Samuel D. Oberdick, PhD

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Education

University of Chicago *June 2010*
BA in Physics, with Honors

Carnegie Mellon University *June 2012*
MA in Physics

Carnegie Mellon University *December 2016*
PhD in Physics
Advisor: Sara Majetich
Thesis: "Patterned Magnetic Structures via Directed Assembly of Nanoparticles and E-Beam Lithography"

Professional Appointments and Research Positions

Research Associate, Department of Physics *July 2021-Present*
University of Colorado, Boulder, CO

Postdoctoral Researcher, National Institutes of Health *March 2020-August 2020*
Joint position – National Institute of Neurological Disorders and Stroke (NINDS) and National Institute of Standards and Technology (NIST)
Boulder, CO
Advisor: Gary Zabow

Postdoctoral Researcher, PREP (Professional Research Experience Program) *March 2019-July 2021*
University of Colorado, Boulder, CO
Advisor: Gary Zabow

National Research Council (NRC) Postdoctoral Fellow *March 2017-March 2019*
National Institute of Standards and Technology, Boulder, CO
Advisor: Gary Zabow

Graduate Research Assistant *June 2011-December 2016*
Carnegie Mellow University, Pittsburgh, PA
Advisor: Sara Majetich

Publications

Total citations: 470 h-index: 11
Publication count: 19 (7 as 1st author)

1. **S. D. Oberdick**, S. J. Dodd, A. P. Koretsky, G. Zabow, "Shaped magnetogel microparticles for multispectral resonance contrast and sensing." *ACS Sensors*, 9 (1), 42-51 (2024).
2. **S. D. Oberdick**, K. V. Jordanova, J. T. Lundstrom, G. Parigi, M. E. Poorman, G. Zabow, K. E. Keenan. "Iron oxide nanoparticles as positive T1 contrast agents for low-field magnetic resonance imaging at 64 mT." *Scientific Reports*, 13, 11520 (2023).
3. M. Kraft, S. Ryger, B. P. Berman, M. Downs, K. V. Jordanova, M. E. Poorman, **S. D. Oberdick**, S. E. Ogier, S. E. Russek, J. Dagher, K. E. Keenan. "Towards a barrier-free anthropomorphic brain phantom for

quantitative magnetic resonance imaging: design, first construction attempt, and challenges." *PLOS One,* 18 (7), e0285432 (2023).

4. **S. D. Oberdick**, J. A. Borchers, K. L. Krycka. "Magnetic correlations of iron oxide nanoparticles as probed by polarized SANS in stretched magneto-elastomer composites." *Applied Physics Letters,* 120 (5), 05240 (2022).
5. K. J. Walsh, S. Shah, P. Wei, **S. D. Oberdick**, D. M. McTigue, G. Agarwal. "Effects of fixatives on histomagnetic evaluation of iron in rodent spleen." *Journal of Magnetism and Magnetic Materials,* 521, 167531 (2020).
6. **S. D. Oberdick**, S. E. Russek, M. E. Poorman, G. Zabow. "Observation of iron oxide nanoparticle growth in magnetogels using magnetic resonance imaging." *Soft Matter,* 16 (45), 10244-10251 (2020). ***Cover feature***.
7. **S. D. Oberdick**, G. Zabow. "Patterned surface energy in elastomeric molds as a generalized approach to polymer particle fabrication." *ACS Applied Polymers*, 2 (2), 846 (2020).
8. Y. Ijiri, I. Hunt-Isaak, H. Pan, J. Hsieh, K. L. Krycka, J. A. Borchers, J. J. Rhyne, **S. D. Oberdick**, A. Abdelgawad, and S A. Majetich. "Correlated spin canting in ordered core-shell $Fe_3O_4/Mn_xFe_{3-x}O_4$ nanoparticle assemblies." *Physical Review B,* 99 (9), 094421 (2019).
9. M. Bapna, B. Parks, **S. D. Oberdick**, H. Almasi, C. Sun, P. M. Voyles, W. Wang, S. Majetich. "Effect of Mo capping in sub-100 nm CoFeB-MgO tunnel junctions with perpendicular magnetic anisotropy." *Journal of Magnetism and Magnetic Materials*, 483, 34 (2019).
10. K. Krycka, J. Rhyne, **S. D. Oberdick**, A. Abdelgawad, J. Borchers, Y. Ijiri, S. Majetich, J. Lynn. "Spin waves across 3-dimensional, close-packed nanoparticles." *New Journal of Physics*, 20, 123020 (2018).
11. M. Bapna, B. Parks, **S. D. Oberdick**, H. Almasi, W. Wang, S. A. Majetich. "Spin-orbit-torque switching in 20-nm perpendicular magnetic tunnel junctions." *Physical Review Applied,* 10, 024013 (2018).
12. **S. D. Oberdick**, A. Abdelgawad, C. Moya, S. Mesbahi-Vasey, D. Kepaptsoglou, V. K. Lazarov, R. F. L. Evans, D. Meilak, E. Skoropata, J. van Lierop, I. Hunt-Isaak, H. Pan, Y. Ijiri, K. L. Krycka, J. A. Borchers, S. A. Majetich. "Spin canting across core-shell $Fe_3O_4/Mn_xFe_{3-x}O_4$ nanoparticles." *Scientific Reports,* 8, 3425 (2018). ***Top 100 Physics Publications in Scientific Reports for 2018 (27th most accessed paper).***
13. Z. Nedelkoski, D. Kepaptsoglou, L. Lari, T. Wen, R. A. Booth, **S. D. Oberdick**, D. Gilks, Q. M. Ramasse, R. F. L. Evans, S. A. Majetich, V. K. Lazarov. "Origin of reduced magnetization and domain formation in small magnetite nanoparticles." *Scientific Reports,* 7, 45997 (2017).
14. S. K. Piotrowski, M. Bapna, **S. D. Oberdick**, S. A. Majetich, M. Li, C. L. Chien, R. Ahmed, and R. H. Victora. "Size and voltage dependence of effective anisotropy in sub-100-nm perpendicular magnetic tunnel junctions." *Physical Review B*, 94, 014404 (2016).
15. Abdelgawad, **S. D. Oberdick**, S. A. Majetich. "Formation of FePt nanoparticle arrays using nanohole templates." *AIP Advances*, 6, 056114 (2016).
16. M. Bapna, S. K. Piotrowski, **S. D. Oberdick**, M. Li, C. L. Chien, and S. A. Majetich. "Magnetostatic effects on switching in small magnetic tunnel junctions." *Applied Physics Letters*, 108 (2), 022406 (2016).
17. Y. Zhang, **S. D. Oberdick**, E. R. Swanson, S. L. Anna, S. Garoff. "Gravity driven current during the coalescence of two sessile drops." *Physics of Fluids,* 27, 022101 (2015).
18. K. Hasz, Y. Ijiri, K. L. Krycka, J. A. Borchers, R. A. Booth, **S. D. Oberdick**, and S. A. Majetich. "Particle moment canting in $CoFe_2O_4$ nanoparticles." *Phys. Rev. B,* 90, 180405 (2014).
19. **S. D. Oberdick** and S. A. Majetich. "Electrophoretic deposition of iron oxide nanoparticles on templates." *J. Phys. Chem. C,* 117, 18709 (2013).

Press Features

- Shape-Shifting Probes Will Help Improve MRI Imaging (2024)
- NIST's Ultra-small, Shape-shifting GEMS Offer an Easier and Cheaper Way to Improve MRI (2023)
- Iron Oxide Nanoparticles Boost the Contrast in Low-Field MRI Scanners (2023)
- New NIST Measurements Aim to Advance and Validate Portable MRI Technology (2023)
- The Creative Minds Working Behind the Scenes on Agents of MRI Contrast (2023)
- Polymer Microparticle Molds (2020)

Seminars and Invited Talks

1. "Magnetic Nano- and Microstructures for Unambiguous MRI Contrast Generation and Sensing." Invited speaker at 2024 Institute of Electrical and Electronics Engineers (IEEE) Nano Conference Pneumosensor Workshop. Gijon, Spain (2024).
2. "Emerging Applications of Magnetic Nanoparticles for MRI Contrast: Positive T1 Contrast at Low Field and 'Color' Contrast at High Field." Invited speaker for 68th Annual Conference on Magnetism and Magnetic Materials. Dallas, TX (2023).
3. "Emerging Applications of Magnetic Nanoparticles for MRI Contrast: Positive T1 Contrast at Low Field and 'Color' Contrast at High Field." Invited speaker for the 1st Conference of Magnetic Technologies and Clinical Applications in Neuroscience, University of Minnesota. Minneapolis, MN (2023).
4. "Unambiguous MRI Contrast with Magnetic Nanoparticles: 'Color' Contrast at High Field and Positive Contrast at Low Field." Invited speaker for American Physical Society (APS) annual meeting focus session, "Biomagnetic Imaging and Sensing." Las Vegas, NV (2023).
5. "Exploring Nanomagnetism in Magnetic Polymer Composite Materials." Micro-Nano Seminar for Dept. of Mechanical and Aerospace Engineering, The Ohio State University. Columbus, OH (2022).
6. "New Approaches for Fabrication of Multispectral MR Agents Using Magnetic Hydrogel (Magnetogel) Composites." Seminar for Laboratory of Functional and Molecular Imaging Group at Natl. Inst. of Health (NIH). Virtual Talk (2020).
7. "Magnetic Nano- and Micro- Structures for MRI Contrast Generation and Sensing." Mini-Seminar for Physical Measurement Laboratory, NIST. Virtual talk (2020).
8. "Polymer Scaffolds as Templates for Synthesis of Magnetic Nanoparticles." University of Colorado at Colorado Springs, Magnetic Nanoparticle Workshop. Colorado Springs, CO (2019).
9. "Magnetic Nanoparticles: Form, Function and Synthesis." University of Colorado at Colorado Springs, Physics Department Seminar. Colorado Springs, CO (2019).
10. "Dynamic Visualization and Characterization of Nano-Iron Growth using MRI." Frontiers in Biomagnetic Particles Conference. Telluride, CO (2019).
11. "Magnetic Nanoparticles 101." Summer Undergraduate Research Fellowship (SURF) Seminar (Educational seminar aimed at introducing undergraduate level students to a particular field of research). NIST. Boulder, CO (2018).
12. "Making the Most of the Moment - A Guide to Magnetic Nanoparticles." Seminar for Laboratory of Functional and Molecular Imaging Group at Natl. Inst. of Health (NIH). Bethesda, MD (2018).

Contributed Talks

1. "Shaped Magnetic Hydrogel Microparticles for Multispectral Magnetic Resonance Contrast and Smart Sensing." Frontiers in Magnetic Particles. Greenville, SC (2023).

2. “Iron oxide nanoparticles as T1 agents for low-field MRI.” Scientific and Clinical Applications of Magnetic Carriers, 13th Meeting. London, UK (2022).
3. “Magnetic correlations of iron oxide nanoparticles as probed by PASANS in stretched magnetogel composites.” Magnetism and Magnetic Materials-Intermag Joint Conference (MMM-Intermag). Virtual talk (2022).
4. “MRI visualization of nano-iron growth in magnetic polymers,” Rocky Mountain MRI Mashup. Virtual talk (2020).
5. “In-situ visualization of iron oxide nanoparticle growth within a hydrogel network using magnetic resonance imaging (MRI).” Magnetism and Magnetic Materials (MMM). Las Vegas, NV (2019).
6. “Control of separation in self-assembled nanoparticle arrays.” ACS - Colloid and Surface Science Symposium. Carnegie Mellon University (2015).
7. “Field-Induced Magnetic Shell Formation in Ferrite Nanoparticles.” Magnetism and Magnetic Materials (MMM). Honolulu, Hawaii (2014).
8. “Electrophoretic deposition of iron oxide nanoparticles: Dynamics and 2D assembly.” ACS - Colloid and Surface Science Symposium. University of Pennsylvania (2014).
9. “Electrophoretic patterning of magnetic nanoparticles." Magnetism and Magnetic Materials - Intermag Joint Conference. Chicago, Illinois (2013).
10. “Electric field driven self-assembly of gold nanoparticles suspended in a nonpolar solvent.” ACS - Colloid and Surface Science Symposium. Johns Hopkins University (2012).
11. “Interference between vibrational modes in bubble break-up.” APS - DFD. Long Beach, CA (2010).
12. “Combinations of neck vibrations in bubble break-up.” APS - DFD. Minneapolis, Minnesota (2009).

Contributed Posters

1. “Microfabricated Magnetic gel Composites as pH Sensitive Contrast Agents.” Scientific and Clinical Applications of Magnetic Carriers. Copenhagen, Denmark (2018).
2. “Magnetization Reduction and Domain Formation in Magnetite Nanoparticles: A Comparative Study of Three Common Thermal Decomposition Based Syntheses.” Frontiers in Biomagnetic Particles Conference. Asheville, North Carolina (2017). ***Best Poster Winner.***
3. “Dense Nanodot Arrays from Nanoparticle Masking.” C-SPIN Annual Review. University of Minneapolis, Minnesota (2015).
4. “Electrophoretic Deposition of Nanoparticles on Patterned Substrates.” Fall MRS Conference. Boston, Massachusetts (2013).
5. “Electric field driven self-assembly of close-packed monolayers of gold nanoparticles suspended in a nonpolar solvent.” Spring MRS Conference. San Francisco, California (2012).
6. “Breakup of an underwater bubble: singularity, memory, and interference.” SIAM Annual Meeting, Pittsburgh, PA (2010). ***Best Undergraduate Poster Award.***

Mentoring and Outreach

Legend: (*) Undergraduate student authored or co-authored a peer-reviewed scientific publication
Acronyms: Magnetic resonance imaging (MRI), Magnetic nanoparticles (MNPs), Magnetic force microscopy (MFM)

High School Students (1 student)

Name:	Location, year(s):	Project Description:
1. Katie Carson	NIST, 2020	• MRI phantoms

Undergraduates (7 students)

Name:	Location, year(s):	Project Description:
1. Gabriella Erich	NIST, 2024	• Low-field MRI contrast agents
2. Sierra Reis	OSU & NIST 2023-2024	• MNP TEM image analysis & MFM on clusters of MNPs
3. Katie Betz	NIST, 2023	• Bio-inspired clusters of MNPs
4. Andrew Kabos	NIST, 2022	• 3D printer for MNP-polymer composites
5. John Lundstrom (*)	NIST, 2021 – 2022	• MNP TEM image analysis
6. Mikhail Kraft (*)	NIST, 2019 – 2022	• Anthropomorphic MRI brain mimic
7. Sonal Nanda	CMU, 2014-2015	• Directed assembly of MNPs

Graduate Students (2 students)

Name:	Location, year(s)	Project Description and PhD Subject Area:
1. Kenzi Kottenbrock	OSU & NIST, 2022 - present	• MFM on bio-inspired clusters of MNPs • PhD student in Biomedical Engineering at OSU
2. Kevin Walsh	OSU & NIST, 2019 - 2022	• Magnetic characterization of biological MNPs • PhD student in Biophysics at OSU

Additional mentoring activities:

- Serving on CU Boulder graduate student (ECEE) Jan Bartos' Ph.D. dissertation committee (April 2024 - present)
- Member of the NIST Boulder Summer Undergraduate Research Fellowships (SURF) Committee (2024 to present)
- For the summers of 2022 and 2023, acquired funding for and developed REU internships for two undergraduate level students (Katie Betz and Andrew Kabos) where they participated in hands-on research at NIST, Boulder
- Served on OSU graduate student (Biophysics) Kevin Walsh's Ph.D. dissertation committee (April 2022)
- Delivered presentation on careers in science to UChicago Science Trek program (March 2022)
- Designed a kitchen-safe, hands-on laboratory, enabling a high school student intern (Katie Carson) to perform science while restricted from the lab due to COVID-19. The learning module used virtual interactions with scientists in the lab, allowing the student to participate in measurements made on "MRI phantoms" that they made at home (Summer, 2020)
- Hosted and mentored OSU graduate student, Kevin Walsh, as part of NSF Non-Academic Research Internships for Graduate Students (INTERN) program (NIST, Summer 2019)
- Delivered introductory lecture on magnetic nanoparticles for SURF (Summer Undergraduate Research Fellows) at NIST (Summer, 2018)

Teaching

- Teaching Assistant, Physics 1 for Engineering Students (Spring 2011)
- Teaching Assistant, Physics 1 for Engineering Students (Autumn 2010)

Professional Service

- Treasurer of Rocky Mountain Chapter of IEEE Magnetics Society (2022 to present)

- Member of APS Topical Group on Magnetism and its Applications (Since 2022)
- Member of IEEE and IEEE Magnetics Society (Since 2019)
- Participated in "Career Panel" session at Frontiers in Magnetic Particles meeting. Greenville, SC (2023)
- Chaired "Imaging" session at Frontiers in Magnetic Particles meeting. Greenville, SC (2023)
- Co-chaired joint GMAG/GMED focus session entitled "Biomagnetic Imaging and Sensing" at American Physical Society (APS) annual meeting. Las Vegas, NV (2023)
- Chaired "Synthesis" session at Frontiers in Magnetic Particles meeting. Telluride, CO (2019)
- Participated in "Career Panel" session at Frontiers in Magnetic Particles meeting. Telluride, CO (2019)
- Ad hoc reviewer for *Nature Communications Biology, Nanoscale Advances, Journal of Magnetism and Magnetic Materials, Particle and Particle Systems Characterization, Journal of Magnetic Resonance, ACS Applied Nano Materials, ACS Advances, IEEE Transactions on Magnetics, IEEE Magnetics Letters, NIST Editorial Review Board (ERB)*

Grants and Funding

1. NIST CHIPS Program
   Metrology for Integration of New Magnetic Materials
   Characterization of high-frequency (RF and microwave) response of novel magnetic materials for applications in microelectronics and chip-scale devices. $4,260k over 4 years.
   Role: Team Member
   Date: FY 2024 - FY 2027
2. NSF-CBET (2038046)
   Magnetic Mapping of Bio-Inspired Clusters of Iron Oxide Nanoparticles
   Project focused on exploring relationship between nanoparticle clustering in bio-inspired environments and resultant magnetization for mapping or signal detection. ~$100k/year.
   Role: PI at CU Boulder (joint with G. Agarwal at OSU)
   Date: 4/1/2021 - 3/31/2024
3. NSF-CBET REU Supplement (2038046)
   Characterization of Bio-Inspired Magnetic Nanoparticle Clusters
   Received REU supplement to fund summer project for an undergraduate engineering student. $8k.
   Role: PI at CU Boulder
   Date: May 2023 – August 2023
4. NSF-CBET REU Supplement (2038046)
   Design of a 3D-Bioprinter for Fabricating Voxelated Magnetic Polymer Composites
   Received REU supplement to fund summer project for an undergraduate engineering student from CU Boulder. $7k.
   Role: PI at CU Boulder
   Date: May 2022 – August 2022
5. National Research Council Fellowship
   A research proposal is required for application to the NRC Fellowship program. Oberdick wrote a proposal for his successful application suggesting investigation of novel forms of contrast generation using magnetic micro-/nano- structure with MRI/NMR. The Fellowship provided funding for two years of salary at NIST, Boulder.
   Role: Fellow
   Date: March 2017 - March 2019

Awards, Honors and Fellowships

- Selected to attend "Introduction to Academic Radiology for Scientists Workshop" at annual Radiological Society of North America (RSNA) meeting (PhD scientists in imaging research and biomedical engineering are introduced to the scope of research and the keys to success in the imaging sciences) (2019)
- Top 100 in Physics Publication in Scientific Reports (27th most accessed paper) (2018)
- Best Poster Award, Frontiers in Biomagnetic Particles Conference (2017)
- National Research Council (NRC) Postdoctoral Fellowship (2017 - 2019)
- J. Michael McQuade Nanophysics and Energy Fellowship (2013)
- Best Undergraduate Student Poster, SIAM (Society for Industrial and Applied Mathematics) Conference (2010)
- James Frank Institute (University of Chicago) Undergraduate Fellow (2009)

Technical Skills

Nano and microfabrication: Experience developing multi-step fabrication schemes to create patterned magnetic materials for applied physics research. Skills include photolithography, thin film deposition, electron beam lithography, dry etching, argon ion milling, deep reactive ion etching, spinning of photoresist, and chemical development and processing of micropatterned wafers.

Characterization of magnetic materials: Expert at measurement of magnetic properties of nano- and microscale magnetic materials. Skills include various types of magnetometry (superconducting quantum interference device or SQUID, vibrating sample magnetometry, alternating gradient magnetometry) and polarized neutron scattering. Some familiarity with magnetic force microscopy.

Characterization of nano- and micromaterials: Routinely characterizes structural and chemical properties of nanomaterials. Skills include transmission electron microscopy (TEM), scanning electron microscopy (SEM), optical microscopy, X-ray diffraction, atomic absorption spectroscopy (AAS), optical absorption measurements, dynamic light scattering and profilometry.

Magnetic resonance: Experience using magnetic resonance techniques to probe bio-magnetic systems. Skills include nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI).

Software, analysis and programming: Regularly performs analysis of data and modelled magnetic structures. Skills include Python, MATLAB, COMSOL, Origin, Igor. Familiarity with Java.

Laboratory management: During time at NIST, helped design and maintain 800 sq. ft. laboratory space used for fabrication and synthesis of magnetic microdevices. Regularly writes safe operating procedures for laboratory procedures evaluates safe practices in the lab.