



**College of Natural Sciences
& Mathematics**

UNIVERSITY OF DENVER

Physics & Astronomy Colloquium

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Across many research fields, engineered local variations in physical properties have enabled transformative material functionalities that underpin emerging technologies. Using lithography instrumentation originally developed for 2.5D photoresist patterning, we have recently shown that direct-write laser annealing can create arbitrarily shaped magnetic potential-energy landscapes in a wide range of application-relevant magnetic thin-film systems. By enabling spatially programmable and continuously tunable magnetic properties, this approach is particularly well suited for neuromorphic and unconventional computing architectures that rely on analog, history-dependent, and nonlinear device responses.

Exemplifying the versatility of direct-write laser annealing, we have engineered continuous variations in the magnetic compensation temperature of ferrimagnets, the interlayer coupling strength of synthetic antiferromagnets, and the magnetic anisotropy of ferromagnets and synthetic antiferromagnets. Within the context of neuromorphic computing, we further demonstrate how the energy landscapes we create can be used to emulate brain-inspired neuromorphic computing behaviors such as leaky integration and passive reset functionalities in simple magnetic structures.

Unlike conventional approaches for locally modifying materials, this direct-write process does not require patterned resist layers or ultrahigh-vacuum environments, substantially simplifying fabrication while maintaining high spatial precision. Ongoing work is currently exploring the combination of the permanently defined magnetic energy landscapes created by direct-write laser annealing with reversible magneto-ionic control, enabling hybrid static and dynamically reconfigurable functionalities relevant to further neuromorphic computing applications. We envisage that the capability to directly program local physical properties through laser annealing will enable new device concepts not only in spintronics and neuromorphic computing, but more broadly in thin-film materials whose properties respond to localized heating.

BIO: Jeff Brock has been an assistant professor in the Department of Physics and Energy Science at the University of Colorado, Colorado Springs since Fall of 2025. Before joining UCCS, he was a PSI COFUND Postdoctoral Fellow at the Paul Scherrer Institute and ETH Zurich. He earned a PhD in Materials Science and Engineering from the University of California, San Diego in 2022, and an MSc and a BSc in Physics from Miami University in 2017 and 2015, respectively.