Integrable Supersymmetric Many-Body Systems and Many-Body Localization

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In this work we use partial symmetry algebras, described by generalized group structures known as *symmetric inverse semigroups* to realize supersymmetry in (0+1) dimensions and to build many-body quantum systems on a chain. The algebras of partial symmetries naturally realize the fermionic algebra and more generally they give rise to centrally extended fermionic algebras. Using these the construction of the SUSY system then goes by associating appropriate supercharges to chain sites, in analogy to what is done in spin chains. For simple enough choices of supercharges, we show that the resulting states have a finite non-zero Witten index, which is invariant under perturbations, therefore defining supersymmetric phases of matter protected by the index. The Hamiltonians we obtain are integrable and display a spectrum containing both product and entangled states. By introducing disorder and studying the out-of-time-ordered correlators (OTOC), we find that these systems are in the many-body localized phase and do not thermalize. Finally, we reformulate a theorem relating the growth of the second Rényi entropy to the OTOC on a thermal state in terms of partial symmetries.

[1] Pramod Padmanabhan, S. J. Rey, D. Teixeira, D. Trancanelli, *Supersymmetric Many-Body Systems from Partial Symmetries: Integrability, Localization and Scrambling*, arXiv:1702.02091 [hep-th] and to be published in JHEP.