

# Felix Büttner

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<b>KEYWORDS</b>	<b>Topological materials (skyrmions), thin-film magnetic materials, coherent soft x-ray imaging, ultrafast science, x-ray free-electron lasers</b>
<b>EDUCATION</b>	<b>University of Mainz</b> , Germany. PhD in Physics. Nov 2013 <b>University of Göttingen</b> , Germany. Diplom (MS equivalent) in Physics. Feb 2010
<b>RESEARCH EXPERIENCE</b>	<b>Helmholtz-Zentrum Berlin</b> , Germany. Research Group Leader. Mar 2020 – present <b>Massachusetts Institute of Technology</b> , USA. Postdoc. Oct 2015 – Feb 2020
<b>INDUSTRY EXPERIENCE</b>	<b>Daimler AG</b> , Stuttgart, Germany. IT Engineer. Feb 2014 – Jul 2015
<b>PUBLICATIONS</b>	<b>Metrics</b> Peer-reviewed articles: >35, citations: >1500, h-index: 18 (Google Scholar) <b>Selected Publications</b> ( <a href="#">Link to full publication list</a> ) <ol style="list-style-type: none"><li>Thermal nucleation and high-resolution imaging of sub-micrometer bubbles in ultrathin thulium iron garnet films. <a href="#">F. Büttner</a><sup>†</sup>, M. A. Mawass<sup>†</sup>, J. Bauer, E. Rosenberg, L. Caretta, C. O. Avci, J. Gräfe, S. Finizio, C. A. F. Vaz, N. Novakovic, M. Weigand, K. Litzius, J. Förster, N. A. Träger, F. Groß, D. Suzuki, M. Huang, J. Bartell, F. Kronast, G. Schütz, C. A. Ross, and G. S. D. Beach. <i>Physical Review Materials</i> <b>4</b>, 011401(R) (2020).</li><li>Fast current-driven domain walls and small skyrmions in a compensated ferrimagnet. L. Caretta<sup>†</sup>, M. Mann<sup>†</sup>, <a href="#">F. Büttner</a><sup>†</sup>, K. Ueda, B. Pfau, C. M. Günther, P. Hession, A. Churikova, C. Klose, M. Schneider, D. Engel, C. Markus, D. Bono, K. Bagschik, S. Eisebitt, and G. S. D. Beach. <i>Nature Nanotechnology</i> <b>13</b>, 1154 (2018).</li><li>Theory of isolated magnetic skyrmions: From fundamentals to room temperature applications. <a href="#">F. Büttner</a>, I. Lemesh, and G. S. D. Beach. <i>Scientific Reports</i> <b>8</b>, 4464 (2018).</li><li>Field-free deterministic ultrafast creation of skyrmions by spin-orbit torques. <a href="#">F. Büttner</a><sup>†</sup>, I. Lemesh<sup>†</sup>, M. Schneider, B. Pfau, C. M. Günther, P. Hession, J. Geilhufe, L. Caretta, D. Engel, B. Krüger, J. Viefhaus, S. Eisebitt, and G. S. D. Beach. <i>Nature Nanotechnology</i> <b>12</b>, 1040 (2017) (cover story).</li><li>Dynamics and inertia of skyrmionic spin structures. <a href="#">F. Büttner</a><sup>†</sup>, C. Moutafis<sup>†</sup>, M. Schneider, B. Krüger, C. M. Günther, J. Geilhufe, C. v. Korff Schmising, J. Mohanty, B. Pfau, S. Schaffert, A. Bisig, M. Foerster, T. Schulz, C. A. F. Vaz, J. H. Franken, H. J. M. Swagten, M. Kläui, and S. Eisebitt. <i>Nature Physics</i> <b>11</b>, 225 (2015).</li></ol> <b>Patents</b> <ol style="list-style-type: none"><li>Methods and apparatus for making magnetic skyrmions. <a href="#">F. Büttner</a>, I. Lemesh, and G. S. D. Beach. U.S. Patent US10541074B2 (2020).</li></ol>
<b>CONFERENCES</b>	<b>Selected Invited Talks</b> 12/2020 IEEE Conference on Advances in Magnetism (AIM), Moena, Italy 09/2020 International Science@FELs Conference, Hamburg, Germany 09/2020 Congress of the International Commission on Optics and International Conference on Optics in the Life Sciences, Dresden, Germany 01/2020 WEH Workshop on Magnetism, Bad Honnef, Germany 08/2019 SPIE Conference, San Diego, CA, USA 06/2019 Workshop on Skyrmion Imaging Techniques, Singapore 07/2018 International Surface X-ray and Neutron Scattering Conference (SXNS15), Pohang, South Korea 04/2018 IEEE International Magnetism Conference (Intermag), Singapore 03/2018 Spring Meeting of the German Physical Society (DPG), Berlin, Germany 03/2018 Spring Meeting of the American Physical Society (APS), Los Angeles, CA, USA

01/2018 IEEE Conference on Advances in Magnetism (AIM), Italy  
08/2017 International Workshop on Topological Structures in Ferromagnetic Materials, Leeds, UK

#### AWARDS & SCHOLARSHIPS

- Helmholtz Young Investigator Award 2020
- NLS-II Director's Postdoc Fellowship 2018
- Best Young Researcher Award of the IEEE Italy and IEEE Magnetism Society 2018
- DFG Research Fellowship 2016

#### TEACHING ACTIVITIES

- TA for "Electrical, Optical, and Magnetic Properties of Materials" 2017
- TA for graduate physics lab courses ("Fortgeschrittenenpraktikum") 2013
- Lecturer for spring break class on thermodynamics and statistical mechanics 2010
- TA for undergraduate physics lab course ("Anfängerpraktikum") 2007 & 2009
- TA for quantum mechanics 2007
- TA for mathematics for physicists 2006

#### FULL LIST OF PUBLICATIONS

1. Interfacial Dzyaloshinskii-Moriya interaction arising from rare-earth orbital magnetism in insulating magnetic oxides.  
L. Caretta, E. Rosenberg, F. Büttner, T. Fakhru, P. Gargiani, M. Valvidares, P. Reddy, C. A. Ross, G. S. D. Beach.  
*Nature Communications* **11**, 1090 (2020).
2. Thermal nucleation and high-resolution imaging of sub-micrometer bubbles in ultrathin thulium iron garnet films.  
F. Büttner<sup>†</sup>, M. A. Mawass<sup>†</sup>, J. Bauer, E. Rosenberg, L. Caretta, C. O. Avci, J. Gräfe, S. Finizio, C. A. F. Vaz, N. Novakovic, M. Weigand, K. Litzius, J. Förster, N. A. Träger, F. Groß, D. Suzuki, M. Huang, J. Bartell, F. Kronast, G. Schütz, C. A. Ross, and G. S. D. Beach.  
*Physical Review Materials* **4**, 011401(R) (2020) (editor's selection).
3. Voltage-gated optics and plasmonics enabled by solid-state proton pumping.  
M. Huang, A. J. Tan, F. Büttner, H. Liu, Q. Ruan, W. Hu, C. Mazzoli, S. Wilkins, C. Duan, J. K. W. Yang, and G. S. D. Beach.  
*Nature Communications* **10**, 5030 (2019).
4. Measurement of interfacial Dzyaloshinskii-Moriya interaction from static domain imaging.  
P. Agrawal, F. Büttner, I. Lemesh, S. Schlotter, and G. S. D. Beach.  
*Physical Review B* **100**, 104430 (2019).
5. Generation and stability of structurally imprinted target skyrmions in magnetic multilayers.  
N. Kent, R. Streubel, C.-H. Lambert, A. Ceballos, S.-G. Je, S. Dhuey, M.-Y. Im, F. Büttner, F. Hellman, S. Salahuddin, and P. Fischer.  
*Applied Physics Letters* **115**, 112404 (2019).
6. Hydration of gadolinium oxide (GdO<sub>x</sub>) and its effect on voltage-induced Co oxidation in a Pt/Co/GdO<sub>x</sub>/Au heterostructure.  
A. J. Tan, M. Huang, S. Sheffels, F. Büttner, S. Kim, A. H. Hunt, I. Waluyo, H. L. Tuller, and G. S. D. Beach.  
*Physical Review Materials* **3**, 064408 (2019).
7. Interface-Driven Chiral Magnetism and Current-Driven Domain Walls in Insulating Magnetic Garnets.  
C. O. Avci, E. Rosenberg, L. M. Caretta, F. Büttner, M. Mann, C. Marcus, D. Bono, C. A. Ross, and G. S. D. Beach.  
*Nature Nanotechnology* **14**, 561 (2019).
8. Magneto-ionic control of magnetism using a solid-state proton pump.  
A. J. Tan, M. Huang, C. O. Avci, F. Büttner, M. Mann, W. Hu, C. Mazzoli, S. Wilkins, H. L. Tuller, and G. S. D. Beach.  
*Nature Materials* **18**, 35 (2019).
9. Fast current-driven domain walls and small skyrmions in a compensated ferrimagnet.  
L. Caretta<sup>†</sup>, M. Mann<sup>†</sup>, F. Büttner<sup>†</sup>, K. Ueda, B. Pfau, C. M. Günther, P. Hession, A. Churikova, C. Klose, M. Schneider, D. Engel, C. Markus, D. Bono, K. Bagschik, S. Eisebitt, and G. S. D. Beach.  
*Nature Nanotechnology* **13**, 1154 (2018) (cover story).

10. Current-Induced Skyrmion Generation through Morphological Thermal Transitions in Chiral Ferromagnetic Heterostructures.  
I. Lemesh, K. Litzius, M. Böttcher, P. Bassirian, N. Kerber, D. Heinze, J. Zázvorka, F. Büttner, L. Caretta, M. Mann, M. Weigand, S. Finizio, J. Raabe, M.-Y. Im, H. Stoll, G. Schütz, B. Dupé, M. Kläui, and G. S. D. Beach.  
*Advanced Materials* **30**, 1805461 (2018) (cover story).
11. Theory of isolated magnetic skyrmions: From fundamentals to room temperature applications.  
F. Büttner, I. Lemesh, and G. S. D. Beach.  
*Scientific Reports* **8**, 4464 (2018).
12. Magnetostatic twists in room-temperature skyrmions explored by nitrogen-vacancy center spin texture reconstruction.  
Y. Dovzhenko, F. Casola, S. Schlotter, T. X. Zhou, F. Büttner, R. L. Walsworth, G. S. D. Beach, and A. Yacoby.  
*Nature Communications* **9**, 2712 (2018).
13. Field-free deterministic ultra fast creation of skyrmions by spin orbit torques.  
F. Büttner<sup>†</sup>, I. Lemesh<sup>†</sup>, M. Schneider, B. Pfau, C. M. Günther, P. Hessler, J. Geilhufe, L. Caretta, D. Engel, B. Krüger, J. Viehhaus, S. Eisebitt, and G. S. D. Beach.  
*Nature Nanotechnology* **12**, 1040 (2017) (cover story).
14. Investigation of the Dzyaloshinskii-Moriya interaction and room temperature skyrmions in W/CoFeB/MgO thin films and microwires.  
S. Jaiswal, K. Litzius, I. Lemesh, F. Büttner, S. Finizio, J. Raabe, M. Weigand, K. Lee, J. Langer, B. Ocker, G. Jakob, G. S. D. Beach, M. Kläui.  
*Applied Physics Letters* **111**, 022409 (2017).
15. Accurate model of the stripe domain phase of perpendicularly magnetized multilayers.  
I. Lemesh, F. Büttner, and G. S. D. Beach.  
*Physical Review B* **95**, 174423 (2017).
16. Skyrmion Hall Effect Revealed by Direct Time-Resolved X-Ray Microscopy.  
K. Litzius, I. Lemesh, B. Krüger, L. Caretta, K. Richter, F. Büttner, P. Bassirian, J. Förster, R. M. Reeve, M. Weigand, I. Bykova, H. Stoll, G. Schütz, G. S. D. Beach, and M. Kläui.  
*Nature Physics* **13**, 170 (2017).
17. Magnetic Skyrmions: From Fundamental to Applications.  
G. Finocchio, F. Büttner, R. Tomasello, M. Carpentieri, and M. Kläui.  
*Journal of Physics D: Applied Physics* **49**, 423001 (2016) (Review Article).
18. Modification of magnetic anisotropy in Ni thin films by poling of (011) PMN-PT piezoelectrodes.  
A. Tkach, A. Kehlberger, F. Büttner, G. Jakob, S. Eisebitt, and M. Kläui.  
*Ferroelectrics* **499**, 135 (2016).
19. Quantitative analysis of magnetization reversal in Ni thin films on unpoled and poled (011)[PbMg<sub>1/3</sub>Nb<sub>2/3</sub>O<sub>3</sub>]<sub>0.68</sub>–[PbTiO<sub>3</sub>]<sub>0.32</sub> piezoelectric substrates.  
A. Tkach, A. Kehlberger, F. Büttner, G. Jakob, S. Eisebitt, and M. Kläui.  
*Journal of Physics D: Applied Physics* **49**, 335004 (2016).
20. Accurate calculation of the transverse anisotropy in perpendicularly magnetized multilayers.  
F. Büttner, B. Krüger, S. Eisebitt, and M. Kläui.  
*Physical Review B* **92**, 054408 (2015).
21. Dynamics and inertia of skyrmionic spin structures.  
F. Büttner, C. Moutafis, M. Schneider, B. Krüger, C. M. Günther, J. Geilhufe, C. v. Korff Schmising, J. Mohanty, B. Pfau, S. Schaffert, A. Bisig, M. Foerster, T. Schulz, C. A. F. Vaz, J. H. Franken, H. J. M. Swagten, M. Kläui, and S. Eisebitt.  
*Nature Physics* **11**, 225 (2015).
22. Electric field modification of magnetotransport in Ni thin films on (011) PMN-PT piezoelectrodes.  
A. Tkach, A. Kehlberger, F. Büttner, G. Jakob, S. Eisebitt, and M. Kläui.  
*Applied Physics Letters* **106**, 062404 (2015).

23. Magnetoelectric properties of epitaxial  $\text{Fe}_3\text{O}_4$  thin films on (011) PMN-PT piezosubstrates.  
A. Tkach, M. Baghaie Yazdi, M. Foerster, F. Büttner, M. Vafae, M. Fries, and M. Kläui.  
*Physical Review B* **91**, 024405 (2015).
24. Domain wall transformations and hopping in  $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$  nanostructures imaged with high resolution x-ray magnetic microscopy.  
S. Finizio, M. Foerster, B. Krüger, C. A. F. Vaz, T. Miyawaki, M. A. Mawass, L. Peña, L. Méchin, S. Hühn, V. Moshnyaga, F. Büttner, A. Bisig, L. Le Guyader, S. El Moussaoui, S. Valencia, F. Kronast, S. Eisebitt, and M. Kläui.  
*Journal of Physics: Condensed Matter* **26**, 456003 (2014).
25. Efficient spin transfer torque in  $\text{La}_{2/3}\text{Sr}_{1/3}\text{MnO}_3$  nanostructures.  
M. Foerster, L. Pena, C. A. F. Vaz, J. Heinen, S. Finizio, T. Schulz, A. Bisig, F. Büttner, S. Eisebitt, L. Mechin, V. Moshnyaga, and M. Kläui.  
*Applied Physics Letters* **104**, 072410 (2014).
26. Monolithic focused reference beam X-ray holography.  
J. Geilhufe, B. Pfau, M. Schneider, C. M. Günther, S. Werner, S. Schaffert, E. Guehrs, F. Büttner, S. Frömmel, M. Kläui, and S. Eisebitt.  
*Nature Communications* **5**, 3008 (2014).
27. Synchronous precessional motion of multiple domain walls in a ferromagnetic nanowire by perpendicular field pulses.  
J.-S. Kim, M.-A. Mawass, A. Bisig, B. Krüger, R. Reeve, T. Schulz, F. Büttner, M. Weigand, H. Stoll, J. Yoon, C.-Y. You, S. Eisebitt, H. J. M. Swagten, B. Koopmans, and M. Kläui.  
*Nature Communications* **5**, 3429 (2014).
28. Automatable sample fabrication process for pump-probe x-ray holographic imaging.  
F. Büttner, M. Schneider, C. M. Günther, C. A. F. Vaz, B. Lägél, D. Berger, S. Selve, M. Kläui, and S. Eisebitt. *Optics Express* **21**, 30563 (2013).
29. Breakdown of the X-Ray Resonant Magnetic Scattering Signal during Intense Pulses of Extreme Ultraviolet Free-Electron-Laser Radiation.  
L. Müller, C. Gutt, B. Pfau, S. Schaffert, J. Geilhufe, F. Büttner, J. Mohanty, S. Flewett, R. Treusch, S. Düsterer, H. Redlin, A. Al-Shemmary, M. Hille, A. Kobs, R. Frömter, H. P. Oepen, B. Ziaja, N. Medvedev, S.-K. Son, R. Thiele, R. Santra, B. Vodungbo, J. Lüning, S. Eisebitt, and G. Grübel.  
*Physical Review Letters* **110**, 234801 (2013).
30. Correlated velocity and domain wall spin structure oscillations.  
A. Bisig, M. Stärk, M.-A. Mawass, C. Moutafis, J. Rhensius, J. Heidler, F. Büttner, M. Noske, M. Weigand, S. Eisebitt, T. Tyliczszak, B. v. Waeyenberge, H. Stoll, G. Schütz, and M. Kläui.  
*Nature Communications* **4**, 2328 (2013).
31. Endstation for ultrafast magnetic scattering experiments at the free-electron laser in Hamburg.  
L. Müller, C. Gutt, S. Streit-Nierobisch, M. Walther, S. Schaffert, B. Pfau, J. Geilhufe, F. Büttner, S. Flewett, C. M. Günther, S. Eisebitt, A. Kobs, M. Hille, D. Stickler, R. Frömter, H. P. Oepen, J. Lüning, and G. Grübel.  
*Review of Scientific Instruments* **84**, 013906 (2013).
32. Magnetic states in low-pinning high-anisotropy material nanostructures suitable for dynamic imaging.  
F. Büttner, C. Moutafis, A. Bisig, P. Wohlhüter, C. M. Günther, J. Mohanty, J. Geilhufe, M. Schneider, C. v. Korff Schmising, S. Schaffert, B. Pfau, M. Hantschmann, M. Riemeier, M. Emmel, S. Finizio, G. Jakob, M. Weigand, J. Rhensius, J. H. Franken, R. Lavrijsen, H. J. M. Swagten, H. Stoll, S. Eisebitt, and M. Kläui.  
*Physical Review B* **87**, 134422 (2013).
33. S. Flewett, C. M. Günther, C. v. Korff Schmising, B. Pfau, J. Mohanty, F. Büttner, M. Riemeier, M. Hantschmann, M. Kläui, and S. Eisebitt. Holographically aided iterative phase retrieval. *Optics Express* **20**, 29210 (2012).

34. Ultrafast optical demagnetization manipulates nanoscale spin structure in domain walls.  
B. Pfau, S. Schaffert, L. Müller, C. Gutt, A. Al-Shemmary, F. Büttner, R. Delaunay, S. Düsterer, S. Flewett, R. Frömter, J. Geilhufe, E. Guehrs, C. M. Günther, R. Hawaldar, M. Hille, N. Jaouen, A. Kobs, K. Li, J. Mohanty, H. Redlin, W. F. Schlotter, D. Stickler, R. Treusch, B. Vodungbo, M. Kläui, H. P. Oepen, J. Lüning, G. Grübel, and S. Eisebitt.  
*Nature Communications* **3**, 1100 (2012).
35. Thickness dependence of the magnetic properties of ripple-patterned Fe/MgO(001) films.  
F. Büttner, K. Zhang, S. Seyffarth, T. Liese, H.-U. Krebs, C. A. F. Vaz, and H. Hofsäss.  
*Physical Review B* **84**, 064427 (2011).