

# Inertial Systems in Relation to Accelerated Masses (or why Dark Matter is Obsolete)

Frank Paysan and Bernd Paysan

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 masses till now).

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## 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 can 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 can 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 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.

## I. 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 can assume this 'photon' to be a particle). Such a pul-

sation 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, 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

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

the superposition results in

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

with

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

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

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

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. 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.

## II. 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,

$$\operatorname{div} \sum A_0 \vec{k} \nu = 0 \quad (5)$$

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  $\nu$  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

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

to be the definition equation for the inertial frame.

## III. 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:

**Center** 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  $r_{\text{universe}} = 2 * 10^5 r_{\text{galaxy}}$  [5], 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.

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.

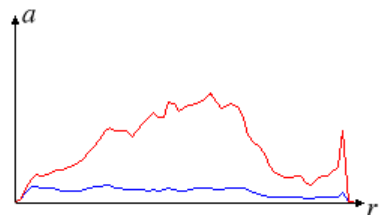


Figure 2: Gravitation and total acceleration

## IV. CONCLUSION

The result of the calculations of inertia for galaxies shows that the magnitude of acceleration is in good correspondence with observation without the assumption of additional gravitation effect of dark matter. Furthermore, a better understanding of formation of galaxies and of the dynamics of clusters will be possible.

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- [1] E. Mach: *The science of Mechanics*, Open Court 1960, Chap. II, Sec. VI (translation of the 9<sup>th</sup> edition of *Die Mechanik in ihrer Entwicklung*, Leipzig 1933)
- [2] C. Brans, R. H. Dicke: *Mach's Principle and a Relativistic Theory of Gravitation*, *Physical Review*, 124: 925-935 (1961)
- [3] L. de Broglie: *Einführung in die Wellenmechanik*, Akademische Verlags Gesellschaft Leipzig 1929
- [4] S. M. Faber, J. S. Gallagher: *Masses and Mass-to-Light Ratios of Galaxies*, *Annu. Rev. Astron. Astrophys.*, 17: 135-87 (1979)
- [5]  $r_{\text{galaxy}} := 20\text{kpc}$ ,  $r_{\text{universe}} := 4\text{Gpc}$

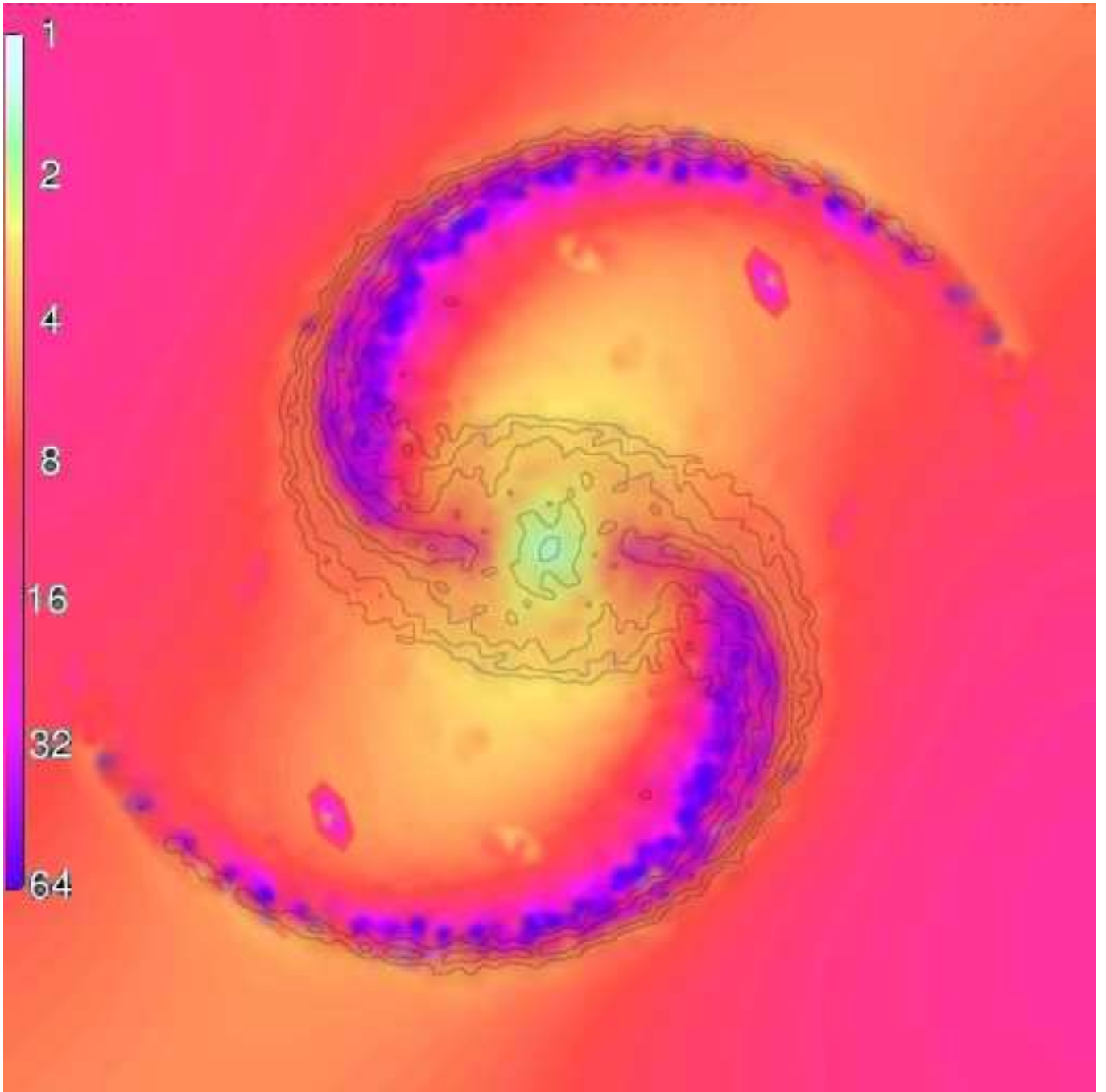


Figure 1:  $a_{\text{total}}/a_{\text{gravitation}}$  calculated for a model galaxy