

Preface

Since Einstein's introduction of the cosmological constant in 1917, and its interpretation as a vacuum-like state of a physical medium by E.B. Gliner in 1965, dark energy (DE) is usually treated as perfectly uniform, always and everywhere. However, it is not *necessarily* so when other sources of gravity are present: interaction of DE with matter leads to its variation in space and time.

In this book, I systematically study cosmological implications of this fact by analyzing cosmological models in which DE density interacts with matter and thus changes with time. I model the DE–matter interaction by specifying the rate of change of the DE density as an arbitrary function of it and the density of matter, in a single-phase case. In the case of several matter components interacting with dark energy, I assume the rate of every interacting phase density to be an arbitrary function of this density and the DE density. Some properties of cosmological solutions valid for a general law of DE–matter interaction are described, and physical admissibility of the interaction laws is discussed.

I investigate numerous families of exact solutions, singular, non-singular, and mixed. Some of them exhibit interesting properties, such as absence of the horizon problem due to the initial fast growth of the scale factor (any power of time possible); non-singular evolution from one de Sitter universe (pure DE with no matter) to the other one with a different DE density; DE dominating either from some moment of time on, or throughout the expansion; and dark matter dominating normal matter at large times without any parameter tuning. All the results are obtained strictly within the framework of general relativity, Einstein's theory of gravity, without modifying it in any way.

This book ends with my translation from the Russian of a paper about E.B. Gliner written by A.D. Chernin, 'Why does the Universe expand?' (Istoriko-astronomicheskie issledovaniya, **38**, 239–253. Moscow, 2016), made on author's request. It elucidates the remarkable life and work of Gliner, which is not enough known, especially outside Russia.

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