Journal of Advances in Mathematics and Computer Science

28(3): 1-13, 2018; Article no.JAMCS.42590

ISSN: 2456-9968

(Past name: British Journal of Mathematics & Computer Science, Past ISSN: 2231-0851)

Acceleration in a Fundamental Bound State Theory and the Fate of Gravitational Systems

Hans-Peter Morsch[1*]

[1]*HOFF, Brockmüllerstr. 11, D-52428 Jülich, Germany.*

Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/JAMCS/2018/42590

Editor(s):

(1) Dr. Octav Olteanu, Professor, Department of Mathematics-Informatics, University Politehnica of Bucharest, Bucharest, Romania.

(2) Dr. Paul Bracken, Professor, Department of Mathematics, The University of Texas-Pan American, Edinburg, USA.

Reviewers:

(1) Igor Bulyzhenkov, Moscow Institute of Physics and Technology, Russia.

(2) Mohammed A. El-Lakany, Cairo University, Egypt.

(3) Orchidea Maria Lecian, Sapienza University of Rome, Italy.

(4) Najimuddin Khan, Indian Institute of Science, India.

(5) Godwe Emile, University of Maroua, Cameroon.

Complete Peer review History: http://www.sciencedomain.org/review-history/25929

Received: 19th May 2018

Accepted: 5th August 2018

Published: 16th August 2018

Original Research Article

Abstract

The dynamics of a bound state theory - based on a QED like Lagrangian with fermions coupled to boson fields - has been studied explicitly. Different from the Hamilton approach studied earlier, an additional acceleration term is found, which is spurious for fundamental bound states. However, for composite systems of many particles this term drives individual particles to a coherent rotation, which lowers the kinetic energy and leads to a collapse.

Applied to gravitation - described by magnetic binding of lepton-hadron pairs - a self-consistent fit of the primary (e-p)^2 bound state is obtained. Of importance, the acceleration term is quite large and drives composite systems to a collapse and complete annihilation. However, stable galactic objects are obtained, if the lowering of the kinetic energy is compensated by a reduction of binding.

*Corresponding author: E-mail: h.p.morsch@gmx.de

Of special interest, a "matter-antimatter symmetric" system, composed of equal amounts of (e^-p^+) and (e^+p^-) pairs (or hydrogen and antihydrogen atoms), leads to a delayed and incomplete collapse, in which the matter-antimatter symmetry is broken due to the chiral structure of leptons.

Keywords: Dynamics of a fundamental bound state theory; acceleration terms important for composite gravitational systems; leading to a collapse and annihilation; Rotational velocities of galaxies and evolution of a matter-antimatter symmetric system.

2010 Mathematics Subject Classification: 81T10, 46N50, 81P10, 83C47.

1 Introduction

Based on the success of quantum electrodynamics (QED), divergent quantum field theories with first-order Lagrangians - as those in the Standard Model of particle physics (SM), see e.g. ref. [1, 2] - have been widely used for the description of fundamental forces (except gravitation). Because these Lagrangians have no $(1/mass)^n$ factor, the underlying field theories are renormalizable. However, in the SM more than 20 external parameters are needed, coupling constants, mixing parameters of different fields, elementary fermion and boson masses, which had to be adjusted by experimental data. Another shortcoming is that these theories are divergent and cannot describe the finite structure of hadrons and atoms (with well defined root mean square radii). Further, in logical extensions of the SM a series of supersymmetric particles is predicted, which have not been found. Finally, these theories cannot give a clue on the development of the universe: they can predict only the creation of matter-antimatter symmetric systems (with the same amount of protons and antiprotons, or hydrogen and antihydrogen atoms), but in the universe only matter (dominated by hydrogen atoms) and extremely little antihydrogen atoms have been found. This indicates a strong breaking of the matter-antimatter symmetry.

On the other side, divergent field theories with higher-order Lagrangians need a $(1/mass)^n$ factor and are therefore not renormalizable. Further, it has been shown that such Lagrangians can generate unphysical and ambiguous results [3]. However, a special third-order theory introduced in refs. [4, 5] solves the above problems and leads to the long sought **finite** bound state description of particles. This formalism is based on a Lagrangian similar to that of electrodynamics, but with fermions accompanied by vector-boson operators. The coupling to bosons is essential to guarantee momentum conservation; further, it leads to constraints on geometry and energy-momentum conservation, by which unphysical solutions can be eliminated. The fermion and boson fields can be combined to finite wave functions (for momenta or radii $\rightarrow 0$ and ∞) with parameters, which can be determined from basic constraints. This leads to a description based on first principles and may be considered as fundamental.

This statement is strongly supported by the fact that this model represents a unified quantum description of all fundamental forces: by using one universal boson-exchange interaction it can be applied to hadrons [4], leptons [5] and atoms [4, 6], but also to gravitational systems [5, 7]. The generated bound states can be considered as the building blocks of nature. Different from the SM, in which leptons are considered as elementary fermions with masses determined by experimental data, these particles are understood as composite systems of massless fermions (quantons) bound by magnetic forces [5].

Of particular interest is gravitation, which has been described by Newton's theory of gravitation and Einstein's theory of general relativity [8]. In the latter, gravitation is considered as a deformation of space-time caused by massive objects. In this description global space-time related parameters, curvature, expansion, cosmological constant etc. have to be adjusted to astronomical data, which do not allow to make absolute predictions, which can be tested experimentally. Differently, in the present formalism gravitational systems are understood as states bound by magnetic forces. Since all parameters of the model are determined from basic boundary conditions, this should allow us to investigate in an unbiased way all mechanisms, which led from the cosmic beginning to the present expanding universe.

So far, static matrix elements have been derived from the Lagrangian, but the bound state dynamics has been calculated by use of a Hamiltonian. In this way reliable and self-consistent solutions could be extracted, in which about ten boundary conditions could be satisfied by three or four (effectively one or two) parameters only.

Differently, in the approach discussed here the complete dynamics is derived from the Lagrangian, which leads to a more complex structure. In addition to the kinetic energy an acceleration term is obtained, which is spurious for fundamental bound states, but drives the individual particles in composite systems to coherent rotation.

In the present paper the complete dynamics of the Lagrangian is applied to the basic magnetically bound (e-p)^2 system. Then different gravitational systems are discussed: first, one without additional condition, which leads rapidly to a collapse; second, stable galactic objects, which require a balance between coherent motion and binding; and third, a matter-antimatter symmetric system created out of the vacuum of fluctuating boson fields during the genesis of the universe.

2 Structure of the Bound State Theory

The underlying Lagrangian may be written in the form

$$\mathcal{L} = \frac{1}{\tilde{m}^2}\bar{\Psi}\; i\gamma_\mu D^\mu D_\nu D^\nu \Psi \;-\; \frac{1}{4} F_{\mu\nu}F^{\mu\nu} \;, \tag{1}$$

where $\tilde{m}$ is a mass parameter and Ψ in general a two-component fermion field $\Psi = (\Psi^+ \; \Psi^o)$ and $\bar{\Psi} = (\Psi^- \; \bar{\Psi}^o)$ with charged and neutral part. Vector boson fields A_μ with charge coupling g are contained in the covariant derivatives $D_\mu = \partial_\mu - igA_\mu$ and the Abelian field strength tensor $F^{\mu\nu} = \partial^\mu A^\nu - \partial^\nu A^\mu$.

Interestingly, by assuming $D_\nu D^\nu \sim 1$ the QED Lagrangian is restored, giving rise to the Coulomb potential $V_{coul}(r) = \alpha\hbar/r$ and the correct binding of atomic states. In the present theory the atomic binding energies are also reproduced [6], but in a rather complex way, satisfying a linear quantum condition on the radius. Further, the electric fine structure constant $\alpha \sim 1/137$ is reproduced by the sum of equivalent first order coupling constants.

We insert $D^\mu = \partial^\mu - igA^\mu$ and $D_\nu D^\nu = \partial_\nu\partial^\nu - ig(A_\nu\partial^\nu + \partial_\nu A^\nu) - g^2 A_\nu A^\nu$ in eq. (1) and obtain for the first term of $\mathcal{L}$

$$\begin{aligned}\mathcal{L}_1 = \frac{1}{\tilde{m}^2}\bar{\Psi}\; i\gamma_\mu D^\mu D_\nu D^\nu \Psi = \frac{i}{\tilde{m}^2}\bar{\Psi}\;\gamma_\mu\partial^\mu\partial_\nu\partial^\nu\Psi + \frac{g}{\tilde{m}^2}\bar{\Psi}\;\gamma_\mu A^\mu\partial_\nu\partial^\nu\Psi \\ +\frac{g}{\tilde{m}^2}\bar{\Psi}\;\gamma_\mu\partial^\mu A_\nu\partial^\nu\Psi + \frac{g}{\tilde{m}^2}\bar{\Psi}\;\gamma_\mu\partial^\mu\partial_\nu A^\nu\Psi - \frac{ig^2}{\tilde{m}^2}\bar{\Psi}\;\gamma_\mu A^\mu A_\nu\partial^\nu\Psi \\ -\frac{ig^2}{\tilde{m}^2}\bar{\Psi}\;\gamma_\mu A^\mu\partial_\nu A^\nu\Psi - \frac{ig^2}{\tilde{m}^2}\bar{\Psi}\;\gamma_\mu\partial^\mu A_\nu A^\nu\Psi - \frac{g^3}{\tilde{m}^2}\bar{\Psi}\;\gamma_\mu A^\mu A_\nu A^\nu\Psi\;.\end{aligned} \tag{2}$$

The gauge condition $\partial_\mu A^\mu = 0$ used for simpler Lagrangians (as in QED) is replaced in our case by $\partial^2 A^\nu = 0$.

In eq. (2) the number of field derivatives and boson couplings varies between the first and last term.

This shows that the various terms are related to static as well as dynamical properties, important for the description of stationary systems.

As discussed in former papers [4, 5], static fermion matrix elements can be derived from the above Lagrangian, which can be written in the form $\mathcal{M}(p'-p) = < g.s.|\ K(q)\ |g.s. >\sim \bar\psi(p')\ K(q)\ \psi(p)$, where $\psi(p)$ are fermionic wave functions $\psi(p) = \frac{1}{\tilde m^{3/2}}\Psi(p_1)\Psi(p_2)$ of scalar and vector structure with a coupling of $\Psi(p_1)$ and $\Psi(p_2)$ to spin=0 and 1 (scalar and vector, respectively). Further, $K(q) = \frac{1}{\tilde m^{2(n+1)}}\ [O^n(q)\ O^n(q)]$, where O^n is a cubic operator containing boson fields and/or derivatives as given in eq. (2).

Following this rule, the Lagrangians $\mathcal{L}_{1,6}$, $\mathcal{L}_{1,7}$ and $\mathcal{L}_{1,8}$ give rise to matrix elements of the form

$$\mathcal{M}_{2g} = \frac{\alpha^2}{\tilde m^5}\ \bar\psi(p')\ \gamma_\mu\gamma^\mu A_\nu(q)\ \partial^\nu A_\sigma(q)\ A^\sigma(q)\ \partial_\rho A^\rho(q)\ \psi(p) \tag{3}$$

and

$$\mathcal{M}_{3g} = \frac{-\alpha^3}{\tilde m^5}\ \bar\psi(p')\ \gamma_\mu\gamma^\mu A_\nu(q)A^\nu(q)\ A_\sigma(q)A^\sigma(q)\ A_\rho(q)A^\rho(q)\ \psi(p)\ , \tag{4}$$

where $\alpha = g^2/4\pi$.

In addition, the Lagrangians $\mathcal{L}_{1,3}$ – $\mathcal{L}_{1,7}$ lead to matrix elements, which include the derivative of the fermion wave function $\partial\psi$

$$\mathcal{T}_{1g} = \frac{\alpha}{\tilde m^3}\ \bar\psi(p')\ \gamma_\mu\gamma^\mu\ \partial_\nu A^\nu(q)\ \partial_\rho A^\rho(q)\ \partial\psi(p) \tag{5}$$

and

$$\mathcal{T}_{2g} = \frac{\alpha^2}{\tilde m^3}\ \bar\psi(p')\ \gamma_\mu\gamma^\mu\ A_\nu(q)A^\nu(q)\ A_\rho(q)A^\rho(q)\ \partial\psi(p)\ . \tag{6}$$

These matrix elements are related to the kinetic energy of the system.

Finally, the Lagrangians $\mathcal{L}_{1,2}$ - $\mathcal{L}_{1,4}$ lead to a matrix element with second derivative of the fermion wave function $\partial^2\psi$

$$\mathcal{B}_{1g} = \frac{\alpha}{\tilde m}\ \bar\psi(p')\ \gamma_\mu\gamma^\mu\ A_\nu(q)A^\nu(q)\ \partial^2\psi(p)\ , \tag{7}$$

which corresponds to an acceleration of the system. In the expressions (5), (6) and (7) the derivatives of the fermion wave functions are given by $\partial^n\psi(p) = \frac{1}{\tilde m^{(3/2+2n)}}\partial^n\Psi(p_1)\partial^n\Psi(p_2)$.

Following the derivation in refs. [4, 5] the γ-matrices can be removed. To generate a bound system an equal time requirement of the boson fields allows to replace all fermion four-vectors by three-vectors in momentum or r-space. Analog to the fermion wave functions $\psi(p)$, two coupled boson fields on the right and left can be regarded as bosonic (quasi) wave functions $W_\mu^\nu(q) = \frac{1}{\tilde m}A_\mu(q)A^\nu(q)$ of scalar and vector character ($A_\mu(q)$ and $A^\nu(q)$ coupled to spin=0 and 1, respectively). The remaining boson pair in eq. (4) can be considered as boson-exchange interaction $V_v(q) = A_\mu(q)A^\nu(q)$. By a reduction of these quantities to two dimensions, boson wave functions $w_{s,v}(q)$ and an interaction $v_v(q)$ are obtained, which are two-dimensional. This yields matrix elements of the form

$$M_{2g} = \frac{\alpha^2}{2\tilde m^3}\ \bar\psi(p')\ w_s(q)\partial^2 w_s(q)\ \psi(p) \tag{8}$$

and

$$M_{3g} = \frac{-\alpha^3}{\tilde m^2}\ \bar\psi(p')\ w_{s,v}(q)v_v(q)w_{s,v}(q)\ \psi(p)\ , \tag{9}$$

further

$$T_{1g} = \frac{\alpha}{\tilde m^2}\ \bar\psi(p')\ \partial^2 w_{s,v}(q)\ \partial\psi(p)\ , \tag{10}$$

$$T_{2g} = \frac{\alpha^2}{\tilde m}\ \bar\psi(p')\ w_{s,v}(q)w_{s,v}(q)\ \partial\psi(p)\ , \tag{11}$$

and

$$B_{1g} = \alpha\ \bar{\psi}(p')\ w_{s,v}(q)\ \partial^2 \psi(p)\ . \tag{12}$$

Transformation to r-space leads to static fermion matrix elements M_{ng} (n=2,3) and the corresponding binding energies

$$E_{ng} = 4\pi \int r^2 dr\ M_{ng} = 4\pi \int r^2 dr\ \bar{\psi}(r)\ V_{ng}(r)\ \psi(r) \tag{13}$$

with potentials (different for scalar and vector states)

$$V_{2g}(r) = \frac{\alpha^2(2s+1)(\hbar c)^2}{8\tilde{m}}\ \Big(\frac{d^2 w_s(r)}{dr^2} + \frac{2}{r}\frac{dw_s(r)}{dr}\Big)\frac{1}{w_s(r)} + E_o\ , \tag{14}$$

with s=0 for scalar and s=1 for vector states, and

$$V_{3g}(r) = \frac{\alpha^2(\hbar c)}{\tilde{m}} \int dr'\ w_{s,v}(r')\ v_v(r-r')\ w_{s,v}(r') \tag{15}$$

with an interaction $v_v(r) \sim -\alpha(\hbar c)\ w_v(r)$. $V_{2g}(r)$ has the characteristic form of the "confinement" potential, required in hadron bound state models [9]. For $E_o = 0$ the theory couples to the vacuum. This allows the creation of fermions-antifermion bound states out of the vacuum of fluctuating boson fields in the form of $q\bar{q}$ mesons, where q denotes massless elementary fermions (quantons).

Transformation of the dynamical matrix elements to r-space leads to kinetic energies

$$E^T_{ng} = \frac{4\pi}{2} \int r^3 dr\ T_{ng} = \frac{4\pi}{2} \int r^3 dr\ \bar{\psi}(r)\ V^T_{ng}(r)\ \frac{d\psi(r)}{dr} \tag{16}$$

with

$$V^T_{1g} = \frac{\alpha(2s+1)(\hbar c)^3}{4\tilde{m}^2}\ \Big(\frac{d^2 w_s(r)}{dr^2} + \frac{2}{r}\frac{dw_s(r)}{dr}\Big) \tag{17}$$

and

$$V^T_{2g} = \frac{\alpha^2(\hbar c)^2}{\tilde{m}}\ w_{s,v}(r) w_{s,v}(r)\ , \tag{18}$$

whereas the acceleration term is obtained of the form

$$\Delta E_{1g} = \frac{4\pi}{2} \int r^4 dr\ B_{1g} = \frac{4\pi}{2}\alpha(\hbar c) \int r^4 dr\ \bar{\psi}(r)\ w_{s,v}(r)\ \frac{d^2\psi(r)}{dr^2}\ . \tag{19}$$

For fundamental systems the term (19) is spurious, but for composite systems of many particles it allows to lower the kinetic energy.

In addition to the fermion matrix elements, there are boson matrix elements of the form

$$M^g = \frac{\alpha^3}{\tilde{m}^2}\ w_{s,v}(q)\ v_v(q)\ w_{s,v}(q) \tag{20}$$

and

$$T^g = \frac{\alpha^2}{2\tilde{m}^3}\ w_{s,v}(q)\ \partial^2 w_{s,v}(q)\ . \tag{21}$$

Transformation to r-space leads to a binding energy

$$E^g = 2\pi \int rdr\ M^g = 2\pi\alpha^2 \int rdr\ w_{s,v}(r)\ v_v(r)\ w_{s,v}(r)\ , \tag{22}$$

a kinetic energy

$$E^g_T = \frac{2\pi}{2} \int r^2 dr\ T^g = 2\pi\frac{\alpha^2(\hbar c)}{4} \int r^2 dr\ w_s(r)\ \frac{1}{r}\frac{dw_s(r)}{dr} \tag{23}$$

and a contribution from acceleration

$$\Delta E^g = \frac{2\pi}{2}\int r^2 dr\ B^g = 2\pi \frac{\alpha^2(\hbar c)}{8}\int r^2 dr\ w_s(r)\ \frac{d^2 w_s(r)}{dr^2}\ . \tag{24}$$

The full formalism (including the acceleration term) can be exploited in gravitational systems, described by lepton-hadron (e-p) pairs bound by magnetic forces [5, 7], which arise from the motion (rotation) of two fermions with relative velocity (v/c). The corresponding matrix elements can be expressed straight forward by those above with additional velocity factors (v/c) for fermions, but also for bosons. For static matrix elements this is given explicitly in ref. [5].

For the evaluation of these matrix elements and their eigenvalues fermion and boson wave functions $\psi_{s,v}(r)$ and $w_{s,v}(r)$ have been used of similar form, $\psi_{s,v}(r) \sim w_{s,v}(r)$, with

$$w_s(r) = w_{s_o}\ exp\{-(r/b)^\kappa\} \tag{25}$$

and

$$w_v(r) = w_{v_o}\ [w_s(r) + \beta R\ \frac{dw_s(r)}{dr}]\ . \tag{26}$$

The normalization of $\psi_{s,v}(r)$ and $w_{s,v}(r)$ has been obtained from $4\pi\int r^2 dr\ \psi^2_{s,v}(r) = 1$ and $2\pi\int rdr\ w^2_{s,v}(r) = 1$, with $\beta R = -\int r^2 dr\ w_s(r)/\int r^2 dr\ [dw_s(r)/dr]$. The radial form of $w_s(r)$ has been chosen [4, 5] to satisfy the geometric boundary condition

$$|V^v_{3g}(r)| \sim c\ w^2_s(r)\ . \tag{27}$$

The wave function shape and slope parameters κ and b as well as the coupling constant α have been deduced from boundary conditions related to momentum, energy-momentum conservation and a mass-radius constraint [4, 5]. We require momentum matching between fermions and bosons

$$< q^2_g >^{1/2}_{rec} - < q^2_f >^{1/2}_{rec} = 0 \tag{28}$$

as well as energy-momentum conservation

$$[< q^2_g >^{1/2} + < q^2_f >^{1/2}](v/c) + E_g - x\ M_f = 0\ , \tag{29}$$

where $x = \sqrt{2\tilde{m}/M_f}$ and (v/c) taken positive.
The momenta are given by $< q^2_g > = < q^2_g >_{rec}$ and $< q^2_{f_s} > = < q^2_{f_s} >_{rec}$, but for vector particles $< q^2_{f_v} > = \int q^4 dq\ \psi_v(q) V^v_{3g}(q)/ < q^0_{f_v} >$, where the Fourier transformed quantities are given by $(\psi_v, V^v_{3g})(q) = 4\pi\int r^2 dr\ j_1{}^2(qr)(\psi_v, V^v_{3g})(r)$.

Further, a mass-radius condition has been derived from the potential $V_{2g}(r)$

$$Rat_{2g} = \frac{(\hbar c)^2 (v/c)^2}{\tilde{m}(M_s/2) < r^2 >} = 1\ , \tag{30}$$

where $< r^2 >$ should be between $< r^2_{w_s} >$ and $< r^2_{\psi_s} >$.

2.1 Hamiltonian approach

In previous studies the dynamics of the bound state has been taken from a Hamiltionian $H = T + V$, with T being the derivative of V. This leads to dynamic matrix elements for fermions

$$T^H_{(n-1)g} = \frac{1}{2}\int r^3 dr\ \bar{\psi}(r)\ \frac{dV_{ng}(r)}{dr}\ \psi(r) \tag{31}$$

and for bosons

$$T^g_H = \frac{\alpha^2}{2}\int r^2 dr\ w_{s,v}(r)\ \frac{dv_v(r)}{dr}\ w_{s,v}(r)\ , \tag{32}$$

but there are no acceleration terms.

This approach has given a very satisfactory description of fundamental systems, as hadrons and leptons, but also of light atoms, in which all the (about ten) boundary conditions had to be fulfilled by adjusting three or four parameters (effectively one or two) only.

In spite of the success of the Hamilton approach, an explicit consideration of the full dynamics of the Lagrangian is important to test, whether eq. (1) really leads to a complete bound state theory with a structure as deduced in ref. [4, 5], but also to investigate, whether the additional acceleration terms (7) and (24) are important for composite systems.

3 Gravitation Described by Magnetic Binding of Lepton-Hadron Pairs

As mentioned above, the self-consistency of the above formalism can be tested in gravitational systems. In addition, it is important to see, whether the acceleration terms (19) and (24) are sufficiently large to be able to drive in complex systems the random motion of the individual fermion-hadron pairs to a coherent rotation.

3.1 Fundamental (e-p)^2 bound state

A basic state of (e-p)^2 structure has been found [5, 7] with an extremely small binding energy in the order of 10^{-38} GeV and a first-order equivalent coupling constant consistent with Newton's gravitational constant G_N. To avoid parameter ambiguities between b and $(v/c)^2$, an additional boundary condition has been introduced [7], which relates the relative velocity to the kinetic energy of the system $(v/c) = \sqrt{2E_{kin}/M_{tot}}$, where $M_{tot} = (2m_e + 2m_p)$. To be consistent with previous studies [4, 5] the parameters $\kappa = 1.35$ and $\alpha = 2.14$ were not changed. Then, the evaluation of the complete Lagrangian (with all fermion and boson matrix elements as given above) shows a very consistent description of the (e-p)^2 system. In the upper part of table 1 the parameters are given together with $2E_{kin}/M_{tot}$ (which is in agreement with $(v/c)^2$) and the first-order equivalent coupling constant α_{gr} consistent with Newton's gravitational constant G_N, see ref. [5, 7]. Further, the root-mean square radii for bosons and fermions and the masses of the scalar and vector states are given, which are consistent with the results in ref. [7]. For a radius $< r^2 >^{1/2} = \frac{2}{3} < r^2_{w_s} >^{1/2} + \frac{1}{3} < r^2_{\psi_s} >^{1/2}$ the mass-radius condition $Rat_{2g} = 1$ is fulfilled also.

In the second part of table 1 the average momenta multiplied with (v/c) are given together with the boson energies and fermion masses and the energy changes from the acceleration terms for bosons and fermions. The fact that the values of ΔE_g and $x\Delta E_f$ are quite similar underlines the consistency of the present analysis. In the lower part of the table energy-momentum conservation is shown to be reasonably well fulfilled. In the last two columns the average boson and fermion kinetic energy $\bar{E}_{kin}$ and the average acceleration contribution $\Delta\bar{E}$ is given. This shows that $\Delta\bar{E}$ is as large as about half of the kinetic energy, which indicates that in complex systems the generation of coherent rotation of (e-p) pairs is very likely. This is confirmed by the study of galactic systems, see sect. 3.3.

The self-consistency of the results, in which all required boundary conditions are satisfied, indicates clearly that the Lagrangian (1) has the right structure of a fundamental bound state theory. This is supported by the details given in fig. 1, in which the normalized wave functions and their derivatives are given in the upper part. The radial dependence of $\sum_n M_{ng}(r)$, $\sum_n T_{ng}(r)$ and $B_{1g}(r)$ (multiplied

Table 1. Solution of a (e-p)^2 bound state from an explicit derivation of the dynamics of the Lagrangian $\mathcal{L}$, using $\kappa = 1.35$, $\alpha = 2.14$, and values of b and $(v/c)^2$ to fulfill all above boundary conditions. The dimensional quantities b, $< r^2_{w_s} >^{1/2}$ and $< r^2_{\psi_s} >^{1/2}$ are given in fm, the energies, masses and momenta are given in GeV. x is defined as $x = \sqrt{2\tilde{m}/M_f}$ or $x = \sqrt{2\tilde{m}/\Delta E_f}$, respectively.

b	$(v/c)^2$	$2E_{kin}/M_{tot}$	α_{gr}	$< r^2_{w_s} >^{1/2}$	$< r^2_{\psi_s} >^{1/2}$	M_s	M_v
0.269	1.2 10^{-38}	1.2 10^{-38}	5.9 10^{-39}	0.238	0.312	2.6 10^{-38}	1.4 10^{-37}

s	$< q^2_g >^{1/2}$ (v/c)	$< q^2_f >^{1/2}$ (v/c)	E_g	xM_f	ΔE_g	$x\Delta E_f$
0	1.6±0.3 10^{-19}	1.6±0.6 10^{-19}	-2.3 10^{-19}	1.6 10^{-19}	-4.7 10^{-20}	-5.7 10^{-20}
1	2.3±0.5 10^{-19}	5.4±1.0 10^{-19}	-4.5 10^{-19}	3.7 10^{-19}	-9.3 10^{-20}	-7.9 10^{-20}

s	$[< q^2_g >^{1/2} + < q^2_f >^{1/2}]$ (v/c)	$xM_f - E_g$	$\frac{1}{2}(xE^{kin}_f + E^{kin}_g)$	$\frac{1}{2}(x\Delta E_f + \Delta E_g)$
0	3.2±0.9 10^{-19}	3.9 10^{-19}	1.1 10^{-19}	-5.2 10^{-20}
1	7.7±1.5 10^{-19}	8.2 10^{-19}	2.2 10^{-19}	-8.6 10^{-20}

by r) are given in the middle part by solid, dot-dashed and dashed lines, respectively, which can be compared to those of the matrix elements for bosons, $M^g(r)$, $T^g(r)$ and $B^g(r)$ (also multiplied by r) given in the lower part. Importantly, the radial structure of $\sum_n M_{ng}(r)$ is similar to that of $M^g(r)$, indicating that bosons and fermions cover the same volume, as expected. Concerning the dynamics, the radial distributions of $\sum_n T_{ng}(r)$ and $B_{1g}(r)$ are less extended than $T^g(r)$ and $B^g(r)$, but lead to similar values of the kinetic energy for bosons and fermions and a similar value of ΔE_g and $x\Delta E_f$, as expected.

3.2 Composite gravitational systems without additional condition

For systems of many (e-p) pairs (or H-atoms) the binding energy is given by $E_{bind} = N^3 \sum_{i,n} E^i_{ng}$, where N is the number of (e-p) pairs in radial direction and E^i_{ng} the binding energies calculated from the matrix elements (13). Starting from the initially phase, in with all (e-p) pairs are in random motion with kinetic energy $E_{kin} = N^3 \sum_{i,n} E^{T_i}_{ng}$, the acceleration term ΔE allows to change the random motion of the (e-p) pairs to a coherent rotation. This leads to a lowering of the kinetic energy of the system (if all particles would rotate coherently, then $E_{kin} \sim N \sum_{i,n} E^{T_i}_{ng}$). By this effect the virial theorem is broken and the strong binding energy leads to a reduction of the root mean square radius R_{rms}. For smaller radii the probability of coherent rotation increases, leading to a further decrease of the kinetic energy, which drives the system rapidly to a collapse ($R_{rms} \to 0$). Because both electrons and protons are given in the present formalism as binding states of three massless quantons ($q\ \bar{q}^2$) and ($q^2\ \bar{q}$), respectively (see e.g. in ref. [5]), complete annihilation of all (e-p) pairs occurs for a reduction of the radius to $R_{rms} \leq \epsilon$ (ϵ being a very small radius). This would be the same for a system consisting of (e^+p^-) pairs, since positrons and antiprotons are also given by three massless quantons ($q^2\ \bar{q}$) and ($q\ \bar{q}^2$), respectively. However, there are two important exceptions in the evolution of the universe, discussed below.

3.3 Stable galactic systems

The development of a coherent rotation of many H-atoms can be observed in galaxies, for which their rotational velocities have been measured. As discussed in ref. [7] the radial dependence of the

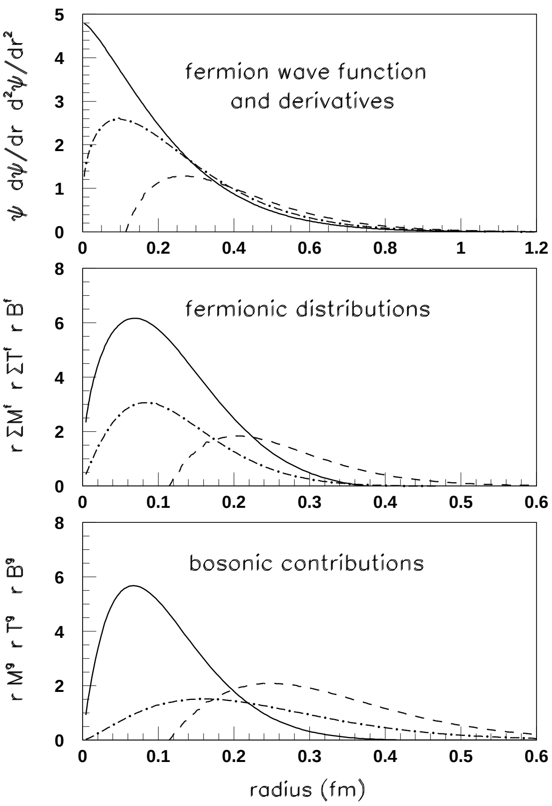

Fig. 1. Scalar fermion wave function $\psi_s(r)$ and their derivatives $d\psi_s(r)/dr$ and $d^2\psi_s(r)/dr^2$ are given in the upper part by solid, dot-dashed and dashed lines, respectively. The radial dependence of corresponding matrix elements (multiplied by r) for fermions, $\sum_n rM_{ng}(r)$ (solid line), $\sum_n rT_{ng}(r)$ (dot-dashed line) and $rB_{1g}(r)$ (dashed line), are shown in the middle and for bosons, $rM^g(r)$, $rT^g(r)$ and $rB^g(r)$, in the lower part.

rotational velocity (for coherent rotation) is given by

$$\frac{v_{rot}(r_{gal})}{c} = \sqrt{\frac{2\ dE_s^{kin}(r)\ r_s}{dr\ \ M_s}\ \frac{N_{gal}}{N_{gal}^r}}\ f_{damp}\ , \tag{33}$$

where $dE_s^{kin}(r)/dr$ is the radial derivative of the kinetic energy of the magnetic state in sect. 3.1 given by

$$\frac{dE_s^{kin}(r)}{dr} = 2\pi\psi_s^2(r)r^3\ (\frac{dV_{2g}(r)}{dr} + \frac{dV_{3g}(r)}{dr}) \tag{34}$$

with radius r_s and mass M_s. Further, N_{gal} is the number of (e-p) pairs, which can be different from N_{gal}^r given by the geometry $< r^2 >_{gal}^{1/2} \ = N_{gal}^r < r^2 >_s^{1/2}$, where $< r^2 >_s^{1/2}$ is the rms-radius of the basic state in sect. 3.1. In addition, a strong damping of coherent rotation (given by f_{damp}) has to be assumed to avoid a collapse as discussed in sect. 3.2.

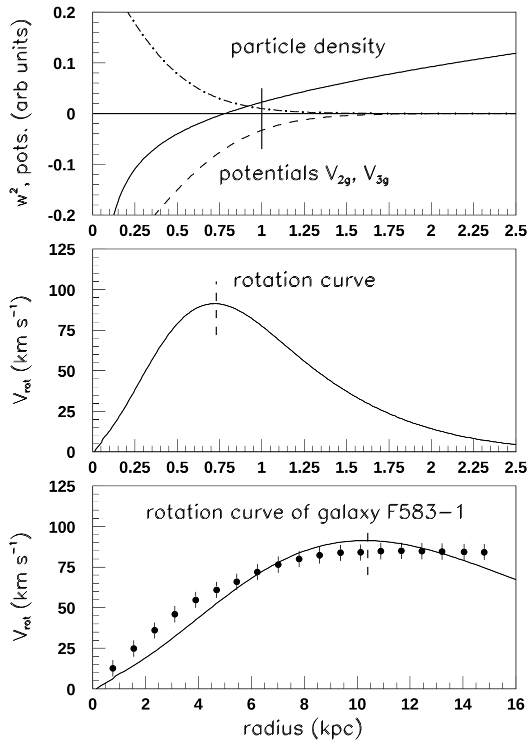

Fig. 2. Upper part: Radial dependence of the density (dot-dashed line) and the potentials $V_{2g}(r)$ and $V_{3g}(r)$ of a galactic system with a rms-radius of 1 kpc, given by solid and dashed lines. The vertical line gives the rms-radius of the density. Middle part: Deduced velocity distribution (solid line). Lower part: Velocity curve with radius fitted to the measured data of the galaxy F583-1 of ref. [10] (solid line). The vertical dashed lines show the maximal rotation velocity.

A second condition requires that the maximum rotation velocity of galaxies is related to (v/c) of the fundamental state by

$$\frac{v_{max}}{c} = (v/c)\ \sqrt{N_{gal}}\ f_{damp}\ , \tag{35}$$

where (v/c) is the rotation velocity of the fundamental state. By the relations (33) and (35) the parameters δ_{gal} and f_{damp} are fixed, which allowed a deduction of galaxy masses [7].

The radial dependence of the calculated density, potentials and rotation curve are given for a galactic system with a radius of 1 kpc in the upper two parts of fig. 2. A comparison is made with rotational velocities [10] measured for the galaxy F583-1 in the lower part. This rotation curve is typical of many low surface brightness galaxies. By scaling the radius to about 15 kpc, a rather good description of the data is obtained.

A study of different galaxies are given in ref. [7]. Importantly, a very systematic dependence of the parameters δ_{gal} and f_{damp} has been found with a damping factor of coherent rotation $f_{damp} \sim 0.01$-0.1 (for the present case $f_{damp} \sim 0.1$). However, the fact that rather stable systems are observed shows also that a significant reduction of the binding energy has to be assumed. This has to be a relic of the high density phase of the universe following the decay of a gravitational system discussed below.

3.4 Matter-antimatter symmetric system

The present fundamental theory couples to the vacuum ($E_o = 0$ in eq. (14)); this allows the creation of fermion-antifermion pairs out of the vacuum of fluctuating boson fields during overlap of boson fields. These fermion-antifermion pairs can be bound by the potentials (8) and (9) to simple mesons, which decay to protons and electrons (defined as matter), but also to antiprotons and positrons (antimatter), leading to an equal number of $(e^- - p^+)$ and $(e^+ - p^-)$ pairs (defined as matter-antimatter symmetric).

In the following discussion the chiral structure of leptons is essential, which is due to the handedness of the magnetic binding (attraction perpendicular to the motion of charge, but **only** in one direction). For leptons of $(q^+q^-)^n q^-$ structure the motion is dominated by negative charge, leading to left-handedness; for $(q^+q^-)^n q^+$ antileptons the motion is dominated by positive charge, giving rise to right-handedness.

Due to the different chiral structure of the electron (left-handed) and positron (right-handed) pure gravitational systems with electrons or positrons lead to a coherent rotation in opposite direction [5] (the accompanying protons or antiprotons are dominated by electric binding and thus without chiral structure). But in a system containing the same number of electrons and positrons a coherent rotation is canceled: if in a rotation in one direction (e^+p^-) pairs probe an attractive potential, the (e^-p^+) pairs feel a repulsive force. This leads to stabilization of the system. By continuous creation of fermion-antifermion pairs out of the vacuum the number of bound particles increases steadily, accumulating a tremendous mass compatible with that of the whole universe. Most likely this process took place during the genesis of the universe.

Finally, we have to assume that this gigantic gravitational system became unstable and decayed. A tiny distortion of the matter-antimatter equilibrium could arise due to CP-violation, a process found in K^o decay. This distortion could eventually initiate a coherent rotation of (e^+p^-) pairs with a stronger binding and a reduction in radius. However, this rotation had the opposite effect on (e^-p^+) pairs: due to the opposite chirality of the electron this rotation gave rise to a lowering of binding and an increasing radius. By further increase of coherent rotation the radius of the (e^+p^-) distribution reduced further, whereas the (e^-p^+) pairs were pushed to larger radii, until they could separate entirely from the (e^+p^-) pairs. This process could be facilitated also by the repulsive interaction between (e^+p^-) and (e^-p^+) pairs. Then, a flip of the rotation of the (e^-p^+) pairs to the opposite direction was possible, by which their interaction became also attractive (due to its chiral structure) and led to a reduction in radius. However, the collapse of (e^+p^-) pairs (antimatter) has been completed already, before $R_{rms}(e^-p^+) \rightarrow \epsilon$. The high yield of backward scattered annihilation photons (from the collapse of the (e^+p^-) pairs) led to strong heating of the accumulated (e^-p^+) pairs, disintegration and radial expulsion of matter, which can be considered as the origin of the "Big Bang".

$K_2^o \rightarrow \pi^+\pi^-$ decays have been observed with a branching ratio of 0.20±0.04 %, see ref. [11].

By the above mechanism we can understand that the present universe exists only of matter, $(e^- p^+)$ pairs in the form of multi-hydrogen atoms and a small amount of heavier atoms, whereas the corresponding $(e^+ p^-)$ pairs (antimatter) have been annihilated. The initiated high photon blast gave rise to the known background radiation and strong expulsion of matter in radial direction. A more detailed discussion consistent with the known facts on the cosmic high density phase shall be given in a future paper.

As a last point, the discussed matter-antimatter symmetry and its breaking in complex systems is clearly different from the elementary fermion-antifermion symmetry, which cannot be broken.

4 Summary

From the Lagrangian (1) dynamical matrix elements have been derived to test the bound state character of a fundamental theory. In addition to static and kinetic energy terms an acceleration component is found, which is spurious for fundamental states, but drives the motion of individual particles in composite systems to a coherent motion.

An application to gravitation shows the following results:

1. A self-consistent description of a basic magnetic (e-p)^2 bound state is obtained, which confirms previous studies, in which an extremely small binding energy of about 10^{-38} GeV and a first-order equivalent coupling constant in agreement with Newton's gravitational constant G_N has been obtained. The deduced change of the kinetic energy due to the acceleration term amounts to about 50 %.

2. For composite gravitational systems this strong acceleration term drives individual (e-p) pairs to coherent rotation. Without further conditions this leads to a collapse of the systems, followed by complete annihilation.

3. The existence of stable galactic objects is possible only, if in addition to a coherent motion of (e-p) pairs the binding energy is reduced. This has to arise from the decay of the early cosmic state, see point 4.

4. For systems composed equally of $(e^- p^+)$ and $(e^+ p^-)$ pairs a complete collapse is prevented by the different chiral structure of electrons and positrons. We can assume that such a system has been generated in the early universe by creation of mesons out of the vacuum of fluctuating boson fields, which decayed equally to $(e^- p^+)$ and $(e^+ p^-)$ pairs. Due to the matter-antimatter equilibrium a system of an extremely large mass could be created (twice the mass of the universe). Eventually, by a small perturbation due to CP-violation a coherent rotation in one direction could arise, which favored attraction, collapse and annihilation of all $(e^+ p^-)$ pairs. The resulting high photon flux led to strong heating, disintegration and expulsion ("Big Bang") of the $(e^- p^+)$ matter.

Acknowledgement

The author is very grateful to B. Loiseau for his interest and discussion of the theoretical formalism.

Competing Interests

Author has declared that no competing interests exist.

References

[1] Peskin ME, Schroeder DV. An introduction to quantum field theory. Addison-Wesley Publ; 1995.

[2] Nakamura K et al. Review of particle properties. J. Phys. G 37, 075021 (2010); Available: http://pdg.lbl.gov/ and refs. Therein.

[3] Lagrangians with higher derivative terms are discussed by Simon JZ. Phys. Rev. 1990;41:3720. Foussats A, Manavella E, Repetto C, Zandron OP. Zandron OS. Int. J. theor. Phys. 1995;34(1). Nesterenko VV. J. Phys. A: Math. Gen. 1989; 22:1673. And refs. therein.

[4] Morsch HP. Unique structure of free particle bound states. Brit. J. Math. and Comp. Sc. 2016;17(6):1-11. Open access.

[5] Morsch HP, Ghosh S. Chiral structure of particles bound by magnetic forces. J. Adv. Math. and Comp. Sc. 2017;24(4):1-11. Open access.

[6] Morsch HP. Fundamental bound state description of light atoms and the fine structure constant $\alpha \sim 1/137$. Boson J. of Modern Physics. 2017;3(1):197. Open access.

[7] Morsch HP. Origin of gravitation and description of galaxy rotation in a fundamental bound state approach. Global J. Sci. Front. Research. 2018;18(4) v.1, p. 25. Open access.

[8] Landau LD, Lifschitz EM. Classical field Theory, textbook of theor. Physics. Academie Verlag Berlin; 1963. See also Einstein A. Über die spezielle und allgemeine Relativitätstheorie, Vieweg, Braunschweig 1920; A. Einstein, Z. Phys. 1923;16:228.

[9] Barbieri R, ögerler RK, Kunszt Z, Gatto R. Bethe-Salpeter equations for $q\bar{q}$ and qqq systems in the instantaneous approximation. Nucl. Phys. 1976;105(125). Eichten, Gottfried KE, Kinoshita T, Lane KD, Yan TM. Charmonium: the model. Phys. Rev. 1978;17:3090. Godfrey S, Isgur N. Mesons in a relativized quark model with chromodynamics. Phys. Rev. 1985;32:189. Ebert D. RN. Faustov, VO Galkin. Properties of heavy quarkonia and Bc mesons in the relativistic quark model. Phys. Rev. D. 2003;67:014027.And refs. Therein.

[10] McGaugh SS, De Blok WJG. Testing the dark matter hypothesis with low surface brightness galaxies and other evidence. Astrophys. J. 1998;499(41). Testing the hypothesis of modified dynamics with low surface brightness galaxies and other evidence. Astrophys. J. 1998;499(66). (arXiv:astro-ph/9801102 and 9801123) and refs. Therein.

[11] JH Christenson, JW Cronin, VL Fitch, Turlay R. Evidence for the 2π decay of the K_2^o Meson. Phys. Rev. Lett. 1964;13:138.

Peer-review history:
The peer review history for this paper can be accessed here (Please copy paste the total link in your browser address bar)
http://www.sciencedomain.org/review-history/25929