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Future sudden singularities in Palatini cosmology

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Abstract. We show that future singularities which have appeared in the Palatini cosmological models investigated in [1] are of finite size at finite time type [2].

Doomsday scenarios for cosmological models are subject of numerous investigations and speculations. For example the standard LCDM model predicts a thermal death caused by the expansion forever. In this short note we solve similar problem for the Palatini cosmological models investigated already in [1].

First of all we recall that, similarly to LCDM case, Palatini models are described by dynamical systems of Newtonian type. They are fully determined by effective potential functions $V(a)$ defined by Friedmann equation (see [1]). The evolution of the Universe described by such system is given by:

$$\frac{\dot{a}^2}{2} = -V(a) \Rightarrow \ddot{a} = -\frac{\partial V}{\partial a} \tag{1}$$

where a denotes the cosmic (FRWL) scale factor. From the potential plot (fig . 1) one can see that:

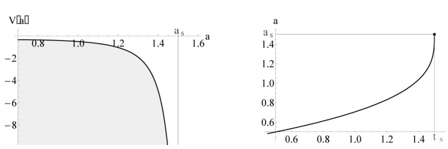

Figure 1. Left panel: typical future singularity of the potential function for cosmological models presented in [1]. Right panel: example of time dependency of the scale factor near singularity.

$$\lim_{a\to a_s^-} V(a) \to= -\infty, \qquad \lim_{a\to a_s^-} \ddot{a} >= +\infty \tag{2}$$

as well as

$$\lim_{a\to a_s^-} \dot{a} = +\infty \tag{3}$$

for some finite $a_s < \infty$ singular (final) point.

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The question is whether the singular (finite) point has to be reached at finite time $t_s < \infty$. Assuming (a'contrario) $\lim_{t\to+\infty} a(t) = a_s^-$ gives rise to

$$\lim_{t\to+\infty} \dot{a}(t) = 0^+ \tag{4}$$

which contradicts with (3). Therefore t_s has to be finite (sudden).

As illustrative examples of time (analytic) dependency nearby singular point one can consider the family of functions (see (fig. 1) and [2])

$$a(t) = a_s - b(t_s - t)^\alpha \tag{5}$$

with $b > 0$ and $0 < \alpha < 1$. Thus $\dot{a} = b\alpha(t_s - t)^{\alpha-1}$ and $\ddot{a} = b\alpha(1-\alpha)(t_s - t)^{\alpha-2}$. It is worth to mention that typical values of a_s obtained in [1], after constraining model parameters by astrophysical data, are $1.4 < a_s < 2.5$.

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