A bouncing scale factor and the cosmology under the purview of holographic fluid

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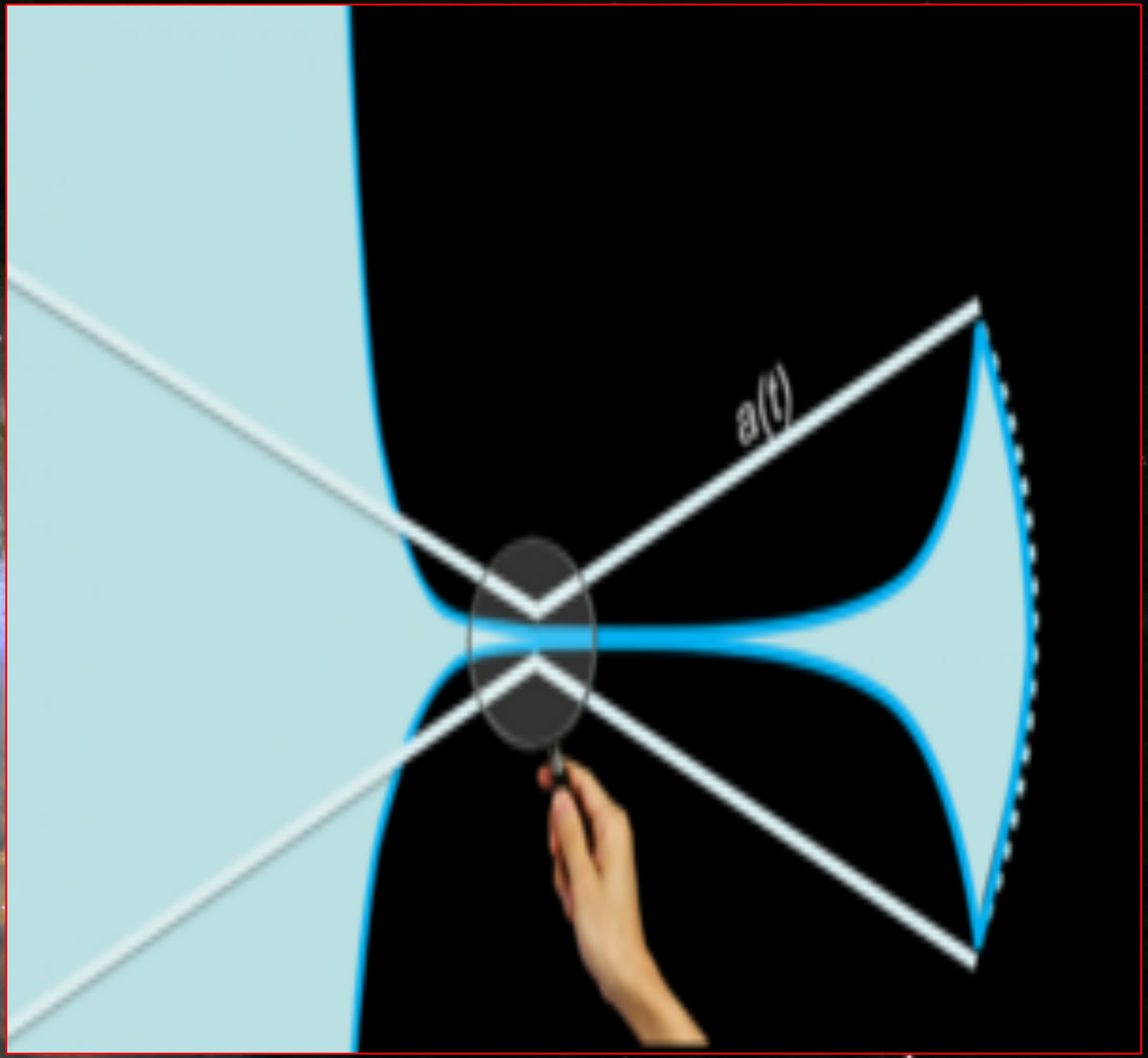
Objectives of our work

- To reconstruct f(T) gravity with holographic fluid
- To study the behaviour of EoS parameter
- To study the slow-roll parameters

The Big Bounce

The Big Bounce is a hypothetical cosmological model for the origin of the present universe. In the Big Bounce theory, the universe is expanding and contracting, seesawing back and forth in a massively big-picture timeline.

The concept of the Big Bounce envisions the Big Bang as the beginning of a period of expansion that followed a period of contraction.



$$a(t) = a_0 e^{H_0 t}$$

$$a(t) = a_0 e^{H_0 (t - t_0)}$$

$$a(t) = a_0 \left(1 + H_0(t - t_0) + \frac{H_0^2}{2}(t - t_0)^2 + \frac{H_0^3}{6}(t - t_0)^3 + \frac{H_0^4}{24}(t - t_0)^4 + \frac{H_0^5}{120}(t - t_0)^5 \ldots \right).$$

Case 1:

$$a(t) = a_0 \left[1 + H_0(t - t_0) + \frac{H_0^2}{2}(t - t_0)^2\right]$$

Modified Scale Factor

Modified Hubble Parameter

$$\frac{H_o + H_o^2(t - t_o)}{1 + H_o(t - t_o) + \frac{1}{2} H_o^2 (t - t_o)^2}$$

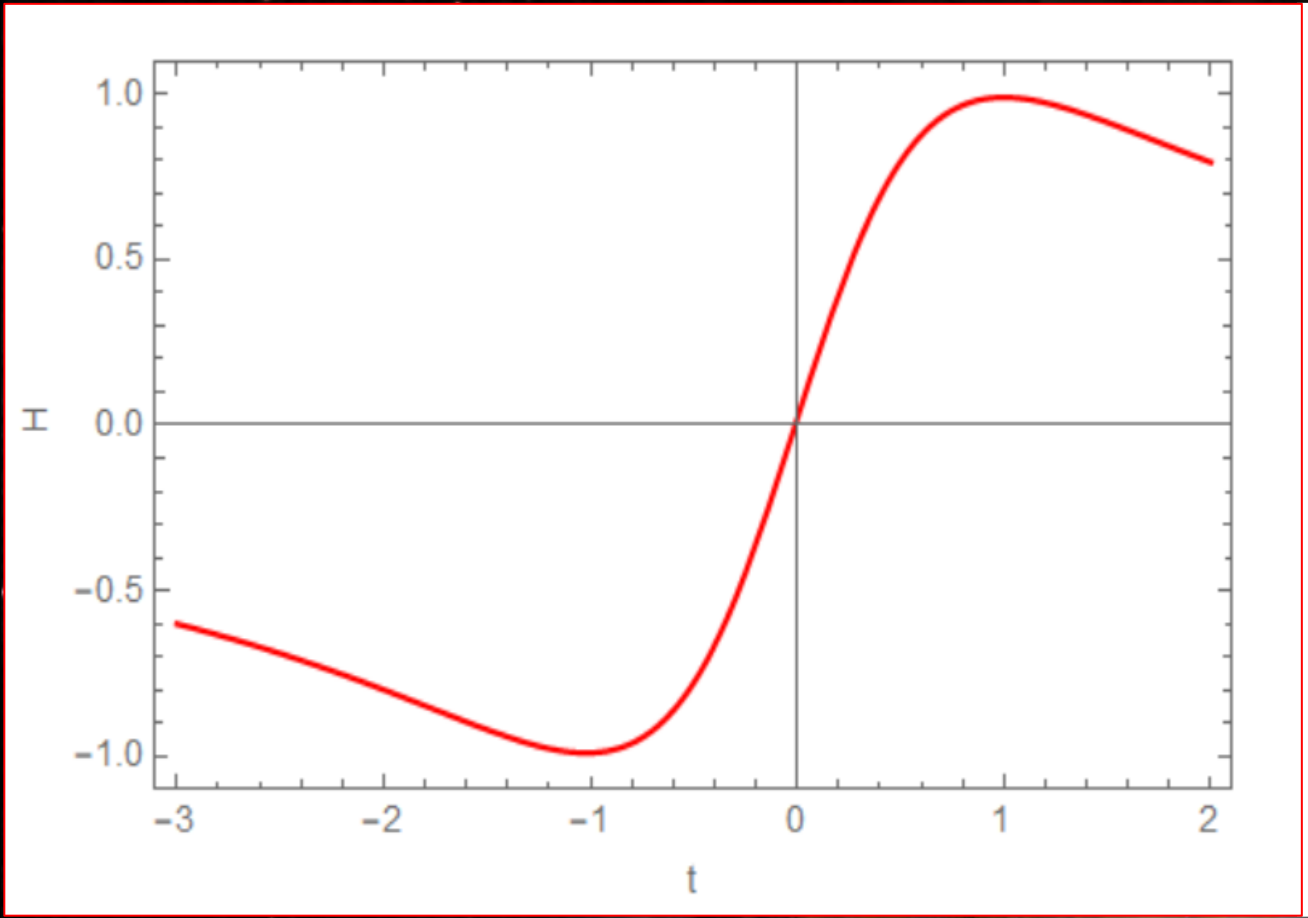
Case 2:

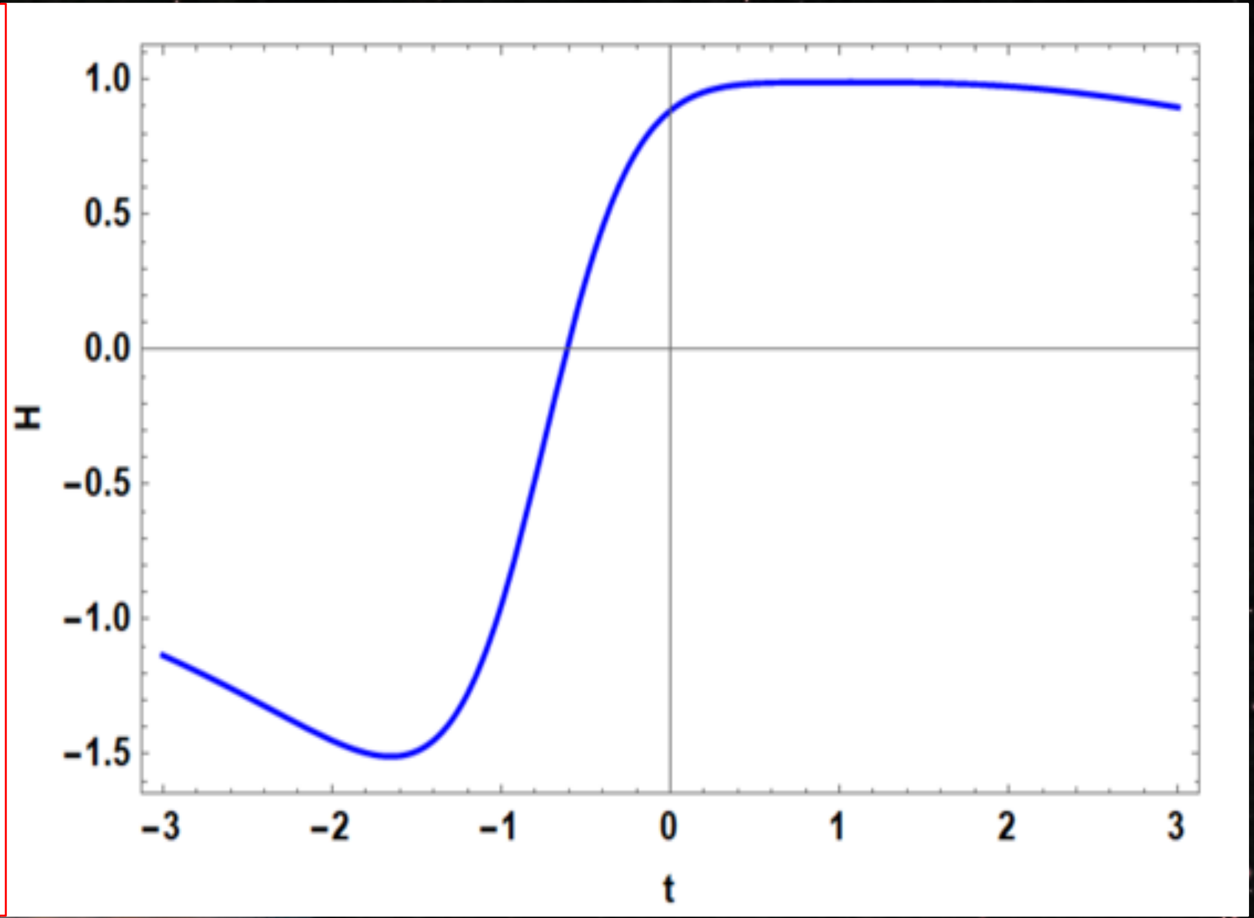
$$a(t) = a_0 \left[1 + H_0(t - t_0) + \frac{(H_0)^2}{2}(t - t_0)^2 + \frac{(H_0)^3}{6}(t - t_0)^3 + \frac{(H_0)^4}{24}(t - t_0)^4\right]$$

Modified Scale Factor

Modified Hubble Parameter

$$H = \frac{H_0 + H_0^2(t - t_0) + \frac{1}{2}H_0^3(t - t_0)^2 + \frac{1}{6}H_0^4(t - t_0)^3}{1 + H_0(t - t_0) + \frac{1}{2}H_0^2(t - t_0)^2 + \frac{1}{6}H_0^3(t - t_0)^3 + \frac{1}{24}H_0^4(t - t_0)^4}$$


1.0
0.5
0.0
−0.5
−1.0
H
−3
−2
−1
0
1
2
t


1.0
0.5
0.0
−0.5
−1.0
−1.5
H
−3
−2
−1
0
1
2
3
t

$T = -6H^2$

$$\rho_T = \frac{1}{2} - 12H^2 f_T - f + 6H^2$$

Density Of holographic ricci dark energy

$$3c^2(\dot{H} + 2H^2)$$

$$3c^2\left(\frac{(H_o+H_o^2(t-t_o))^2}{\left[1+H_o(t-t_o)+\frac{1}{2}H_o^2(t-t_o)^2\right]^2} + \frac{H_o^2}{1+H_o(t-t_o)+\frac{1}{2}H_o^2(t-t_o)^2}\right)$$

Equating the density of HRDE to ρ_t

$$\rho_t = \frac{1}{2}\left(-12H^2\frac{f'[t]}{\dot{T}} - f[t] + 6H^2\right)$$

$$f(T(t)) = \frac{(1+H_o(t-t_o))\left(c_1 - 12H_o^2\left[\frac{c^2}{1+H_o(t-t_o)} - \frac{2(-1+c^2)(1+H_o(t-t_o))}{2+2H_o(t-t_o)+H_o^2(t-t_o)^2} + 2c^2 ArcTan[1+H_o(t-t_o)]\right]\right)}{2+2H_o(t-t_o)+H_o^2(t-t_o)^2}$$

$$f_T = \frac{\dot{f}}{\dot{T}}$$

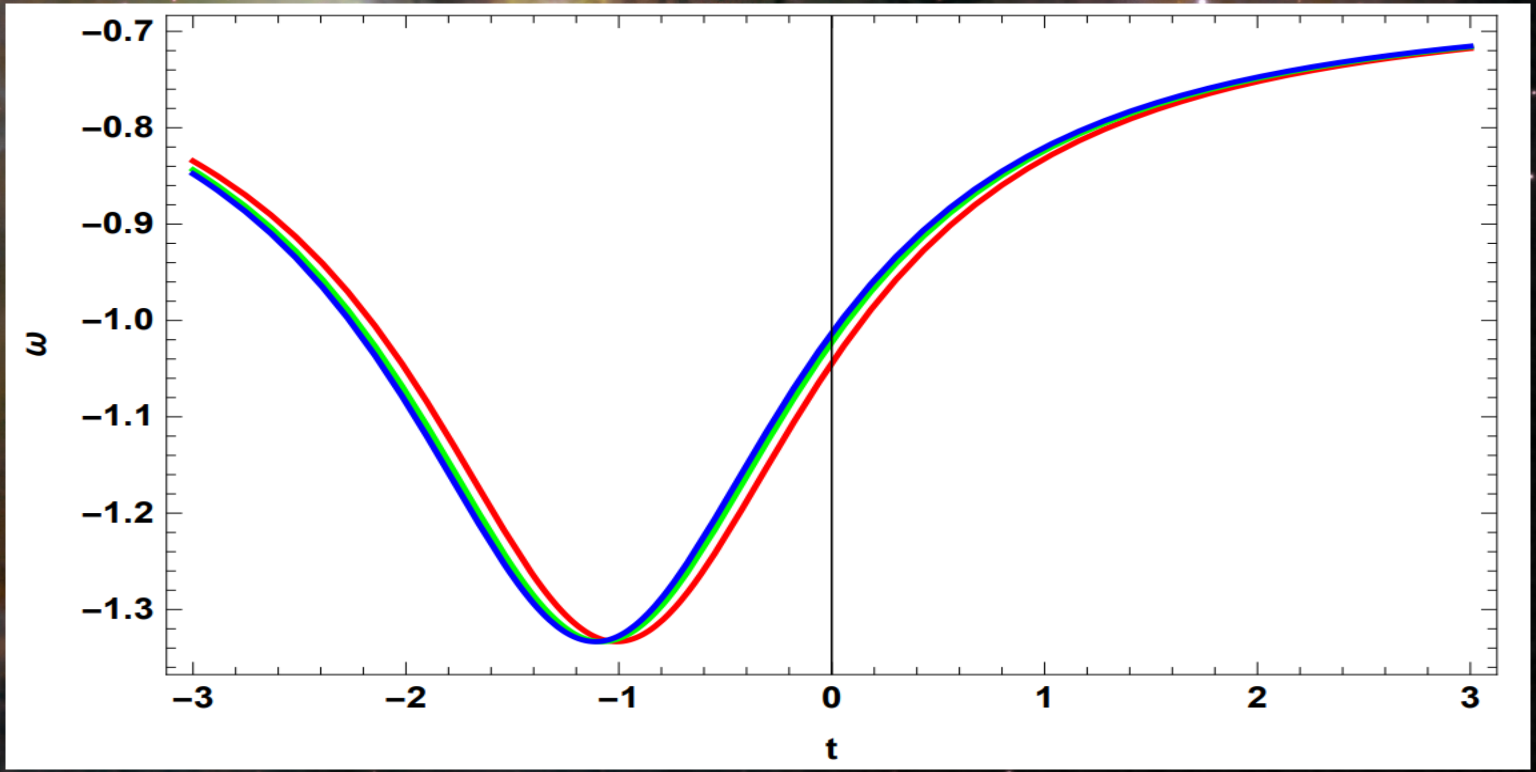
$$P_T = \frac{-1}{2}(-8\dot{H}Tf_{TT} + 2T - 4\dot{H}f_T - f + 4\dot{H} - T)$$

$$-\frac{4c^2H_o^2(5+3H_o(2+H_o(t-t_o))(t-t_o))}{(2+H_o(2+H_o(t-t_o))(t-t_o))^2}$$

EQUATION OF STATE PARAMETER (ω):

$$\omega = \frac{p_T}{\rho_T}$$

$$\omega = -\frac{2}{3} - \frac{2}{3(4+3H_o(2+H_o(t-t_o))(t-t_o))}$$

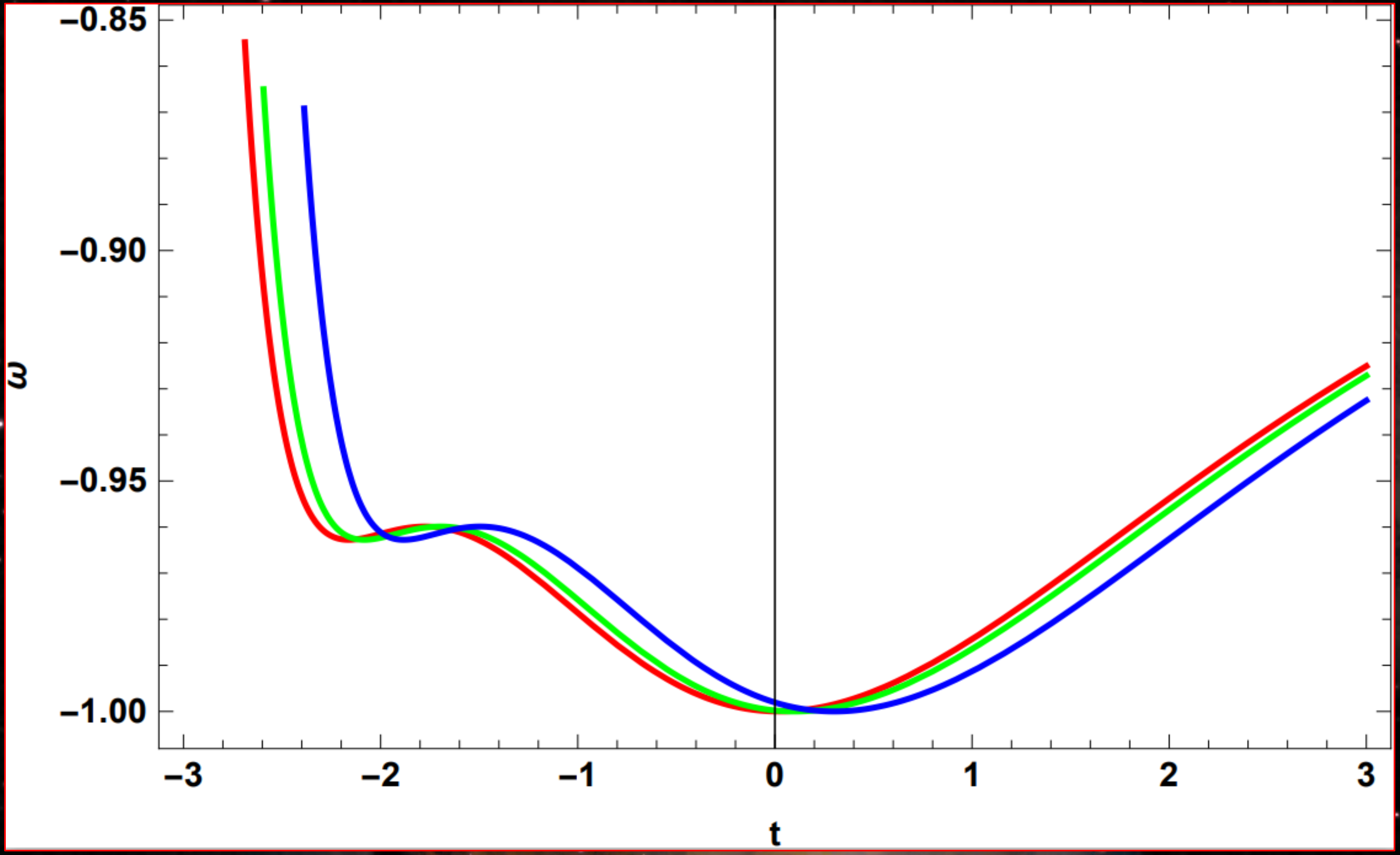


$$H = \frac{H_0 + H_0^2(t-t_0) + \frac{1}{2}H_0^3(t-t_0)^2 + \frac{1}{6}H_0^4(t-t_0)^3}{1 + H_0(t-t_0) + \frac{1}{2}H_0^2(t-t_0)^2 + \frac{1}{6}H_0^3(t-t_0)^3 + \frac{1}{24}H_0^4(t-t_0)^4}$$

$$\begin{aligned} p_T = &-\left(\frac{2c^2H_0^2(10368+31104H_0\tau+45792H_0^2\tau^2+43488H_0^3\tau^3)}{(6+H_0(6+H_0(3+H_0\tau)\tau)\tau)(24+H_0(24+H_0(12+H_0(4+H_0\tau)\tau)\tau)\tau)^2}\right) \\ &-\left(\frac{2c^2H_0^2(29520H_0^4\tau^4+414976H_0^5\tau^5+5712H_0^6\tau^6)}{(6+H_0(6+H_0(3+H_0\tau)\tau)\tau)(24+H_0(24+H_0(12+H_0(4+H_0\tau)\tau)\tau)\tau)^2}\right) \\ &-\left(\frac{2c^2H_0^2(1608H_0^7\tau^7+315H_0^8\tau^8+35H_0^9\tau^9)}{(6+H_0(6+H_0(3+H_0\tau)\tau)\tau)(24+H_0(24+H_0(12+H_0(4+H_0\tau)\tau)\tau)\tau)^2}\right) \end{aligned}$$

$$\rho_T = \frac{12c^2H_0^2(288+H_0(576+H_0(576+H_0(360+H_0(150+7H_0(6+H_0\tau)\tau)\tau)\tau)\tau)\tau)}{(24+H_0(24+H_0(12+H_0(4+H_0\tau)\tau)\tau)\tau)^2}$$

$$\omega = -\left(\frac{10368+31104H_0\tau+45792H_0^2\tau^2+43488H_0^3\tau^3+29520H_0^4\tau^4+14976H_0^5\tau^5+5712H_0^6\tau^6+1608H_0^7\tau^7+315H_0^8\tau^8+35H_0^9\tau^9}{6(6+H_0(6+H_0(3+H_0\tau)\tau)\tau)(288+H_0(576+H_0(576+H_0(360+H_0(150+7H_0(6+H_0\tau)\tau)\tau)\tau)\tau)\tau)}\right)$$


-0.85
-0.90
-0.95
-1.00
ω
-3
-2
-1
0
1
2
3
t

SLOW-ROLL PARAMETERS:

$$\dot{H} = -\frac{1}{2}\dot{\phi}^2 + \frac{k}{a^2}$$

$$\xi_H = -\frac{1}{2}\frac{\ddot{H}}{H\dot{H}}$$

$$\xi_V = -\frac{1}{2}\frac{\left[\frac{dV}{d\Phi}\right]^2}{V}$$

$$3H^2 = \rho_\Lambda + \rho_m$$

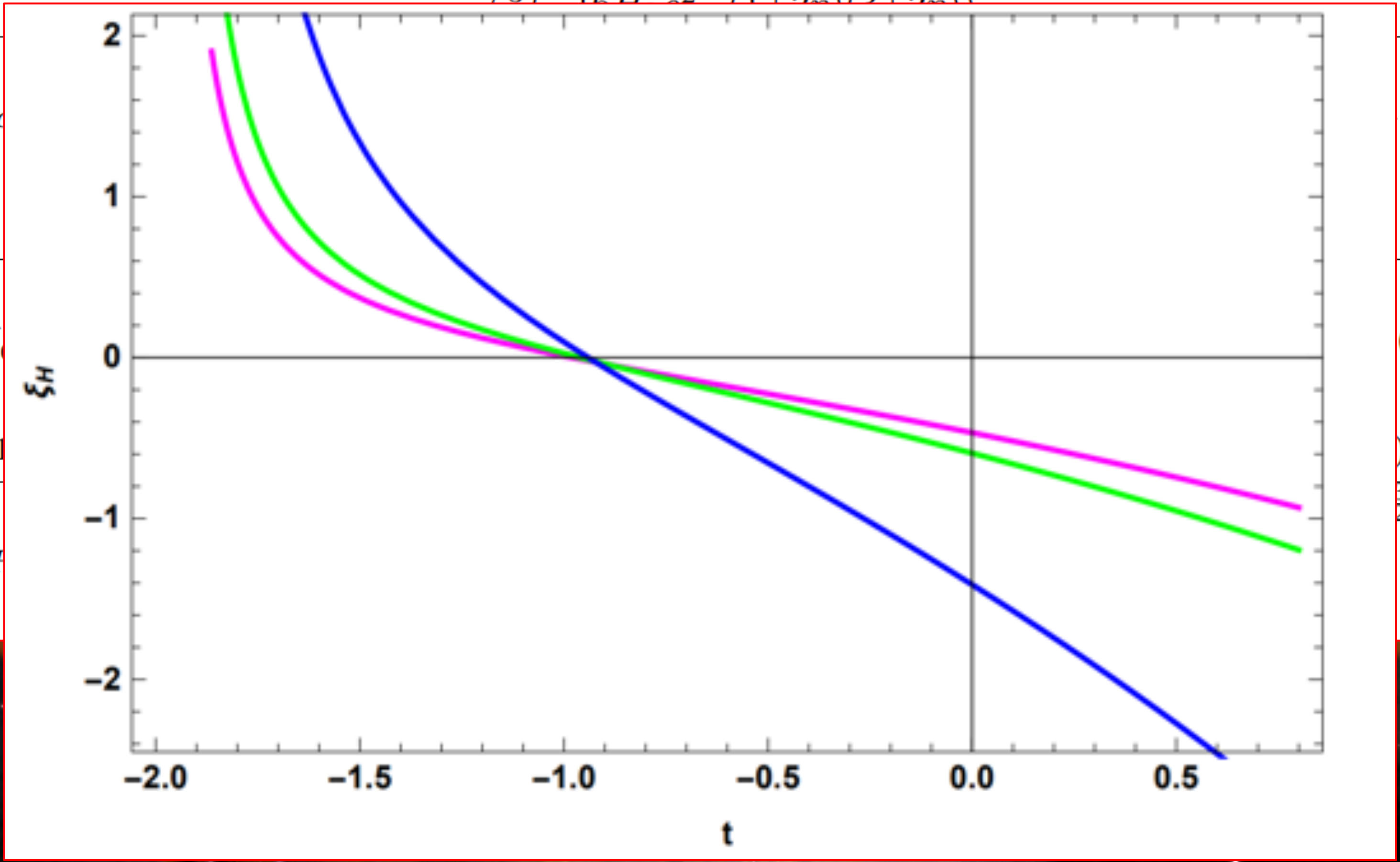
$$H = \frac{\sqrt{\frac{6c^2H_o^2(4+3H_o(2+H_o(t-t_o))(t-t_o))}{(2+H_o(2+H_o(t-t_o))(t-t_o))^2}+\frac{\rho_{m_o}}{a_o^3\left(1+H_o(t-t_o)+\frac{1}{2}H_o^2(t-t_o)^2\right)^3}}}{\sqrt{3}}$$

$$\dot{H} = -\frac{\sqrt{6}\left(4H_o\rho_{mo}+a_o^3c^2H_o^3(2+H_o(2+H_o(t-t_o))(t-t_o))(2+3H_o(2+H_o(t-t_o))(t-t_o))\right)(1+H_o(t-t_o))}{a_o^3\sqrt{\frac{\frac{4\rho_{mo}}{a_o^3}+3c^2H_o^2(2+H_o(2+H_o(t-t_o))(t-t_o))(4+3H_o(2+H_o(t-t_o))(t-t_o))}{(2+H_o(2+H_o(t-t_o))(t-t_o))^3}}(2+H_o(2+H_o(t-t_o))(t-t_o))^4}$$

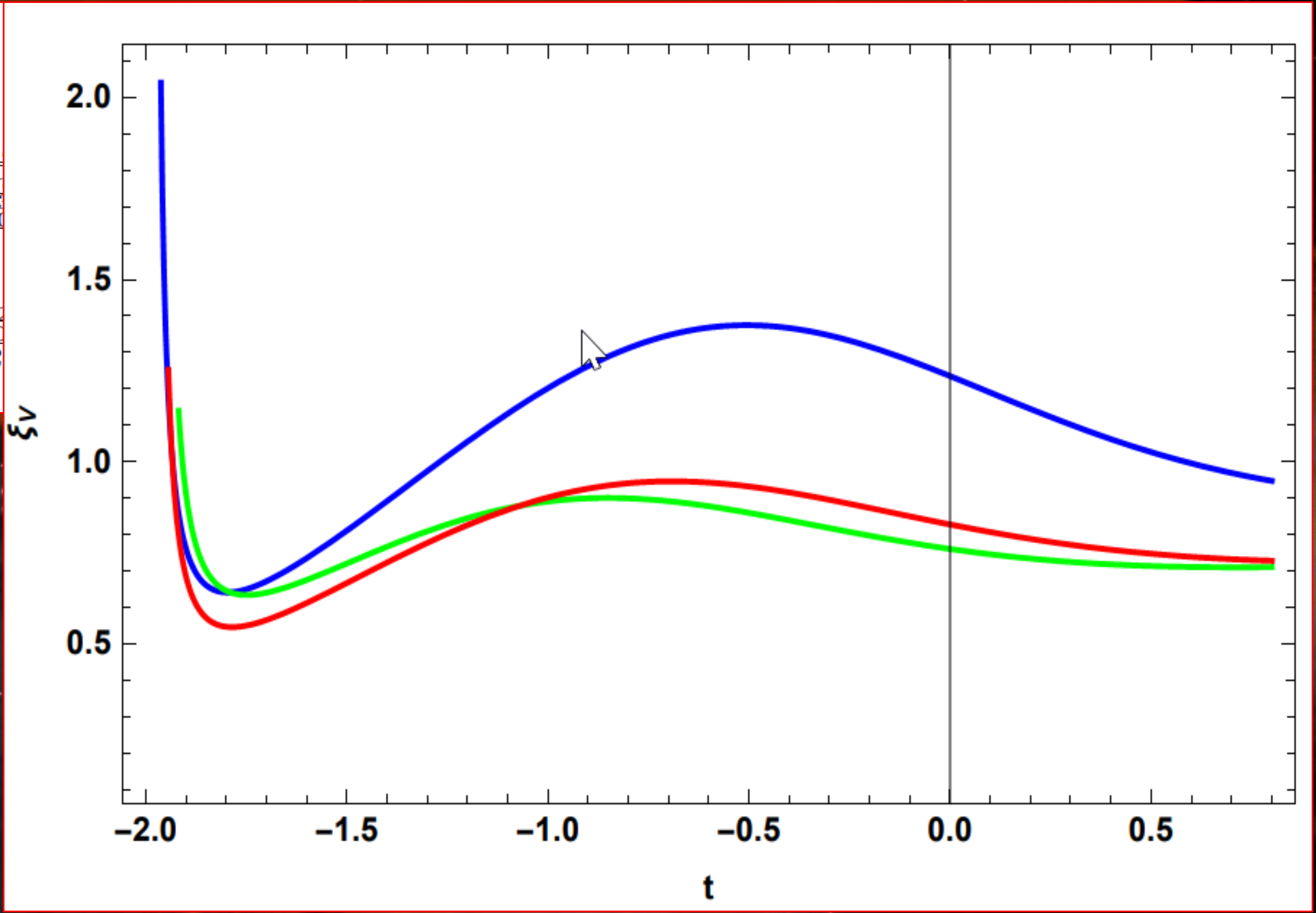
$$\xi_H = \frac{\sqrt{3}(-16H_0 c^2 \ldots (1+2\eta)(3+2\eta))}{\left[2a_0^3(4H_0\rho_{m0}+a_0^3 \ldots \right]^{\frac{3}{2}} (2+H_0(2+\eta)\tau)^4}$$

$$\left[2a_0^3(4H_0\rho_{m0}+a_0^3c^2H \ldots (2+H_0(2+\eta)\tau)^4 \right]$$

$$- \frac{\sqrt{\frac{3}{2}}(- \ldots \tau)))}{\left[2a_0^3(4H_0\rho_{m0}+a_0^3c^2 \ldots \right]^{\frac{3}{2}} (2+H_0(2+\eta)\tau)^4}$$



$$\xi_V = \Bigg[-\frac{(\sqrt{6}(4H_0 \ldots}{\left(a_0^3\sqrt{\left(\frac{4\rho r \ldots}{a_0^{\ldots}} \ldots\right.}\right.} \ldots - \left[\left(\frac{6c^2 H_0^{2} \ldots}{2 \ldots}\right.\right. \ldots$$



Summary

- A holographic bounce is studied, for which the Hubble parameter close to the bounce event is represented in the form of a Taylor series expansion.
- Truncating the series up to higher orders, we have stopped at the first order because it has been observed that for the form a(t) = $a_0[1 + H_0(t - t_0) + \frac{{H_0}^2}{2}(t - t_0)^2]$ the bounce realization occurs in a better way in the sense that H < 0, H= 0 and H > 0 before, at and after the turn-around point.
- This reconstructed f (T) gravity has been used to obtain the reconstructed Eos parameter while observing that under this reconstruction scheme the Eos parameter is violating the null energy condition at the bouncing point.
- We have studied slow-roll parameters, ξ_V and ξ_H , in this bouncing scenario.

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THANK YOU