บทที่ 1

Introduction

Present cosmic accelerating expansion was spotted by various observations, for example supernovae type Ia [1], cosmic microwave background anisotropies [2, 5], large scale galaxy surveys [3] and X-Ray source [4]. However, the acceleration can not be understood in the framework of standard cosmology. Proposals to explain this acceleration made till today could be, in general, categorized into three ways of approach [6]. In the first approach, in order to achieve acceleration, we need some form of scalar fluid so called *dark energy* with equation of state $p = w\rho$ where $w < -1/3$. Various types of model in this category have been proposed and classified (for a recent review see Ref. [7, 8]). The other two ways are that accelerating expansion is an effect of backreaction of cosmological perturbations [9] or late acceleration is an effect of modification in action of general relativity. This modified gravity approach includes braneworld models (for review, see [10]). Till today there has not yet been true satisfied explanation of the present acceleration expansion.

Although the simplest way to explain this behavior is the consideration of a cosmological constant [11], the known fine-tuning problem [12] led to the dark energy paradigm. The dynamical nature of dark energy, at least in an effective level, can originate from a variable cosmological ''constant'' [13], or from various fields, such is a canonical scalar field (quintessence) [14], a phantom field, that is a scalar field with a negative sign of the kinetic term [15, 16], or the combination of quintessence and phantom in a unified model named quintom [17]. Finally, an interesting attempt to probe the nature of dark energy according to some basic quantum gravitational principles is the holographic dark energy paradigm [18] (although the recent developments in Horava gravity could offer a dark energy candidate with perhaps better quantum gravitational foundations [19]).

Inflation driven by the open string sector through dynamical Dp-branes recently is of interest, so-called DBI inflation [20, 24]. The model lies in a special class of K-inflation models. It was originally thought that such models yielded large levels of non-Gaussian perturbations which could be used as a falsifiable signature of string theory [21]. However subsequent work has shown that this is not in fact the case, and that the simplest DBI models are essentially indistinguishable from standard field theoretic slow roll models [29, 28, 26]. However, that the models proposed in [29, 25] evade such problems. The problem is that the WMAP5 dataset imposes very tight constraints on the allowed tuning of the free parameters in the theory. We are then left with the choice of either having large non-gaussianities but with vanishing tensors, or assume that the tensor spectrum will be visible - in which case there is no non-

Gaussian signature. The models are only falsifiable once these conditions are relaxed. One can get around these conditions by considering more complicated models such as multi-field, multiple branes [27], wrapped branes [30] or monodromies [31] - but even here there are still problems with fine tuning, backreaction and the apparent breakdown of perturbation theory in the inflationary regime [32].

DBI models may still have some use as an explanation for a dynamical equation of state. Moreover this fits in nicely with several intuitive ideas from string theory. Namely that inflation can still occur, albeit only through the closed string sector. This suggests that dark energy may well be a dynamical process, and moreover in the light of these open string constructions, retains a sense of being geometric in nature. Therefore DBI-driven dark energy comes on stage as [33, 34] which dealt with the dynamics of a solitary $D3$-brane moving through a particular warped compactification of type IIB.

Coupling between the dark sectors is somehow possible. However this could create fifth force which is not seen in nature. A mechanism to suppress this force is through "chameleon mechanism" [35]. The chameleon model is a scalar-tensor theory of gravity, in which the scalar field couples non-minimally to the metric, this reduces effective mass of the scalar field to be in order of Hubble parameter. The scalar field coupled to the metric tensor causes violations of the equivalence principle and can produce fifth force effects if the scalar field is massive but the chameleon model the scalar field couples to matter in a non-minimal way. This allows the chameleon interaction to be suppressed in laboratory experiments, because its mass depends on the local matter density environment.

It is possible that at foundation, the theory of gravity could be made up from open string constructions giving DBI-kinetic term at the same time, there could be chameleon mechanism to reduce the mass of DBI scalar field so that the fifth force effect is reduced. In this report, our circa is to investigate DBI chameleon dark energy and its dynamics in various aspects.