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Title:A Study of Cosmological Aspects Through Brane Model

The aim of the thesis is to first investigate the effective gravity on a hypersurface using the contribution of surface tension,in addition to the extrinsic curvature,and then use it to study the brane cosmology with this new action.Also,to investigate the gravitational instability between epochs of equality an recombination,using modified dynamics for the dark matter,in the standard Newtonian,General relativistic and string cosmology scenarios.We have based our studies on the ΛCDM cosmology.Our aim is to build a model for self-interacting collisionless dark matter which can help us in resolving the core-cusp problem.The discrepancy in the determination of central mass distributions using rotation curves i.e. through astronomical observations and the one from CDM simulations is known as the core-cusp controversy. It is important to mention here that the core-cusp problem is one of the major problems which cannot be explained by ΛCDM cosmology.

We have modified the famous Gibbons-Hawking action,with a new action,which for the first time accepts the contribution of the surface tension,in addition to the extrinsic curvature,for a non-compact geometry of the surface.We can use this action for studying cosmological scenarios,when the reference background is not asymptotically flat and for non-compact geometries with no inner boundaries.We also define a reference background for calculating the boundary term for non-compact geometries with no inner boundaries.In order to achieve this aim,we have made the representation of surface tension of a hypersurface frame invariant by expressing it in terms of normal curvature.This has been a great improvement in the theory of surface layers in general relativity,in the sense that since last thirty years the expression of tangential pressure in terms of the mean curvature was not frame-invariant,due to it being dependent on the four-velocity of the hypersurface.It is important to note that the expression of negative tangential pressure of surface layer has intrigued general relativists since the days of Einstein.Our modified action,with a frame invariant representation of surface tension opens up new avenues for carrying out the surface studies of black hole and its entropy corrections and to study the critical surface tension at which radiation discharge occurs in stars.Also,studying the effective gravity of Branes with this new action will give a new perspective to the Brane cosmology,where the tension of the Brane is now taken separately from the contribution of the extrinsic curvature term,which is calculated as per the traditional Gibbs-Hawking action. In another work, we have explored the Dark matter dynamics using the variable mass formalism of Merscerskii,to recover the standard CMB i.e,$\Theta = \frac{\delta\phi}{3}$ .This we have done in the Jeans static universe and the standard Newtonian expanding universe scenario.This gives us new perspectives regarding the stage when the dark energy started to dominate and additional parameters to explore the second peak of CMB.We have established the collisionless nature of the dark matter by inherent novel assumptions in the model.Our model also supports the self-interacting nature of dark matter in its dynamics,a fact supported by some recent astrophysical data.The fact the we recover the same standard CMB,with inherent assumptions of collisionless,feebly,self-interacting nature of dark matter embedded in the dynamics of dark matter in the presence of strongly coupled baryon-radiation plasma ,at epochs between equality and recombination,strongly supports the SIDM model. Moreover,on this new dark matter model,we will in immediate future propose a new simple explanation for the rotation curves of the core halo model in Giant low surface brightness galaxies. In another work,we study the fractional M2 Branes in N = 1 superspace.

In the course of carrying out the above mentioned specific work,we studied the following things.We studied the surface layers in general relativity with the purpose of getting more information about the effective gravity on the hypersurface i.e.,a world sheet of the Brane.The representations of the negative tangential intrinsic pressure and the surface tension on a hypersurface starting from a very early period of general relativity to the most recent one was investigated.The investigation was carried out in the most general way i.e.,keeping compact and non-compact geometries in mind.A detailed study of the Riemannian geometry on an Einsteinian manifold and differential geometry was carried out for this purpose.Also,the theory of hypersurfaces in General relativity was studied. Then all the important aspects in the standard cosmological model like the CMB and the nucleosynthesis were studied.Also,aspects beyond the standard model like dark matter,dark energy and inflation were studied.The theory of gravitational instability between epochs of equality and recombination was investigated,both in the Jeans theory,Newtonian and the General relativistic scenario.The theory of string cosmology was also studied where we could follow the tree level equations and its Einstein frame representation.A study of Brane/Antibrane inflation was also carried out.We have based our work on the self-interacting cold dark matter with a view to give a proposal for resolution of the core-cusp problem i.e the formation of dark matter halos of massive galaxies and their rotation curves.

In view of the implications arising from my work from my recent discussions among top level research groups i feel the need to extend my studies into non-compact geometry.This is because strong gravity cannot be defined using a compact geometry.The only reason we avoid non-compact geometry is due to its comlexity and also because Riemannian geometry is not defined for a noncompact manifold.So,geometric flows like Ricci flows in non-compact geomtries could reveal interesting information for the loss of information in strong gravity scenarios like a black hole.Also,i am interested to explore how the new equations for surface tension and negative tangential pressure behave in various types of geometries and what are their implications.

We can calculate new effective equations determining the gravitational field on the brane by using the gravitational action modified with the new boundary term.I intend to study the 5-layer model for gravastar suggested by Mazur and Mottola as an alternative to black hole singularity.The gravastar is free from information paradox problem.There is also a 3-layer model by Visser Wiltshire.We can investigate the variable transient time between the SN and the associated GRB .We can use our new representation of negative tangential pressure and surface tension in strange stars.This is based on the theory of formation of strange stars by cosmic phase separation in early universe by Witten.It is important to mention here that these strange stars formed in early universe could be possible candidates of dark matter,as suggested by Witten.There is a transtient time delay from few seconds to sometimes few days to 2-3 yrs between the SN and the GRB.This can be explained by high values of surface tension of the Quark crystal which forms at the interface of the hadron boundary inside the core of such a star.We can assume this interface to be a noncompact geometry and then using the representation of surface tension and intrinsic pressure for such a geometry can further investigate this problem and leading possibly to new insights.The investigation of dark matter dynamics between equality and recombination with new self-interacting cold dark matter in an imperfect fluid scenarion could also reveal interesting information about the second peak of the CMB and large-scale structure.This could also reveal more specific information about the epochs when the dark energy exactly starts to dominate.There is also a lot of scope of investigating the gravitational instability in a general relativistic environment using various scenarios like fluids having strange equation of states e.g. an exotic fluid like chaplygin gas or phantom fields and reveal more information about the late time acceleartion of the universe.The explorations can be carried out with various types of self interactions in cold dark matter and this will have great significance both for the constitution and number of galaxies in the known universe.This will also help us to explain the constancy of rotations curves in massive LSB galaxies e.g. NGC 7589. A more accurate,frameinvariant and geometric representation of negative tangential pressure in terms of surface tension free from local parameters can be utilized in constructing more accurate computational models for studies of fluid-interfaces.

There is always a scope to investigate the metrics of gravitational wave sources like neutron stars to understand the effect of time delay due to gravitational sources in addition to the kinematical delay.This can be further extended to studying the effect of gravitational refractive index using optical-mechanical analogy theories to reveal information useful in understanding the factors affecting the gravity waves.This can help us in enhancing our instrumentation for gravity wave detection.My personal opinion is that it is important to embed our spacetimes in higher dimensional euclidean spacetime using Nash's theorm and try to understand dark energy and dark matter in such a scenario.We can explore the extrinsic curvature and normal curvature of various kinds of bulk-brane scenarios in diverse types of geometries to add to the theory of hypersurfaces.