innovate achieve lead

Energy conditions in non-minimally coupled $f(R,T)$ gravity

P.K. Sahoo, S. Mandal, S. Arora

Birla Institute of Technology and Science-Pilani,
Hyderabad Campus, Hyderabad-500078, India

IWARA
From Quarks to Cosmos

pksahoo@hyderabad.bits-pilani.ac.in sanjaymandal960@gmail.com dawrasimran27@gmail.com

ABSTRACT:

Energy conditions play a crucial role in determining physical constraints for relativistic theories and cosmological evolution. The Raychaudhuri equation allows the analysis of the space-time structure. It is generally viewed as the representation of gravity's attractive nature. We discuss the energy conditions in non-minimal coupled $f(R,T)$ gravity. The analysis is performed with the present values of the Hubble parameter and the deceleration parameter. The energy conditions allow us to fix our free parameter α in $f(R,T)$ model that establishes the accelerated expansion of the Universe.

Main questions and problems:

- Why we use modified theories of gravity instead of General Theory of Relativity to study the Universe in modern Cosmology ?
- Metric formalism adopted.
- Concentrate on the energy bounds as per the recent observations.
- Stability of the model checked by the profiles of energy conditions.
- Compare with the ΛCDM.
- Problem: Accelerated expansion of the Universe.

f(R,T) gravity: There are three forms of $f(R,T)$ gravity i.e.

$$f(R,T) = \begin{cases} R + 2f(T) \\ f_1(R) + f_2(T) \\ f_1(R) + f_2(R) f_3(T) \end{cases}$$

Here we have considered the nonlinear form i.e. $f(R,T) = R + \alpha RT$, For $\alpha=0$, It reduces to GR.

For perfect fluid matter distribution, the energy conditions are given as below

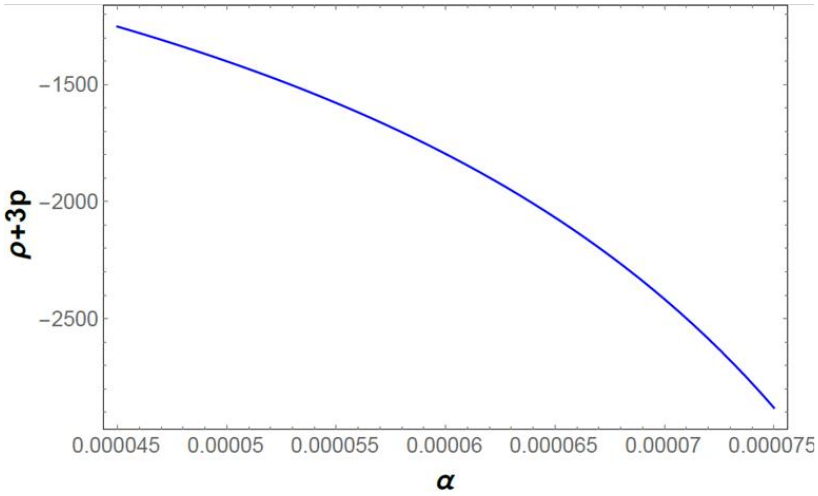
Null energy condition (NEC): $\rho+p\geq 0$ Weak energy conditions (WEC): $\rho+p\geq 0$, $\rho\geq 0$

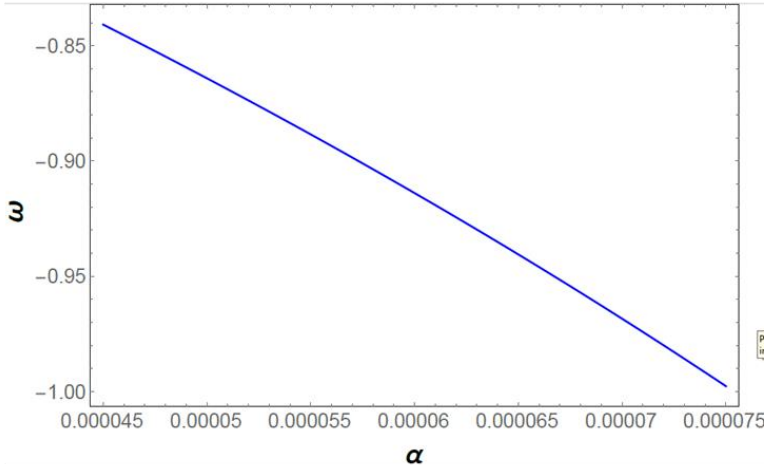
Strong energy conditions (SEC): $\rho+3p\geq 0$ Dominant energy conditions (DEC): $\rho\geq 0$, $|p|\leq \rho$

Since the SEC and the equation of state parameter ω are used to study the accelerating expansion, their values and the figures with the possible range of free parameter α in our model are given below

$$SEC=\frac{24H_0^2\pi q_0+3H_0^4(-1+q_0)(19+16q_0)\alpha}{32\pi^2+144H_0^2\pi(-1+q_0)\alpha+27H_0^4(-1+q_0)^2\alpha^2},$$

$$\omega=p/\rho=\frac{\pi(-4+8q_0)+9H_0^2(-1+q_0^2)\alpha}{12\pi+3H_0^2(-1+q_0)(10+7q_0)\alpha}$$





CONCLUSIONS: It is demonstrated that SEC plays a significant role in the framework of accelerated expansion among all the energy conditions. This is due to the violation of SEC conditions, whereas all the energy conditions are satisfied. Also, the equation of state parameter is close to -1 supporting the ΛCDM observations.