Cosmological Dynamics of D-Blonic and DBI Scalar Field and Coincidence Problem of Dark Energy

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Cosmological dynamics of D-Blonic

D-Blonic (C. Burrage and J. Khoury, 2014)

The D-Blonic is one of the screening mechanisms which arises from DBI-like Lagrangian.

DBI-like action (ϕ couples conformally to matter)

$$S = \int d^4x\sqrt{-g}\left[+\Lambda^4\sqrt{1-\Lambda^{-4}(\partial\phi)^2} + \frac{g\phi}{M_{Pl}}T_m\right]$$

DBI action

$$S = \int d^4x\sqrt{-g}\left[-f(\phi)^{-1}\sqrt{1+f(\phi)(\partial\phi)^2} + f(\phi)^{-1} - V(\phi)\right]$$

$\therefore$ Signs have been flipped $\Rightarrow$ necessary for screening mechanism

D-Blonic screening

EOM of D-Blonic scalar field is

$$\nabla_\mu \left(\frac{\nabla^\mu \phi}{\sqrt{1 - \Lambda^{-4}(\partial\phi)^2}} \right) = -\frac{g}{M_{Pl}} T_m \,.$$

This consists of linear regime and non-linear regime. $\Rightarrow$ similar to the Vainshtein mechanism.

Far from the source $r \gg r_*$,

$$\phi'(r) \simeq \Lambda^2 \left(\frac{r_*}{r}\right)^2 \quad \rightarrow \propto \frac{1}{r^2}$$

$$\therefore F_\phi / F_N \simeq 2g^2 \text{ Unscreened!}$$

Close to the source $r \ll r_*$,

$$\phi'(r) \simeq \Lambda^2 \quad \rightarrow \text{constant}$$

$$\therefore F_\phi / F_N \simeq 2g^2 \left(\frac{r}{r_*}\right)^2 \ll 1$$

D-Blonic screening

We will find cosmological dynamics of the D-Blonic (also DBI) scalar field.

Necessary to the model

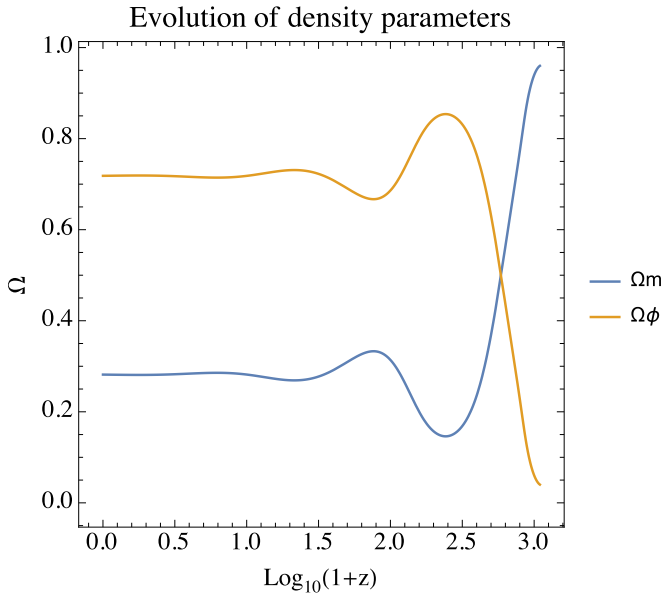
- Coupling to matter $\Rightarrow$ solves coincidence problem
- Screening for fifth force $\Rightarrow$ satisfies solar system constraints

Results

We found

1. the scalar field (dark energy) dominated solution the same as in DBI theory and coupled quintessence model.

2. a new scaling solution which is stable even though the coupling constant is small (in D-Blonic only).



3. However, ϕMDE is still difficult to realise.