GALACTIC ROTATION AND LARGE
SCALE STRUCTURES

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Abstract

On the basis of a recent cosmological model, the puzzle of galactic rotational velocities at their edges is explained without invoking dark matter. A rationale for the existence of structures like galaxies and superclusters is also obtained.

1 Introduction

In a previous communication[1] we had described a cosmological scheme which is consistent with observations and yet does not invoke dark matter. It is ofcourse well known that the puzzle of galactic rotational velocities can be explained by the dark matter hypothesis[2, 3]. Briefly put, using the well-known relation for rotation under gravitation,

\[ \frac{mV^2}{r} = \frac{GMm}{r^2} \quad (1) \]

we would expect that from (1) the rotational velocities \( V \) at the edges of galaxies would obey the relation

\[ V^2 = \frac{GM}{r} \quad (2) \]

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where $M$ is the galactic mass, $r$ the radius of the galaxy and $G$, the gravitational constant. That is the velocities would fall off with increasing distance from the centre of the galaxy. However, it is observed that these velocities tend to a constant\[^3\],

$$V \sim 300 \text{Km/sec}$$  \hspace{1cm} (3)

Alternatively, it is observed that the mass of the universe obeys the law\[^4\],

$$M \propto R^n, n \approx 1$$  \hspace{1cm} (4)

These discrepancies can be explained if there is unobserved or unaccounted, that is missing or dark matter, whose gravitational influence is nevertheless present. This would also close the universe, that is the expansion would halt and a collapse would ensue. While no dark matter has yet been discovered, it must be mentioned that one candidate is a massive neutrino\[^5\]. Recently, the Superkamiokande experiments have yielded the first evidence for this\[^6\], but it is recognized that this mass, roughly of the order of a billionth that of the electron is far too small to be the missing or dark matter.

On the other hand, latest observations of distant supernovae by different teams of observers show that the universe would continue to expand for ever\[^7\], \[^8\].

The cosmological scheme considered in reference \[^1\] (cf. also ref.\[^9\]) predicts precisely such a behaviour and moreover, explains (4) without invoking dark matter. In this scheme, particles, typically pions are fluctuationally created out of a background ZPF. (Other mysterious, hitherto empirical relations, like Dirac’s large number equations or the inexplicable Weinberg pion-Hubble constant relation are deduced in this theory).

We will now show that in this cosmological scheme, not only the puzzling galactic rotation relation \[^3\] is explained, but also the fact that structures like galaxies and superclusters would naturally arise.

## 2 Galactic Rotation

We first observe that for a typical galaxy, the mass $'M'$ which is about $10^{11}$ solar masses, is given by

$$M = Nm = 10^{70}.m$$  \hspace{1cm} (5)
where \( m' \) is the mass of a typical elementary particle, which in the literature has been taken to be a pion \([10]\) and \( N' \) their number.

We next observe that the size \( r' \) of a typical galaxy (about a 100000 light years) is given by,

\[
    r = \sqrt{N} l
\]  

(6)

where \( l' \) is the pion Compton wavelength and \( N' \) is given in (5).

Finally in the cosmological scheme referred to (cf.ref.[1, 9]), we have,

\[
    G = a/\sqrt{\bar{N}}
\]  

(7)

where \( \bar{N} \sim 10^{80} \) is the number of pions in the universe and \( a \sim 10^{32} \).

Introducing (5), (6) and (7) into (4), we get for the rotational velocity, because as we go to the edge, the number of particles \( \rightarrow N \), the relation (3), consistent with observations.

3 Large Scale Structures

It is quite remarkable that equation (6) is true for the universe itself, as originally pointed out by Eddington, and also for superclusters, as can be verified. Moreover (6) is a very general relation in the theory of Brownian motion - it shows that the system under consideration could be thought of as a collection of these elementary particles in random motion[11, 12]. Further, (6) also shows that these structures have an overall flat or two-dimensional character, which is indeed true[13]. In particular, galaxies have vast flat discs and superclusters have a cellular character[2]. It must also be pointed out that recent observations do indeed suggest such an anisotropy[14]. Finally, the recently discovered neutrino masses are small, in which case the particles have relativistic speeds, and this is known to imply the above type of flat structures[3].

On the other hand, (6) is not valid for stars. At these distance scales, gravitation is strong enough so that the Brownian approximation (6) is no longer valid.
4 Conclusion

We have thus explained without invoking dark matter, the galactic rotational relation (3) and also have obtained a rationale for the existence of structures like galaxies and superclusters.

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