

UDC 520.607

Origins of Phantom Cosmology in Superfluid Vacuum Theory of Quantum Gravity

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Abstract. Using superfluid vacuum approach to fundamental physical vacuum and quantum gravity, we derive the unified model of inflation period and contemporary dark energy epoch. The model contains the tachyonic phantom field non-minimally coupled to the quintessence field, which is the novel feature in phantom cosmological models.

Keywords: cosmology, quantum gravity, dark energy, inflation, superfluid vacuum theory

Introduction. Superfluid vacuum theory (SVT) is a theory of fundamental physical vacuum, or non-removable background, where the latter is considered to be a superfluid [1]. In its “infrared” or “phononic” limit (assuming low-momentum small excitations), superfluid vacuum theory generates Lorentz symmetry and curved spacetime, which de-facto makes it a generalization of general relativity [2]. By construction, SVT is also the theory of quantum gravity, which is well-defined in quantum-mechanical sense and free from divergences and anomalies.

Methods and materials; results. Using the superfluid-spacetime correspondence [2], we demonstrate that laminar superflow of the physical vacuum modelled by logarithmic quantum Bose liquid in 3D space generates a 4D relativistic system of the “quinton” type.

This type of theories comprises the dilaton field playing the role of the inflaton in the early universe and the quintom field, a combination of the quintessence and tachyonic phantom fields. All three fields are thus shown to be projections of the dynamical evolution of superfluid vacuum density and its fluctuations onto the measuring apparatus of a relativistic observer.

Conclusion. The unified model describes the transition from the inflationary period in the early universe to the contemporary accelerating expansion of the universe, commonly referred to as the “dark energy” period. The quintessence and tachyonic scalar components of the derived model turn out to be non-minimally coupled, which is a hitherto unexplored generalization of cosmological phantom models.

We thus showed that the dilaton-driven inflation and the effects attributed to “dark energy” can be viewed as different manifestations of the same object and a kind of matter, superfluid vacuum [3].

References

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