supervision of the research of international exchange students at Kyoto University (2017-2018)
- Teaching assistant for CHEM 120: Physical and Chemical Properties of Matter and CHEM 123: Chemical Reactions, Equilibria and Kinetics at University of Waterloo (2013-2014)

## ACADEMIC SERVICES

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- CIFAR Spring School on Quantum Materials Organizing Committee (June 2023)
- Session chair at Materials and Mechanisms of Superconductivity (M2S) Conference (July 2022)
- Organizer of seminar on high-entropy materials at University of British Columbia (2021-2023)
- Reviewer for publications in *Advanced Materials* & *APL Materials*
- Provided lab tours at SBQMI for funders from government and industry (2019-present)
- Presented results in press release at Kyoto University to local news papers (Oral-Japanese, 2016)

## INVITED TALKS

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- TU Wien, Austria (2023) Discovery of Superconductivity and Electron-Phonon Drag in the Non-Centrosymmetric Semimetal LaRhGe<sub>3</sub>
- ETH, Switzerland (2022) - Discovery of Superconductivity in the Non-Centrosymmetric Semimetal LaRhGe<sub>3</sub>
- Aalto University, Finland (2021) - Unusual Sn State in the Superconducting Disordered Selenide
- Rice University, USA (2020) - Antimonides, Tellurides, and Square-Net Materials
- ETH Zurich, Switzerland (2019) - Exploration of Ag-Bi-O Phases Synthesized Under High Pressure
- Ringberg Meeting, MPI, Germany (2018) - Thermoelectric Properties of BaCu<sub>6-x</sub>(S,Se)Te<sub>6</sub>
- Hokkaido University, Japan (2017) - Superconductivity in the Antiperovskite Oxide Sr<sub>3-x</sub>SnO
- Yukawa Institute, Kyoto University (2016) - The Superconducting Antiperovskite Oxide Sr<sub>3-x</sub>SnO
- Waterloo Institute of Nanotechnology (2014) - Localized Cu-Ion Mobility in Thermoelectric Chalcogenides

## CONTRIBUTED TALKS

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- APS March Meeting - 2022, Magnetic Order in Ga-Substituted Spinel Type High Entropy Oxide (MnFeCrCoNi)<sub>3-x</sub>Ga<sub>x</sub>O<sub>4</sub>
- APS March Meeting - 2019, Boston, USA - Towards Topological States in Silver Bismuthates Synthesized under High-Pressure
- JPS Spring Meeting, Osaka, Japan (2017) - Dependence of the Properties of Superconducting Sr<sub>3-x</sub>SnO on Sr Deficiency
- JPS Fall Meeting, Kanazawa, Japan (2016) - Superconductivity in the antiperovskite oxide Sr<sub>3</sub>SnO

## POSTERS

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- CIFAR Meeting, Montreal, Canada (2023) - Discovery of Superconductivity and Electron-Phonon Drag in the Non-centrosymmetric Semimetal LaRhGe<sub>3</sub>
- Strongly Correlated Electron Systems (SCES), Amsterdam, Netherlands (2022) - Type-I Superconductivity in Non-centrosymmetric LaRhGe<sub>3</sub>
- MPI-UBC-UTokyo Meeting, Vancouver, Canada (2019) - Unusual Sn State in the Superconducting Entropy Stabilized Selenide Ag<sub>1-x</sub>Sn<sub>1+x</sub>Se<sub>2</sub>
- Spectroscopies in Novel Superconductors, Tokyo, Japan (2019) - Spectroscopy of Ag-Bi-O Phases Synthesized Under High Pressure

## LANGUAGES

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- Native in English and Arabic, fluent in Japanese

## PUBLICATIONS

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- M. Oudah**, Y. Cai, M. V. De Toro Sanchez, J. Bannies, M. C. Aronson, K. M. Kojima, D. A. Bonn, “Critical Field Anisotropy and Muon Spin Relaxation Study of Superconducting Dirac-Semimetal  $\text{CaSb}_2$ ” *Phys. Rev. B*, 110, 134524 (2024)
- M. Oudah**, H. H. Kung, S. Sahu, N. Heinsdorf, A. Schulz, K. Philippi, M. V. De Toro Sanchez, Y. Cai, K. M. Kojima, A. P. Schnyder, H. Takagi, B. Keimer, D. A. Bonn, A. M. Hallas, “Discovery of Superconductivity and Electron-Phonon Drag in the Non-Centrosymmetric Semimetal  $\text{LaRhGe}_3$ ” *npj Quantum Mater.*, 9, 88 (2024)
- M. Oudah**, M. Kim, R. Dinnebier, G. McNally, K. Foyevtsova, D. A. Bonn, H. Takagi, “A New High-Pressure High-Temperature Phase of Silver Antimonate  $\text{AgSbO}_3$  with Strong Ag-O Hybridization” *Inorg. Chem.*, 63, 22379 (2024)
- V King, S. Choi, D. Chen, B. Stuart, J. Kim, **M. Oudah**, J. Kim, B. J. Kim, D. A. Bonn, S. A. Burke, “Using  $k$ -means to sort spectra: Electronic order mapping from scanning tunneling spectroscopy measurements” *Appl. Phys. Lett.*, 125, 181603 (2024)
- P.-Y. Cheng, **M. Oudah**, T.-L. Hung, C.-E. Hsu, C.-C. Chang, J.-Y. Huang, T.-C. Liu, C.-M. Cheng, M.-N. Ou, W.-T. Chen, L.Z. Deng, C.-C. Lee, Y.-Y. Chen, C.-N. Kuo, C.-S. Lue, J. Machts, K. M. Kojima, A. M. Hallas, C.-L. Huang, “Physical properties and electronic structure of the two-gap superconductor  $\text{V}_2\text{Ga}_5$ ” *Phys. Rev. Res.*, 2405, 03499 (2024)
- S. S. Aamlid, M. Kim, M. U. González-Rivas, **M. Oudah**, H. Takagi, and A. M. Hallas., “Effect of high pressure synthesis conditions on the formation of high entropy oxides” *Appl. Phys. Lett.*, 125, 021901 (2024)
- G. Baker, T. W. Branch, J. S. Bobowski, J. Day, D. Valentinis, **M. Oudah**, P. McGuinness, S. Khim, P. Surówka, Y. Maeno, R. Moessner, J. Schmalian, A. Mackenzie, D. A. Bonn, “Non-Local Microwave Electrodynamics in Ultra-Pure  $\text{PdCoO}_2$ ” *Phys. Rev. X*, 14, 011018 (2024)
- J. O. Ticknor, J. R. Adelman, A. Chatzichristos, M. H. Dehn, L. Egoriti, D. Fujimoto, V. L. Karner, Robert F. Kiefl, C. D. P. Levy, R. Li, R. M. L. McFadden, **M. Oudah**, G. D. Morris, M. Stachura, E. Thoeng, W. A. MacFarlane, “Ion-Implanted  $^8\text{Li}$  Nuclear Magnetic Resonance in Highly Oriented Pyrolytic Graphite”, *Phys. Rev. B*, 108, 195437 (2023)
- J. Weng, H. Shin, S. Godin, **M. Oudah**, R. Sutarto, R. Pons, B. A. Davidson, K. Zou, “Ordered Deficient Perovskite  $\text{La}_{2/3}\text{TiO}_3$  Films Grown via Molecular Beam Epitaxy”, *J. Vac. Sci. Tech. A*, 41, 6 (2023)
- S. S. Aamlid, G. H. J. Johnstone, S. Mugiraneza, **M. Oudah**, J. Rottler, A. M. Hallas, “Phase Stability of Entropy Stabilized Oxides with the  $\alpha\text{-PbO}_2$  Structure”, *Commun. Mater.*, 4, 45 (2023)
- W. A. MacFarlane, **M. Oudah**, R. M. L. McFadden, D. Huang, A. C. Chatzichristos, D. Fujimoto, V. L. Karner, R. F. Kiefl, C. D. P. Levy, R. Li, I. McKenzie, G. D. Morris, M. R. Pearson, M. Stachura, J. O. Ticknor, E. Thoeng, H. Nakamura, H. Takagi, “ $^8\text{Li}$   $\beta$ -NMR Studies of Epitaxial Thin Films of the 3D Topological Dirac Semimetal  $\text{Sr}_3\text{SnO}$ ”, *J. Phys.: Conf. Ser.*, 2462, 012057 (2023)
- S. S. Aamlid, **M. Oudah**, J. Rottler, A. M. Hallas, “Understanding the Role of Entropy in High Entropy Oxides”, *J. Am. Chem. Soc.* 145, 5991 (2023) [Review Article]
- G. H. J. Johnstone, M. U. González-Rivas, K. M. Taddei, R. Sutarto, G. A. Sawatzky, R. J. Green, **M. Oudah**, A. M. Hallas, “Entropy Engineering and Tunable Magnetic Order in the Spinel High Entropy Oxide”, *J. Am. Chem. Soc.*, 144, 20590 (2022)

- M. Oudah\***, J. Bannies\* D. A. Bonn, M. C. Aronson, “Superconductivity and Quantum Oscillations in Single Crystals of the Dirac Nodal Line Semimetal  $\text{CaSb}_2$ ”, *Phys. Rev. B*, 105, 184504 (2022)
- M. Kim, G. M. McNally, H. Kim, **M. Oudah**, A. Gibbs, P. Manuel, R. Green, T. Takayama, U. Wedig, M. Isobe, R. K. Kremer, D. Bonn, B. Keimer, and H. Takagi, “Discovery of Superconductivity in  $(\text{Ba,K})\text{SbO}_3$ ”, *Nat. Mater.*, 21, 627 (2022)
- B. A. Stuart, S. Choi, J. Kim, L. Muechler, R. Queiroz, **M. Oudah**, L. M. Schoop, D. A. Bonn, S. A. Burke, “Quasiparticle Interference Observation of the Topologically Non-Trivial Drumhead Surface State in  $\text{ZrSiTe}$ ”, *Phys. Rev. B*, 105, L121111 (2022)
- M. Oudah**, M. Kim, K. Rabinovich, K. Foyevtsova, G. McNally, B. Kilic, K. Küster, R. J. Green, A. V. Boris, G. A. Sawatzky, A. Schnyder, D. A. Bonn, B. Keimer, H. Takagi, “Electronic Structure of the Bond Disproportionated Bismuthate  $\text{Ag}_2\text{BiO}_3$ ”, *Phys. Rev. Mater.*, 5, 064202 (2021)
- R. J. Kirby, L. Muechler, S. Klemenz, C. Weinberg, A. Ferrenti, **M. Oudah**, D. Fausti, G. D. Scholes, L. M. Schoop, “Signature of an Ultrafast Photoinduced Lifshitz Transition in the Nodal-Line Semimetal  $\text{ZrSiTe}$ ” *Phys. Rev. B*, 103, 205138 (2021)
- R. J. Kirby, A. Ferrenti, C. Weinberg, S. Klemenz, **M. Oudah**, S. Lei, C. P. Weber, D. Fausti, G. D. Scholes, L. M. Schoop, “Transient Drude Response Dominates Near-Infrared Pump–Probe Reflectivity in Nodal-Line Semimetals  $\text{ZrSiS}$  and  $\text{ZrSiSe}$ ”, *J. Phys. Chem. Lett.*, 11, 15, 6105 (2020)
- A. Ikeda, Z. Guguchia, **M. Oudah**, S. Koibuchi, S. Yonezawa, D. Das, T. Shiroka, H. Luetkens, Y. Maeno, “Penetration Depth and Gap Structure in the Antiperovskite Oxide Superconductor  $\text{Sr}_{3-x}\text{SnO}$  revealed by  $\mu\text{SR}$ ”, *Phys. Rev. B*, 101, 174503 (2020)
- A. Ikeda, S. Koibuchi, S. Kitao, **M. Oudah**, S. Yonezawa, M. Seto, Y. Maeno, “Negative Ionic States of Tin in the Oxide Superconductor  $\text{Sr}_{3-x}\text{SnO}$  Revealed by Mössbauer Spectroscopy”, *Phys. Rev. B*, 100, 245145 (2019)
- M. Oudah**, J.N. Hausmann, S. Kitao, A. Ikeda, S. Yonezawa, M. Seto, Y. Maeno, “Evolution of Superconductivity with Sr-Deficiency in Antiperovskite Oxide  $\text{Sr}_{3-x}\text{SnO}$ ”, *Sci. Rep.*, 9, 1831 (2019)
- $\text{Ba}_3\text{Cu}_{16-x}(\text{S,Te})_{11}$ ”, *J. Mater. Chem. C*, 6, 13043 (2018)
- S. Kitagawa, K. Ishida, **M. Oudah**, J.N. Hausmann, A. Ikeda, S. Yonezawa, Y. Maeno, “Normal-State Properties of the Antiperovskite Oxide  $\text{Sr}_{3-x}\text{SnO}$  Revealed by  $^{119}\text{Sn}$ -NMR”, *Phys. Rev. B*, 98, 100503 (2018)
- A. Ikeda, T. Fukumoto, **M. Oudah**, J.N. Hausmann, S. Yonezawa, S. Kobayashi, M. Sato, C. Tassel, F. Takeiri, H. Takatsu, H. Kageyama, Y. Maeno, “Theoretical Band Structure of the Superconducting Antiperovskite Oxide  $\text{Sr}_{3-x}\text{SnO}$ ”, *Physica B*, 536, 752 (2018)
- J.N. Hausmann\*, **M. Oudah\***, A. Ikeda, S. Yonezawa, Y. Maeno, “Controlled Synthesis of the Antiperovskite Oxide Superconductor  $\text{Sr}_{3-x}\text{SnO}$ ”, *Supercond. Sci. Technol.*, 31, 055012 (2018)
- M. Oudah**, A. Ikeda, J.N. Hausmann, S. Yonezawa, T. Fukumoto, S. Kobayashi, M. Sato, Y. Maeno, “Superconductivity in the Antiperovskite Dirac-Metal Oxide  $\text{Sr}_{3-x}\text{SnO}$ ”, *Nat. Comm.*, 7, 13617 (2016)
- M. Oudah**, K. M. Kleinke, H. Kleinke, “Thermoelectric Properties of the Quaternary Chalcogenides  $\text{BaCu}_{5.9}\text{STe}_6$  and  $\text{BaCu}_{5.9}\text{STe}_6$ ”, *Inorg. Chem.*, 54, 845-849 (2015)
- A. Allagui, **M. Oudah**, X. Tuae, S. Ntais, F. Almomani, E.A. Baranova, “Ammonia Electro-Oxidation on Alloyed PtIr Nanoparticles of Well-Defined Size”, *Int. J. Hydrog. Energy*, 38, 5, 2455-2463 (2013)

SUBMITTED/ACCEPTED

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**M. Oudah**, D. Takegami, S. Kitao, J. L. Lado, A. Meléndez-Sans, D. S. Christovam, M. Yoshimura, K. D. Tsuei, G. McNally, M. Isobe, K. Küster, M Seto, B. Keimer, D. A. Bonn, H. Tjeng, G. Sawatzky, H. Takagi, “Charge-Entropy-Stabilized Selenide (Ag,Sn)Se” Under review in *Comm. Mater.* (2024)

X.Y. Li, A. Nocera, K. Foyevtsova, G.A. Sawatzky, **M. Oudah**, N. Murai, M. Kofu, M. Matsuura, H. Tamatsukuri, M.C. Aronson, “Frustrated  $S=1/2$  Chains in One-Dimensional Correlated Metal  $\text{Ti}_4\text{MnBi}_2$ ” Under review in *Nat. Mater.*, *arXiv:2409.02880* (2024)

J. Bannies, M. Michiardi, H.-H. Kung, S. Godin, J.W. Simonson, **M. Oudah**, M. Zonno, S. Gorovikov, S. Zhdanovich, I.S. Elfimov, A. Damascelli, M.C. Aronson, “Electronically-driven switching of topology in  $\text{LaSbTe}$ ” Under review in *Nat. Mater.*, *arXiv:2407.08798* (2024)

Y. Zhang, Y. Gao, A. Pulkkinen, X. Guo, J. Huang, Y. Guo, Z. Yue, J. S. Oh, A. Moon, **M. Oudah**, X.-J. Gao, A. Fedorov, S.-K. Mo, M. Hashimoto, D. Lu, A. Rajapitamahuni, E. Vescovo, J. Kono, A. M. Hallas, R. J. Birgeneau, L. Balicas, J. Min’ar, P. Hosur, K. T. Law, E. Morosan, M. Yi, “Kramers nodal lines in intercalated  $\text{TaS}_2$  superconductors” Submitted to *Nat. Mater.* (2024)

M. Roppongi, Y. Cai, K. Ogawa, S. Liu, G. Q. Zhao, **M. Oudah**, T. Fujii, K. Imamura, S. Fang, K. Ishihara, K. Hashimoto, K. Matsuura, Y. Mizukami, M. Pula, M. V. De Toro Sanchez, C. Young, I. Markovici, D. A. Bonn, T. Watanabe, A. Yamashita, Y. Mizuguchi, G. M. Luke, K. M. Kojima, Y. J. Uemura, and T. Shibauchi, “Topology meets time-reversal symmetry breaking in  $\text{FeSe}_{1-x}\text{Te}_x$  superconductors” Under review in *Nat. Comm.* (2024)