Many-Minds Quantum Mechanics

Claes Johnson

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Preface

This is a draft of an upcoming book with a computational approach to quantum mechanics based viewing the the Schrödinger equation for a many-electron atom or molecule as a non-linear system of of one-electron equations in the spirit of Hartrees classical method, which is solved in a collective computational process with each electron updating its own three-dimensional wave function according to the wave functions of the other electrons. I refer to this version as *Many-Minds Quantum Mechanics* (MMQM) with each electron representing a (simple) mind seeking to solve its own Schrödinger equation.

This is to be compared with the accepted view according to the Copenhagen Interpretation with a multidimensional wave function satisfying a linear scalar Schrödinger equation, with the modulus squared of the wave function representing the probability of a pointlike electron configuration. One may refer to this verion as One-Mind Quantum Mechanics (OMQM) with the multidimensional wave function being solved by One Supermind.

The big trouble with OMQM is that the wave function does not represent any physical quantity, only a probability which has no physical representation, a fact which has made quantum mechanics into a deeply mystical subject beyond the comprehenion of human minds, as witnesses by many Nobel Laurates of Physics: Quantum mechanics cannot be understood but is nevertheless very useful.

On the other hand, the collection of one-electron wave functions of MMQM has a direct physical meaning. This book explores this approach with the hope of reducing the mystery by making of quantum mechanics both understandable and useful.

The book also presents a many-minds approach to relativity theory with the hope of finding a unified many-minds model including both gravitation and quantum mechanics.

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Claes Johnson

Part I

Many-Minds Quantum Mechanics

Chapter 1

Quantum Mechanics

> With very few exceptions (such as Einstein and Laue) all the rest of the theoretical physicists were unadulterated asses and I was the only sane person left...The one great dilemma that ail us... day and night is the wave-particle dilemma... So unable is the good average physicist to believe that any sound person could refuse to accept the Copenhagen oracle.. (Schrödinger in a letter to Synge 1959)

> Niels Bohr brainwashed a whole generation of theorists into thinking that the job of interpreting quantum theory was done 50 years ago. (1969 Nobel Laureate Murray Gell-Mann)

> In general the many-electron wave function $\psi(x_1, ..., x_N)$ for a system of N elextrons is not a legitimate scientific concept when $N \geq N_0$, where $N_0 \approx 10^2 - 10^3$. (Walter Kohn Nobel Lecture 1998)

1.1 Schrödinger and his Equation

Quantum Mechanics based on the *Schrödinger equation* was developed by Erwin Schrödinger in four revolutionary articles in the *Annales de Physique* 1926 in an outburst of creativity (inspired by the ingenious thesis of de Broglie [47]), which gave Schrödinger the Nobel Prize in 1933, shared with Paul Dirac. Solutions to the Schrödinger equation are referred to as *wave functions*. It appears that a vast amount of physics on atomic scales can be described by wave functions, but the physical interpretation of Schrödinger's wave functions has remained a mystery. In the *Copenhagen Interpretation* proposed by Born, and propagated by Bohr and Heisenberg, the square of the modulus of the wave function is interpreted as a probability density indicating the probability of a certain configuration of electrons and atomic kernels viewed as "point particles" without extension in space, an interpretation never accepted by the inventor Schrödinger himself.

1.2 The Copenhagen Interpretation

In Computational Thermodynamics I argue that statistical considerations in thermodynamics create more problems than they solve, and thus run the risk of representing pseudo-science in the sense of Popper. The same argument applies to the Copenhagen Interpretation of quantum mechanics, and both Schrödinger and Einstein passed away without being convinced, despite a (very) strong pressure from the physics community. However, lacking an alternative, the Copenhagen Interpretation has become an accepted "truth" presented in (almost) all text books in quantum mechanics, although a recent poll (at a 1997 UMBC quantum mechanics workshop) gave it less than half of the votes [79].

Stimulated by the failing belief in statistical quantum mechanics indicated by the poll result, we now proceed to present an alternative to the Copenhagen interpretation, which is free of statistics, and which we will refer to as *Many-Minds Quantum Mechanics (MMQM)*, in a paraphraze to the Many-Worlds Interpretation proposed by Everett in 1957, which scored second in the poll. MMQM is closely related to the Hartree-Kohn electron density approach [115], and connects to Kohn's standpoint that a many-electron wave function is not a "legitimate scientific concept", in other words, simply does not exist.

1.3 Information Flow of Quantum Mechanics

MMQM uses the general idea of information flow presented above, in a new approach to the quantum mechanics of a system of electrons with negative charge evolving in time subject to electrostatic Coulomb forces from mutual interaction and from a set of positively charged atomic kernels, assumed to start with to be fixed as in the Born-Oppenheimer model. We attribute to each electron a (very simple) "mind" through which each electron can register electric potentials and move accordingly. We thus do not give any outside observer or surveyor the job of telling the electrons what to do, or simply precribe that the Schrödinger wave equation should be obeyed no matter how, but allow the system to evolve "freely" with each electron doing its best registering electric potentials and moving accordingly. In the MMQM model the electron system is described by a set of wave functions, one for each electron, each of which represents an average of the classical complete wave function containing all possible particle interactions, and which satisfies a one-electron version of the Schrödinger equation. We will argue that the complete wave function is fictional and as such "does not exist", while the set of individual averages thereof in MMQM, do exist as a reflection of the existence of the (freely) interacting electron system.

1.4 The MMQM Interpretation

MMQM invites to a natural deterministic physical interpretation (of the square of the modulus) of the wave function for each electron as the density or "presence" in space time of the electron. Together the electron wave functions thus form a deterministic electron density in the spirit of Hartree and Kohn. In contrast, the complete wave function seems impossible to interprete derministically and the only way out seems to be the statistical Copenhagen Interpretation with all its complications. We avoid all these difficulties simply by not at all speaking of the (probably non-existent) complete wave function, following Wittgenstein's device to keep quite of which you cannot speak.

MMQM is like a many-minds interaction of a group of human beings, with each human mind having its own perception of the full interaction, as a form of blurred average of a fictional unknown complete "wave function" expressing the totality of all interactions. We can also interprete MMQM as representing a "free democratic society" of individuals taking individual decisions based on individual experience, as compared to a totalitarian society with each individual required to (somehow) follow the dictate of one Leader (having full information of all interactions through an ideal KGB or Stazi). Evidence of the existence of democratic societies is abundant, while totalitarian systems seem to be in quick transition to non-existence (or have already ceased to exist).

1.5 Schrödinger's Cat

Classical quantum mechanics is based on the existence of complete wave functions as solutions to the *Schrödinger equation*, with the linearity of the equation playing an important role, in particular suggesting that quantum states can be linearly superimposed. This led to the famous *Schrödinger cat paradox* with a cat in a box being in a combined superimposed state of both life and death, until a final verdict is given by simply an observation by opening the box. The cat would thus be neither dead nor alive prior to observation, but sort of half-dead and half-alive and only by the act of observation would become fully dead or fully alive in what Heisenberg called a "collapse of the wave function". Schrödinger constructed his cat paradox to show that a careless use of quantum mechanics could lead to absurdities, way beyond the supposed 9 lives of a cat.

1.6 Quantum Computers?

Today Schrödinger's cat has come back in the form of projected *quantum computers* supposedly being able to perform many parallel computations by superimposing many quantum states and using a final observation to select useful information. Quantum computers are based on the existence of complete wave functions, which may not exist for many-electron systems, and therefore it is not (at all) clear that a quantum computer can be brought to existence, (except very simple ones consisting of a few so called quantum bits or qubits).

1.7 Hartree and Kohn-Sham Methods

In the classical *Hartree method* [116] the Schrödinger equation is replaced by a system of one-electron equations, which may be viewed as a form of MMQM (with central field approximations). The individual wave functions represent different mean value approximation in space of a (possibly non-existent) full wave function, and together form an approximate solution to the Schrödinger equation, from which typical macroscopic outputs such as energy levels and electron densities can be computed. The Hartree method has been used extensively apparently with good results. A related successful method is the electron-density method by Kohn-Sham, for which Walter Kohn got the Nobel Prize in 1998 [115].

1.8 Outline

We now proceed to present a MMQM model for a multi-electron system, starting with the Schrödinger equation for the one-electron Hydrogen atom and the two-electron Helium atom. We also present a model for radiation which is a quantum mechanical analog of the model for black-body radiation considered above. For simplicity we do not take electron spin into account. (It may be that spin can be left out altogheter from the discussion, as well as the Pauli exclusion principle not allowing two electrons with the same spin to have overlapping wave functions).

Chapter 2

Hydrogen Atom

2.1 Schrödinger's Equation

The *Schrödinger equation* for the Hydrogen atom takes the form:

$$\begin{aligned} i\bar{h}\dot{\psi} + (\frac{\bar{h}^2}{2m}\Delta + V)\psi = 0 \quad \text{in } \mathbb{R}_+ \times \mathbb{R}^3, \\ \psi(0,\cdot,\cdot) = \psi^0 \quad \text{in } \mathbb{R}^3. \end{aligned} \tag{2.1}$$

where $\psi(t, x)$ is the (complex-valued) *wave function*, Δ is the Laplacian with respect to x, and

$$V(x) = \frac{e^2}{|x|}$$

is the *Coulomb potential* modeling the interaction of the negative electron with the positive proton kernel. Here $\bar{h}$ is Planck's (reduced) constant, m is the electron mass, and e the elementary charge. We normalize to $\bar{h}^2/m = 1$ and $e^2 = 1$ using customary *atomic units* in which case (2.1) takes the form:

$$\begin{aligned} i\dot{\psi} + (\frac{1}{2}\Delta + V)\psi = 0 \quad \text{in } \mathbb{R}_+ \times \mathbb{R}^3, \\ \psi(0,\cdot,\cdot) = \psi^0 \quad \text{in } \mathbb{R}^3. \end{aligned} \tag{2.2}$$

with $V(x) = \frac{1}{|x|}$.

2.2 Radiating Hydrogen Atom

A Hydrogen atom absorbing energy from a given forcing f and radiating energy into a surrounding vacuum, can in the spirit of the model for black-body radiation above, be modeled by

$$\begin{aligned} i\dot{\psi} + (\frac{1}{2}\Delta + V)\psi - \gamma\dddot{\psi} - \delta^2\Delta\dot{\psi} = f \quad \text{in } \mathbb{R}_+ \times \mathbb{R}^3, \\ \psi(0,\cdot) = \psi^0 \quad \text{in } \mathbb{R}^3, \end{aligned} \tag{2.3}$$

where the term $-\gamma\dddot{\psi}$ represents radiation with dissipation intensity $\gamma|\ddot{\psi}(x,t)|^2$, $-\delta^2\Delta\dot{\psi}$ represents a G2 stabilization with dissipation intensity $\delta^2|\nabla\dot{\psi}|^2$, and we assume that $\gamma << \delta^2 \sim 1$. We note the basic energy balance (with $f = 0$):

$$\frac{1}{4}\frac{d}{dt}\int_{\mathbb{R}^3} |\nabla\psi|^2 dx + \int_{\mathbb{R}^3} \gamma|\ddot{\psi}|^2 dx + \int_{\mathbb{R}^3} \delta^2|\nabla\dot{\psi}|^2 dx = 0,$$

exhibiting the radiation and G2 dissipation.

Chapter 3

Helium Atom

3.1 Schrödinger's Equation

The Schrödinger equation for the two-electron *Helium atom* takes the form: Find $\psi(t, x_1, x_2)$ such that

$$\begin{aligned} i\dot{\psi} + (\frac{1}{2}\Delta_1 + \frac{1}{2}\Delta_2 + V_1 + V_2 - V_{12} - V_{21})\psi = 0 \quad \text{in } \mathbb{R}_+ \times \mathbb{R}^3 \times \mathbb{R}^3, \\ \psi(0, \cdot, \cdot) = \psi^0 \quad \text{in } \mathbb{R}^3 \times \mathbb{R}^3, \end{aligned} \tag{3.1}$$

where Δ_j is the Laplacian with respect to x_j, and

$$V_j(x_j) = \frac{2}{|x_j|}, \quad V_{jk}(x_j, x_k) = \frac{1}{2|x_j - x_k|}, \quad j, k = 1, 2,$$

are the Coulomb potentials modeling the interaction of the two electrons with the kernel (consisting of two protons and two neutrons), and with each other with the factor of 2 in the denominator coming from the repeated appearance of the interaction potential with $V_{12} + V_{21} = 1/|x_1 - x_2|$.

We note that the wave function $\psi(t, x_1, x_2)$ has two space variables x_1 and x_2 both ranging over $\mathbb{R}^3$, and thus has a space dependence over $\mathbb{R}^6$. For N electrons the space variables range over $\mathbb{R}^{3N}$, which makes computational (and also analytical) solution of the Schrödinger equation impossible for a a many-electron system.

3.2 MMQM for Helium

MMQM for the Helium atom takes the form of the following system of equations in $\mathbb{R}^3$: Find $\psi_j(t,x)$ for $j = 1, 2$, such that

$$\begin{aligned} i\dot{\psi}_1 + (\frac{1}{2}\Delta + V - W_{12})\psi_1 = 0, \quad \text{in } \mathbb{R}_+ \times \mathbb{R}^3 \\ i\dot{\psi}_2 + (\frac{1}{2}\Delta + V - W_{21})\psi_2 = 0, \quad \text{in } \mathbb{R}_+ \times \mathbb{R}^3, \end{aligned} \tag{3.2}$$

where

$$\begin{aligned} W_{12}(t,x) &= \int \frac{|\psi_2(t,y)|^2}{2|x-y|} dy, \\ W_{21}(t,x) &= \int \frac{|\psi_1(t,y)|^2}{2|x-y|} dy, \end{aligned}$$

Δ is the Laplacian with respect to x, and $V(x) = \frac{2}{|x|}$. Here electron j is described by the wave function $\psi_j(t,x)$ with $|\psi_j(t,x)|^2$ a weight representing the "density" of electron j at (t,x). To compute $W_{12}(t,x)$ it is cost effective to solve the Poisson equation $\Delta W_{12} = 2\pi|\psi_2(t,\cdot)|^2$, and simililarly for W_{21}.

We notice that the MMQM model (3.2) is a non-linear "multi-species" system of wave functions $\psi_j(t,x)$ defined $\mathbb{R}_+ \times \mathbb{R}^3$ and $t > 0$, where each electron solves its own equation integrating over the influence of the other electron in the spirit of the Hartree method. We compare with the Schrödinger equation, which is a linear equation in a scalar wave function $\psi(t, x_1, x_2)$ defined on $\mathbb{R}_+ \times \mathbb{R}^3 \times \mathbb{R}^3$. We understand that the computational complexity of MMQM is much smaller than that of the full Schrödinger equation. If each space dimension is discretized into n cells, MMQM requires $2n^3$ and Schrödinger n^6 cells, and for large n the difference is large.

Since the potentials V and W_j are real, the solutions of (3.2) are easily seen to satisfy

$$\frac{d}{dt}\int |\psi_j(t,x)|^2 dx = 0 \qquad \text{for } t > 0,$$

which justifies the interpretation of $|\psi_j(t,x)|^2$ as a weight indicating the "presence" of electron j, with the normalization

$$\int |\psi_j(t,x)|^2 dx = 1 \qquad \text{for } t > 0.$$

We may view the MMQM model (3.2) as a an alternative to Schrödinger's equation (3.1). To find a relation between the two models, we multiply the first equation in (3.2) by ψ_2 and the second by ψ_1 and add up to get for $\psi(x_1) = \psi_1(x_1)\psi(x_2)$:

$$i\dot{\psi} + (\frac{1}{2}\Delta_1 + \frac{1}{2}\Delta_2 + V_1 + V_2 - W_{12} - W_{21})\psi = 0.$$

If the electrons are localized at $\bar{x}_1$ and $\bar{x}_2$ at time t, we have

$$W_1(t, x_1) \approx \frac{1}{2|x_1 - \bar{x}_2|}, \quad W_2(t, x_2) \approx \frac{1}{2|\bar{x}_1 - x_2|}$$

and thus

$$W_{12} + W_{21} \approx V_{12} + V_{21}.$$

Thus, there is an obvious connection between the two models, with the Schrödinger wave function being a product of MMQM one-electron wave functions.

Since Schrödinger's equation is an ad hoc model, which is not derived from a more basic model, it may as well be possible to start from an ad hoc model of the MMQM form. If (as we expect) the MMQM system can be solved, while Schrödinger's equation cannot, the question of the relation between solutions of the two models does not come up in practice. We may check to what extent a product of MMQM one-electron wave functions satisfies the Schrödinger equation, and take the residual as a measure the existence of full wave function (which may not exist).

3.3 MMQM for the Ground State of Helium

The ground state for the Helium MMQM model (3.2) is the pair of stationary wave functions (ψ_1, ψ_2) which minimize the *total energy*

$$E(\psi_1, \psi_2)$$
$$= \sum_j \int_{\mathbb{R}^3} (\frac{1}{2}|\nabla\psi_j|^2 - V|\psi_j|^2)dx + \sum_{j \neq k} \int_{\mathbb{R}^3 \times \mathbb{R}^3} \frac{|\psi_j(x_j)|^2|\psi_k(x_k)|^2}{2|x_j - x_k|} dx_j dx_k,$$

where $\frac{1}{2}|\nabla\psi_j|^2$ represents the intensity of the kinetic energy of electron j. Using spherical coordinates $x = (r\sin(\varphi)\cos(\theta), r\sin(\varphi)\sin(\theta), r\cos(\varphi))$ assuming rotational symmetry around the x_3 axis with independence of θ, we have with $Q = \mathbb{R}_+ \times [0,\pi]$

$$E(\psi_1,\psi_2) = \pi\sum_j\int_Q |\psi_{j,r}|^2 r^2\sin(\varphi)drd\varphi + \pi\sum_j\int_Q |\psi_{j,\varphi}|^2\sin(\varphi)drd\varphi$$
$$-2\pi\sum_j\int_Q |\psi_j|^2 r\sin(\varphi)drd\varphi + \sum_{j\neq k}\int_{\mathbb{R}^3\times\mathbb{R}^3}\frac{|\psi_j(x_j|^2|\psi_k(x_k)|^2}{2|x_j-x_k|}dx_jdx_k,$$

where $\psi_{j,r} = \frac{\partial\psi_j}{\partial r}$ and $\psi_{j,\varphi} = \frac{\partial\psi_j}{\partial\varphi}$.

For minimizing wave functions (ψ_1,ψ_2), we must have by symmetry across the plane $x_3 = 0$, that

$$\psi_1(r,\varphi) = \psi_2(r,\pi-\varphi).$$

Assuming both ψ_1 and ψ_2 are one-electron symmetric wave functions (independent of φ) of the form $\psi_j \sim e^{-r}$, we obtain according to [99] $E = -2.85$, while the actual value is claimed to be -2.90. This indicates that $E(\psi_1,\psi_2)$ can be made smaller by allowing the electrons to be unsymmetric with ψ_1 primarily localized to the half-space $x_3 > 0$ and ψ_2 to $x_3 < 0$, thus with a dependence on the angle φ, resulting in a decrease of interaction energy and an increase of kinetic energy, probably with an overall decrease of the total energy.

The total energy minimization problem is equivalent to the following non-linear eigenvalue problem: Find the smallest real number E such that the system

$$(\frac{1}{2}\Delta + V - W_j)\psi_j = E\psi_j \quad j = 1,2,$$

admits a non-zero solution $(\psi_1(x),\psi_2(x))$. Since E is real, this system decouples into the real and imaginary part of the same form. Some simple iterative strategy solving a sequence of linear eigenvalue problems could lead to a solution.

Solving the minimization probem numerically, we obtain.....We see as expected that the wave functions are unsymmetric with electron 1 primarily localized to $x_3 > 0$ and ψ_2 to $x_3 < 0$. We see that the MMQM solution violates Pauli's exclusion principle in the sense that the wave function $\psi_1(x_2)\psi_2(x_2)$ is neither symmetric nor antisymmetric with respect to interchange of x_1 and x_2. Yet the MMQM solution gives the correct value $E = -2.90$??????

3.4 MMQM for the Hydrogen Molecule H_2

A Hydrogen molecule consists of two protons held together by two electrons in a so-called *covalent binding*. An MMQM approach indicates that one of the electrons will take a central position between the two proton kernels, and the other electron will take an outer position around the kernels. The central electron will act like a spring force pulling the protons together, a force which will be balanced by the repulsion between the protons. The outer electron will act like a shield repelling other hydrogen molecules.

We show the MMQM electron densities in Fig ...

Chapter 4

Many-Electron Systems

MMQM directly generalizes to an arbitrary number of electrons and kernels, and takes the following form in the case of one positive kernel (fixed at the origin) with charge N and N electrons: Find $\psi_j(t,x)$ for $j = 1,..,N$, such that for $j = 1,...,N$,

$$i\dot{\psi}_j + (\frac{1}{2}\Delta + V - W_j)\psi_j = 0, \quad \text{in } \mathbb{R}_+ \times \mathbb{R}^3, \tag{4.1}$$

$$W_j(t,x) = \sum_{k\neq j} \int_{\mathbb{R}^3} \frac{|\psi_k(t,y)|^2}{2|x-y|}\, dy, \quad x \in \mathbb{R}^3,\, t > 0 \tag{4.2}$$

where $V(x) = \frac{N}{|x|}$. We note that W_j is the potential of the charge distribution $\sum_{k\neq j} |\psi_k|^2$ of all the electrons except electron j. We see that (4.1) is one-electron Schrödinger equation for electron j with the potential W_j resulting from the sum of the charge distributions for electrons $k \neq j$.

We write may write MMQM alternatively in the form: Find $\psi_j(t,x)$ for $j = 1,..,N$, such that for $j = 1,...,N$,

$$\begin{aligned} i\dot{\psi}_j + (\frac{1}{2}\Delta + V - W_j)\psi_j = 0, \quad \text{in } \mathbb{R}_+ \times \mathbb{R}^3, \\ \delta\dot{w}_j - \Delta w_j(t,\cdot) = -2\pi|\psi_j(t,\cdot)|^2, \quad \text{in } \mathbb{R} \times \mathbb{R}^3, \\ W_j = \sum_{k\neq j} w_k, \end{aligned} \tag{4.3}$$

where $\delta \geq 0$ is a relaxation parameter. We note that MMQM in the form (4.1) involves only locally acting differential operators, and thus is analogous to the to the alternative gravitational model considered in [12].

To connect to the Schrödinger equation, we multiply (4.1) by ψ_k for $k \neq j$ and sum over vj to get for $\psi(x_1,...,x_N) = \psi_1(t,x_1)...\psi_N(t,x_N)$:

$$i\dot{\psi} + \sum_j (\frac{1}{2}\Delta_j + V_j - W_j)\psi = 0,$$

where $V_j(x_j) = N/|x_j|$, and with the same argument as above, we may expect that

$$W_j(t,x_j) \approx \sum_{k\neq j} \frac{1}{2|x_j - \bar{x}_k|} \approx V_{jk},$$

and thus a MMQM solution may be viewed as an approximate solution of the full Schrödinger equation:

$$\imath\dot{\psi} + (\sum_j \frac{1}{2}\Delta_j + \sum_j V_j - \sum_{k\neq j} V_{jk})\psi = 0.$$

The computational complexity of MMQM is Nn^3 with n cells in each space dimension, while that of the full Schrödinger equation is n^{3N}, and the difference is enormous: The full Schrödinger equation for n and N of size $10^2 - 10^3$, which covers a large range of applications, is completely intractable, while MMQM appears completely tractable.

A time-periodic MMQM solution of the form $\exp(iEt)(\psi_1(x),...,\psi_N(x)$ with angular frequency E solves the non-linear eigenvalue problem

$$(\frac{1}{2}\Delta + V - W_j)\psi_j = E\psi_j \quad j = 1,...,N,$$

where E is the eigenvalue and $\psi_1,...,\psi_N$, the corresponding eigenfunctions.

Chapter 5

Pauli's Exclusion Principle

An MMQM set of wave functions $(\psi_1, ..., \psi_N)$ for an N-electron system cannot be expected to satisfy *Pauli's Exclusion Principle (PEP)* demandingthat the product wave function $\psi = \psi_1(x_1)....\psi_N(x_N)$ is symmetric or antisymmetric, that is, any interchange of two coordinates x_j and x_k would correspond to multiplying ψ by ± 1. Thus, we see no reason to believe that N-electron systems obey PEP, just as there is no reason to believe that the interaction between a set of (equal) human beings must be either symmetric or anti-symmetric.

Chapter 6

Radiating Many-Electron Systems

Combining the above models we obtain the following MMQM model for a radiating multi-electron system: Find ψ_j for $j = 1, .., N$, such that

$$i\dot{\psi}_j + (\frac{1}{2}\Delta\psi_j + V\psi_j - W_j)\psi_j - \gamma\dddot{\psi}_j - \delta^2\Delta\dot{\psi}_j = f, \quad \text{in } \mathbb{R}_+ \times \mathbb{R}^3, \quad j = 1, ..., N, \tag{6.1}$$

where

$$W_j(t, x) = \int \frac{\sum_k |\psi_k(t, y)|^2}{2|x - y|} dy.$$

The total dissipation from radiation and computation is now

$$\sum_j \int_{\mathbb{R}^3} (\gamma|\ddot{\psi}_j|^2 + \delta^2|\nabla\dot{\psi}_j|^2 dx.$$

6.1 Radiating Many-Atom Systems

We can naturally generalize to a multi-atom system allowing also the kernels to move in order to account for temperature effects, e.g. instance by using a classical Newtonian model for the kernels and a quantum model for the electrons. Such a model should have a considerable range of applicability.

Chapter 7

Model Problem

We consider the following model problem in one space dimension: Find $\psi(t,x_1) = (\psi_1(t,x_1), ..., \psi_N(t,x_N))$ such that

$$i\dot{\psi}_j + \frac{1}{2}\psi_j'' + V\psi_j - W_j\psi_j = 0, \quad \text{in } \mathbb{R}_+ \times (-1,1), \quad j = 1, ..., N, \tag{7.1}$$

where

$$\begin{aligned} W_j(t,x) &= \infty \quad \text{if } \psi_k(t,x) \neq 0 \quad \text{for some } k \neq j, \\ W_j(t,x) &= 0 \quad \text{else}, \\ V(x) &= \delta_0 \quad \text{for } |x| \leq \epsilon, \\ V(x) &= -\infty \quad \text{for } |x| > 1, \end{aligned}$$

where δ_0 is the delta-function at $x = 0$, and $\psi_j' = \frac{d\psi_j}{dx}$. This corresponds to an extreme form of repulsion between electrons and attraction from the kernel at the origin. The ground state ψ is defined as a solution to the time-independent minimization problem

$$\min_{\psi_1,...,\psi_N} \sum_j \left(\int_{-1}^{1} \frac{1}{4}|\psi_j'|^2 dx - \frac{1}{2}|\psi_j(0)|^2 \right),$$

where the functions $\psi_j(x)$ have disjoint supports, satisfy the boundary conditions $\psi_j(-1) = \psi_j(1) = 0$, and the normalization condition $\int |\psi_j(x)|^2 dx = 1$.

If $N = 1$, then the wave function $\psi = \psi_1$ is symmetric around $x = 0$ and has the form $\alpha \sin(\beta x)$ for $x > 0$ for certain constants α and β, with a “kink” (discontinuity of ψ') at $x = 0$.

If $N = 2$, then both wave functions ψ_1 and ψ_2 are of the form $\alpha \sin(\beta x)$ with the support of ψ_1 equal to $[-1, 0]$ and the support of ψ_2 equal to $[0, 1]$. The corresponding product wave function $\psi(x_1, x_2) = \psi_1(x_1)\psi_2(x_2)$ is neither symmetric nor anti-symmetric, and thus violate the PEP.

If $N > 3$, then ψ_1 is symmetric around $x = 0$ and ψ_2 and ψ_3) are restricted to $x > 0$ and $x < 0$, respectively. Again PEP is violated.

7.1 Comparison with EG2

MMQM and EG2 are methods for computating approximate solutions to the the Schrödinger equation and the Euler equations, which do not seem to admit exact solutions. MMQM and EG2 approximate solutiopns thus do exist and can provide useful information, while exact solutions probably do not exist and in any case are uncomptable and thus cannot provide useful information.

7.2 Connection to Leibniz Monads

We cannot refrain from making a connection to Leibniz *Monad Theory*, which may be viewed as an early version of a MMQM. A Leibniz monad is like an elementary particle such as an electron. According to Leibniz, each monad has its own (blurred) perception of the other monads and is acting accordingly. Only God can collect the totality of all perceptions, and he keeps it for himself, letting each monad do its best on its own, in a form of MMQM.

Part II

Many-Minds Relativity

Chapter 8

Special Theory of Relativity

> Space is the order of coexistence, and time is the order of succession of phenomena. (Leibniz)
>
> Why is it that nobody understands me, and everybody likes me? (Einstein in New York Times, March 12, 1944)

8.1 Information Flow in Gravitational Systems

As another basic example of the aspect of information flow in physics, we now present a new approach to relativity theory, where we resolve the apparent contradiction of the independence of the speed of light to both the speed of the source and the receiver, in a different way than Einstein did in his theory of special relativity in 1905. The new approach of *Many-Minds Relativity (MMR)* can be viewed as an analog of the MMQM approach to quantum mechanics sketched above.

The theories of *relativity* and *quantum mechanics* are viewed as the founding pillars of modern physics, although they have shown to be difficult to combine into a unified field theory. The theory of *special relativity* was proposed by Einstein in the manuscript *On the electro-dynamics of moving bodies* [40] submitted to Annalen der Physik in June 1905, a publication which was first completely ignored by the scientific community but was then brought to the center of discussion by Planck with the motivation: *"For me its appeal lay in the fact that I could strive toward deducing absolute, invariant features following from its theorems"*. Einstein himself quickly turned away from special relativity to the challenge of *general relativity*, which after a long struggle he presented in November 1915.

The essence of special relativity is to connect observations in different *inertial coordinate systems* moving with constant speed with respect to each other, by the *Lorentz coordinate transformation*. Einstein claimed in [40] that a clock moving with respect to an observer would appear to run slow as compared to an identical clock fixed to the observer in a new form of physics of *time dilation*. Special relativity contains the *twin paradox* with two twins moving with respect to each other, and each twin considering the other twin to age more slowly (probably with some envy). Since it is physically and logically impossible for each of two twins to be younger than the other, a contradiction can only be avoided by viewing the time dilation of special relativity as an illusion and not a real effect. In the same way as two people of the same length looking at each other at distance, both may have the illusion that the other is smaller. In 1916 Einstein [83, 11] admitted that the twin paradox was "unresolvable within special relativity".

Despite the seemingly inevitable conclusion from the twin paradox that special relativity is either contradictory and thus non-scientific, or just an illusion, it has remained into our days as the physics theory par excellence, and an ideal source for science fiction.

Special relativity has been criticized seriously by many physicists over the years and the twin paradox is just one of several unresolved contradictions of the theory [83, 87] including the ladder and the barn paradox, Ehrenfest's space rocket paradox and the spinning disc paradox. In the 1950s the twin paradox was again brought to the forefront by the physicist Herbert Dingle [2, 3] resulting in heated debates in the scientific journal *Nature*, without any reconciliation. Mueller [10] has compiled a list of 3700 critical publications in a furious crusade against special relativity available from www.ekkehard-friebe.de. The physics community generally has met the criticism with silence and instead claims that special relativity serves as a theoretical basis of everything from the atomic physics of nuclear weapons over the GPS-system to the large scale structure of the Universe, and thus cannot be questioned by the physics community and certainly not by non-physicists.

Special relativity presents a completely new view on the fundamental concepts of space and time using only elementary mathematics, which is truely amazing but for an applied mathematician seems too good to be true. We present here an alternative approach which may too true to be good. In any case, our ambition is modest and is just to follow up on the many-minds idea in relativity, and possibly stimulate some discussion. The mathematics of special relativity is so elementary that almost anybody could form an opinion.

8.2 Special Relativity as a One-Mind Theory

We know that the *geo-centric* view of the World with the Earth in the center was replaced by Galileo by a *helio-centric* view with the Sun in the center, while astronomers of today see no center at all in an expanding Universe of hundreds of millions of galaxies moving away from each other with ever increasing velocity, which can be described as a *many-centers* or *no-center* view.

Thus, physics has given up geo-centricity for a many-centers or no-center view, but has kept a principle of *objectivity* in the form of objective observations by objective observers of an objective reality. Each observer uses one or several coordinate systems, and so the observations in different coordinate systems by one observer or by several observers, may come out differently, but must conform to a unique existing objective reality. Specifically, a basic principle is that of a *one-mind* view of an *ideal physicist* capable of making conforming observations in different coordinate systems of a unique objective reality.

This is of course a desirable feature of a scientific theory, and may be maintained in many cases, but special relativity came out as an attempt to combine this principle with the observations that (i) the speed of light is independent of the speed of the source and observer, and (ii) it is impossible to detect any motion through any medium (referred to as an *aether*) through which light would propagate with constant velocity. Einstein thus developed special relativity in order to combine a one-mind view with (i) and (ii).

Einsteins resolution boils down to the Lorentz transformation, used before Einstein by Lorentz and Poincaré, claimed to connect space-time observations by one observer or one-mind in different inertial systems with effects of *length contraction* and time dilation in coordinate systems moving with respect to the observer. The accepted "truth" today within the physics community is that these effects are real and not just illusions from coordinate transformation (in opposition to Max Born [87]), while Einstein's standpoint 1911 was ambigous: *"The question whether the Lorentz contraction does or does not exist is confusing. It does not really exist in so far as it does not* *exist for an observer who moves (with the rod); it really exists, however, in the sense that it can as a matter of priniciple be demonstrated by a resting observer"*. Obviously, Einstein here states that the space and time contraction of special relativity is a matter of principle forced upon us by pure logic and thus is not a matter of falsifiable physics.

In [**?**] we present a more detailed critical analysis of special relativity and Einstein's interpretation of the Lorentz transformation.

Chapter 9

Many-Minds Relativity

In Many-Minds Relativity I propose a different approach to reconcile (i) and (ii), which we refer to as a *many-minds* view, or alternatively as a *no-mind* view, where the coordinate system used by an observer always is fixed to the observer and the question of comparison to observations in a moving different coordinate system does not appear, or there is no observer at all. The result is that different observers fixed to different coordinate systems moving with respect to each other, may get partly different perceptions of space by using different length scales, but not of time which they share. In particular, twins in different inertial systems will age equally fast, and the twin paradox disappears. We claim that a many-minds view is more realistic than a one-mind view in the sense that there is no reason to believe that observations by humans in a coordinate system fixed to the Earth, or our Solar system or our galaxy, will be in full conformity with observations by humans in a coordinate system fixed to a planet or planetary system in a far away galaxy, the latter anyway being impossible to perform. Further, the no-mind view describes an existing reality without any human observers, reflecting that presumably Earth would orbit around the Sun even without human observations, in which case it still remains to explain what makes the Earth orbit as it does.

The many-minds view for relativity proposed here connects to the many-minds view of quantum mechanics advocated in [8], where each electron is left to solve it's own version of the Schrödinger equation (as in the Kohn-Sham density method), which opens the possibility of a unified many-minds field theory including both gravitation and quantum mechanics.

We start with an observer fixed to the origin O of a coordinate axis with coordinates denoted by x. We thus think of a, for simplicity one-dimensional, universe consisting of (pointlike) objects which may move along the x-axis. We assume that each point of the x-axis is equipped with a standard cesium clock showing the same time in the same time unit of seconds s with one second equal to 9192631770 clock cycles. We follow the 1983 SI standard of Conference Generale des Poids et Measure to define the length scale along the x-axis to be meters m, with one meter being the distance traveled by light in 0.000000003335640952 seconds or 9192631770/299792458 cycles of a cesium clock. More precisely, we mark along the x-axis points with $x = \pm 1$, $x = \pm 2$,..., as points from which a light signal takes $t = 1\,s$, $t = 2\,s$,..., to reach the origin from either direction. Instead of meters as length scale we may use *light-seconds* with one light-second being the distance in meters traveled by light in one second, that is $2.999792458 \cdot 10^8\,m$, that is the speed of light $c = 2.999792458 \cdot 10^8\,m/s \approx 3 \cdot 10^8\,m/s$. Of course, this makes the constancy of the speed of light equal to $c = 1$ ligth-seconds/s a matter of definition, and not experimental observation of any existing physical reality. In particular, the speed of light will be the same (equal to c) in both directions of the x-axis, which is consistent with a null result in a Michelson-Morley experiment to detect motion with respect to an aether.

An observer fixed to O will thus *receive* light signals (from both directions) which *by definition* travel with the constant speed c. This conforms of course with a model of light as wave propagation in an aether medium fixed to the x-axis, that is at rest with respect to the observer, but we do not assume that light has this nature.

Let now an object like a rocket R move towards the origin O along the x-axis with a certain velocity $v\,m/s$, and let an observer at the origin receive light continuously sent out from R of say frequency 1. We *assume* that the light signal also carries the information of the time at which the signal was sent from the rocket (like in the GPS-system). We also *assume* that the received frequency f at the origin O is given by

$$f = \frac{c}{c-v} = \frac{1}{1-\frac{v}{c}}, \tag{9.1}$$

which corresponds to the standard *Doppler shift* conforming with a model of light propagating with constant speed c along the x-axis in an aether at rest (but again we don't make this assumption). It amounts to a *blue-shift* for a rocket approaching the origin (with $v > 0$) and a *red-shift* for a rocket moving away from the origin with ($v < 0$). It is possible to postulate a different Doppler shift dependence on velocity, if experiments so motivate.

The observer fixed at the origin O now observes the frequency f as well as the time of arrival of the signal, from which the velocity v of R can be computed as well as the duration t of the travel of the signal and thus the distance d to R in light-seconds (at the time when the light signal was sent from R). The observer at the origin thus computes the velocity v of R and distance d to R, from measuring the frequency f and time duration t of the received light signals. This computation is of course consistent in the sense that the time to encounter of R with O is equal to $\frac{d}{v} = \frac{c}{v}t$.

Let us now change view and fix the observer and the x-axis to the rocket R and let the observer receive light signals sent out from the original origin O now moving with respect to the new x-axis, assuming that the light signals travel with constant velocity c along the new x-axis. We then have a fully analogous situation to the previous one, and we thus may *assume* that the observations of frequency and time lag and computed velocity v and distance d, will be the same. That the time lag will be the same for any two observers communicating by light signals, that is that they will agree on their mutual distance in light-seconds, will have to be tested experimentally, and for the discussion we *assume* that tests are confirmative.

We conclude that two observers fixed to two coordinate systems moving with constant velocity with respect to each other, will agree on their relative velocity and mutual distance (and time of encounter), both assuming that they receive light signals traveling with the same constant speed in their own coordinate system. We note that in this case there is no conventional model of wave propagation through a medium which conforms with both observers point of view, since both conform to models of wave propagation in a medium at rest, and the two observers move with respect to each other. We thus have an example of a many-minds view, without a (known) common objective reality; each observer would have the impression to "drag the aether along" and so there would be "no common aether".

We may generalize to a *many-minds model* in the form collection of N observers with observer $j = 1, ..., N$, fixed to the origin of an x_j-axis moving with constant speed with respect to the other observers and their coordinate axes. We assume as above that the different observers observe the frequency and time duration of received signals sent out from all the others, assuming the same speed of light in all coordinate systems, and then compute velocities and distances. We then note that each pair of observers will agree on their common relative velocity and mutual distance (and time of encounter).

9.1 Composite Doppler Shifts

We first consider the issue of composite Doppler shifts corresponding to two rockets $R1$ and $R2$ approaching an observer at the origin O with $v_1 > 0$ the velocity of $R1$ vs O and $v_2 > 0$ the velocity of $R2$ vs $R1$. Let d_1 the distance from $R1$ to O (as viewed by observers fixed to O and $R1$) at initial time, and d_2 the distance from $R2$ to $R1$ (as viewed by observers at $R1$ and $R2$) at initial time. For simplicity of discussion, assume that $d_1 = v_1$ and $d_2 = v_2$, so that after time $\bar{t} = 1$ both rockets encounter at O.

It is now natural to *assume* that light signals from $R2$ passing $R1$ (possibly with some amplification but not any change of frequency), will be received at O with the composite frequency

$$f = \frac{1}{1-\frac{v_1}{c}}\frac{1}{1-\frac{v_2}{c}}. \tag{9.2}$$

The observer at O would then compute the velocity of $R2$ relative to O according to (9.1) to be

$$\bar{v} = v_1 + v_2 - \frac{v_1 v_2}{c}, \tag{9.3}$$

and could thus from the time $\bar{t} = 1$ of encounter compute the distance from O to $R2$ to be

$$\bar{d} = v_1 + v_2 - \frac{v_1 v_2}{c}.$$

Alternatively, the observer at O would measure the time duration of a light signal from $R2$ to be

$$\hat{t} = \frac{d_2}{c} + \frac{d_1 - \frac{d_2}{c}v_1}{c}$$

and thus would find the distance from O to R2 to be

$$\bar{d} = d_2 + d_1 - \frac{d_2 v_1}{c},$$

as desired from consistency point of view.

However, an observer at $R1$ would estimate the distance between O and R2 to be $d_1 + d_2 > \bar{d}$ and the velocity of $R2$ relative to O to be $v_1 + v_2 > \bar{v}$, and thus observers at O and $R1$ would have different opinions on the velocity and distance of O vs $R2$.

We note that the composite velocity $\bar{v}$ according to (9.3) satisfies $0 < \bar{v} < c$ if $0 < v_1, v_2 < c$. We further note that the composite Doppler shift (9.2) is symmetric in the velocities v_1 and v_2.

The formula (9.3) also holds for $v_1 < 0$ and $v_2 < 0$ with R1 and R2 receding form the observer at O, in which case $-\bar{v} > -(v_1 + v_2)$ allowing $-\bar{v} > c$. A rocket thus can recede from O with a speed larger than c, but approach only with a speed less than c.

9.2 Length Scale Contraction/Expansion

Suppose two observers $O1$ and $O2$ meet at $t = 0$ and receive a light signal from a rocket R marked by the time $t = -d$ seconds giving both $O1$ and $O2$ the impression that R is d light-seconds away. Suppose further that R approaches $O1$ with speed $-v_1 < 0$ and $O2$ moves with respect to $O1$ with speed $v_2 > 0$. $O1$ will then perceive $O2$ and R to approach each other with speed $v_1 + v_2$, while $O2$ (or an observer at R) in the meter scale m_1 of $O1$ will perceive R to approach $O2$ with the composite speed $\bar{v} = v_1 + v_2 - v_1 v_2$ according to (9.3), assuming here that $c = 1$. The time to encounter of $O2$ and R as perceived by $O1$ is equal to $\frac{d}{v_1+v_2}$ and thus $O2$ must perceive the distance $\bar{d}$ to R in the meter scale m_1 of O1 to be

$$\bar{d} = \frac{d}{v_1 + v_2}\bar{v} = (1 - \frac{v_1 v_2}{v_1 + v_2})d,$$

a distance which in the meter scale m_2 of $O2$ must be equal to d light-seconds. It follows that $O2$ must use a light-second meter scale m_2 related to the light-second meter scale m_1 of $O1$ by

$$m_2 = (1 - \frac{v_1 v_2}{v_1 + v_2})m_1 < m_1,$$

with a scale contraction depending on both $v_1 > 0$ and $v_2 > 0$, and $m_2 = m_1$ if either v_1 or v_2 vanishes. We may naturally generalize to any sign of velocity.

We conclude that two observers moving with respect to each other will use different meter scales defined in light-seconds, which can be viewed as an effect of *length-scale contraction/expansion* between different observers. We emphasize that the contraction/expansion concerns the length scale in space and is not an actual physical contraction/expansion of space.

9.3 A Michelson-Morley Experiment

The many-minds model is consistent with the observed null results in a Michelson-Morley experiments, where the times it takes for a light signal to go in both directions between two points with fixed distance d moving along the x-axis with a certain speed v, are compared. If there was an aether fixed to the x-axis through which light did propagate with velocity c, then the times would read $\frac{d}{c-v}$ and $\frac{d}{c+v}$ and thus would give a non-zero result. Thus the many-minds model is consistent with the observed non-existence of an aether.

9.4 Relativistic Form of Newton's 2nd Law

The standard (non-relativistic) form of Newton's 2nd law for a rocket R moving with velocity $v(t)$ in a (x,t)-coordinate system with origin O, is

$$m\dot{v} = F, \tag{9.4}$$

where $\dot{v} = \frac{dv}{dt}$ is the acceleration, m is the *mass* of R, and F is the *force* acting on R like gravitation.

We can alternatively formulate Newton's 2nd law as follows: Let R move towards an observer at O with positive velocity through negative values of x. Let $\bar{t}$ be a given time instant, let $v_1 = v(\bar{t}) > 0$ and let (x_1, t) be a coordinate system with the x_1-axis moving with the velocity v_1 with respect to the x-axis. Let $v_2(t)$ be the velocity of R with respect to the x_1-axis for $t > \bar{t}$. Newton's 2nd law in the (x_1, t) system takes the form

$$m\dot{v}_2 = F.$$

Further, the composite velocity $\bar{v}$ of R with respect to the x-axis given by (9.3) satisfies, since $\dot{v}_1 = 0$,

$$\frac{d\bar{v}}{dt} = \dot{v}_1 + \dot{v}_2 - \frac{\dot{v}_1 v_2}{c} - \frac{v_1 \dot{v}_2}{c} = (1 - \frac{v_1}{c})\dot{v}_2 = \frac{1 - \frac{v_1}{c}}{m} F,$$

and we are thus led to the following form of Newton's 2nd law in the (x,t)-system

$$\frac{m}{1 - \frac{v}{c}}\dot{v} = F, \tag{9.5}$$

where we replaced v_1 by the momentary velocity $v(t)$. We see that in this form of the 2nd law the mass m is modified by the factor $1/(1-\frac{v}{c})$, which we may compare with the factor $1/\sqrt{1-\frac{v^2}{c^2}}$ of Einstein's special relativity.

Similarly, if R is moving with positive velocity v away from O through positive values of x, then Newton's 2nd law for an observer at O may take the form

$$\frac{m}{1+\frac{v}{c}}\dot{v} = F, \tag{9.6}$$

with in this case an apparent reduction of the mass.

Choosing $F/m = 1$ and $c = 1$, we obtain for an object approaching an observer at the origin following (9.5), receeding from the origin according to (9.6), or satisfying the standard 2nd law (9.4):

$$v(t) = 1 - \exp(-t), \quad v(t) = \exp(t) - 1, \quad v(t) = t, \tag{9.7}$$

all similar for small t, but not else.

Which form of the 2nd law is now the more correct one, the standard (9.4) or the relativistic ones (9.5) or (9.6)? Accelerator experiments seem to favor (9.5), since acceleration seems to be more demanding as the velocity increases, as if the mass was increasing with velocity. We note that the standard (9.4) and (9.6) allow any speed to be reached with sufficient acceleration, while with (9.5) only speeds $v < c$ are possible to attain. Thus in approach only velocities less than the speed of light are possible to attain, while in recession according to (9.6) any speed appears to be possible.

9.5 A Composite Model for Light Propagation

The composite Doppler shift suggests the following model of propagation of light from a source R approaching the origin with velocity $v > c = 1$: We introduce $n-1$ (fictious) intermediate objects with velocities vm/n with $m = 1, ..., n$, transmitting light from R with the relative velocity $c = 1$, where we choose n so that $v/n < 1$. This leads to the composite Doppler frequency

$$f = \frac{1}{(1-v/n)^n}.$$

Letting n tend to infinity, we have

$$log(f) = -\lim_{n\to\infty} n\log(1-v/n) = v,$$

and thus the corresponding composite velocity $\bar{v}$ would be given by

$$\bar{v} = 1 - \exp(-v) < 1,$$

valid for all $v >> 1$, with corresponding length scale factor $\frac{1-\exp(-v)}{v}$. A velocity $v > c$ also in approach thus would seem to be possible, but not attainable from acceleration according to the 2nd law.

9.6 A No-Mind Gravitational Model

We consider a set (galaxy) of N pointlike objects (stars) S_i of mass m_i with $i = 1, ..., N$, interacting by gravitational forces in three-dimensional Euclidean space $\mathbb{R}^3$. We adopt the no-mind view letting the galaxy evolve without the concern of any human observations, assuming that star S_j (somehow) is capable of inducing a gravitational force F_{ij} on star S_i with $i \neq j$. We assume each S_i changes velocity (and then position) according to Newton's 2nd law formulated in a coordinate system with origin at the position of S_i at time t, that is,

$$m_i\dot{v}_i(t) = \sum_{j\neq i} F_{ij}(t), \quad i = 1, ..., N,$$

where according to Newton's law of gravitation

$$F_{ij}(t) = Gm_im_j\frac{x_i(t) - x_j(t)}{|x_i(t) - x_j(t)|^3}$$

with $x_i(t) \in \mathbb{R}^3$ the position of S_i at time t in the fixed universal coordinate system represented by $\mathbb{R}^3$, and G is the gravitational constant. We note that the consistency $F_{ij} = -F_{ji}$ is satisfied if S_i and S_j both use a length scale of light-seconds.

9.7 A Simple Cosmological Model

We now present a simple cosmological model motivated by the observation that all galaxies we can observe appear to move away from us with a speed (redshift) proportional to the distance from our own galaxy.

We start at time $t = 0$ with a collection of $2N + 1$ unit masses (galaxies) positioned at i/N with velocity $v_i = i/N$, $i = 0, \pm 1, ..., \pm N$. This initial state may be attained from acceleration from zero velocity over the time span $[-1, 0]$ due to the gradient $-x$ of a pressure $p(x) = 1 - x^2/2$ satisfying $-\frac{d^2p}{dx^2} = f \equiv 1$ for $-1 < x < 1$ together with the boundary condition $p(-1) = p(1) = 0$. Here $f = 1$ represents the intensity of a heat source acting over the time interval $[-1, 0]$, p couples to f through a heat equation, and by the state equation of an ideal gas, p is proportional to temperature. We thus may obtain the initial condition from the Euler equations for an ideal gas with a heat source from a Big Bang nuclear reaction.

Assuming now that the pressure force dissapears for $t > 0$ and that no other forces such as gravitation are of importance, the unit masses will then move away from the origin with constant velocity $v_i = i/N$ to reach the positions $x_i(t) = tv_i$ for $t > 0$. Thus, the galaxies will move away from the origin with a velocity proportional to the distance from the origin, as observed.

9.8 Basic Assumption and Summary

We assume that each observer (I) is fixed to the origin of a (one-dimensional) coordinate system and uses a common universal time as measured by a cesium clock and defines the space length scale in light-seconds, (II) computes the distance to an object by the time it takes for a signal from the object to reach the observer, (III) computes the velocity of an object from the received frequency using (9.1), and (IV) uses the rule (9.3) to compute composite velocities. We assume that every pair of different observers agrees on their mutual distance, relative velocity and composite Doppler shifts (and of time), but not necessarily on other distances or relative velocities. The model may naturally be extended with Newton's 2nd Law in the form (9.5) or (9.6) o formally including relativistic corrections of mass.

The new model based on (I)-(IV) appears to be free of internal contradictions and paradoxes, and thus from scientific point of view should be better than Einstein's model with time dilation considered as real and not just an illusionary effect, which leads to paradoxes and contradictions. It appears that the new model can be extended to a unified field model combining quantum mechanics and gravitation, which could add to its potential interest.

Part III

Many-Minds Unified Model

Chapter 10

Schrödinger-Maxwell Equations

Quantum mechanics and electromagnetics can naturally be combined because charged particles in relative motion generate electrical currents which generate electric and magnetic fields.

Chapter 11

Relativistic Quantum Mechanics

Combining quantum mechanics with Einstein's special relativity is considered to be difficult, if not impossible, because Schrödinger's equation is Galilean but not Lorentz invariant, and special relativity is based on the Lorentz transformation. However, a combination with many-minds relativity seems perfectly natural since many-minds relativity is largely based on Galilean invariance.

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[77] ... those who have talked of 'chance' are the inheritors of antique superstition and ignorance...whose minds have never been illuminated by a ray of scientific thought. (T. H. Huxley)

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