Chapter 7

Conclusion

7.1 Conclusion:

The present thesis has presented different theoretical studies of influences of dark sector on few local gravitational phenomena with the objective to explore theoretically possibilities of testing dark sector and discriminating different models of dark sector, at least in principle.

The influence of dark matter/energy on gravitational time advancement has been studied and analytical expressions for the time advancement has been obtained which is found to depend on the strength of dark matter/energy. The results of the present investigation suggest that in principle the measurements of gravitational time advancement at large distances can verify the dark matter and a few dark energy models or put an upper limit on the dark matter/energy parameter. The findings demonstrated that dark energy gives only a (positive) gravitational time delay, irrespective of the position of the observer. Consequently, there will be no time advancement effect at all at radial distances where the gravitational field due to dark energy is stronger than the gravitational field of the Schwarzschild geometry. In the alternative dark matter models like conformal gravity model or Grumiller's modified gravity the time advancement take place irrespective of gravitational field of the observer if dark matter field is stronger than the gravitational field of luminous matter.

The expressions for gravitational time advancement of particles with non-zero mass has been deduced in Schwarzschild geometry. Subsequently the effect of dark matter and dark energy on gravitational time advancement for particles with non-zero mass have been studied. It has been proposed that comparison of gravitational time advancement for a photon and a relativistic particle of a non-zero mass can be used, at least in principle, as a tool to verify the presence of dark matter and dark energy.

Gravitational lensing studies have been performed for global monopole space time. The bending angle is found negative when lensed by an isolated global monopole system which is a clear signature of the global monopole system. The present study suggests that the global monopole description of dark matter is not compatible with gravitational lensing observations.

Grumiller's modified gravity theory and conformal gravity theory can describe flat rotation curve of galaxies without invoking dark matter. After confronting the theoretical predictions with the observations involving the rotation velocities at large distances from the galactic centre for a sample of sixty galaxies the Grumiller's modified gravity theory and conformal gravity theory are found consistent with baryonic Tully-Fisher feature.

Considering observed flat rotation curve feature as an input and assuming presence of cold dark matter a new space-time metric has been obtained by solving Einstein field equations. The gravitational lensing for the derived space time has been studied and it is found that the model correctly describes the lensing observation for the cluster Abell 370.

The problem of dark matter and dark energy, particularly their origin and nature are very challenging. Further detailed studies on various aspects and on various directions are needed to progress in understanding the outstanding problems of dark sector. In near future the author will take up gravitational lensing studies for alternative dark matter and dark energy models.

In summary the works presented in the thesis explore the possible signature of dark matter and dark energy on gravitational time advancement phenomenon, has questioned the viability of global monopole model of dark matter through gravitational lensing studies, the consistency of two notable alternative models of dark matter, the Grumiller's modified gravity theory and the conformal gravity theory, with baryonic Tully-Fisher feature is established. The gravitational lensing features of a general static spherically symmetric spacetime metric, which is deduced assuming flat feature of galactic rotation curve and the presence of cold dark matter, are studied.