

Triply Periodic Helical Weaves

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2025 October 17 Friday 3:00 PM

Physics Seminar in Neckers 440

Abstract: Weaving typically involves forming a surface by interlacing fibers into a mechanically stable arrangement, effectively making a two-dimensional object out of one-dimensional objects. Moorish Fretwork involves interweaving solid helical elements into mechanically stable two-dimensional arrangements by exploiting the helices' screw symmetry. A three-dimensional extension of this idea was demonstrated by Alexandru Usineviciu at the Bridges mathematical art conference in 2015. Here we expand the idea further by considering cases informed by invariant cylindrical rod packing and discuss interweaving geodesics of the gyroid. Simulations and/or physical models of twenty-eight unique triply periodic arrangements of interwoven helices are shown, with physical models demonstrated for sixteen.

Biography: Duston Wetzel is a recent graduate of SIU, receiving an M.S. in Physics in 2021 and a Ph.D. in Applied Physics in 2024. Before that, he received a B.S. in Nanoscience from Northwest Missouri State University. While at SIU, Duston's formal research focused on magneto-transport and magneto-optics in the novel materials and heterostructures laboratory. Among other things, he studied magneto-transport in bilayers involving ferromagnets and topological insulators for his M.S. and the anomalous and topological Hall effects in a novel Mn-based Heusler thin film for his Ph.D. In addition to his schoolwork, as something of a hobby project since 2019, he has been involved in the design and development of dozens of "helical weaves", including doubly periodic, triply periodic, polygonal, and polyhedral weaves. These structures exploit the screw symmetry of helical modular elements and friction

to realize complex geometric forms without glue or welding. In his free time, Duston enjoys spending time with friends and family, creating mathematical art, playing musical instruments, and exploring nature.