Archimedean-type force in a cosmic dark fluid. II. Qualitative and numerical study of a multistage universe expansion

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Abstract

In this (second) part of the work we present the results of numerical and qualitative analysis, based on a new model of the Archimedean-type interaction between dark matter and dark energy. The Archimedean-type force is linear in the four-gradient of the dark energy pressure and plays a role of self-regulator of the energy redistribution in a cosmic dark fluid. Because of the Archimedean-type interaction the cosmological evolution is shown to have a multistage character. Depending on the choice of the values of the model-guiding parameters, the Universe expansion is shown to be perpetually accelerated, periodic or quasiperiodic with a finite number of deceleration/acceleration epochs. We distinguished the models, which can be definitely characterized by the inflation in the early Universe, by the late-time accelerated expansion and nonsingular behavior in intermediate epochs, and classified them with respect to a number of transition points. Transition points appear, when the acceleration parameter changes the sign, providing the natural partition of the Universe's history into epochs of accelerated and decelerated expansion. The strategy and results of numerical calculations are advocated by the qualitative analysis of the instantaneous phase portraits of the dynamic system associated with the key equation for the dark energy pressure evolution. © 2011 The American Physical Society.