Inertial Systems in Relation to Accelerated Masses (or why Dark Matter is Obsolete)

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Abstract

A description of matter by a pair of spread–out waves with light velocity is derived from DE BROGLIE's foundation of quantum mechanics. Inertia is discussed for an ensemble of masses relatively accelerated. With the resulting modified inertia, an increased rotation of galaxies is calculated (as observed; explained as gravitation effect of "dark matter" till now).

Introduction

DE BROGLIE used Special Relativity on his approach to Quantum Mechanics (QM). A new interpretation of this approach is given. In this paper, we deal with one of the consequences: We quantize the relations between accelerated masses and inertial systems.

In discussion about NEWTON's law of inertia, MACH comes to the conclusion that this law is relative. It needs a relation to enough fixed bodies (for example to explain planet orbits, fixed stars are sufficient) [1]. For more complicated movements in the universe (especially accelerated) he requests to adapt the theory to new observations (subsection 9).

MACH dismissed the idea of space as an absolute physical structure, and assumed that the physical properties of space (especially the inertial frame) have their origin in the matter contained therein. Other ideas that have their origin in the discussion about MACH's writings here, for example those discussed in [2] are not helpful in this discussion.

We calculate the movements in surroundings of relatively accelerated stars according to the current state of astronomic observations. The effect of this insight is shown for a model spiral and a s0 galaxy (for galaxies, a rotation is observed, that cannot be explained by the visible galaxy mass. Rotation of galaxies is assumed to result of "dark matter," using NEWTON's law in an uncritical manner. MACH's well founded doubts were ignored). The result shows that the magnitude of acceleration is in good correspondence with observation without additional gravitation effect of dark matter.

Why has this Problem been Unnoticed for Such a Long Time?

"Laws of nature" are obtained by analyzing measurement data and forming a quantized theory thereof. The law of gravitation bases on the data obtained by TYCHO BRAHE, analyzed by JOHANNES KEPLER, and generalized further by ISAAC NEWTON; GALILEO GALILEI also contributed significantly to that effort by performing experiments and introducing the concept of inertial frames. This process was accompanied with a much disputed change between a geocentric and a heliocentric view of the world and the struggle between scholastic and scientific approaches to gain knowledge. The data obtained by BRAHE are data from the solar system; for obvious reasons there were no other data available at that time. Data from the solar system are still by far the most precise we have. The solar system however is a special case of gravitational law in such that more than 99.9% of the mass is in the single central star. Similar ratios are valid for other many–particle systems in the solar system (e.g. Jupiter and moons), so essentially all gravitational interactions in the solar system bog down to solving the one–particle case and applying perturbation calculation. Side–effects of many–particle systems are too small to observe.

However, the common case in the universe at large is *not* the single–particle system, it's the many–particle system of a galaxy or a cluster. Data for these are available, and don't fit well with the results of NEWTON's law of gravitation. Corrections later added by EINSTEIN are only important for strong fields, but gravitation in a galaxy or cluster is very weak even compared to the solar system.

When data don't fit the theory, either *data* or *theory* are wrong. Assuming "dark matter" to correct the distribution of matter in a galaxy to make its rotational curve fit with NEWTON's theory is correcting the *data.* However, after half a century of searching, any evidence of this dark matter other than its gravitational effect is still missing. The *data* have been verified again and again, it is robust, can be obtained from various different objects in the larger universe, where similar objects have similar deviations from NEWTON's law and is in obvious contradiction to the *theory.* It contradicts the *theory* by about an order of magnitude, which is really large.

MACH already pointed out a problem of NEWTON's law of inertia a century ago [1]. His assumption is that NEWTON's law of inertia is only valid in a surroundings of unaccelerated masses. The major shortcoming of his argument is that the formula he provided to define inertial system doesn't lead to much different results from NEWTON's law of inertia, since masses far away contribute as much as masses nearby, and since there are more masses far away than nearby, any effect of local accelerations would vanish.

1 The Model for a Structure Underlying Quantum Mechanics

It is possible to derive a structure underlying QM from the foundation of QM describing a particle to be spatial extended including information transport with light velocity within the particle structure.

We want to remind that DE BROGLIE laid the foundation of wave mechanics by applying LORENTZ transformation to an assumed spread out pulsation in the rest frame of a 'photon' with non–vanishing rest mass [3] (we assume this 'photon' to be a particle). Such a pulsation everywhere simultaneous in a given frame seemed absurd as a physical entity, and so this assumption seems to be forgotten. But it makes sense if we realize that this pulsation can be described by the superposition of two elementary waves with light velocity,[1] one of them moving in direction of the center of the particle, the other moving outward forming a stationary state. The frequency of one of the waves has to be assumed to be negative.

For a moving particle, taking covariant frequency

$$\frac{\omega}{2\pi} = \nu = \frac{\nu_0}{\sqrt{1-\beta^2}} \tag{1}$$

the superposition results in

$$\begin{aligned} \psi(t,x) \quad &\propto \quad \exp\left(\pm i\omega(1+\beta)\left(t-\frac{x}{c}\right)\right) + \\ &\quad\quad \exp\left(\mp i\omega(1-\beta)\left(t+\frac{x}{c}\right)\right) \\ &= \quad 2\cos\left(\pm\omega\left(t-\beta\frac{x}{c}\right)\right) * \\ &\quad\quad \exp\left(\pm i\omega\left(\beta t-\frac{x}{c}\right)\right) \end{aligned} \tag{2}$$

with

$$\omega/2\pi = \nu = \frac{m_0 c^2}{h\sqrt{1-\beta^2}} = mc^2/h \tag{3}$$

using $\lambda_C = h/mc$ and $\lambda_B = h/mv$ we get de Broglie's wave as envelope of the interference:

$$\begin{aligned} \psi(t,x) \quad &\propto \quad \cos\left(\omega t - 2\pi\frac{x}{\lambda_B}\right) * \\ &\quad\quad \exp\left(\pm i\beta\omega t \mp 2i\pi\frac{x}{\lambda_C}\right) \end{aligned} \tag{4}$$

With this model, DE BROGLIE's assumption of particles that are spatial extended becomes more plausible. Our interpretation is that we have a description of the interaction of the particle — thus the

[1] actually with arbitrary velocity, but we choose light speed for purpose

interaction function ψ will spatially diminish with $\frac{1}{r^2}$. We assume interaction of the particle may be described by interactions with the two elementary waves. Moreover the two waves transform separately with LORENTZ transformation. We will now apply this model for long–range interactions.

Note: This model has consequences for the interpretation of QM (e.g. the Copenhagen interpretation).

2 Inertia with an Ensemble of Masses Relatively Accelerated

The description of a particle by the superposition of two elementary waves contains the assumption, that the physical entity of the particle is described by a symmetric wave function in coordinates at rest relative to the particle. Interactions are supposed to disturb this symmetry, but we suppose the possibility to reestablish the symmetry by a transformation due to the DOPPLER shift for both waves.

The question is about the definition of the coordinate system for symmetry (the inertial frame). It is proposed that this coordinate system is defined by all elementary waves of mass in universe.

Analog to the conservation of energy for electromagnetic waves, we propose an equivalent conservation $\sum A_0\vec{k}\nu$ for all elementary waves crossing a mass–free space element. In other terms,

$$\operatorname{div}\sum A_0\vec{k}\nu = 0 \tag{5}$$

defines an inertial frame. This is obvious for an inertial frame for waves originating in non–accelerated sources. We generalize this equation for waves originating in relatively accelerated sources supposing the locally observable variables determine inertial frames also in this case.

We ask for the consequences in nearly EUCLIDean space, and mass points far away. There, the changing of amplitude A_0 in space will be neglectable. For a single mass point accelerated by $\vec{a}$, the sum of the product of the wave vector $\vec{k}$ and the frequency ν of both elementary waves changes in space by retardation proportional to $\vec{a}$ for both the longitudinal component due to first order DOPPLER shift and the transversal component due to the aberration effect. This model is consistent with NEWTON's law in an environment of not accelerated masses, because $\sum A_0\vec{k}\nu$ is zero for $v = \text{const}$.

With the amplitude $A_0 \propto \frac{M}{r^2}$ (corresponding to gravitation) we get for several relatively accelerated mass points

$$\sum_i \frac{M_i\vec{a}_i}{r_i^2} = 0 \tag{6}$$

to be the definition equation for the inertial frame.

3 Calculation of Acceleration for a Model Spiral Galaxy

The effect of this definition equation (6) is shown for a model spiral galaxy. For galaxies, a rotation is observed, that cannot be explained by the visible galaxy mass (an overview is found in [4]). A still greater mass discrepancy is observed for groups of galaxies and clusters. We make a calculation for a galaxy, because the effect is well known and sufficient data are available.

In this model galaxy mass distribution is:

Bulge distribution in an ellipsoid ($r_{\text{center}} \approx \frac{1}{4}r_{\text{galaxy}}$, $M_{\text{center}} = \frac{1}{3}M_{\text{galaxy}}$), relation of axis is 1:3.

Spiral arms Two spiral arms are assumed. Stars are distributed arbitrary. Each spherical shell of the galaxy contains the same mass. In the plane of the galaxy we take a GAUSS distribution, in the vertical direction extension reduces with $\frac{1}{r}$, the vertical distribution is also non–uniform (square of a uniform random number).

The rest of the universe is assumed with radius $r_{\text{universe}} = 2 * 10^5 r_{\text{galaxy}}$[2], consisting of 10^{11} galaxies, out of which 10% are big galaxies (the others don't contribute much to the mass), uniformly distributed. No acceleration is assumed between the galaxies.

[2] $r_{\text{galaxy}} := 20\text{kpc}$, $r_{\text{universe}} := 4\text{Gpc}$

The result of the calculation is shown in Figure 1 with different colors indicating the relation of total acceleration to static gravitation effect towards the center of the galaxy. Mass distribution is shown by lines of equal density.

Variation of relation of galaxy mass to mass density of the universe by factor 2 does change the relation of acceleration by less than 20%. Main parameters are radial mass distribution and the density of the spiral arms of the galaxy.

Figure 2 shows both gravitation acceleration (lower curve) and total acceleration (upper curve) dependence on radius of the model galaxy. Assuming circular orbit of the spiral arms of a galaxy the result for total acceleration is consistent with the observation that the inner part of a galaxy rotates like a solid disk.

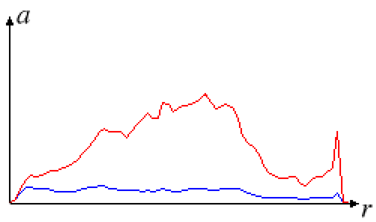

Figure 2: Gravitation and total acceleration

A less dense elliptical galaxy, not flattened as disk and without spiral arm structure shows no significant difference between gravitational and total acceleration, as observed by Romanowsky et al. [5].

4 Calculation of Acceleration for a Model S0 Galaxy

The calculation for a spiral galaxy looks reasonable, but unfortunately, we have no astronomical evidence that our assumed mass distribution is reasonable. Furthermore, spiral galaxies contain a significant amount of mass in form of gas and dark clouds. So we asked an astronomer for better data — which he gave us for the case of a S0 galaxy (where stars are uniformly distributed and gas doesn't play an important role) [6]. The model was as follows:

Bulge with $6e9\odot$, distribution as above

Disk with $6e10\odot$ within $R = 10$kpc, and surface density of $\Sigma(R) = \Sigma_0 * e^{-R/R_e}$, $R_e = 3.5$kpc, and a thickness of 200pc.

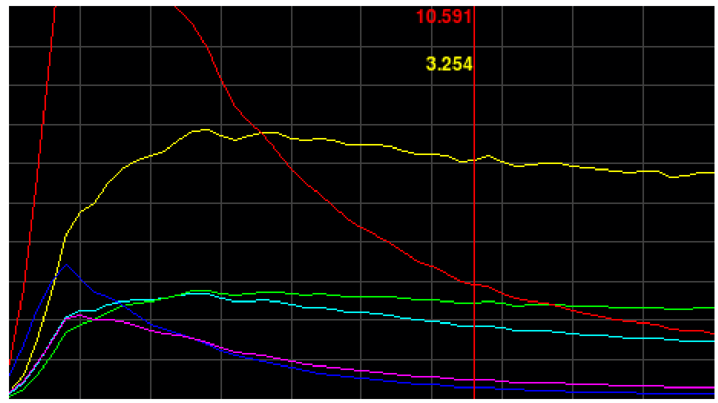

Figure 3: Gravitation and total acceleration for an s0 galaxy

Figure 3 shows rotation with a purely gravitational model (cyan) and calculated rotation with our theory, using the gravitational rotation as base (yellow). The x axis is divided into 1e20m per square, the y axis into 100km/s per square. We assume the mass distribution is obtained from the kinematics of the observed galaxy, and not through measurement of the actual masses (e.g. star counts and classification). The actual relation between mass and observed light emission from the galaxy therefore is presumed unknown. Scaling the calculated rotation down to observed values at ˜10kpc gives a basically flat curve with about 250km/s rotation towards the outer rim of the S0 galaxy (green) — this is in good correspondence with observation.

5 Conclusion

The result of the calculations of inertia for galaxies shows that the rotation curve is in good correspondence with observation without the assumption of additional gravitational effect of dark matter. Further-

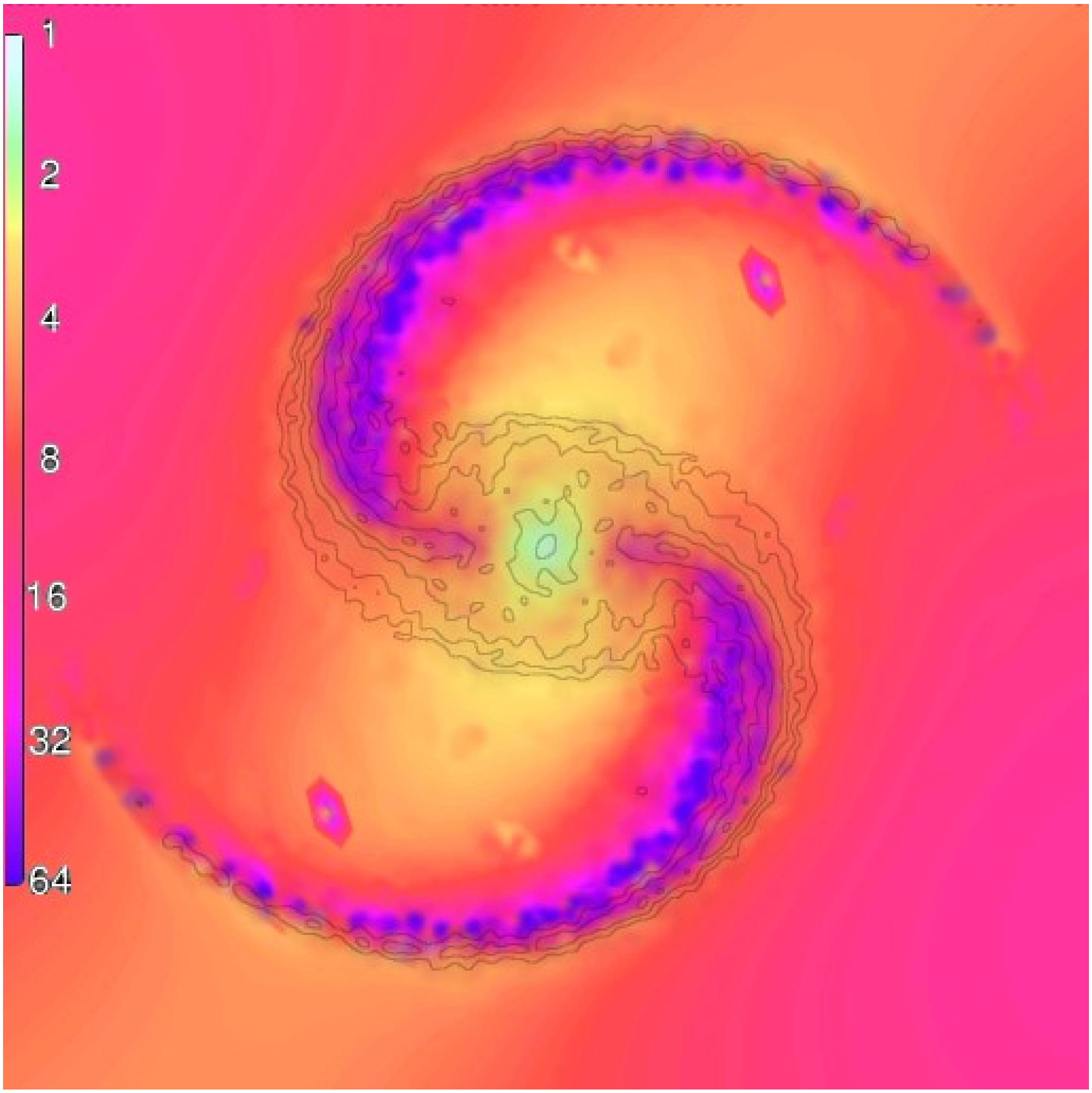

Figure 1: $a_{\rm total}/a_{\rm gravitation}$ calculated for a model galaxy

more, a better understanding of formation of galaxies and of the dynamics of clusters will be possible.

References

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