

Dr. Lucas Lindsay

Oak Ridge National Laboratory
Materials Science and Technology Division
PO Box 2008, Oak Ridge, TN 37831
lindsaylr@ornl.gov (865) 576-6215

Research:

- 2014-pres. Research scientist, Materials Sciences and Technology Division at Oak Ridge National Laboratory
- 2011-2014 National Academy of Sciences Fellowship, U.S. Naval Research Laboratory
- Computational materials physics:
- develop microscopic first-principles methods to predict vibrational thermal transport in bulk and nanoscale materials for thermal management applications
 - advance fundamental understanding of phonon-defect scattering

Education:

- 2010 Ph.D. in Physics, Boston College, Chestnut Hill, MA
Dissertation Title: *Theory of phonon thermal transport in single-walled carbon nanotubes and graphene (supervisor: Dr. David Broido)*
- 2004 B.S. in Physics, Magna Cum Laude, College of Charleston, Charleston, SC

Teaching Experience:

- 2009-2011 Instructor, Department of Physics, Computer Science and Engineering, Christopher Newport University, Newport News, VA
- planned and taught introductory physics courses for majors and non-majors
- 2004-2007 Teaching Assistant, Department of Physics, Boston College, Boston, MA
- guided students in introductory physics and physiology laboratory courses

Funding and Awards:

- 2019 DOE Early Career Award
- 2018 Outstanding Referee for the *Physical Review*
- 2017-2019 LDRD project lead
- 2014 NRC/ASEE Postdoctoral Research Publication Award, NRL
- 2013 NRC/ASEE Postdoctoral Research Publication Award, NRL
- 2011 NRC Research Associateship Award, NRL
- 2006 Donald J. White Teaching Excellence Award, Boston College
- 2004 Albert E. Rainis Memorial Scholarship, College of Charleston

Professional Service:

- 2019 MRS Symposium Co-organizer
- 2017 Breakout session lead at DOE HEATER workshop
- 2017 ORNL/BES strategic planning effort
- 2016 STEM outreach at USA Science and Engineering Festival
- 2015-2017 Knoxville Jewish Day School STEAM advisory board

2015 Thesis advisory committee for Ankit Jain, Carnegie Melon University
2008-2009 University Research Council, Boston College, Boston, MA

Refereed proposals for NSF and DOE and numerous papers for *Science*, *Physical Review*, *Physics Today*, *Scientific Reports*, *European Physics Letters*, *Applied Physics Letters*, *ACS Nano*, *Carbon*, *Nanoscale*, etc.

Mentoring:

2020- Caroline Gorham – postdoctoral fellow
2019- Simon Thébaud – postdoctoral fellow
2016-2019 Carlos Polanco – postdoctoral fellow
2015-2017 Saikat Mukhopadhyay – postdoctoral fellow
2016 Wangwei Lan – graduate student from Theo Siegrist’s group at Florida State Univ.

Patent:

2018 US Patent 9,986,663 B2, “*High Thermal Conductivity Materials for Thermal Management Applications*,” D. A. Broido, T. L. Reinecke and **L. Lindsay**.

Publications:

Total citations=5327 *h*-index=29

- 2020 70. “*Lattice instabilities and phonon thermal transport in TlBr*,” T. Pandey, L. Lindsay, B. C. Sales, and D. S. Parker, *Physical Review Materials* 4, 045403 (2020).
69. “*Unfolding the complexity of phonon quasi-particle physics in disordered materials*,” S. Mu, R. Olsen, B. Dutta, **L. Lindsay**, G. D. Samolyuk, T. Berlijn, E. D. Specht, K. Jin, H. Bei, T. Hickel, B. C. Larson, and G. M. Stocks, *npj Computational Materials* 6, 4 (2020).
68. “*Defect-limited thermal conductivity in MoS₂*,” C. A. Polanco, T. Pandey, T. Berlijn, and **L. Lindsay**, *Physical Review Materials* 4, 014004 (2020).
- 2019 67. “*Long mean free paths of room-temperature THz acoustic phonons in a high thermal conductivity material*,” T.-H. Chou, **L. Lindsay**, A. A. Maznev, J. S. Gandhi, D. W. Stokes, R. L. Forrest, A. Bensaoula, K. A. Nelson, and C.-K. Sun, *Physical Review B* 100, 094302 (2019).
66. “*Generalized Fourier’s law for non-diffusive thermal transport: Theory and experiment*,” C. Hua, **L. Lindsay**, X. Chen, and A. J. Minnich, *Physical Review B* 100, 085203 (2019) “*Editor’s Suggestion*”.
65. “*High-pressure nuclear inelastic scattering with backscattering monochromatization*,” I. Sergueev, K. Glazyrin, M. G. Herrmann, P. Alexeev, H.-C. Wille, O. Leupold, A. F. May, T. Pandey, **L. Lindsay**, K. Friese, and R. P. Hermann, *Journal of Synchrotron Radiation* 26, 5 (2019).
64. “*Ab initio investigation of single-layer high thermal conductivity boron compounds*,” H. Fan, H. Wu, **L. Lindsay**, and Y. Hu, *Physical Review B* 100, 085420 (2019).

63. “*Perspective on ab initio phonon thermal transport*,” **L. Lindsay**, A. Katre, A. Cepellotti, and N. Mingo, *Journal of Applied Physics* 126, 050902 (2019).
62. “*Phonon interaction with ripples and defects in thin layered molybdenum disulfide*,” B. Smith, **L. Lindsay**, J. Kim, E. Ou, R. Huang, and L. Shi, *Applied Physics Letters* 114, 221902 (2019).
61. “*Modulating the thermal conductivity in hexagonal boron nitride via controlled boron isotope concentration*,” C. Yuan, J. Li, **L. Lindsay**, D. Cherns, J. W. Pomeroy, S. Liu, J. H. Edgar, and M. Kuball, *Communication Physics* 2, 43 (2019).
60. “*Phonons, magnons, and lattice thermal transport in antiferromagnetic semiconductor MnTe*,” S. Mu, R. P. Hermann, S. Gorse, H. Zhao, M. E. Manley, R.S. Fishman, and **L. Lindsay**, *Physical Review Materials* 3, 025403 (2019). [1 citation]
59. “*Phonon thermal conductance across GaN-AlN interfaces from first principles*,” C. A. Polanco and **L. Lindsay**, *Physical Review B* 99, 075202 (2019). [1 citation]
58. “*Dislocation-induced thermal transport anisotropy in single-crystal group-III nitride films*,” B. Sun, G. Haunschild, C. A. Polanco, J. Ju, **L. Lindsay**, G. Koblmüller, and Y. K. Koh, *Nature Materials* 18, 136 (2019). [4 citations]
57. “*Phonon-induced multicolor correlations in hBN single-photon emitters*,” M. A. Feldman, A. Poretzky, **L. Lindsay**, E. Tucker, D. P. Briggs, P. G. Evans, R. F. Haglund, and B. J. Lawrie, *Physical Review B* 99, 020101(R) (2019).
- 2018 56. “*Survey of ab initio thermal transport calculations*,” **L. Lindsay**, C. Hua, X. Ruan, and S. Lee, *Materials Today Physics* 7, 106 (2018). [3 citations]
55. “*Symmetry-driven phonon chirality and transport in one-dimensional and bulk Ba₃N-derived materials*,” T. Pandey, C. A. Polanco, V. R. Cooper, D. S. Parker, and **L. Lindsay**, *Physical Review B* 98, 241405(R) (2018). [3 citations]
54. “*Thermal transport by first-principles anharmonic lattice dynamics*,” **L. Lindsay** and C. A. Polanco, book chapter in *Handbook of Materials Modeling*, Eds: W. Adreoni and S. Yip (Springer, Cham, Switzerland, 2018), pp. 1-31.
53. “*Fermi surface nesting and phonon frequency gap drive anomalous thermal transport*,” C. Li, N. K. Ravichandran, **L. Lindsay**, and D. Broido, *Physical Review Letters* 121, 175901 (2018). [4 citations]
52. “*Antisite pairs suppress the thermal conductivity of BAs*,” Q. Zheng, C. A. Polanco, M.-H. Du, **L. Lindsay**, M. Chi, J. Yan, and B. C. Sales, *Physical Review Letters* 121, 105901 (2018). [8 citations]
51. “*Thermal conductivity of InN with point defects from first principles*,” C. A. Polanco and **L. Lindsay**, *Physical Review B* 98, 014306 (2018). [9 citations]
50. “*Two-channel model for ultralow thermal conductivity of crystalline Tl₃VSe₄*,” S. Mukhopadhyay, D. S. Parker, B. C. Sales, A. A. Poretzky, M. A. McGuire, and **L. Lindsay**, *Science* 360, 1455 (2018). [16 citations]

2017

49. “Anisotropic thermal transport in bulk hexagonal boron nitride,” P. Jiang, X. Qian, R. Yang, and **L. Lindsay**, *Physical Review Materials* 2, 064005 (2018). [7 citations]
48. “Interfacial phonon scattering and transmission loss in $>1\ \mu\text{m}$ thick silicon-on-insulator thin films,” P. Jiang, **L. Lindsay**, X. Huang, and Y. K. Koh, *Physical Review B* 97, 195308 (2018). [4 citations]
47. “Propagation of THz acoustic wave packets in GaN at room temperature,” A. A. Maznev, T.-C. Hung, Y.-T. Yao, T.-H. Chou, J. S. Gandhi, **L. Lindsay**, H. D. Shin, D. W. Stokes, R. L. Forrest, A. Bensaoula, C.-K. Sun, and K. A. Nelson, *Applied Physics Letters* 112, 061903 (2018). [1 citation]
46. “Ultralow-loss polaritons in isotopically pure boron nitride,” A. J. Giles, S. Dai, I. Vurgaftman, T. Hoffman, S. Liu, **L. Lindsay**, C. T. Ellis, N. Assefa, I. Chatzakis, T. L. Reinecke, J. G. Tischler, M. M. Fogler, J. H. Edgar, D. N. Basov, and J. D. Caldwell, *Nature Materials* 17, 134 (2018). [54 citations]
45. “Ab initio phonon point defect scattering and thermal transport in graphene,” C. A. Polanco and **L. Lindsay**, *Physical Review B* 97, 014303 (2018). [13 citations]
44. “High temperature magneto-structural transition in van der Waals-layered $\alpha\text{-MoCl}_3$,” M. A. McGuire, J. Yan, P. Lampen-Kelly, A. F. May, V. R. Cooper, **L. Lindsay**, A. Puretzy, L. Liang, Santosh KC, E. Cakmak, S. Calder and B. C. Sales, *Physical Review Materials* 1, 064001 (2017) “Editor’s Suggestion”. [16 citations]
43. “Four-phonon scattering significantly reduces intrinsic thermal conductivity of solids,” T. Feng, **L. Lindsay**, and X. Ruan, *Physical Review B* 96, 161201(R) (2017). [23 citations]
42. “Ab initio phonon thermal transport in monolayer InSe, GaSe, GaS and alloys,” T. Pandey, D. S. Parker, and **L. Lindsay**, *Nanotechnology* 28, 455706 (2017). [11 citations]
41. “The curious case of cuprous chloride: Giant thermal resistance and anharmonic quasiparticle spectra driven by dispersion nesting,” S. Mukhopadhyay, D. Bansal, O. Delaire, D. Perrodin, E. Bourret-Courchesne, D. J. Singh and **L. Lindsay**, *Physical Review B* 96, 100301(R) (2017). [5 citations]
40. “Phonon thermal transport in 2H, 4H and 6H silicon carbide from first principles,” N. H. Protik, A. Katre, **L. Lindsay**, N. Mingo, and D. Broido, *Materials Today Physics* 1, 31 (2017). [8 citations]
39. “Lattice thermal transport in $\text{La}_3\text{Cu}_3\text{X}_4$ ($X=\text{P}, \text{As}, \text{Sb}, \text{Bi}$) compounds: Interplay of anharmonicity and scattering phase space,” T. Pandey, C. A. Polanco, **L. Lindsay** and D. S. Parker, *Physical Review B* 95, 224306 (2017). [3 citation]
38. “Hydrodynamic phonon drift and second sound in a (20,20) single-wall carbon nanotube,” S. Lee and **L. Lindsay**, *Physical Review B* 95, 184304 (2017). [1 citation]
37. “Effects of functional group mass variance on thermal transport in graphene,” **L. Lindsay** and Y. Kuang, *Physical Review B* 95, 121404(R) (2017). [9 citations]

2016

36. “Boron arsenide phonon dispersion from inelastic x-ray scattering: Potential for ultrahigh thermal conductivity,” H. Ma, C. Li, S. Tang, J. Yan, A. Alatas, **L. Lindsay**, B. C. Sales, and Z. Tian, *Physical Review B* 94, 220303(R) (2016). [13 citations]

35. “Optic phonons and anisotropic thermal conductivity in hexagonal $Ge_2Sb_2Te_5$,” S. Mukhopadhyay, **L. Lindsay**, and D. J. Singh, *Scientific Reports* 6, 37076 (2016). [13 citations]

34. “Isotope scattering and phonon thermal conductivity in light atom systems: LiH and LiF ,” **L. Lindsay**, *Physical Review B* 94, 174304 (2016). [7 citations]

33. “Physically founded phonon dispersions of few-layer materials and the case of borophene,” J. Carrete, W. Li, **L. Lindsay**, D. A. Broido, L. J. Gallego, and N. Mingo, *Materials Research Letters* 4, 204 (2016). [73 citations]

32. “Basal-plane thermal conductivity of nanocrystalline and amorphized thin germanane,” G. Coloyan, N. Cultrara, A. Katre, J. Carrete, M. Heine, E. Ou, J. Kim, S. Jiang, **L. Lindsay**, N. Mingo, D. A. Broido, J. Heremans, J. Goldberger, and L. Shi, *Applied Physics Letters* 109, 131907 (2016). [4 citations]

31. “First principles Peierls-Boltzmann thermal transport: A topical review,” **L. Lindsay**, *Nanoscale and Microscale Thermophysical Engineering* 20, 67 (2016). [31 citations]

30. “Role of low-energy phonons with mean-free-paths $>0.8 \mu m$ in heat conduction in silicon,” P. Jiang, **L. Lindsay**, and Y. K. Koh, *Journal of Applied Physics* 119, 245705 (2016). [15 citations]

29. “Electronic structure and electron-phonon coupling in TiH_2 ,” K. V. Shanavas, **L. Lindsay** and D. S. Parker, *Scientific Reports* 6, 28102 (2016). [6 citations]

28. “Thermal conductivity of graphene mediated by strain and size,” Y. Kuang, **L. Lindsay**, S. Shi, X. Wang, and B. Huang, *International Journal of Heat and Mass Transfer* 101, 772 (2016). [29 citations]

27. “Optic phonon bandwidth and lattice thermal conductivity: the case of Li_2X ($X=O, S, Se, Te$),” S. Mukhopadhyay, **L. Lindsay** and D. S. Parker, *Physical Review B* 93, 224301 (2016). [11 citations]

26. “Tensile strains give rise to strong size effects for thermal conductivities of silicene, germanene and stanene,” Y. D. Kuang, **L. Lindsay**, S. Q. Shi, and G. P. Zhen, *Nanoscale* 8, 3760 (2016). [68 citations]

2015

25. “Calculated transport properties of CdO : thermal conductivity and thermoelectric power factor,” **L. Lindsay** and D. Parker, *Physical Review B* 92, 144301 (2015). [10 citations]

24. “Unusual enhancement in intrinsic thermal conductivity of multi-layer graphene by tensile strain,” Y. Kuang, **L. Lindsay**, and B. Huang, *Nano Letters* 15, 6121 (2015). [38 citations]

23. “Reexamination of basal plane thermal conductivity of suspended graphene samples measured by electro-thermal micro-bridge methods,” I. Jo, M. T. Pettes, **L.**

Lindsay, E. Ou, A. Weathers, A. L. Moore, Z. Yao, and L. Shi, *AIP Advances* 5, 053206 (2015). [21 citations]

22. “Low-loss, infrared and terahertz nanophotonics using surface phonon polaritons,” J. D. Caldwell, **L. Lindsay**, V. Giannini, I. Vurgaftman, T. L. Reinecke, S. A. Maier, and O. J. Glembocki, *Nanophotonics* 4, 44 (2015). [177 citations]

21. “Anomalous pressure dependence of thermal conductivity of large mass ratio compound materials,” **L. Lindsay**, D. A. Broido, J. Carrete, N. Mingo, and T. L. Reinecke, *Physical Review B* 91, 121202(R) (2015). [27 citations]

2014 20. “The Seebeck coefficient and phonon drag in silicon,” G. D. Mahan, **L. Lindsay**, and D. A. Broido, *Journal of Applied Physics* 116, 245102 (2014). [13 citations]

19. “Phonon thermal transport in strained and unstrained graphene from first principles,” **L. Lindsay**, W. Li, J. Carrete, N. Mingo, D. A. Broido, and T. L. Reinecke, *Physical Review B* 89, 155426 (2014). [174 citations]

18. “Ab initio thermal transport,” chapter in *Length-Scale Dependent Phonon Interactions, Topics in Applied Physics*, Vol. 128, pp. 137-173, N. Mingo, D. A. Stewart, D. A. Broido, **L. Lindsay**, and W. Li, edited by S. L. Shinde and G. P. Srivastava (Springer, New York, 2014). [38 citations]

2013 17. “Ab initio study of the unusual thermal transport properties of boron arsenide and related materials,” D. A. Broido, **L. Lindsay**, and T. L. Reinecke, *Physical Review B* 88, 214303 (2013). [46 citations]

16. “Phonon-isotope scattering and thermal conductivity in materials with a large isotope effect: A first-principles study,” **L. Lindsay**, D. A. Broido, and T. L. Reinecke, *Physical Review B* 88, 144306 (2013). [45 citations]

15. “First-principles determination of ultrahigh thermal conductivity of boron arsenide: A competitor for diamond?,” **L. Lindsay**, D. A. Broido, and T. L. Reinecke, *Physical Review Letters* 111, 025901 (2013) “Editor’s Suggestion”. [175 citations]

Selected for a Viewpoint in *Physics* (<http://physics.aps.org/articles/v6/76>) and featured in *Physics Today* 67(8), 27 (2014).

14. “Ab initio thermal transport in compound semiconductors,” **L. Lindsay**, D.A. Broido, and T. L. Reinecke, *Physical Review B* 87, 165201 (2013) “Editor’s Suggestion”. [161 citations]

2012 13. “Thermal conductivity of bulk and nanowire $Mg_2Si_xSn_{1-x}$ alloys from first principles,” W. Li, **L. Lindsay**, N. Mingo, D. A. Broido, and D. A. Stewart, *Physical Review B* 86, 195436 (2012). [235 citations]

12. “Thermal conductivity of diamond under extreme pressure: A first principles study,” D. A. Broido, **L. Lindsay**, and A. Ward, *Physical Review B* 86, 115203 (2012). [47 citations]

11. “Thermal conductivity and large isotope effect in GaN from first principles,” **L. Lindsay**, D. A. Broido, and T. L. Reinecke, *Physical Review Letters* 109, 095901 (2012). [142 citations]
10. “Thermal conductivity of diamond nanowires from first principles,” W. Li, N. Mingo, **L. Lindsay**, D. A. Broido, D. A. Stewart, and N. A. Katcho, *Physical Review B* 85, 195436 (2012). [167 citations]
9. “Theory of thermal transport in multilayer hexagonal boron nitride and nanotubes,” **L. Lindsay** and D. A. Broido, *Physical Review B* 85, 035436 (2012). [45 citations]
- 2011 8. “Enhanced thermal conductivity and isotope effect in single-layer hexagonal boron nitride,” **L. Lindsay** and D. A. Broido, *Physical Review B* 84, 155421 (2011). [163 citations]
7. “Flexural phonons and thermal transport in multilayer graphene and graphite,” **L. Lindsay**, D. A. Broido, and N. Mingo, *Physical Review B* 83, 235428 (2011). [163 citations]
- 2010 6. “Diameter dependence of carbon nanotube thermal conductivity and extension to the graphene limit,” **L. Lindsay**, D. A. Broido, and N. Mingo, *Physical Review B* 82, 161402(R) (2010). [110 citations]
5. “Flexural phonons and thermal transport in graphene,” **L. Lindsay**, D. A. Broido, and N. Mingo, *Physical Review B* 82, 115427 (2010) “Editor’s Suggestion”. [371 citations]
4. “Optimized Tersoff and Brenner empirical potential parameters for lattice dynamics and phonon thermal transport in carbon nanotubes and graphene,” **L. Lindsay** and D. A. Broido, *Physical Review B* 81, 205441 (2010). [515 citations]
3. “Two-dimensional phonon transport in supported graphene,” J. H. Seol, I. Jo, A. L. Moore, **L. Lindsay**, Z. H. Aitken, M. T. Pettes, X. Li, Z. Yao, R. Huang, D. A. Broido, N. Mingo, R. S. Ruoff, and L. Shi, *Science* 328, 213 (2010). [1083 citations]
- 2009 2. “Lattice thermal conductivity of single-walled carbon nanotubes: Beyond the relaxation time approximation and phonon-phonon scattering selection rules,” **L. Lindsay**, D. A. Broido, and N. Mingo, *Physical Review B* 80, 125407 (2009). [94 citations]
- 2008 1. “Three-phonon phase space and lattice thermal conductivity in semiconductors,” **L. Lindsay** and D. A. Broido, *Journal of Physics: Condensed Matter* 20, 165209 (2008). [122 citations]

Invited Presentations:

- 2020 “Advancing insights into phonon thermal transport with theory/experiment interactions,” invited talk at the TMS annual meeting, San Diego, CA (February)
- 2019 “Phonon thermal transport in 2D materials (and 1D and bulk),” invited talk at the International Institute of Physics Workshop: 2D Materials: From Fundamentals to Spintronics, Natal, Brazil (September)

- “My struggles with phonon transport,”* invited talk at the Telluride Science Research Center, Thermal Transport at the Nanoscale workshop, Telluride, CO (June)
- “Phonon thermal transport in nanostructured materials,”* invited talk at the International Workshop on Computational Nanotechnology, Evanston, IL (May)
- “Building understanding of phonon thermal transport – Calculations and experiment,”* Tutorial at Materials Research Society spring meeting, Phoenix, AZ, (April)
- “Predicting thermal transport in materials: Challenges and insights,”* invited colloquium at the University of South Florida, Tampa, FL (February)
- “Phonon thermal transport: Reconciling predictions with reality,”* invited talk at the Electronic Materials and Applications conference (American Ceramics Society), Orlando, FL (January)
- 2018 *“Predicting anharmonic phonon lifetimes and lattice properties,”* invited tutorial at American Physical Society March meeting, Los Angeles, CA (March)
- “Lattice thermal transport: Barriers and channels, challenges and insights,”* invited seminar at University of California, LA, Los Angeles, CA (March)
- 2017 *“Phonon thermal transport: Barriers and channels, challenges and insights,”* invited seminar at Vanderbilt University, Nashville, TN (September)
- “Enhanced thermal conductivity in new materials,”* invited talk at Highly Efficient Advanced Thermal Energy Research (HEATER) workshop, Berkeley, CA (July)
- “Nanoscale phonon thermal transport: insights and predictions,”* invited talk at IEEE International Conference on Nanotechnology, Pittsburgh, PA (July)
- “First principles nanoscale phonon transport: insights and predictions,”* invited talk at the 9th US-Japan Joint Seminar on Nanoscale Transport Phenomena, Tokyo, Japan (July)
- “Phonon thermal transport: barriers and channels, challenges and insights,”* invited colloquium at Missouri University of Science and Technology, Rolla, MO (April)
- 2016 *“Phonons from first principles: scattering and transport in bulk and nanoscale systems,”* invited seminar/guest lecture at University of Texas at Austin, Austin, TX
- “First principles phonon thermal transport: from bulk to the nanoscale,”* invited talk at the International Institute of Physics Workshop: *Thermal and Electronic Transport in Nanostructures*, Natal, Brazil
- 2015 *“Lattice thermal transport from first principles: predictive power?”* invited seminar at Carnegie Mellon University, Pittsburgh, PA
- “Lattice thermal transport from first principles: predictive power?”* invited seminar at Oak Ridge National Laboratory, Oak Ridge, TN
- “First principles lattice thermal transport: nanoscale systems,”* invited talk at Materials Research Society spring meeting, San Francisco, CA

2014 “*First principles phonon thermal transport*,” invited talk at Stony Brook University, Stony Brook, NY

 “*First principles phonon thermal transport*,” invited talk at the Army Research Laboratory, Adelphi, MD

 “*First principles phonon thermal transport*,” invited talk at the University of Texas at Austin, Austin, TX