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ORIGINAL ARTICLE

Acceleration of black hole universe

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Abstract Recently, Zhang slightly modified the standard big bang theory and developed a new cosmological model called black hole universe, which is consistent with Mach's principle, governed by Einstein's general theory of relativity, and able to explain all observations of the universe. Previous studies accounted for the origin, structure, evolution, expansion, and cosmic microwave background radiation of the black hole universe, which grew from a star-like black hole with several solar masses through a supermassive black hole with billions of solar masses to the present state with hundred billion-trillions of solar masses by accreting ambient matter and merging with other black holes. This paper investigates acceleration of the black hole universe and provides an alternative explanation for the redshift and luminosity distance measurements of type Ia supernovae. The results indicate that the black hole universe accelerates its expansion when it accretes the ambient matter in an increasing rate. In other words, i.e., when the second-order derivative of the mass of the black hole universe with respect to the time is positive $\ddot{M}(t) > 0$. For a constant deceleration parameter $q = -M(t)\ddot{M}(t)/\dot{M}(t) \sim -0.6$, we can perfectly explain the type Ia supernova measurements with the reduced chi-square to be very close to unity, $\chi_{\rm red} \sim 1.0012$. The expansion and acceleration of black hole universe are driven by external energy.

Keywords Cosmology · Supernova · Luminosity Distance · Dark Energy · Redshift · Black Hole

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1 Introduction

Distant type Ia supernovae appear fainter and are thus farther away from us than expected, in accordance with the luminosity distance and redshift measurements taken by the High-z Supernova Search Team (Riess et al. 1998) and the Supernova Cosmology Project Group (Perlmutter et al. 1999). This observational fact indicates that our universe has been recently accelerated. Dark energy is the widely accepted hypothesis to explain the observation. Two proposed candidates for the dark energy are the cosmological constant Λ (Carroll 2001) and scalar field Φ (Ratra and Peebles 1988; Caldwell et al. 1998; Li et al. 2012). Recently, Zhang (2013a, 2013b) revised the luminosity distance-redshift relation with an extra factor $\sqrt{1+Z}$, which can take the role of dark energy in explaining the type Ia supernova measurements without any free parameter.

The highly precise map of cosmic microwave background (CMB) radiation from the data recently measured by the Planck satellite has shown anomalies that reveal the first hard evidence for multiverse (Taylor 2013). The standard big bang universe model predicts that the cosmic microwave background radiation of the universe should be evenly distributed, but the map shows a stronger concentration or hotter in the south half of the sky and a large colder spot that is also not understandable under conventional physics. The analysis and measurements for the structure and weak lensing of the CMB might not be accurate enough as were thought to provide an independent check or evidence on the existence of dark energy (Corasaniti et al. 2005; Sherwin et al. 2011), because the errors in the CMB observation data may be much larger than previously thought (Sawangwit and Shanks 2010) since the CMB power spectrum is very sensitive to the beam profiles.

Zhang (2007) proposed an alternative cosmological model called black hole universe, which is a multiverse model