Dark Energy Research Report

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1. Introduction

The report investigates the nature of dark energy and its implications for the universe's expansion. It aims to understand the universe's growth rate by using Type Ia Supernovae as standard candles, which provide consistent brightness during explosions, facilitating accurate distance measurements.

2. Motivation

The motivation behind this study is to measure the universe's growth rate, represented by the Hubble constant, to estimate the universe's age. Redshift data and dimming of light from distant celestial bodies help in calculating the growth rate. The research uses a range of distance measurements derived from Type Ia supernovae to establish a correlation between velocity and distance, aiding in the analysis of cosmic expansion.

3. Methods

We assume that the universe is expanding at a constant rate, the Hubble constant. If this assumption is true, there should be a linear relationship between our distance to celestial objects and the velocity at which they are moving away from us. Using data on the distances and velocities of type 1a supernovae, we estimate the slope of this relationship (which is the Hubble constant).

Our assumption implies that at 1/(Hubble constant) years ago, all distances in the universe collapsed to zero. This means that our method enables us to estimate the age of the universe as well.

4. Results

The resulting estimate for the Hubble constant is 48.5 km/s per megaparsec, suggesting an implied age of the universe of approximately 20.2 billion years. This differs from standard estimates, but not by more than an order of magnitude. A possible explanation for this difference is the presence of large errors in the measurements data corresponding to distant supernovae which we included in our regression. Applying the same method to only nearby supernovae produces estimates for the Hubble constant and age of the universe which are more similar to standard values.

4. Conclusion

The findings confirm that Type Ia supernovae are reliable standard candles for cosmic distance measurement. The linear distance-velocity relationship supports the expanding universe model, underlining the importance of precise measurements in understanding cosmic evolution and estimating the universe's age.

5. References

The Astrophysical Journal, Volume 594, Pages 1–24, September 1, 2003

6. AI Statement

No AI tools were utilized during this project.

7. Contribution Statement

Zachary Cohen: Authored the Motivation, AI Statement, Contribution Statement, and References slides.

John Wright: Developed the code for the Methods slides.

Dechong Wang: Wrote the Conclusion slide, and organized and redesigned the presentation.