Dynamical frames and relativity of subsystems

One of the most basic notions in physics is the partitioning of a system into subsystems and the study of correlations among its parts. Operationally, subsystems are distinguished by physically accessible observables which are often implicitly specified relative to some external frame, such as the laboratory, or a background notion of locality. In the absence of external relata as in Page-Wootters dynamics, gauge theories, and gravity, physical observables must be relationally specified relative to some internal dynamical degrees of freedom (an internal reference frame). In this talk, I will introduce the notion of dynamical reference frames within the so-called perspective-neutral approach, moving from simple finite-dimensional systems to local subregions in gauge theories, where the dynamical frames are provided by boundary edge modes. I will then discuss how different internal frames identify distinct external-frame-independent/gauge-invariant algebras of subsystem's observables. As a result, physical properties of subsystems are contingent on the choice of the internal frame. If time allows, special attention will be reserved to subsystem entropies; in particular, I will explain how such a relational definition of subsystems provides an alternative proposal for defining a gauge-invariant notion of entanglement entropy and compare it to the so-called center construction usually employed in the context of constrained and gauge systems.