

CONDENSED MATTER COLLOQUIUM SERIES

Ankara

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Rice University



A strange exchange: paraparticles and where to find them

All known particles are fermions or bosons. While exceptions are known in 2D space (anyons), in 3D fermions and bosons were widely believed to be the only possibilities. In this talk, I will describe our results [Z Wang and KRA Hazzard, Nature 637, 314 (2025)] showing it is possible to have particles that are inequivalent to fermions and bosons, known as paraparticles, in arbitrary dimension. I will describe how these emerge in solvable spin models whose excitations are paraparticles. These constructions satisfy all known physical principles required of a quantum theory, including the principle of locality, i.e. that disturbing a system at some point in space does not instantaneously affect far away points. This is crucial, as powerful theorems of algebraic quantum field theory show that locality constrains particle statistics, which presented an obstacle to previous theories of paraparticles. I will describe how our construction evades these theorems' constraints, some implications, and experimental systems in ultracold matter where we may begin to search for paraparticles.

Kaden Hazzard is an Associate Professor at Rice University, where he studies the theory of interacting quantum matter, especially in ultracold quantum systems. He studies experimentally-motivated problems in these systems, often motivated by connections to condensed matter and quantum information with a mix of analytic and numerical techniques. He also studied fundamental issues underpinning such systems, for example using mathematical physics techniques to understand the consequences of locality and – recently – constraints on particle statistics. He was elected as an APS Fellow (2023) for his work on ultracold matter.

He studied at Ohio State (BS), Cornell (PhD), and did a postdoc at JILA/NIST/CU-Colorado before joining Rice University as faculty in 2014. Prof Hazzard also serves in roles as the director of the Rice Quantum Initiative and Chair of the Graduate Program in the Department of Physics and Astronomy.

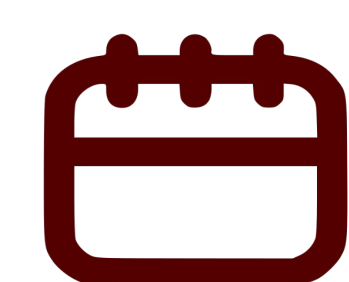
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February, 18
Tuesday



19:00, (Ankara Time)



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