73rd Annual Meeting of the APS

Division of Fluid Dynamics

Sunday–Tuesday, November 22–24, 2020; Virtual, CT (Chicago time)

Session   **W13.00001 :**

Session W13.00001: General Fluid Dynamics: Viscous Flows
10:00 AM, Tuesday, November 24, 2020

Claude MASSOT, Ingénieur Ecole Centrale de Paris, M.Sc., PhD
Emeritus Independent Theoretical Engineering Physicist
cmassot@iphid137.org   33 7 61 98 16 25
INITIATIVE PHYSIQUE HEURISTIQUE INDUCTIVE et DETERMINISTE

A New , Complex, Dual, Wave/Particle Theoretical Theory of Viscous Flow Turbulence
TOWARD A NEW, ABSOLUTE FLUID PHYSICS
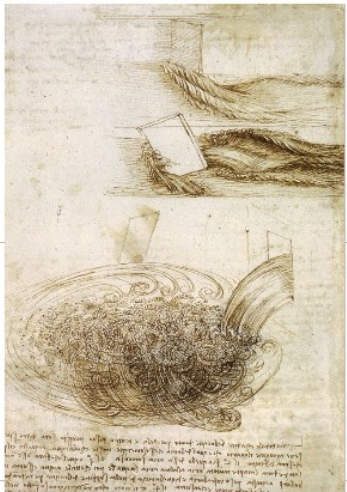**(NON-RELATIVIST & POST-QUANTUM)**
UNIFIED
with DUAL/QUATERNION COMPLEX ALGEBRA
for MATERIAL & i-MATERIAL FLUID DYNAMICS
(with $i^2=-1$)

Let us Celebrate the Founders on Fluid Dynamics
starting with the eddies of Descartes and Leonardo da Vinci.

Navier

Stokes

Reynolds

But,   Today …...

Transport equations need to adjust to the new Physics

The 20th century findings related to the relativistic and quantum approaches have to be applied to flow motion. Some only affect, rather high velocities, but they are very important for the future, in particular for plasma.

Tentative Bird's eye View of 20th Century Theoretical Physics :

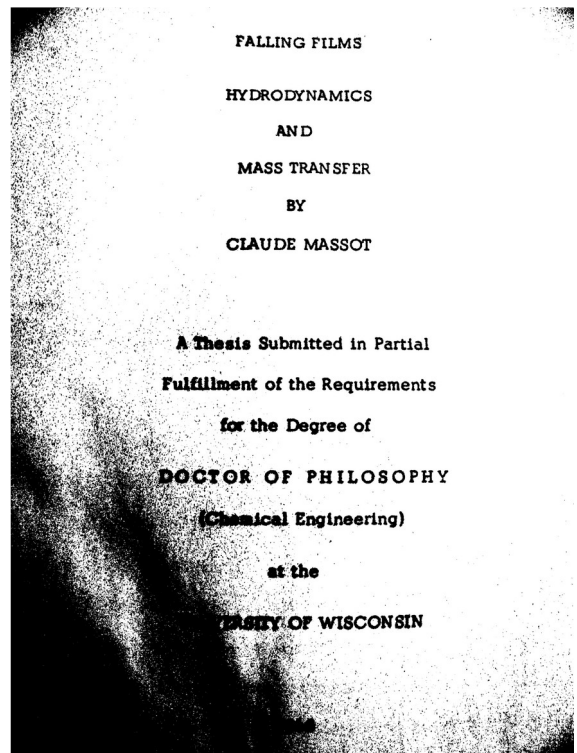

and especially of Schrodinger and de Broglie for the quantum theory
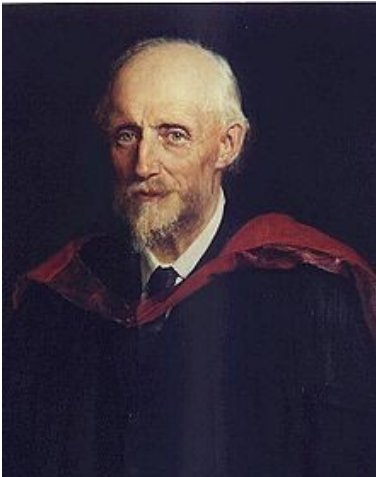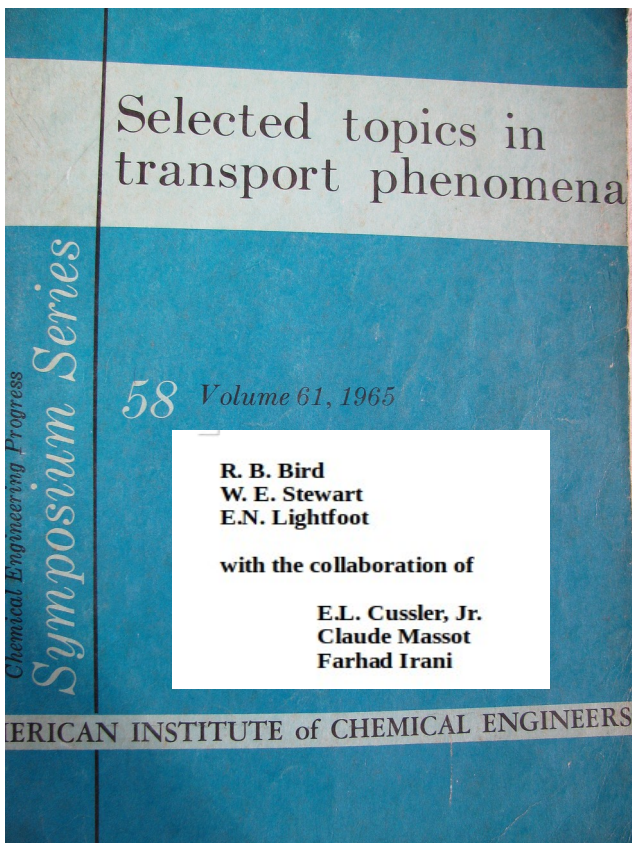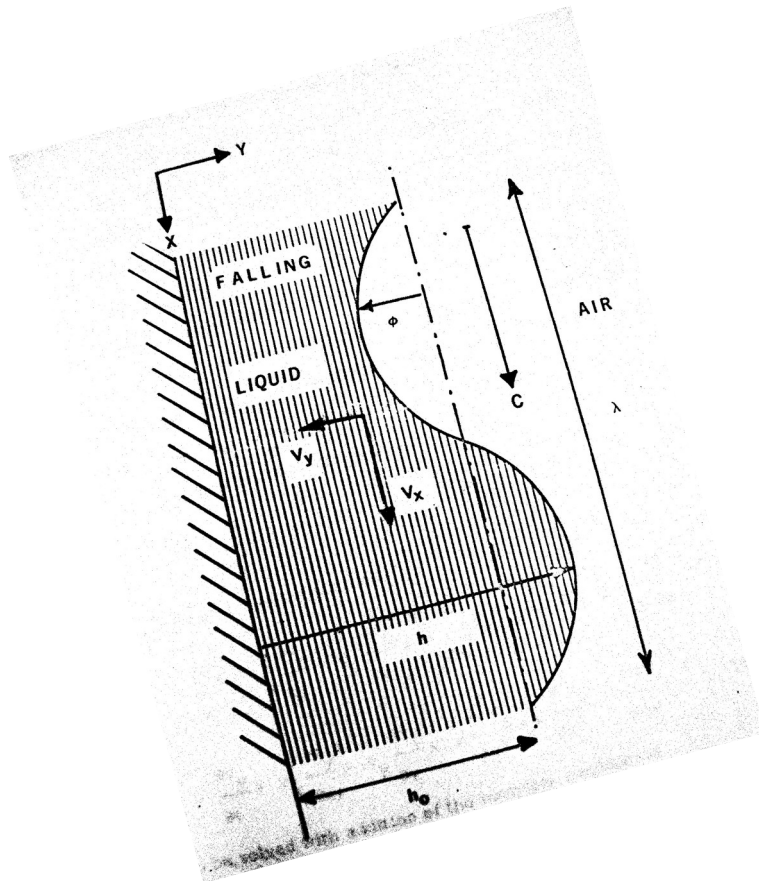
**My in-lovement with Fluid Dynamics stem from my doctorate
at the University of Wisconsin in Madison,
with Transport Phenomena
Robert Byron Bird, Warren Stewart and Edwin Lightfoot
(Bob is in great shape nowadays at 86) ,**

Chemical Engineering Progress

Symposium Series

Selected topics in transport phenomena

58 Volume 61, 1965

R. B. Bird
W. E. Stewart
E.N. Lightfoot

with the collaboration of

E.L. Cussler, Jr.
Claude Massot
Farhad Irani

AMERICAN INSTITUTE of CHEMICAL ENGINEERS

FALLING FILMS

HYDRODYNAMICS
AND
MASS TRANSFER

BY

CLAUDE MASSOT

A Thesis Submitted in Partial
Fulfillment of the Requirements
for the Degree of
DOCTOR OF PHILOSOPHY
(Chemical Engineering)
at the
UNIVERSITY OF WISCONSIN

Schlieren picture of a falling liquid film

TREATMENT OF NAVIER-STOKES EQUATION
as a Quantum Tunneling effect

My own contribution during my Ph.D. Thesis was adapting the solution of Schrodinger's equation to Navier's Stokes for an compressible fluid

Solution of Navier-Stokes equation, Independent of Time

<u>for a falling film</u>:

Gravitational Energy can be considered as potential energy

$$\rho \partial V / \partial t = \mu \partial^2 V / \partial x^2 + \rho g$$

$$V = \rho g D (1 - (x/D)^2 / 2\mu) \quad U = \rho g = 2\mu V / (1 - (x/D)^2)$$

$$0 = \mu d^2 V / dx^2 - (\rho E / \mu - U) V \qquad E = 1/2 \rho V^2$$

$$\Re^2 = (\rho^2 V^2 D^2 / \mu^2) = 4$$

The critical value is given at x=0 by the Reynolds number equals to 2
Experimentally the critical Reynolds Number for a falling film is about 10

<u>For a flow in a tube :</u>

$$\rho \partial V / dt = \mu \partial^2 V / dx^2 - dP / dz$$

$$V = (dP/dz) R^2 (1 - (r/R)^2) / 4\mu$$
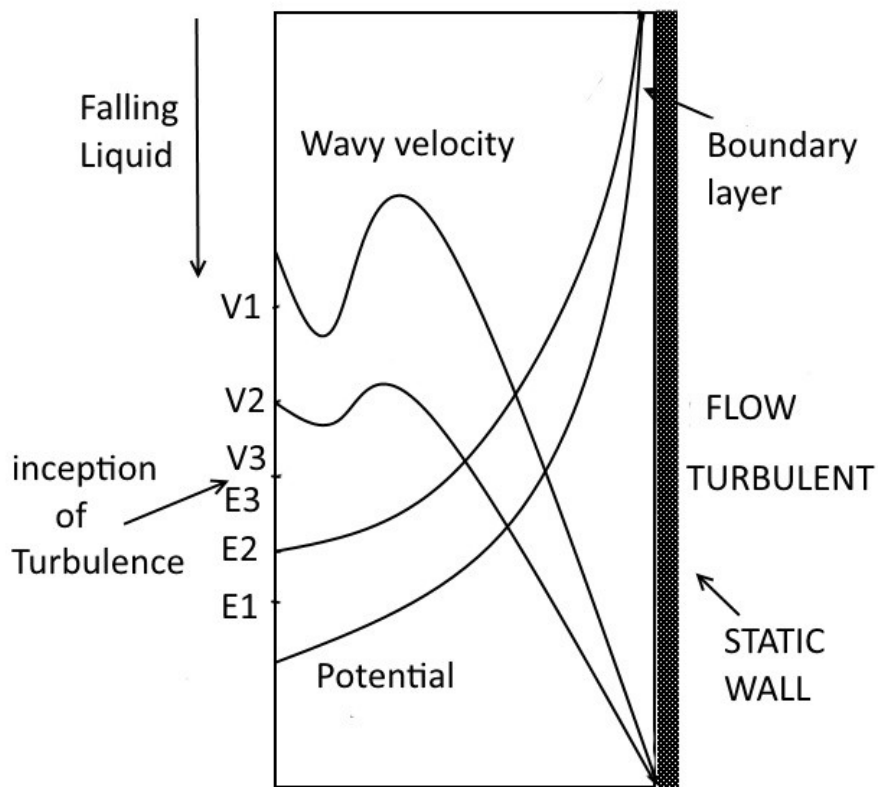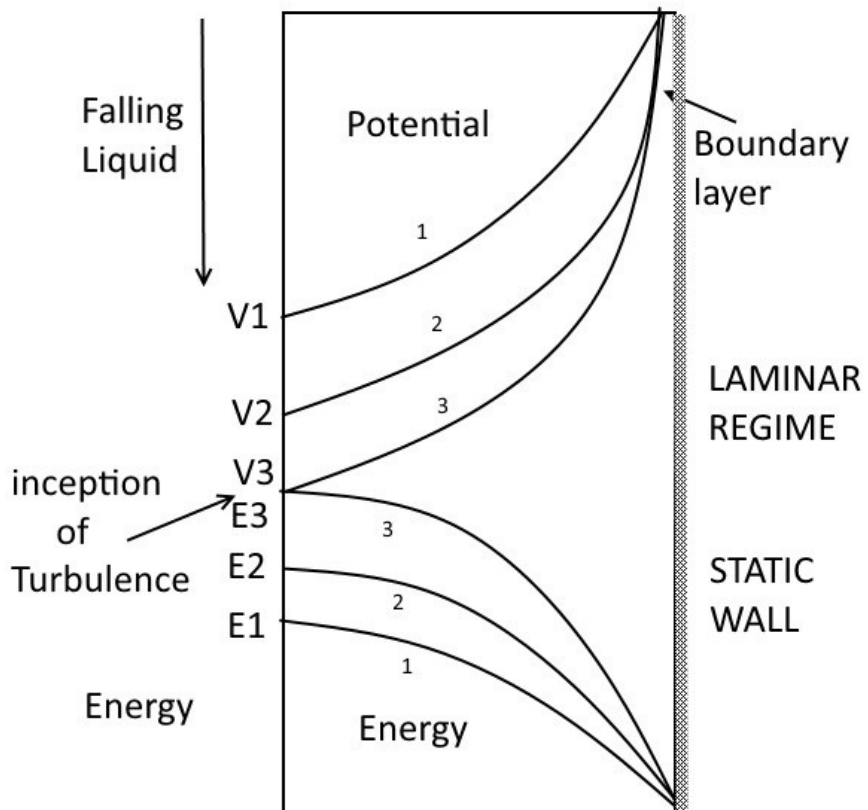$$U = dP / dz = 4\mu V / (1 - (x/D)^2)$$

$$E = 1/2 \rho V^2 \qquad 0 = \mu d^2 V / dx^2 - (\rho E / \mu - U) V$$

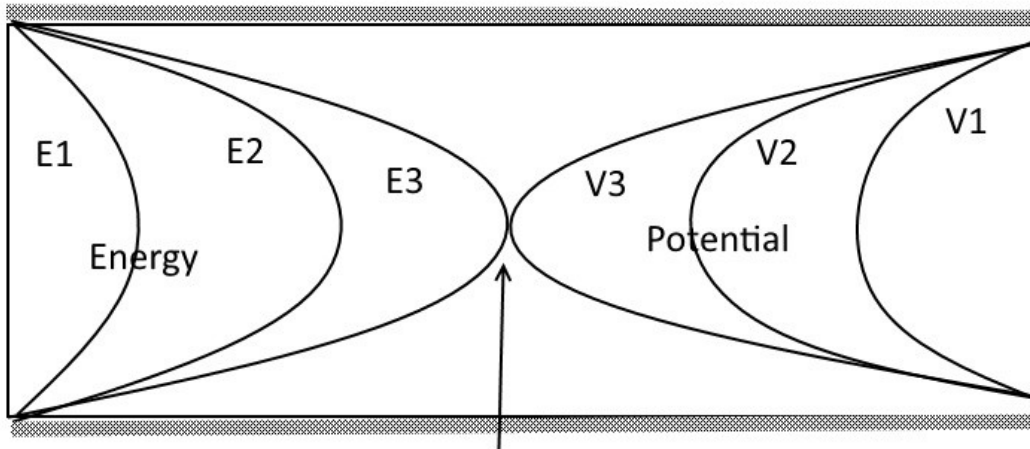$$\Re^2 = (\rho^2 V^2 D^2 / \mu^2) = 8$$

In a tube the critical Reynolds Number is about 2100. The above result points out at a likely meta stability of the flow enclosed in the tube.

CONCLUSION:
<u>Turbulence appears as a tunneling quantum effect .</u>

Falling Liquid

Potential

Boundary layer

1

V1

2

V2

3

V3

inception of Turbulence

E3

E2

E1

LAMINAR REGIME

STATIC WALL

3

2

1

Energy

Energy

Falling Liquid

Wavy velocity

Boundary layer

V1

V2

V3

inception of Turbulence

E3

E2

E1

FLOW

TURBULENT

STATIC WALL

Potential

LAMINAR
FLOW of LIQUID IN A TUBE

E1   E2
        E3   V3   V2   V1
    Energy   Potential

INCEPTION OF TURBULENCE

LAMINAR LIQUID FLOW IN A TUBE

LAMINAR
FLOW of LIQUID IN A TUBE

BOUNDARY LAYER

ENERGY

POTENTIAL
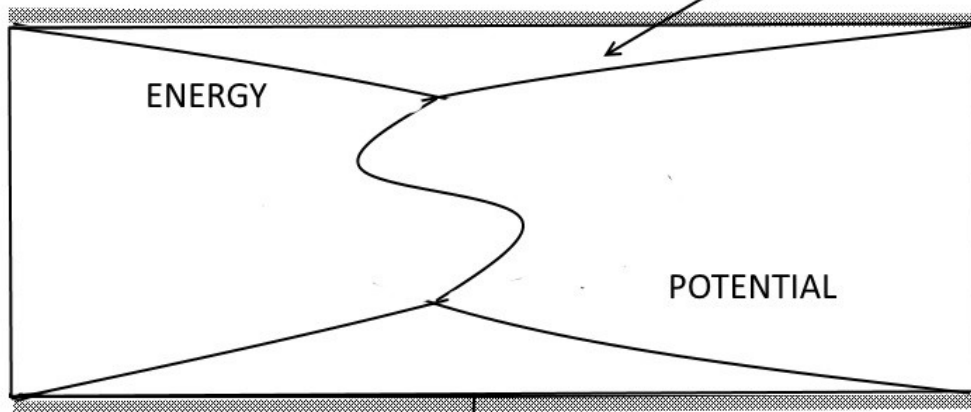
TURBULENT   LIQUID FLOW IN A TUBE

BUT MATTER IS NOT ONLY WAVY, IT IS DUAL

WHAT are THE laws of MOTION of DUAL/WAVY FLUID MATTER?

Past basic common transport equations did not take into account the quantum and wave nature of moving matter and its broglian wave/particle duality, not its relativistic dependence.

This might be of course due to the fact that the transport equations have been established long before Planck, de Broglie and Einstein.

Turbulence statistical theories are not able either to take into account these discoveries, being extremely complex and mostly empirical.

For flowing plasma theories, given the very high temperatures and the huge electrical forces involved, only numerical calculations seem possible.

On the other hand, de Broglie's contribution opened the gates of Quantum Mechanics, with a very simple relation

There I apply my new non relativistic dual theory to fluid Dynamics.

$$\lambda = h/mv$$

Schrodinger's equation was then used with solutions for particular cases, for the quantum mechanics of atoms, or free particles.

Paradoxically, next to the huge theoretical investment in spectroscopy, very little studies did extend de Broglie's idea, to neutral atoms and group of atoms, submitted only to gravitational forces, besides Couderc.

Motion in the theory of Relativity is considered a a purely relativistic translation between two inertial reference frames.

But observations show that electrical and neutral particles do not simply translate. They spin and wobble .

Besides, Relativity and Quantum Mechanics are incompatible.

So I propose :

a new non Relativistic Physics, compatible with observations

BASIS OF a Non Relativistic Physics
(compatible with most well confirmed results)

Born from my discovery of an **experimental observed analogy**, between diphasic Mechanics and deBroglie's wave/particle duality my **Hypothesis of the Complex Nature of Matter** was presented at the Académie des Sciences by André Lichnerowicz in 1994.

To build my new Dual Mechanics for deBroglie's wave/particle
I discard relativistic hypothesis and call on Complex Algebra

I postulate that a dual wave/particle moving at absolute measurable velocity v with respect to the laboratory) has a dual complex mass m* , such that

$$m^* = m° + i\,m' \quad \text{(with } i^2 = -1\text{)}$$

$m°$ being the real inertial static mass of the particle at rest
m' being the imaginary mass of the wave, mass moving always at the **constant, maximum, speed of light, c.**

I postulate that the real momentum **p** of the wave/particle is given by the momentum balance:

$$p = mv = m'c$$

thus meaning that the wave mass is pulling the wave/particle
So de Broglie's wave is not just, a pilot wave, but a driving wave
The measurable mass modulus of the wave/particle is then given

by
$$m = \sqrt{(m°^2 + m'^2)}$$

Surprisingly, the same relativistic mass dilation comes out:

$$m = m° / \sqrt{(1 - v^2/c^2)}$$

as well as the same relativistic total energy :

$$E = mc^2 = \sqrt{(m°^2 c^4 + p^2 c^2)}$$

In addition, de Broglie wave-length ad wave energy are

$$\lambda = h/mv = h/m'c = c/f$$

$$E' = m'c^2 = hf$$

My hypothesis yields all the relativistic and quantum formulae _
without the need for any relativistic conditions!!!

Without the need of any relativistic hypothesis

Thus, I unify relativistic results with Planck's quantification et de Broglie's particle/wave duality without any relativistic conditions, without calling Lorentz Formulae, nor inertial reference frames...
The revolutionnarynew conclusion is that:
the basic laws of particle physics stem from the fact that
de Broglie's wave is an i-material mass driving the particle

The motion of a wave/particle is an **absolute dual mechanics**.
A moving mass is a **complex dual wave/particle**
Mass dilation, instead of being a purely relativistic effect, stems actually, from the presence of a driving i-material mass pulling the inertial rest mass of the particle.
The two masses of the dual wave/particle
do not add up arithmetically
but according to complex algebra
with values coinciding with relativistic formulae
All this, shows now, that
Moving matter is different from Stationary matter

Fluid dynamics is a domain where the principle of relativity cannot be applied. It is clear that there is not a symmetry between the mowing fluid and its static enclosure.

The momentum transfers from the moving fluid to the static walls. On the other hand if the walls are moving the fluid, the momentum transfer direction is reversed?
The same remark can be made for energy or mass transfer.

I will show below that the i-material mass needed for motion can actually diffuse across the layers of fluid, and this effect can unify momentum, heat and mass transfer mechanisms.

Second Dual COMPLEX model

In my above model, as in relativity, the mass becomes infinite when the velocity v reaches the speed of light c.

At first sight, it might appear reassuring to retrieve all famous relativistic results. But new studies, led me to a major change

My first momentum balance for a dual wave/particle

$$p= \text{m'c} = mv \quad \text{with} \quad m=\sqrt{(m°^2+m'^2)}$$

did actually imply that the imaginary mass m' is pulling, not only the inertial rest mass m°, but also part of its own moving mass, since **p** the momentum of the dual mass is equal to the momentum of the wavy mass. . In other words in my first model the wave is somewhat pulling itself, which is contradictory, since it seems obvious that the wave mass should move naturally, by itself and should not need any more energy fot its motion.

So I made an important improvement

In my new model, Dual motion is still ensured by an i-material moving mass pulling the inertial mass, I still have

$$\text{m*=m°+im'} \quad (\text{ with } i^2=-1)$$

but I choose a new momentum balance:

$$\textbf{p = m°v = m'c} \quad (\textbf{not } \textbf{p = mv = m'c})$$

(stating that the wavemass is naturally pulling itself)

This apparently slight change has an enormous effect:

now the total moving mass modulus is expressed as :

$$m=\sqrt{(m°^2+m'^2)}=m°\sqrt{(1+v^2/c^2)}$$

Now the wave/particle can reach the speed of light with a finite mass!

At the speed of light the wave/particle mass remain finite:

$$m=m°\sqrt{(2)}$$

If futher imaginary mass is added, the velocity stays constant always equal to c.

Then, I extend my approach to introduce spin and helicity in the mechanics of elementary particles with quaternions.

In order to account for the spin and the helicity of an electron
as a moving wave/particle, I extend my model with the use of
quaternion algebra:
instead of a single de Broglie's wave,
I associate 4 waves to a moving particle
thus opening a quaternal wave/particle physics

An inertial wave with a Compton wavelength
A translation wave with de Broglie wavelength
A spin wave with a   Spin wavelength
A helicity wave with a   Helicity wave length

To these 4 waves I associate 4 quaternal masses
the inertial mass $m°$
the translation mass m_T and translation velocity vT
the spin mass m_S and spin velocity   vS
the helicity mass m_H and helicity velocity   vH
with
        $m* = m° + i\, m_T + j\, m_S + k m_H$ and $i^2 = j^2 = k^2 = -1$

and $m^2 = m°^2 + m_T^2 + m_S^2 + m_H^2$

with

with

$$m = m° \sqrt{\left(1 + vT^2/c^2 + vS^2/c^2 + vH^2/c^2\right)}$$

Now, as a big change with respect to the first model :
when the three velocities equal c, the total mass is doubled

This is of great importance for the model of the nucleus in
which neutrons are not neutral elementary particles, but a
combination of proton and electron.

COMPARISON OF MASS DILATIONS

COMPARISON OF MASS DILATIONS

Relativity : No spin

Dual Theory   spin

Quaternal Spin+Helicity

When v=c more energy increases the mass
at constant velocity c

For the neutron, the quaternal electron is orbiting at v=c

Its mass is slightly higher than 2m°

f(x)=1/sqrt(1-x^2)
f(x)=sqrt(1+x^2)
f(x)=sqrt(1+x^2+x^3+x^4)

Relativity

Quaternal theory →

Dual theory

v/c

m/m°