Grain Boundaries through the Looking Glass

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In the early days of thinking about grain boundaries, a widespread view was that they are glassy regions that glue crystalline grains together. Over the next hundred years, we learned about the beautiful of bicrystallography and its impact on the structure of interfaces and this old view fell into disfavor. As a grad student, I felt Takeshi's strong pull to think about structure broadly and Vashek Vitek's view of structure constrained by crystals - this work is an attempt to bring these together by looking at the complexity of grain boundaries through glassy spectacles. In recent years, it has become increasingly clear that instead of one structure, a grain boundary may exhibit multiple structures (stable and metastable) along with structural phase transitions between these. In this presentation, we explore the nature of multiple structural states and demonstrate that the number of such states is typically very large. The presence of so many states has a profound influence on grain boundary properties. Just as the presence of a large number of metastable states dominates the behavior of amorphous materials, so too does it dominate grain boundary properties. Borrowing some ideas from glass dynamics, we show how these multiple states to grain boundary kinetics. We show several examples where grain boundary behavior is effectively glassy.