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The Exploratory Role of Idealizations and Limiting Cases in Models

Abstract. In this article we argue that idealizations and limiting cases in models play an exploratory role in science. Four senses of exploration are presented: exploration of the structure and representational capacities of theory; proof-of-principle demonstrations; potential explanations; and exploring the suitability of target systems. We illustrate our claims through three case studies, including the Aharonov-Bohm effect, the emergence of anyons and fractional quantum statistics, and the Hubbard model of the Mott phase transition. We end by reflecting on how our case studies and claims compare to accounts of idealization in the philosophy of science literature such as Michael Weisberg's three-fold taxonomy.

Keywords: exploration, idealization, models.

1. Introduction

Idealizations and the use of models, which are by their very nature imperfect or highly fictitious representations of reality, are ubiquitous in science.[1] How is one to make sense of the fact that, in attaining empirical adequacy and giving us knowledge about the world, our best scientific theories invoke falsehoods and distortions of reality? A standard, albeit naïve, response to such a worry has been not to allocate any substantive role to idealizations and

[1] Some examples of idealizations include nonviscous fluid flow, a perfect vacuum, perfectly rational agents, and isolated populations, while examples of (idealized) models include the Ising model, the Hardy-Weinberg equilibrium model, and Schelling's segregation model. See Shech ([2018a]) for a related review article.