Journal of High Energy Physics, Gravitation and Cosmology, 2023, 9, 411-413
https://www.scirp.org/journal/jhepgc
ISSN Online: 2380-4335
ISSN Print: 2380-4327

Trials to Resolve Black Holes Instabilities in Brane World Cosmology Models

Poula Tadros[1], Mohamed Assaad Abdel-Raouf[2]

[1]Department of Physics and Astronomy, University of Turku, Turku, Finland
[2]Physics Department, Faculty of Science, Ain Shame University, Cairo, Egypt
Email: pttadr@utu.fi, assaad@sci.asu.edu.eg

How to cite this paper: Tadros, P. and Abdel-Raouf, M.A. (2023) Trials to Resolve Black Holes Instabilities in Brane World Cosmology Models. *Journal of High Energy Physics, Gravitation and Cosmology*, **9**, 411-413.
https://doi.org/10.4236/jhepgc.2023.92029

Received: November 30, 2022
Accepted: April 1, 2023
Published: April 4, 2023

Abstract

In this letter, we report on our trials to remove the instability of black holes in brane world cosmological models consisting of two branes and a bulk. In order to resolve this problem, general types of interaction potentials were employed. Careful analyses have shown that although the black holes instabilities were removed, a sort of arbitrariness adherent to the motion of the two branes towards each other has taken place leading to an unstable system. Thus, the models seem to us rather paradoxical.

Keywords

Brane World Cosmology, String Cosmology, Black Holes

1. Introduction

Brane world type cosmology was introduced by Turok [1] to solve some problems in conventional cosmology. The models propose that there are two 4-dimensional D-branes in a 5-dimensional world, our universe is situated on one of the branes, so called the visible brane, and the other brane is called the hidden brane. Since then, there have been many developments and different models proposed in this field [2] [3] [4] [5]. One model is particularly interesting in terms of the resulting cosmology called the Randall Sundrum (RS) I model [6] where the branes are located on an orbifold. In this model, black holes cannot be present in the universe, because it introduces instabilities to the system.

In this letter, we report on our trials to remove these types of instabilities by modifying the model and introducing an additional potential. It is shown that the removal of intrinsic black holes instability in the model is subjected to the appearance of arbitrariness in the model generated by the relative motion of the two branes. This arbitrariness is due to the too many parameters in the theory which cannot be fixed by the model's dynamics and must be fine-tuned to get desirable results. This matter seems to us rather paradoxical.

2. The Modified Model and the Trial to Remove the Instability

In the original RS I model, the two branes are static, thus, the gravitational force between them exactly cancels the force from the RR charge. In the modification proposed we considered the model where the branes are moving with respect to each other, and there is an additional force between them induced by a potential depending on the separation of the branes.

The action for this model is given by

$$S = \lambda_+ \int \mathrm{d}^5 x R_1 \delta\left(y - y_1(t)\right) + \lambda_- \int \mathrm{d}^5 x R_2 \delta\left(y - y_2(t)\right) + \int \mathrm{d}^5 x V(y),$$

where λ_+ is the positive tension of the first brane, λ_- is the negative tension of the second brane, R_1, R_2 are the Ricci scalars of the first and second branes respectively, y is the coordinate normal to the branes, y_1 and y_2 refer to the positions of the first and second branes at a given time t, and $V(y)$ is the introduced potential.

Two cases might be considered:

1) $V(y)$ is attractive to a certain value of y *at* which it is prevented the approach of the two branes towards each other.

2) $V(y)$ should depend on the difference between the RR and gravitational force such that the total force vanishes everywhere.

The former case introduces another instability in the system from the fact that the branes will collide because the RR force and the gravitational force do not cancel. This implies that the structures on the branes are unstable.

The later, case gives back the original RS I model where black holes are unstable, and the introduction of a potential is redundant.

For both cases taking the potential to be a general series (each case can be derived by adjusting the parameters in the series)

$$V = \sum_{i=-\infty}^{i=\infty} a_i y^i$$

where a_i are adjustable coefficients, which can be used to mitigate or even remove the instability from the black hole. However, an alternative instability connected to the moving system will show up.

It is obvious that the adjustable parameters could be selected to remove the black holes instability but not prevent the motion of the branes towards each other. Also, trials to fix the time taken before the collision are subjected to fine tuning process, this is because the parameters cannot be fixed by the dynamics of the theory but rather fixed by hand.

3. Conclusion

From the trials explained above, we conclude that brane world models consisting of two or more D branes and antibranes with black holes are inherently unstable regardless of the potential added. The origin of the new instability is that the branes are in equilibrium only when they are at rest with respect to each other and at least one of them is located on a fixed point of the ambient orbifold. Adding a new potential to try to balance this force in the presence of black holes on the branes implies the motion of the branes towards each other and eventually collide and this cannot be prevented without fine tuning. Thus, we conclude that stable cosmologies from these types of theorems could not be anticipated.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Khoury, J., *et al.* (2001) Ekpyrotic Universe: Colliding Branes and the Origin of the Hot Big Bang. *Physical Review D*, **64**, Article ID: 123522. https://doi.org/10.1103/PhysRevD.64.123522

[2] Sepehri, A. (2015) Cosmology from Quantum Potential in Brane-Anti-Brane System. *Physics Letters B*, **748**, 328-335. https://doi.org/10.1016/j.physletb.2015.07.017

[3] Burgass, C.P., Majumdar, M., Nolte, D., Quevedo, F., Rajesh, G. and Zhang, R.J. (2012) The Inflationary Brane Anti-Brane Universe. *Journal of High Energy Physics*. arXiv: hep-th/0105204.

[4] Brandenberger, R., Dasgupta, K. and Wang, Z. (2020) Reheating after S-Brane Ekpyrosis. *Physical Review D*, **102**, Article ID: 063514. https://doi.org/10.1103/PhysRevD.102.063514

[5] Khoury, J., Ovrut, B.A., Seiberg, N., Steinhardt, P.J. and Turok, N. (2002) From Big Crunch to Big Bang. *Physical Review D*, **65**, Article ID: 086007. https://doi.org/10.1103/PhysRevD.65.086007

[6] Randall, L. and Sundrum, R. (1999) Large Mass Hierarchy from a Small Extra Dimension. *Physical Review Letters*, **83**, 3370-3373. https://doi.org/10.1103/PhysRevLett.83.3370