Abstract

The motivation of this thesis deals with the fact that light is the carrier of the information of distant astrophysical objects to us. When light from a distant object (source) passes through the environment of another objects (lens) and reaches us (observer), we have some information about the source and the lens through what is known as the effect of gravitational lensing – an effect that has in its core the physical phenomenon of the bending of light around the lens. Such a lens could be a galaxy or a wormhole. Here the thesis includes bending of light in two entirely different scenarios: one is the galactic halo gravity described here by the MKdS geometry that does not require the dark matter and the other is the special class of Ellis wormhole gravity.

To determine the maximum size of a galactic halo for several observed lenses we apply the method of autonomous Hamiltonian dynamical system which can definitely fix, under the physical condition of stability, the sign of an indefinite parameter $\gamma \leq 0$ appearing in the MKdS solution of Weyl conformal gravity with the observed value of the cosmological constant $\Lambda$. Next to calculate light bending in galactic halo gravity, we employ the invariant angle method, recently developed by Rindler and Ishak, which is especially suitable for asymptotically non flat spacetime such as the MKdS spacetime and it also nicely reveals the dependence of light bending both on $\gamma$ and $\Lambda$ together with other physically interesting new combinations. The two way contribution $-\gamma R$ shows that, for $\gamma < 0$, the halo gravity is attractive, as it should be. Using the concept of Einstein- Strauss vacuole we find out various other new contributions to bending.

We derive the exact expression of bending of light by the zero mass Ellis wormhole using the proper length $\ell (-\infty < \ell < \infty)$ which is able to describe the total wormhole geometry rather than the coordinate marker $r_s (a < r_s < \infty)$. The two way bending formula is also confirmed by Perturbation method and Invariant angle method (Rindler & Ishak). Moreover we show that a singularity free wormhole can be obtained from Brans Class I solution by performing a Wick rotation on it. The result is the Brans Class II natural non-singular traversable wormhole solution in the range $-2 < \omega < -3/2$. The Class II solution can also be treated as wormhole analogue to the naked black hole.

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