# Dark Energy and the Accelerating Expansion of Space

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SCI 207 A4

Only two decades ago, scientists believed that the expansion of the universe had to be slowing as a result of the gravitational forces drawing matter together. In 1988, however, observations from the Hubble Telescope determined that further back in time, the universe as actually expanding at a slower rate than today and that the expansion of the universe is accelerating [1]. The Hubble Telescope had observed the supernovae of far away stars and data indicated that the light observed from the explosions was of less intensity than predicted, requiring it to have traveled further in space, an effect that could be explained by an accelerating rate of the expansion of space [2]. Since then, scientists have been reasoning about what is acting against the attractive force of gravity between matter and labeled this phenomenon as dark energy. There are several theories as to what this dark energy actually is, one proposed by Einstein suggests that energy may be a property of space itself, allowing for space devoid of matter to have its own energy [1]. This theory seems to contradict the principle of conservation of energy, as when space expands, its innate property of possessing energy would appear to create energy from nothing. While this introduction of additional energy would possibly account for acceleration of the expansion of space, this proposal is not well understood. A second proposal for the existence of dark energy comes from quantum theory, which proposes that unoccupied space has "virtual particles that continually form and then disappear" creating quantum vacuum energy [1]. When this quantum property was investigated, however, it was concluded that the amount of energy this effect would produce was very different from the amount required to cause the accelerating expansion of space already observed [1]. In fact, in order to account for this expansion, scientists estimate that whatever dark energy is, it composes approximately "70% of the universe" and that in combination with dark matter, only 5% of the universe is composed of conventional atom-based matter [3].

Science continues to research dark energy, in order to better understand the mysterious substance that is estimated to make up so much of the universe. The United States Department of Energy and NASA are planning to launch the Joint Dark Energy Mission (JDEM) program that would use a new telescope in order to measure the brightness of supernovae of distant stars similarly to how

the Hubble Telescope initially did, with the goal of improving science's understanding of the accelerating expansion of space and the presence of dark energy [2]. Additional research into dark energy such as the JDEM program is very important, as it will help scientists predict the future rate of expansion of the universe. One of the most important properties of dark energy that scientists are looking to determine is its density. The density of normal matter in the universe is decreasing, since the amount of mass remains constant, while the expansion of the universe increases the volume this matter occupies. The theories for the density of dark energy, in combination with the most recent observations from stellar supernova suggest that its density is either constant or small fluctuations in density [2]. A constant dark energy density and decreasing normal matter density would cause a greater acceleration in the expansion of space as time goes on, causing galaxies to become increasingly far away and stifling humanity's chance at observing or traveling to distant locations [2]. If the density of dark matter is not only constant but actually increasing, then the universe could speed up too quickly, causing all matter to be ripped apart [2]. In contrast, if it is determined that the density of dark energy is decreasing, then gravitational forces between normal matter will cause the rate of the expansion of space to decrease, and in the distant future, even cause space to collapse [2].

Research into better understanding dark energy and therefore the expansion of the universe will have very important consequences for physics and humanity's understanding of the expansion of space. Dark energy, the predicted source of nearly three quarters of matter remains poorly understood and science still has much to learn about the nature of this mysterious property of the universe.

References

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