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Model Theory of von Neumann Algebras: Beyond Tracial States

The majority of the work done to date in the model theory of von Neumann algebras has been done with the assumption of the existence of a faithful normal tracial state. In this setting, model theory has made enough of an impact that one may wonder about other cases, such as type III von Neumann algebras or type II_∞ factors together with their semifinite tracial weight. In these more general settings, one runs into interesting issues involving the Tomita-Takesaki modular theory and left Hilbert algebras. I will survey some of these issues as they relate to two new frameworks for model theory of von Neumann algebras. One of these frameworks is for σ-finite von Neumann algebras and is joint work with Goldbring, Hart, and Sinclair. The other is for von Neumann algebras in full generality. In the latter setting, we encounter a brand new ultraproduct construction. I will discuss this new ultraproduct and the ways model theory helps us to characterize it, following ideas of Ando and Haagerup.