

Caroline S. Gorham, Ph.D.

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## Higher Education

Aug 2018	<b>Ph.D., Materials Science &amp; Engineering (Prof. David Laughlin )</b> Carnegie Mellon University, Pittsburgh, PA Thesis: "On the formation of crystalline and non-crystalline solid states and their thermal transport properties: A topological perspective via a quaternion orientational order parameter" Proquest Link to Thesis: <a href="https://pqdtopen.proquest.com/pubnum/10933235.html?FMT=AI">https://pqdtopen.proquest.com/pubnum/10933235.html?FMT=AI</a>
Jan 2017	<b>M.S. Materials Science (Prof. David E. Laughlin)</b> Carnegie Mellon University, Pittsburgh, PA Thesis: "Thermal Properties of Dielectric Solids"
May 2015	<b>M.S. Mechanical Engineering (Prof. Alan J. H. McGaughey)</b> Carnegie Mellon University, Pittsburgh, PA Thesis: "Thermal Transport in Buckminsterfullerene Molecular Solids at an Above Room Temperature"
June 2010	<b>B.Eng. Mechanical Engineering, 1<sup>st</sup> Classification Honors</b> King's College London, London, UK

## Awards and Honors

Best Doctoral Thesis in Materials Science Dept. (Paxton Award, Carnegie Mellon University)	2018
NASA Space Technology Research Fellowship	2013 - 2017
NSF Graduate Research Fellowship, Honorable Mention	2013

## Publications

1. **C. S. Gorham**, D. E. Laughlin, "Crystallization in Three-Dimensions: Defect-Driven Topological Ordering and the Role of Geometrical Frustration," *Physical Review B*, 99, 144106, (2019).
2. **C. S. Gorham**, D. E. Laughlin, "Topological Description of the Solidification of Undercooled Fluids and the Temperature Dependence of the Thermal Conductivity of Crystalline and Glassy Solids Above Approximately 50 K," *Journal of Physics: Condensed Matter*, V31(n.10), (2019).
3. **C. S. Gorham**, D. E. Laughlin, "SU(2) Orientational Ordering in Restricted Dimensions: Evidence for a Berezinskii-Kosterlitz-Thouless Transition of Topological Point Defects in Four Dimensions," *Journal of Physics Communications*, Volume 2, Number 7, (2018).
4. R. Cheaito, **C. S. Gorham**, A. Misra, K. Hattar and P. E. Hopkins. "Thermal conductivity measurements via time-domain thermoreflectance for the characterization of radiation induced damage". *Journal of Materials Research*, 30, pp 1403-1412, 10.1557/jmr.2015.11, 2015.
5. **C. S. Gorham**, K. Hattar, R. Cheaito, J. C. Duda, J. T. Gaskins, T. E. Beechem, J. F. Ihlefeld, L. B. Biedermann, E. S. Piekos, D. L. Medlin and P. E. Hopkins. "Ion irradiation of the native oxide/silicon surface increases the thermal boundary conductance across aluminum/silicon interfaces". *Physical Review B*, 90, 024301, 2014.

6. **C. S. Gorham**, J. T. Gaskins, G. N. Parsons, M. D. Losego and P. E. Hopkins. "Density dependence of the room temperature thermal conductivity of atomic layer deposition-grown amorphous alumina ( $\text{Al}_2\text{O}_3$ )". *Applied Physics Letters*, 104, 253107, 2014.
7. B. M. Foley, **C. S. Gorham**, J. C. Duda, R. Cheaito, C. J. Szwejkowski, et al. "Thermal conductivity of water insoluble protein films: anharmonic interactions of vibrations in a fractal structure". *Journal of Physical Chemistry Letters*, 5(7), pp. 1077-1082, 2014.

#### Refereed Conference Proceedings:

8. A. Godeke, P. Bish, D. R. Dietderich, **C. S. Gorham**, A. R. Hafalia, et al., "Novel methods for the measurement of the critical current of superconducting wires". *AIP Conference Proceedings*, 1435, 209, 2012.

#### ArXiv-Preprints/Submitted:

9. **C. S. Gorham**, D. E. Laughlin, "On the Formation of Solid States Beyond Perfect Crystals: Quasicrystals, Geometrically-Frustrated Crystals and Glasses," arXiv:1907.08839 [cond-mat.mtrl-sci] (2019).
10. **C. S. Gorham**, D. E. Laughlin, "Solidification of Icosahedral Quasicrystals: Viewpoint Based on a Quaternion Orientational Order Parameter and the Formation of the E8 Lattice," arXiv:1905.12165 [cond-mat.mtrl-sci] (2019).
11. **C. S. Gorham**, D. E. Laughlin, "Quantized Hall Effect Phenomena and Topological-Order in 4D Josephson Junction Arrays in the Vicinity of a Quantum Phase Transition," arXiv:1903.11945 [hep-th] (2019).

#### Invited Seminars:

1. "Importance of Quaternions, Topological-Ordering & Heisenberg Uncertainty Principle in Understanding Structure and Thermal Conductivity of Glass"  
Washington St. Louis Physics Dept. [St. Louis, MO. Upcoming, 10/2019].
2. "Importance of Lie Algebras, Dimensions & Topological Ordering: Understanding Structure and Thermal Conductivity of Glass"  
Harvard Physics Dept., Condensed Matter Physics Seminar. [Boston, MA 01/2019].
3. "What Hopf Fibrations Can Tell Us About Crystallization and Glass Formation"  
Quantum Gravity Research [Los Angeles, CA 03/2019].

#### Conference Presentations:

1. "Importance of Quaternions & Heisenberg Uncertainty Principle in Understanding the Structure and Thermal Conductivity of Crystals and Glasses"  
International Thermal Conductivity Conference, Wilmington, DE [06/2019].
2. "4D Quaternion Numbers, Topological-Order & Solidification: Inverse Thermal Conductivity of Crystals and Glasses Above Approx. 50 K"  
Materials Research Society, Phoenix, AZ [04/2019].
3. "Thermal transport in buckminsterfullerene molecular solids at and above room temperature".  
American Physical Society, San Antonio, TX [03/2015].

## Poster Presentations:

1. "Solidification of Glasses & Thermal Transport Properties: Importance of Topology & Heisenberg Uncertainty Principle"  
Beg Rohu Summer School: Glasses, Jamming and Slow Dynamics [Bretagne, FR 06/2019]
2. "Order and Transport Properties of Glassy Solids: Importance of Topological Defects"  
American Physical Society Q2C, [Denver, CO, 04/2019].
3. "Order and Transport Properties of Glassy Solids: Importance of Topological Defects"  
Order From Chaos, KAVLI Institute of Theoretical Physics, Santa Barbara, CA [12/2018].
4. "Thermal transport in buckminsterfullerene molecular solids at and above room temperature".  
Carnegie Mellon University, Pittsburgh, PA [03/2015].
5. "Thermal conductivity of water insoluble protein films: anharmonic coupling in a fractal structure".  
American Society of Mechanical Engineers, San Diego, CA [11/2013].
6. "Effects of surface treatments on thermal boundary conductance across Al/Si interfaces".  
Materials Research Society, San Francisco, CA [04/2013].

## Teaching Experience:

Thermodynamics I, Instructor Carnegie Mellon University, Department of Materials Science and Engineering	Fall 2019
Special Topics: Properties of Ferroic and Multiferroic Materials, Instructor Carnegie Mellon University, Department of Materials Science and Engineering	Spring 2019
Thermoelectrics Lab, Instructor University of Virginia, Department of Mechanical and Aerospace Engineering	Spring 2013

## Professional Societies:

Since 2011	National Society of Professional Engineers
Since 2012	Materials Research Society
Since 2012	American Society of Mechanical Engineers
Since 2013	Society of Women Engineers
Since 2014	American Physical Society

## Skills:

Programming: MATLAB, python, bash

Simulations: LAMMPS (molecular dynamics), GULP (harmonic lattice dynamics)

Computational management: linux, PBS-job-queuing, github

Word editors and document preparation: Vi, LaTeX, emacs

## Professional and Research Experience

08/2018—	<p><b>Postdoctoral Research Associate. Materials Science &amp; Engineering</b> Carnegie Mellon University (Prof. David E. Laughlin) Considered generalizations of 2D quantum Hall effects (QHE), in systems of particles with complex symmetry, to 4D and 8D systems of particles with symmetry of quaternion (Q) and octonion (O) compact Lie algebra domains in an effort to understand frustrated ordered ground states in the vicinity quantum phase transitions.</p>
Summer 2015	<p><b>National Renewable Energy Laboratory: Computational Division.</b> Performed linear analysis to correlate the frequency dependence of hole conduction in conjugated polymers, for improved organic photovoltaic material design</p>
Summer 2014	<p><b>NASA Glenn: Photovoltaic and Power Technologies Division.</b> Interrogated vibrational mode properties of C<sub>60</sub> for improved photovoltaic materials</p>
2012/2013	<p><b>Graduate Research Assistant, Mechanical and Aerospace Engineering</b> University of Virginia (Prof. Patrick E. Hopkins) Used optical thermometry-based experiments to measure the thermal conductivity, thermal boundary conductance and sound speed in a wide array of bulk materials and nanosystems.</p>
2010/2011	<p><b>Raytheon Company (IIS): System Engineer and Integrator.</b> Integrated three system level components for the net-centric ground control system for GPS OCX. Developed test procedures to ensure high-value functionality of the ground control system</p>
Summer 2010	<p><b>Lawrence Berkeley National Laboratory: DOE Science Internship.</b> Conducted experiments, at 77 K with a high-intensity applied B, to characterize current entrance lengths in superconducting wires - to minimize material usage in high-throughput studies</p>
Summer 2008	<p><b>NASA Langley: Mechanical Systems Engineering Internship.</b> Fabricated and tested a minimal risk method for testing the moment of inertia of the Orion module. Presented research at NASA headquarters in a national broadcast.</p>

## Certifications

Engineer-In-Training, Mechanical

2011