The Property of Mass: An Interdisciplinary Metaphysical Investigation

Project Description and Background:

The metaphysician strives to create a complete ontology filled with known properties, objects, and relations. Properties such as color, shape, quantity, and many more are debated and categorized by said philosophers. It is odd then, that one of the most fundamental properties of the physical universe, mass, is taken for granted by many a metaphysician. Instead, it is left up to the physicists to supply an account for this property. As physics grows and evolves, the definitions used in the scientific theories also change. Suffice to say, there is little consensus between the scientific and philosophical community as to the property-status of 'mass'.

Mass is an interesting property in that the way it has been thought of has changed drastically in the last couple centuries. Beginning with Isaac Newton, mass was conceived of as the property which gave an object inertia and accounted for the attraction between two objects. In the early twentieth century, Albert Einstein reinvented the way scientists view mass with his theory of relativity. Now, mass was not merely a property which gave an object inertia and magically attracted two objects together, but instead was the property of an object which allowed it to curve space-time. Not only that, but in his special theory of relativity, Einstein proposed a kind of mass-energy equivalence. He derived and showed that there is a sort of conversion between a particle's mass and its energy. Now the metaphysician has seemingly two separate properties! Inertial mass and rest mass.

One of the first metaphysical issues with mass is whether it is an intrinsic or extrinsic property. Scientists such as Newton and Einstein would argue that mass was intrinsic, and belonged to the object in question. In this case, if every other object in reality was removed except the one in question, it would still have mass. Other philosophers of science, such as Ernst Mach, posit the idea that mass is an extrinsic property, and is nothing other than a relation between objects (Mach). This will be the first question I will investigate. The next question is the issue of mass-energy equivalence. Mass and energy are seemingly two separate properties in classical physics, yet an open conversion between the two brings their ontological standing into question. There are three main views concerning this problem in the classical literature. The first of which argues that mass and energy are in fact the exact same property. In this sense, there is no "conversion" between the two, but rather they are only viewed as separate properties because they are measured using different units (Eddington). The unification of space and time in relativity is viewed as evidence that two seemingly separate entities could in fact be the same. The second view also posits that mass and energy do not convert between one another, but are still distinct properties (Bondi and Spurgin). This view asserts that believing in a literal conversion between mass and energy is a gross misunderstanding of Einstein's equation. The final view is that mass and energy are distinct properties, but do in fact convert from one to the other. This is a more modest view as it makes no assumption about mass, but instead states that it is possible within the theory of special relativity for a certain quantity of mass to disappear and an equivalent amount of energy to appear (Rindler). These are not the only philosophical views on mass, but are among some of the most influential. A handful of more recent philosophical articles have been published which are variations of the three views presented above.

As a philosophy and physics major, I will survey both the scientific and philosophical literature on the subject. The purpose of this project is to use both areas of expertise in order to contribute meaningfully to the scholarly debate. My findings and arguments will be compiled in a paper, which will be submitted to various undergraduate philosophical journals for publication upon completion of the project.
Methodology and Timeline:

This project will require extensive reading and research. Fortunately, the University of Nebraska at Omaha has access to various philosophical journals and books. Inter-library loan will be utilized to attain books without any additional project costs. The timeline of the project will be spread out over the course of ten months in order to not interfere with my academics.

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<td>April 1st - September 30th, 2016</td>
<td>The first six months of the project will involve research into both classical and current text on the issues being investigated. This will be the most research intensive portion.</td>
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<td>October 1st - January 15th, 2017</td>
<td>The next three and a half months will be used to construct my arguments based on my previous research in the form of a paper.</td>
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<td>January 16th - February 17th, 2017</td>
<td>I will make the final edits to my manuscript, and submit it for publication in various undergraduate philosophy journals.</td>
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Student/Faculty Roles:

Dr. Newman will act as my faculty advisor for this project. His background in both physics and philosophy will be invaluable when conducting research in the literature and formulating ideas and arguments. I will meet with Dr. Newman on a bi-weekly basis during the project in order to discuss the current literature I will be reading, and to engage in philosophical discussion regarding the problems being tackled. He will also assist me in the finalizing steps of the project, and preparing the paper for submission to undergraduate journals. Dr. Newman will also help direct me to some of the more current and obscure publications which may pertain to the problem.
I am requesting $2000 as a research stipend for compensation of my time. I will be working a minimum of five hours per week for the entirety of the project. This is to insure I maintain a level of academic excellence over the course of ten months. I will work at a standard rate of $10 per hour, at five paid hours a week, for ten months. The additional hours I put toward the project will be voluntary and unpaid. This comes to a total of $2000.

Stipend: $2000
Supplies: $0
Travel: $0

Total Requested: $2000
References


Benjamin Hayworth-FUSE Grant Application

The Property of Mass: An Interdisciplinary Metaphysical Investigation

I strongly recommend Benjamin Hayworth for a FUSE Grant for his proposed interdisciplinary investigation into problems associated with the interpretation of the physical property of mass. He is philosophy major as well as a physics major and has made considerable progress in both areas. He has completed two honours projects with me, both of which were interdisciplinary studies involving physics and philosophy. One was on Galileo’s methodology and his use of thought experiments in the Second Day (Chapter) of Galileo’s Dialogue concerning Two Chief World Systems (1632), completed as part of the Philosophy of Natural Science (PHIL 3400) course. The second was about Julian Barbour’s (a theoretical physicist) claim in his book The End of Time that the theory of relativity undermines our ordinary beliefs in the existence of time, completed as part of the Metaphysics (PHIL 3700) course. His ability, hard work, and enthusiasm shown in these projects and his ordinary coursework show that he is well prepared for his proposed project.

The equivalence of mass and energy has been controversial for some time and has recently attracted the attention of people in the expanding field of philosophy of physics, such as Marc Lange and R. Torretti. Although most of the physics is well-known, it is the interpretation that has given rise to controversy. For example, if it is claimed that mass and energy are equivalent an account is required of what is meant by equivalent, which by itself is vague. One answer is that they are the same property, which requires an account of what a property is, and in particular an account of the identity conditions for properties — under what conditions are two supposedly different properties identical? I have no doubt that Benjamin is capable of understanding the limited literature on this topic, and will be able to make reasonable proposals about resolving some of the issues.

Yours Sincerely,

Andrew Newman
Professor of Philosophy
Chair of the Philosophy Department
University of Nebraska Omaha