Fuzzy and Axion-Like Dark Matter as an Illusion

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Abstract: Here we show that masses of the dark-matter (DM) loops in the massive spiral galaxies have the same values as masses of the postulated fuzzy and axion-like DM particles. The DM loops are not fuzzy and, contrary to the spin-zero axion-like DM particles, spin of them is quantized. The DM loops in galactic halos interact with stars via the weak interactions of the virtual electron-positron pairs created spontaneously in spacetime. Such interactions decrease radii of the DM loops and simultaneously increase the orbital speeds of stars. We calculated also the small-scale cutoff for such loop-like DM.

1. Introduction

The existence of dark matter (DM) results from its gravitational interaction on various astronomical scales.

But the cold dark matter (CDM) models predict cuspy dark matter halo profiles (not seen in the rotation curves of galaxies) and an abundance of low mass halos (not seen in local population of dwarf galaxies). To avoid such problems it is postulated to have warm dark matter (m_{warm} ~ keV) but this in turn disturbs the structure on larger scales. The solution is a free very light scalar particle (m ~ 10^{-21} eV = $1.8 \cdot 10^{-57}$ kg). Such ultra-light scalar particles cause that the dark matter behaves as a classical field and the wave nature of the particle is manifest on astrophysical scales. It is assumed that dark matter halos are stable on small scales because of the uncertainty principle in wave mechanics. It is the reason that such dark matter candidate is called fuzzy cold dark matter (FCDM) [1]. There is a review article about fuzzy and axion-like dark matter [2].

But the possible detection of a postulated axion does not solve all problems related to galaxy halos, for example, we have a problem to describe the origin of the DM halo density profiles.

All the three basic problems (i.e. the cuspy halo problem, existence of low mass halos, and problems concerning the origin of the DM halo density profiles) do not appear in the loop-like DM (LLDM) described within the Scale-Symmetric Theory [3].

2. The today masses of the DM loops in the spiral galaxies

The DM loops, similar as photons, consist of the entangled (it is the superluminal quantum entanglement [3]) spin-1 neutrino-antineutrino pairs but in photons, the unitary spins are perpendicular to velocities while in DM loops, are parallel or antiparallel. In [4] we showed that the initial superphotons (so the DM superloops as well) over time decayed into objects containing less and less the neutrino-antineutrino pairs. In [4] we calculated that today, the

CMB photons (so the DM loops as well) should consist of 4^{16} such pairs so today masses of the DM loops in the spiral galaxies should be

$$m_{SST} = 4^{16} \cdot 2\, m_{Neutrino} = 1.607 \cdot 10^{-21}\ eV = 2.865 \cdot 10^{-57}\ kg\,, \tag{1}$$

where $m_{Neutrino} = 3.335 \cdot 10^{-67}\ kg = 1.87 \cdot 10^{-31}\ eV$ is the mass of the non-rotating-spin lightest neutrinos [3].

The mass m_{SST} is consistent with mass of the postulated axion-like particle (ALP).

Notice that the DM loops are in the rest in relation to centre of a spiral galaxy but their spin speed is equal to the speed of light in "vacuum" c.

3. The mechanism

In [5], applying the SST, we described the interactions of dark-matter with stars and we calculated the orbital speeds of stars in spiral galaxies. The basic formula looks as follows

$$v_{orbital\text{-}speed,advection} = c\,(2\,\alpha_{w(electron\text{-}muon)}\, m_{galaxy,visible} / m_{o,MBH})^{1/2} = const., \tag{2}$$

where $v_{orbital\text{-}speed,advection}$ is the orbital speed of a star, $2\alpha_{w(electron\text{-}muon)} = 2 \cdot 9.511082 \cdot 10^{-7}$ is the coupling constant for weak interactions of the spin-1 virtual electron-positron pairs produced spontaneously in spacetime, $m_{galaxy,visible}$ is the visible mass of a spiral galaxy, and $m_{o,MBH} = 8.525 \cdot 10^{11}$ [solar masses] is the highest mass of the initial black hole which transformed into a massive spiral galaxy and many dwarf galaxies.

The condensates in centres of the charged leptons in the virtual electron-positron pairs interact weakly with both the DM loops and the visible matter the stars consist of.

The weak interactions of the dark matter loops with stars via the virtual electron-positron pairs decrease angular momentum of the DM loops and simultaneously increase orbital speeds of the stars in such a way the resultant change in total angular momentum was equal to zero. It is the advection mechanism for stars caused by the DM loops.

4. The present-day lower limit for radii of the DM loops in massive spiral galaxies

We can calculate the present-day lower limit for radii of the DM loops in massive spiral galaxies. Lowest spin of DM loop must be unitary so initial radius was

$$R_{Initial} = \hbar / (m_{SST}\, c) = 1.23 \cdot 10^{14}\ m\,. \tag{3}$$

But emphasize that there can be created DM loops with smaller radii and higher masses.

Due to the weak interactions, such radius increased $f = 1/(2\alpha_{w(electron\text{-}muon)}) = 5.26 \cdot 10^{5}$ times so the small-scale cutoff in massive spiral galaxies appears at

$$R_{Cutoff} = R_{Initial}\, f = 6.45 \cdot 10^{19}\ m = 2.09\ kpc\,. \tag{4}$$

It suggests that centres of massive spiral galaxies should be free from primordial DM loops.

5. Summary

Notice that the most stringent constraints for mass of DM objects ($m > \sim 10^{-21}$ eV) "are derived from suppressed small-scale power probed by the Lyα forest, luminosity functions of high-z galaxies, and reionization" [2]. The today masses of the primordial DM loops calculated within SST are consistent with such constraints.

The DM loops in spiral galaxies interact with visible matter via the weak interactions of the virtual electron-positron pairs.

Centres of massive spiral galaxies should be free from primordial DM loops.

The DM loops in a halo are entangled and due to the spin orientation of the neutrino-antineutrino pairs, they cannot interact electromagnetically. The DM-halos theory presented here is free from the problems that other theories face.

References

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