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Anisotropic cosmological models in Horndeski gravity

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It was found recently that the anisotropies in the homogeneous Bianchi~I cosmology considered within the context of a specific Horndeski theory are damped near the initial singularity instead of being amplified. In this work we extend the analysis of this phenomenon to cover the whole of the Horndeski family. We find that the phenomenon is absent in the K-essence and/or Kinetic Gravity Braiding theories, where the anisotropies grow as one approaches the singularity. The anisotropies are damped at early times only in more general Horndeski models whose Lagrangian includes terms quadratic and cubic in second derivatives of the scalar field. Such theories are often considered as being inconsistent with the observations because they predict a non-constant speed of gravitational waves. However, the predicted value of the speed {\it at present} can be close to the speed of light with any required precision, hence the theories actually agree with the present time observations. We consider two different examples of such theories, both characterized by a late self-acceleration and an early inflation driven by the non-minimal coupling. Their anisotropies are maximal at intermediate times and approach zero at early and late times. The early inflationary stage exhibits an instability with respect to inhomogeneous perturbations, suggesting that the initial state of the universe should be inhomogeneous. However, more general Horndeski models may probably be stable.

Primary author: Prof. VOLKOV, Mikhail (University of Tours, France)

Co-authors: Prof. STAROBINSKY , Alexey; Prof. SUSHKOV, Sergey; Mr GALEEV, Rafkat; MUHARLYAMOV , Ruslan

Presenter: Prof. VOLKOV, Mikhail (University of Tours, France)

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