PAPER 1

Mach's Principle and its correlation with gravitation & inertia

Nick Greaves[1]

Abstract

This conjectures how it appears possible to reconcile gravitation and inertia with Mach's Principle. Some assumptions have to be made. The first is that the universe is closed and finite, expanding out equally in all directions, and that the distribution of mass is not uniform therein but that there is a large preponderance moving near light velocity at the outer edges with much smaller quantities of matter closer to the centre point moving out far less rapidly. The effect of large amounts of mass near the outside edge moving out at near light velocity enhances the gravitational effect relativistically to strongly affect the motion of all matter further within. This is the universal effect demonstrated by Mach's Principle and Foucault's pendulum, and which also suggests a simple rationalisation of inertia.

Having been surprised in my teens at the explanation of the way in which the Foucault's pendulum swung in the entrance to the Science Museum in South Kensington, and its implication that it bears out Mach's Principle, some years later I read everything that Mach had written translated into English, to see if I could work out a connection between gravitation, inertia and this apparently inexplicable principle. It seems that Mach never defined in specific sentences his principle, although its most graphic verbal form attributed to him was "When the subway jerks, it's the fixed stars that throw you down."

I give just one quote from his Book 'Conservation of energy'

"*Obviously it does not matter whether we think of the earth as turning round on its axis, or at rest while the celestial bodies revolve round it. Geometrically these are exactly the same case of a relative rotation of the earth and of the celestial bodies*

[1] Nick Greaves: ngg@champerty.net - www.mindandmemory.net
Author of "*Mind out of Time*" www.amazon.it/dp/B01CWILRHM

with respect to one another. Only the first representation is astronomically the more convenient and simpler. But if we think of the earth at rest and the other celestial bodies revolving round it, there is no flattening of the earth, no Foucault's experiment, and so on - at least according to our usual conception of the law of inertia. Now, one can solve the problem in two ways: either all motion is absolute, or our law of motion is wrongly expressed. Neumann preferred the first supposition, I, the second ... But, if we wish to apply the law of inertia in an earthquake, the terrestrial points of reference would leave us in the lurch, and, convinced of their uselessness, we would grope after the celestial ones. But, with these better ones, the same thing would happen as soon as the stars showed movements which were very noticeable..... We ask for the first time which star we are to choose, and in this case easily see that the stars cannot be treated indifferently, but that because we can give preference to none, the influence of all must be taken into consideration."

His principle can be defined in simple terms as follows: 'Every particle of matter in the universe, and its motion, has an effect on every other particle elsewhere in the universe.' Foucault's pendulum in the front hall of the Science Museum in Kensington was the example of the principle in operation. My attempt to rationalise gravitation and Mach's principle with inertia was as follows. I had to make a few assumptions, the first being to consider the universe as bounded and finite, which is one of the possible alternatives from the those developed by Alexander Freidman in 1922 and then later by LeMaitre, Robinson and Walker) and which is still very much unresolved. The assumption is therefore that the universe can be visualized in simple terms as a sphere expanding outwards from its centre point of initial big bang.

If so and if the Big Bang certainly took place then initially the radiation must have spread out from the centre at light speed to occupy space where there was nothing formerly, so that there might be a ring of singularity between this space filled with energy in outward motion and beyond it where there would be no such continua of time and space. Reinforcement for this scenario was provided by the work of Arthur Milne, Rouse Ball Professor of Mathematics at Oxford who died aged 54 in 1950 and this will be enlarged on in the second section below.

After the initial explosion matter starts to precipitate out from the hot plasma as energy spreads out and the universe cooled down. When first considering the problem it occurred to me that this precipitation of matter starts initially furthest out from the hot centre as it spreads out and starts to cool, in which case there would be a higher concentration of matter further out towards the edge of the universe which is the position as shown in Diagram 1. However it seems more acceptable to assume in accordance that the distribution of matter in space is homogeneous as per Friedman's solutions for an expanding universe and we know from Hubble's law that it is expanding and that this even distribution has been confirmed as (far as can be observed which I conjecture is probably minimal relative to the actual full dimensions of the universe) by the sky maps produce by the WMAP and Planck satellites.

In this scenario the matter near the edge will be traveling at close to light velocity, so whichever alternative is correct, there would be far larger concentrations of matter distributed nearer the rim as far as an observer within, much closer to the big bang centre, due to the relativity hugely increasing its mass (See Diagram 1).

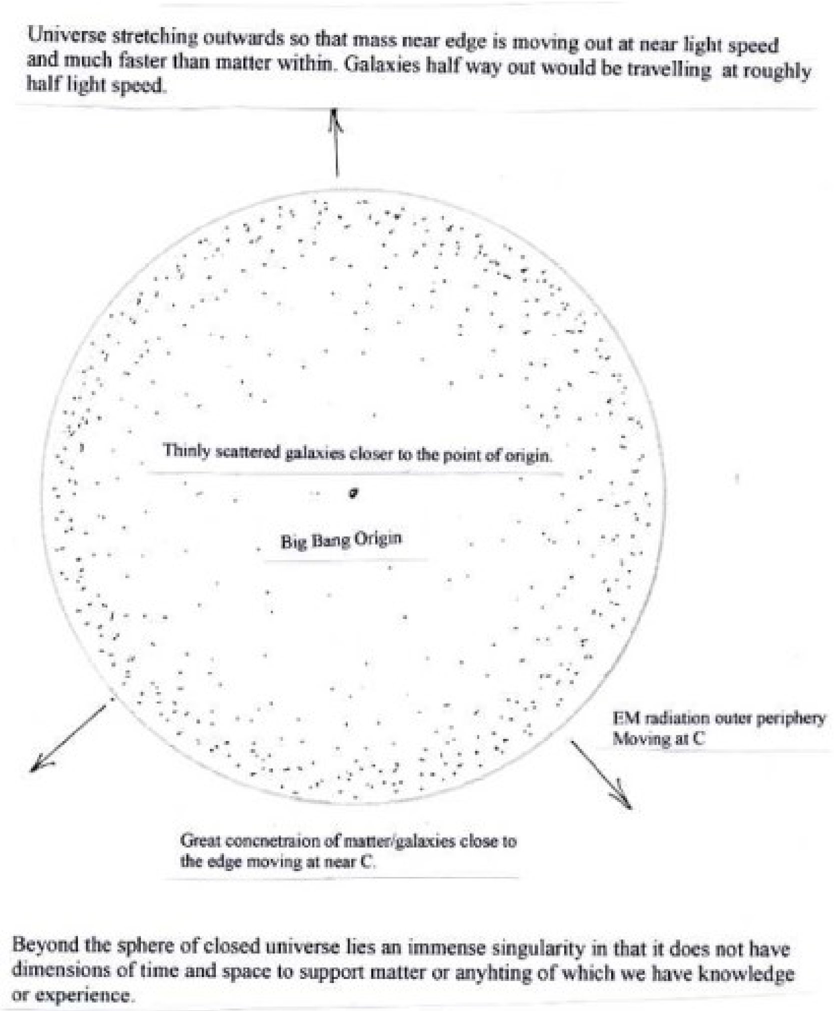

Diagram 1 – The expansion of closed and bounded universe

To repeat a crucial point: the mass of the outer edge galaxies would be relativistically huge if they were traveling at near light velocity in relation to galaxies further in moving out at much lower velocities, regardless of whether the matter distribution was homogeneous or not. The attractive force of gravitation exercised by this vast mass moving out would be experienced by all lesser matter within. If there were to be some force tending to accelerate the motion of the latter away from their motion in a straight line, they would experience a pressure against this: inertia. Such a scenario appears at first sight to satisfy Mach's principle.

Thus the very substantial quantities of matter near the periphery moving very rapidly outward and certainly well beyond the limits of visibility from Earth, would exercise a huge attractive effect on all matter further within the universe. If for instance the attractive effect of just one nearby section of the universe on, say the Earth, were considered, and if the inverse square law were invoked, this would be exactly countered by the much large section at the opposite end of the universe, albeit it so much further distant. In Diagram 2 the forces from opposing sides of the universe are shown to balance out on a stellar mass two thirds of the distance from the centre. In short there would be equilibrium of all such forces of attraction assuming the matter were moving at a constant velocity rather than accelerating.

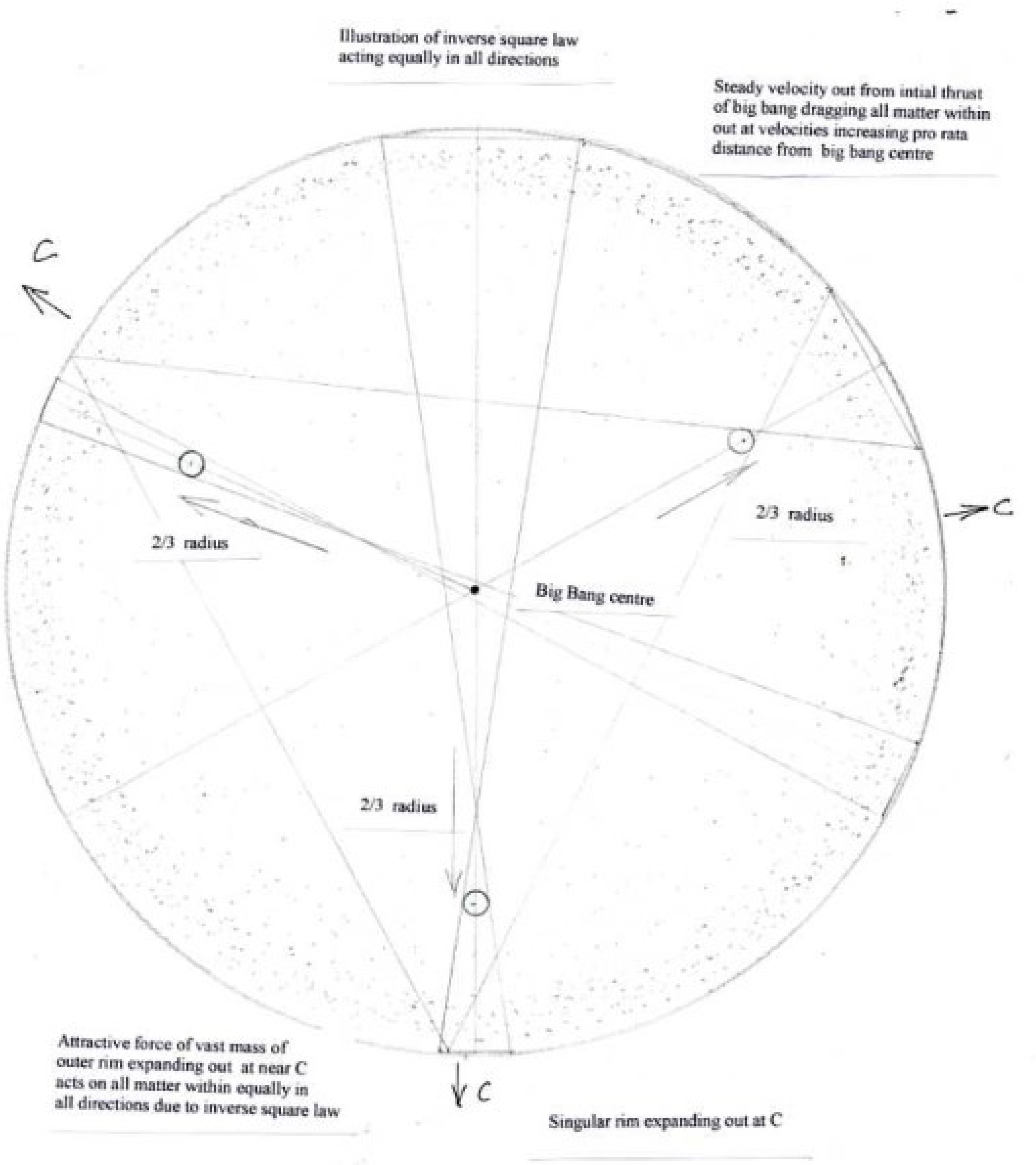

Diagram 2

Such a scenario would be the basis for a revised definition for Mach's Principle, and it would also deliver a basis for the concept of inertia to be redefined. The force of attraction of the vast masses near the periphery would be equal in all directions (inverse square law), and would act on all matter within the universe so that their initial motion expanding outwards would be unaffected whilst at constant velocity, but which would resist any acceleration so that the effect of inertia would be inextricably intertwined with the attractive force of gravitation. There would be no effect of inertia without the existence of the huge hidden mass of the universe expanding out near its periphery.

My conjecture of gravitation and inertia defined in this manner is based on the assumption that the universe is finite, bounded and expanding outwards, and that matter is probably not evenly distributed within. Observations from astronomy have indicated since the 1970s that that visible mass is a very small proportion of matter in the universe, about 4.6% observable matter with 23% being dark matter and the rest 72.4% as dark energy. Given that such observations if correct, are likely to cause our understanding of cosmology to have to be radically revised. Since this conjecture relies on the fundamental assumption that the universe if closed and finite I will conclude by a quote from Einstein in an address to the Berlin Academy of Sciences in 1921:

"I must not fail to mention that a theoretical argument can be adduced in favor of the hypothesis of a finite universe. The general theory of relativity teaches that the inertia of a given body is greater as there are more ponderable masses in proximity to it; thus it seems very natural to reduce the total effect of inertia of a body to action and reaction between it and the other bodies in the universe... From the general theory of relativity it can be deduced that this total reduction of inertia to reciprocal action between masses - as required by E. Mach, for example - is possible only if the universe is spatially finite. On many physicists and astronomers this argument makes no impression..."

References

- Mach E. The Science of Mechanics
- Mach E. The Conservation of Energy
- Einstein A. Berlin Academy of sciences, 1921
- Milne E.A. Relativity, Gravitation & World Structure, 1935