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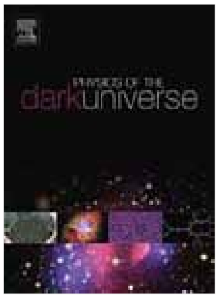

Thin-shell wormholes constrained by cosmological observations

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Thin-shell wormholes constrained by cosmological observations

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We investigate the thin-shell wormholes constrained by cosmological observations for the first time in the literature. Without loss of generality, we study the thin-shell wormholes in ωCDM model and analyze their stability under perturbations preserving the symmetry. Firstly, we constrain the ωCDM model using a combination of Union 2.1 SNe Ia data, the latest $H(z)$ data and CMB data. Secondly, we use the constrained dark energy equation of state (EoS) ω which lies in $[-1\ 05, -0\ 89]$ to investigate thin-shell wormholes generated by various black hole spacetimes. We find that the stable Schwarzschild and Reinssner-Nordstrom thin-shell wormholes constrained by cosmological observations do not exist. In addition, the method we developed can be applied in exploring the stable thin-shell wormholes from any black hole spacetime in the framework of any cosmological theory.

I. INTRODUCTION

In recent years, the seminal paper by Morris and Thorne [1] has motivated a great deal of studies to explore the traversable Lorentzian wormholes. As exotic solutions of gravitational theories, these objects have a throat that connects two widely separated regions of the same universe or two different universes [1, 2]. In general theory of relativity (GR), wormholes are usually generated by exotic matter that violates the null energy condition (NEC). Using the volume integral quantifier (VIQ) [3], the amounts of exotic matter can be substantially small, but at the expense of large stresses at the throat. Further discussions about the energy conditions of wormhole spacetime configurations can be found in Ref. [4].

Generally speaking, thin-shell wormholes are constructed by the so-called cut-and-paste technique, i.e., grafting together two black hole spacetimes at the junction surface which corresponds to a three-dimensional thin shell [2, 5, 6]. These thin-shell wormholes have been widely investigated in the literature, since the stability analysis is very easy to be implemented and the exotic matter is only confined to the thin shell. The stability analysis of spherically symmetric thin-shell wormholes have been implemented under the radial perturbations that preserves the symmetries by several authors [7 12]. The thin-shell wormholes with cylindrical, plane and conformal symmetries have already been analyzed in Refs. [13, 14]. The Schwarzschild thin-shell wormholes with variable equation of state (EoS) was also taken into consideration in Ref. [15].

In the past few years, a renewed interest has arisen in the old field wormholes, since the elegant discovery that our universe is undergoing a phase of an accelerated expansion (in both cases, the NEC is violated) [16, 17]. Dark energy as new source of exotic matter has inspired a number of studies to explore the corresponding wormhole geometries in various kinds of cosmological theories. For example, wormholes supported by phantom energy, Chaplygin gas, generalized Chaplygin gas, viscous fluid and Shan-Chen fluid have been investigated vividly in Refs. [18 24]. Furthermore, the stability of this class of wormholes that are of cosmological origin has been analyzed in Refs. [25 28]. Recently, with more and more high-quality cosmic data, we have studied the geometrical and holographical dark energy wormholes constrained by astrophysical observations for details, and verified that the exotic spacetime configurations wormholes can actually exist in the universe [29, 30]. Based on this concern, a question naturally comes into being, namely, whether one can similarly investigate the thin-shell wormholes constrained by cosmological observations ? Note that this is the starting point of the present work.

This paper is organized in the following manners. In Section 2, we place constraints on the simple ωCDM model using a combination of Union 2.1 type Ia supernovae (SNe Ia) data, the latest $H(z)$ data and the cosmological microwave background (CMB) measurements. In Section 3, we make a review on the thin-shell wormhole formalism. In Section 4, we use the constrained cosmological parameter to study the thin-shell wormholes constructed by various

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