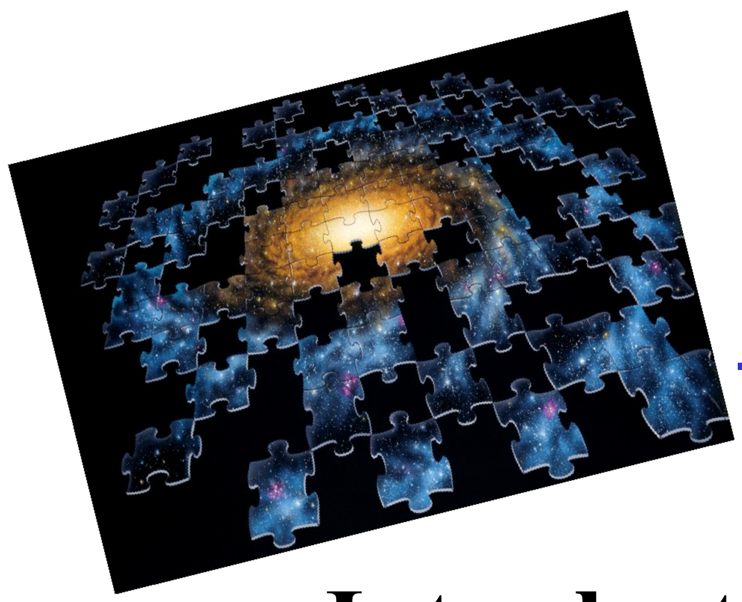
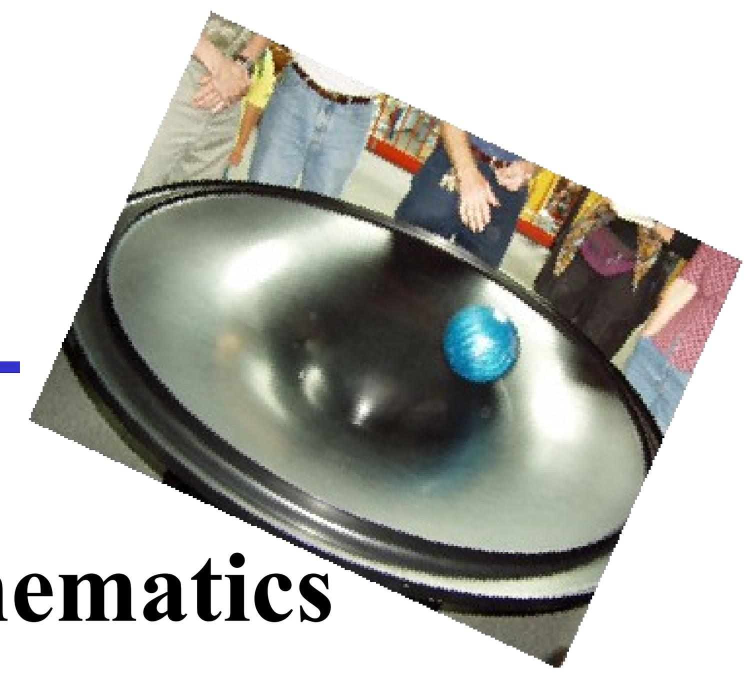


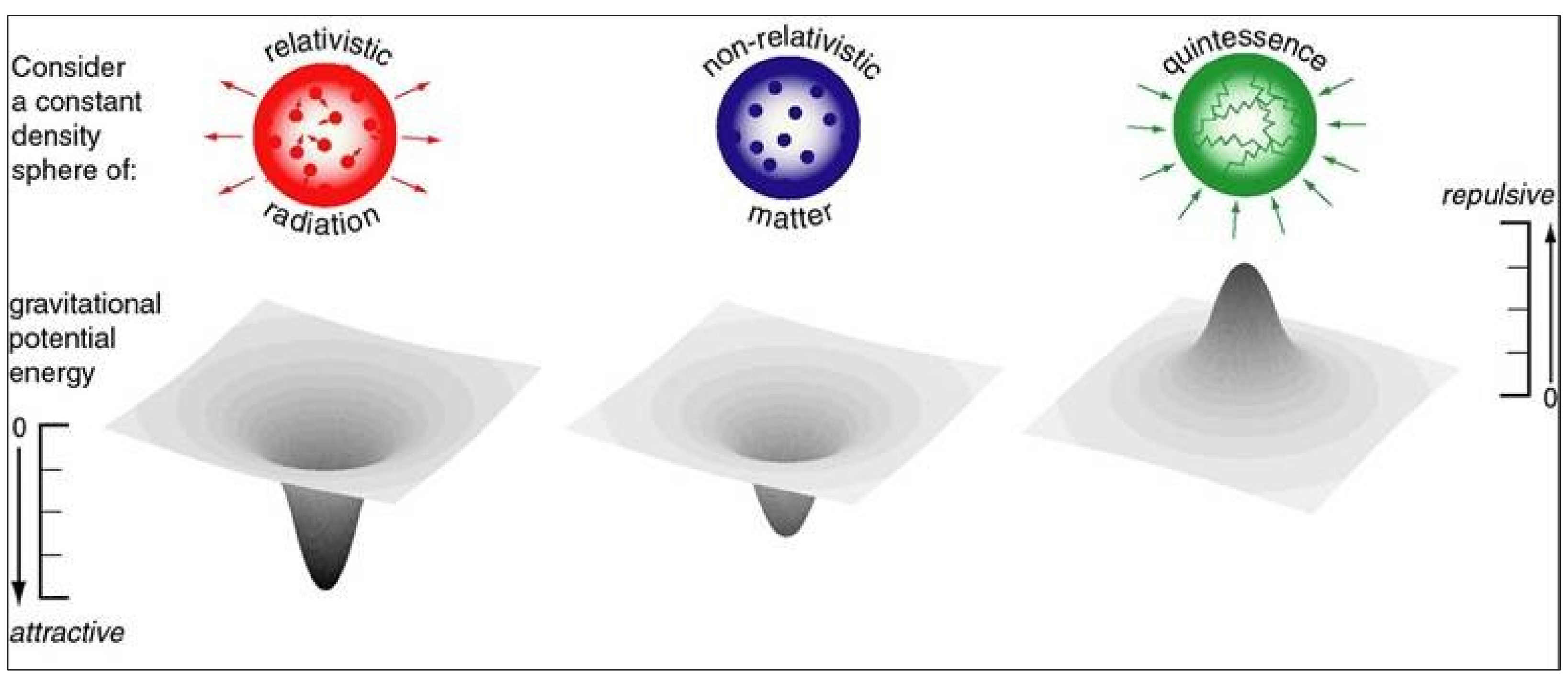
Scalar tensor gravity

- quintessence arising from modified gravity -



Introduction

In physical cosmology , *dark energy* is a hypothetical form of energy which permeates all off space and has strong *negative pressure*. According to the theory of relativity, the effect of such a negative pressure is qualitatively similar to a force acting in opposition to gravity at large scales.
One possibility is that the Universe contains a cosmological constant, similar to the one erringly introduced by Einstein, but originating from vacuum energy. An alternative which we are actively studying is *quintessence*, a dynamical form of dark energy.



In order for quintessence dark energy to cause the cosmic expansion to accelerate, the pressure must be more negative than minus one-third its energy density. One consequence is that inhomogeneities in the quintessence have novel gravitational properties.

Objectives:

We use two types of frames: Jordan frame and Einstein frame and we want to see how omega (the cosmological constant) varies in those two frames for three species: radiation, cold dark matter , with her densities and the rotational scalar field (quintessence). For this we use the conformal transformation and two equation: Fridmann equation and equation of motion. The two equations are listed below:

$$\ddot{\phi} + 3\tilde{H}\dot{\phi} + V(\phi) = \sqrt{2/3}k\beta\,(\tilde{\rho}_m + 3\tilde{p}_m)$$

$$H^2 = \frac{8\pi G}{3}\left(\frac{1}{2}\dot{\phi}^2 + 2V + \rho_m + \rho_\gamma\right)$$

! No evidence of quintessence is yet available, but it cannot be ruled out either

The Mathematics

Consider $F(R) = R + \frac{R^2}{M^2}$ and $V = \frac{RF'(R) - F(R)}{2k^2[F'(R)]^2}$ then the potential is:

$$V(\phi) = \frac{M^2 e^{-2\sqrt{2/3}k\varphi}(e^{-\sqrt{2/3}k\varphi} - 1)^2}{8k^2}$$

Using:

$$3\frac{d^2V}{d\varphi^2} = \frac{1}{3F''(\phi)} + \frac{\phi}{F'(\phi)} - \frac{4F'(\phi)}{F'(\phi)^2}$$

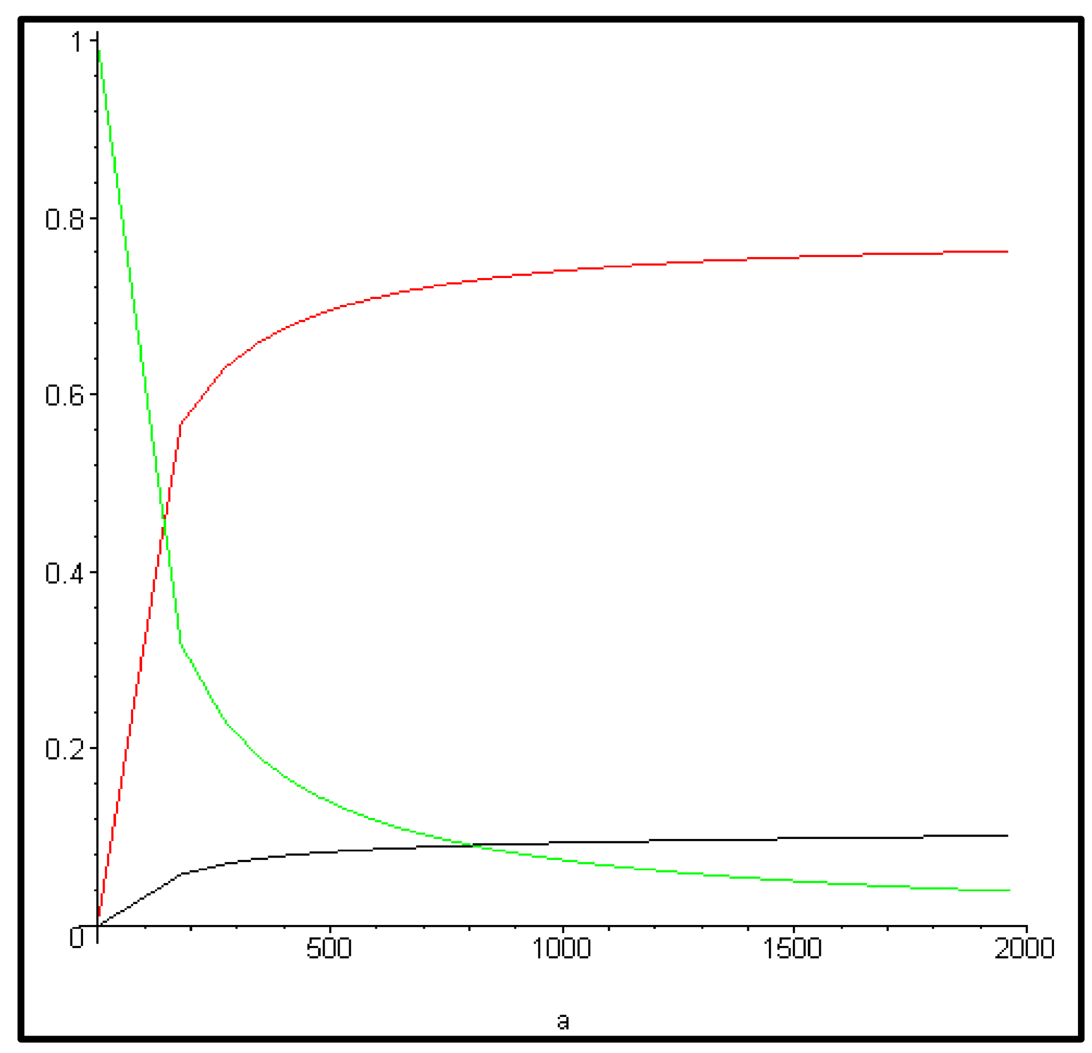
we obtain:

$$3\frac{d^2V}{d\varphi^2} = \frac{M^2}{2} + \phi - 4R$$

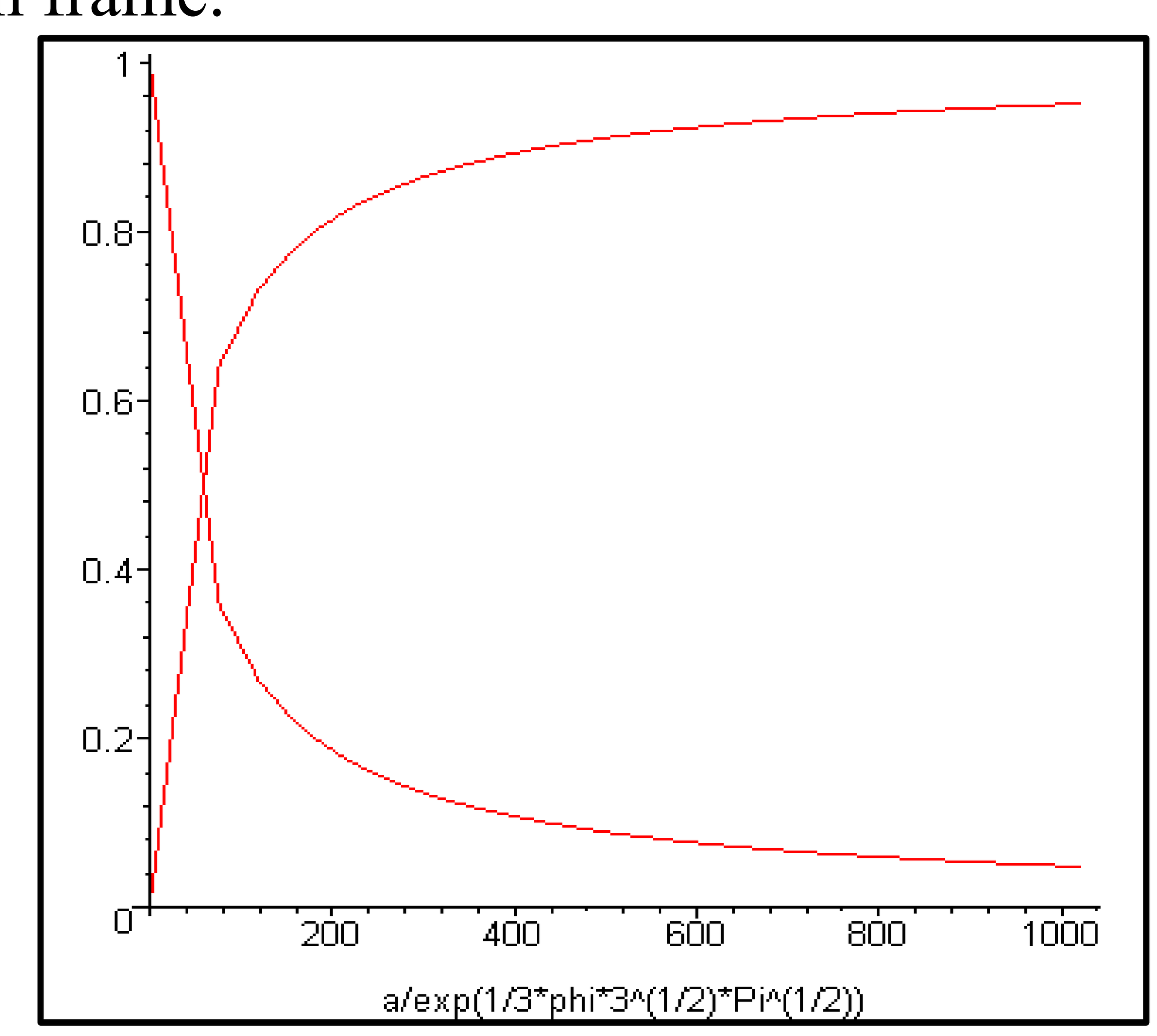
The second derivatite is evaluate around the Minkovski vacuum (φ=0) and gives the effective mass squared of the scalar field M^2 which is much larger than H_0^2.

The plots

We use Maple 9.5 to create the plots. For simplicitz we neglect the matter term from equations. First we reprezent omega as function of a in Einstein frame.



Then we represent omega as function of : $f\left(\frac{a(t)}{e^{k\phi\sqrt{2/3}}}\right) = \frac{\frac{\rho_m}{a(t)^3}}{\frac{\rho_\gamma}{a(t)^2} + \frac{\rho_m}{a(t)^3}}$, in Jordan frame.



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