Abstract: Topological phases of matter entail a prominent research theme, featuring distinct characteristics that include protected metallic edge states and possible fractionalized excitations. With the advent of symmetry protected topological (SPT) phases, many of these phenomena have effectively become accessible in the form of experimentally available band structures. Whereas SPT states protected by unitary and anti-unitary symmetries have been thoroughly understood, the inclusion of lattice symmetries provides for an active area of research. In this talk, I will present a short overview of results on defects in SPT states that directly motivate the existence of additional physics beyond the characterization based on (anti-) unitary symmetries. I will then connect these ideas to our work in which we mapped out all different gapped phases of free fermion systems in the presence of lattice symmetries. This revolves around a very simple algorithm that matches a rather involved mathematical perspective in terms of a framework called K-theory. Subsequently, I will discuss the implications of these combinatorial arguments and a plethora of related ideas that connect to this central theme of topological classification schemes, such as their impact on the description of Weyl semimetals and Wilson loop strategies to elucidate the resulting phases. Lastly, I will attempt to sketch future directions, with a particular emphasis on novel SPT Floquet systems that could be accessible using tailored laser fields and invoking a natural role of interactions in the system.

Bio: Robert-Jan Slager studied Mathematics and Physics at the University of Leiden, obtaining his Ph.D at the same University in 2016. After a postdoc at the Max-Planck Institute for the physics of complex systems in Dresden, he is currently affiliated with Harvard University. While having worked on disordered phase transitions in Weyl semi-metals and lattice gauge formulations of quantum and classical liquid crystals, his most known contributions concern the role of crystalline symmetries in symmetry protected phases. In particular, he co-authored a Nature physics in 2013 that was one of the earlier works to point out new topological insulators that arise by virtue of incorporating these necessarily present symmetries, a field that has been rapidly developing since. In addition to connecting these phases with uniquely defined defect responses, he formalized these ideas within another collaboration in terms of gluing conditions that provide for an a very simple implementable map to the exhaustive K-theory. This work stood at the basis of the formulation of topological quantum chemistry last year [which added new exciting layers to these insights] and is believed to provide for a new framework to discover lots of new topological materials.