International Journal of Advanced Research in Physical Science (IJARPS)
Volume 5, Issue 2, 2018, PP 25-27
ISSN No. (Online) 2349-7882
www.arcjournals.org

On Some Properties of Dark Matter

V.P. Efrosinin

Institute for Nuclear Research, Russian Academy of Sciences, Moscow, Russia

Corresponding Author:** ***V.P. Efrosinin, *Institute for Nuclear Research, Russian Academy of Sciences, Moscow, Russia*

Abstract: *The dark matter, including neutrino, can be found in a spread over cosmic space state of the gravity related systems. It can exist only due to motion of the particles at specified values of speed. Since at present time there is no significant room to doubt the generality of the gravity lows, it is reasonable to assume that the lows of motion for the objects belonging to the dark matter are the same as for other cosmic objects independently of their nature, like stars, planets, asteroids, cosmic dust and so on. So far the study of the dark matter is in its inception phase and there are many gaps in available information and knowledge framework. Nevertheless a number of properties of the dark matter can be defined with appropriate confidence. Some of them are discussed within this paper.*

Keywords: *The dark matter, free path length, equilibrium condition.*

1. Introduction

As it is known, there are gravitational and other factors influencing the unusual behavior of speeds. The gravitational forces have other properties in a scale of the galaxy but at present time there are no theoretical arguments to approve this expectation. Dark matter represents a type of matter composing about 80% of the total matter in the universe. It cannot be directly observed only rather through auxiliary gravitational effects in numerous astrophysical experiments. Two forms of dark matter can be distinguished [2]. The first form is a non-luminous baryonic matter which makes up large planets and ordinary stars. However the multiple astrophysical observations suggest that the baryonic matter is a minority of the dark matter. The dark matter can be composed also by a non-baryonic matter consisting of WIMPS or weakly-interacting massive particles which have ten up to hundred times the proton's mass. The weak interactions with ordinary matter make the particles difficult to detect. The elementary particles as candidates for the dark matter can be divided into three categories dependent on their masses.

The first category includes those particles which were in thermodynamic equilibrium at earlier stages of the Universe. The temperature to be out of balance depends on nature of the relationships of the considered type of particles. Another category consists of those particles which interacted very weakly with ordinary matter, moved slowly compared to the speed of light and they can be described by non-relativistic equation of state at the time when galaxies could just start to form. Such form of dark matter is known as cold dark matter (CDM). Due to their high mass, these dark matter particles would move relatively slowly, at almost the similar speed as the gas and dust in our galaxy. An example is the very heavy neutrino. If these particles at that epoch are described by a relativistic equation of state at the time when galaxies could just start to form, they neither emits nor absorbs light, such a form of dark matter is categorized as hot dark matter (HDM). An example of a hot dark matter particle is the neutrino which has small mass and has no contribution to the four fundamental forces, electromagnetic interaction and strong interaction. There are other possible DM candidates for the dark matter which cannot be treated in earlier defined framework. This category of candidates includes those particles encountered in the phase transition of the cooling Universe. The most popular such candidates are known as gas of axions and arise from trials to interpret why the strong interaction seems to obey the CP symmetry. In case of hot dark matter there are serious difficulties by explanation of the forming the largescale structures of the Universe.

2. Main Results

The dark matter has not been observed directly. It must interact with ordinary baryonic matter and radiation only very weakly. Otherwise the effects arising by interaction with the matter would be directly observable. Another type of interaction is weak and short-range. It manifests itself at very short range of 10^{-16} cm that is only at sub nuclear level. Hence the dark matter is a matter mostly because of gravity which seems to be the main interaction art arising on a cosmic scale in the dark matter. In case of a high enough concentration of the dark matter the quantum mechanical exchange interaction can be manifested itself, that leads in turn to the concentration decreasing of the spin half fermions and to the concentration increasing of the spin-1 bosons [1]. Probably this exchange interaction is a factor defining the contribution of the particles of the specified type to the dark matter which demonstrates the prevalence of certain types of particles.

The dark matter, including neutrino, can be found in a spread over cosmic space state of the gravity related systems. It can exist only due to motion of the particles at specified values of speed. Since at present time there is no significant room to doubt the generality of the gravity lows, it is reasonable to assume that the lows of motion for the objects belonging to the dark matter are the same as for other cosmic objects independently of their nature, like stars, planets, asteroids, cosmic dust and so on. Hence the lows of motion can be derived by virtue of the ordinary methods of the celestial mechanics. According to this approach, the hidden objects of the dark matter are the members of the same hierarchical sequence of the gravity connected systems as the observable objects in the Earth and Solar systems, galaxies and clusters of galaxies. By extremely high concentration it is probably needed to take into account the quantum effects. In a hot Universe, which is filled by interacting particles, there is a thermodynamic. But while the Universe expends and cools, some of the particles can leave behind the state of the thermodynamic equilibrium and segregate from an ensemble of other particles. The equilibrium condition means that the free path length must be much lower than the distance of the particles at the initial moment of time,

$$l \ll v\,t. \qquad (1)$$

If this condition is valid, then the particles interact with a cosmic cocktail and do not leave behind this ensemble. The free path length

$$l = \frac{1}{n\,\sigma}, \qquad (2)$$

where σ denotes the interaction cross-section of the particles and n is their density. Since the speed of extension is inversely to the time

$$H \sim \frac{1}{t}, \qquad (3)$$

the equilibrium condition can be expressed in form

$$\Gamma > H, \Gamma = \frac{1}{v\,n\,\sigma}. \qquad (4)$$

If $\Gamma > H$ at some epoch and $\Gamma < H$ at some later period of time, then there exists a temperature T for which it holds, $\Gamma = H$. The covers of the spheres and systems, consisting of dark matter streams, moving around them over different orbits, will be called neutrino-spheres. It can include those weakly interacted particles as well with rest mass.

There are approximately $2 \cdot 10^{11}$ stars in our Galaxy. It contains also sufficient amount of gas and cosmic dust. The stars of the Galaxy form a complex but rather regular shape in a space. It looks like a regular disk with a spherical bulge in its center. In a central part of the galaxy there is a kern with a high density of starts which has a radius of several parsec. There is a supermassive black hole at the center of the Galaxy with a mass up to 2.4 million solar masses. Spiral arms of the Galaxy are located between a central part and disk's periphery. Spiral arms typically contain a higher density of interstellar gas and dust than the Galactic average as well as a greater concentration of bright star formation [3]. The ranges in age of stars are very high. The old stars form a dark matter halo which is a component of a galaxy which covers the galactic disk and spreads outside the boundary regions of the observable galaxy. The halo's mass makes a larger contribution to the total mass. The young stars can be found only within the disk. The most of stars in the disk are of intermediate age about several billions years old. The Sun belongs to this group of stars. The orbits of the old and young stars have different shapes. While the older stars of the Galaxy move along the eccentric orbits, the younger stars move on near-circular orbits. Gas and cosmic dust have the same lows of motion. The young stars, gas and cosmic dust form in conjunction a high speed spinning disk of matter in the Galaxy, while the dark matter halo of old stars almost doesn't revolve around the center. But in so doing, the disk is embedded into the system of old stars. So far the study of the dark matter is in its inception phase and there are many gaps in available information and knowledge framework. Nevertheless a number of properties of the dark matter can be defined with appropriate confidence. The dark matter is several times superior in mass against the mass of stars in galaxies and mass of galaxies in their clusters.

REFERENCES

[1] D.V. Ahluwalia-Khalilova, D. Grumiller. Spin half fermions with mass dimension one: Theory, phenomenology, and dark matter. arXiv:hep-th/0412080, 2004.

[2] K. Arun, S.B. Gudennavar, C. Sivaram. Dark matter, dark energy, and alternate models: A review. arXiv:1704.06155, 2017.

[3] J.H. Taylor, J.M. Corde. Pulsar distances and the galactic distribution of free electrons. The Astrophysical Journal, Volume 411: 674-684, 1993.

AUTHOR'S BIOGRAPHY

Dr. Vladimir Efrosinin, since 1972 a Senior Scientist at the Institute for Nuclear Research Russian Academy of Sciences, priority scientific interest is the Elementary-Particle Physics. At the present time he deals with a problem of neutrino including evaluation of the role of neutrinos in the modern Universe.

Citation: *V. Efrosinin, "On Some Properties of Dark Matter", International Journal of Advanced Research in Physical Science (IJARPS), vol. 5, no. 2, pp. 25-27, 2018.*