

**Title:** Robustness of SO(5)-Haldane and intermediate-Haldane phases in spin-2 quantum chains

Augustine Kshetrimayum and Román Orús

*Institute of Physics, Johannes Gutenberg University of Mainz, Germany*

**Abstract:** The existence of an Intermediate Haldane phase for a spin-2 Heisenberg chain was suggested by Oshikawa in 1992[1]. However, the evidence for its existence has remained quite elusive. In a recent paper [2] it was proven that such a phase exists in a family of generalized spin-2 quantum Heisenberg chains. In this work, we study the robustness of this phase for generalized spin-2 quantum Heisenberg chains with uniaxial anisotropy, and in the thermodynamic limit. We find very robust symmetry-protected topologically ordered SO(5)-Haldane and intermediate-Haldane phases, which we assess by a variety of methods including the entanglement spectrum of the system and the behavior of string-order parameters. Moreover, we study time-evolution properties of these phases. Our numerical results are based on using Matrix Product States (MPS) to represent the wave function, in combination with the infinite Time-Evolving Block Decimation (iTEBD) method.

**References:**

1. M. Oshikawa, J.Phys.: Condens. Matter 4, 7469 (1992).
2. Intermediate Haldane phase in spin-2 quantum chains with uniaxial anisotropy. H.-Hao Tu, R. Orus, Physical Review B 84, 140407(R) (2011).