

SPACETIME AND RELATIVITY IN NEWTON'S *PRINCIPIA*:

A Radical Reinterpretation

The publication of Isaac Newton's *Principia Mathematica* was met with controversy by a handful of notable figures who objected to Newton's supposed reliance on an absolute spacetime (a term which will be used in spite of the anachronism it invokes). The crux of this objection is that knowledge of whether or not a frame of reference is at absolute rest is something which is unattainable by empirical science. This is an objection against Newtonian spacetime that began in the 17th century and has since seen fervent support throughout the history of philosophy and physics. Following a renewed interest in spacetime at the turn of the 20th century, vocal criticism against Newtonian spacetime reemerged in the form of publications by Hans Reichenbach, Ernst Mach and Albert Einstein.

General objections to Newtonian spacetime rely on a reading of the *Principia* that requires the concept of absolute space to be coherent. In this paper it is shown that a more careful reading of key passages in the *Principia* - along with newly discovered documents made available only recently - will elucidate exactly which metaphysical commitments are required by Newtonian physics. The conclusion is twofold. This is 1) that Newton sidesteps most of the criticisms waged against him by his critics in the *Principia* and 2) that Newton has in fact laid the foundation for a relativistic mechanics that offers a radical reinterpretation of existing literature.

This paper will begin by responding to the relevant criticisms waged against Newtonian spacetime, focusing on the first wave of objections by Huygens, Leibniz, and Berkeley and later touching on early 20th century criticisms by Mach and Einstein. Afterwards, the contemporary debate on Newtonian spacetime is considered and a key

selection of Newtonian writings (Corollaries 3-6, Propositions 65-66, and a recently discovered "Tycho manuscript") is emphasized; this will shed light on why Newtonian physics does not need absolute spacetime in order to constitute a coherent approach to the natural sciences. This position has recently been coined "Newtonian relativity" by contemporary historians and philosophers of science (mainly Craig Fox, Robert DiSalle, and George Smith) and has culminated in a forthcoming book arguing for the radical reinterpretation of spacetime that includes relativistic mechanics in the *Principia*. Finally, this paper will conclude with an explication of how Newtonian Relativity departs from the response to traditional Newtonian spacetime.