Chaotic dynamics of the universe

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The dynamics of the universe at large scale and large time is a very important problem area in physics. Modern cosmology roughly suggest four main periods to explain the evolution of the universe such as vacuum (Planck), radiation, matter and dark energy era. However dynamics of the universe have not been completely understood yet (See Refs. [1-4]) At present, the universe is composed of approximately 5% baryonic matter, 20% dark matter, and 75% dark energy. The effect of interactions between different kinds of components on the dynamics of the universe are unknown yet. Whereas, the mutual interactions between dark energy-dark matter, dark energy-matter and matter-dark matter etc., can be suggested as a possible scenario of universe evolution since mutually interactions of these components may play important role on the dynamics at large scale. For this fact, last decade, the interacting models have been considered to solve coincidence, fine tuning and singularity problems. Another unexpected surprise comes from a recent reports that self-interaction mechanism in dark sector has been predicted and detected in theoretical and experimental studies.

In this study, considering mutual and self-interactions between fluid components dark energy, dark, matter etc., I discuss universe dynamics. Choosing suitable and physically meaningful interaction I show that interacting two-fluid model with linear EoS can be transformed to the Lotka-Volterra equations of the competing two species. On the other hand I show that interacting two-fluid model with quadratic EoS can be transformed to the self-interacting Lotka-Volterra equations. I find fixed points of these equations and discuss the dynamics of universe. Finally I generalize these equations to N interacting Lotka-Volterra equations for more interacting fluids. Obtained results clearly show that dynamics of universe at large scale and within the time may have stable, unstable or chaotic behavior in the presence of the interaction and self-interaction in between dark energy, dark matter, matter and others components of the universe See Ref.[5].

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