THE NEW SPEED COMPOSITION u=v+w/G^2 IN AGREEMENT WITH FIZEAU'S EXPERIMENT

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THE NEW SPEED COMPOSITION $u = v + w/\gamma^2$

IN AGREEMENT WITH FIZEAU'S EXPERIMENT

ABSTRACT

Fizeau's experience with moving water served as a support for the development of the theory of Relativity. The new interpretation proposed here is part of Neo-Newtonian Mechanics, that is to say of classical Newtonian mechanics but without the principle of equivalence. The demonstration is based on the variation of kinetic energy and on a transfer function including momentum, as it exists in classical Newtonian mechanics. That makes it possible to demonstrate a law of composition of the velocities in $u = v + w/\gamma^2$. This new speed composition law is exactly in agreement with Fizeau's experimental results.

Thus, by excluding the aether hypothesis, the theory of Relativity is no longer the only possible explanation for Fizeau's experiment, or for that matter, for other experiments at very high speeds. Neo-Newtonian Mechanics is positioned as a possible alternative to the theory of Relativity while being compatible with Quantum Mechanics. This however needs to be validated by more precise experiments, one of which is recalled in this article.

Keywords : Velocity ; speed ; celerity ; addition ; compound ; Relativity ; neo-Newtonian ; Fizeau ; Fresnel ; water in motion ; Lorentz factor ;

1. INTRODUCTION

Except aether, is the theory of Relativity the only possible explanation for Fizeau's experiment with moving water? The concern with the theory of Relativity is that it is not very compatible with Quantum Mechanics. Neo-Newtonian Mechanics, which is none other than classical Newtonian mechanics without the principle of equivalence, is compatible with Quantum Mechanics. This Neo-Newtonian Mechanics notably makes it possible to use a new law of velocities composition. By application of this law, the speed obtained does not really exceed the limit speed of light. Albert Einstein has shown, independently of the theory of Relativity, that light is made up of photons. By applying this velocities composition law to photons, we get a result exactly in accordance with the results of Fizeau's experiment. At the end of the article, we will also examine the small difference with the relativistic prediction.

2. FIZEAU'S EXPERIMENT AND ITS INTERPRETATION

2.1) Fizeau experiment with water in motion

In 1851, Hyppolyte Fizeau studied the speed of light in moving water 1. In Fizeau's experiment, two beams from the same light source propagate in moving water (one in the direction of the water flow, the other in the opposite direction to the water flow). By recombining these two beams by interferometry, he obtained a phase shift. By varying the water speed w, the phase shift confirms the Fresnel law of velocities composition:

$$u = c/n_0 + w(1 - 1/{n_0}^2) \quad (1)$$

with:

- c speed of light in vacuum
- w water speed
- n_0 refractive index of water at rest
- u resulting speed of light in moving water

2.2) The aether hypothesis

This result cannot be explained in the strict framework of Newtonian mechanics. On the other hand, Fresnel had given an explanation based on the partial training of ether, a medium in which light would travel like a wave. The resulting speed had to be partially proportional to the square of the speed, hence the term in $(1/n^2)$ 2. Fizeau's objective was to test the hypothesis of this luminous aether and the experiment was conclusive. But this aether hypothesis was invalidated by the experiment of Michelson and Morley in 1887

2.3) The theory of Relativity

The theory of Restricted Relativity published in 1905 makes it possible to explain the results of Fizeau's experiment thanks to its law of addition of speeds 2

$$u_{/R2} = (v_{/R1} + w_{R1/R2})/(1 + v_{/R1} * w_{R1/R2}/c^2) \quad (2)$$

Albert Einstein previously highlighted the corpuscular aspect of light with the photon, which explains the propagation of light in vacuum, without the support of an aether.

Fizeau's experience thus became one of the arguments in favor of the theory of Relativity. However,

in particular because this theory is based on a variable time and space according to the frame of reference, it is not compatible with Quantum Mechanics. It is difficult to imagine that the Universe is governed by two different physical laws, one for the microscopic world, Quantum Mechanics, the other for very high-speed phenomena, the theory of Relativity. In a way it recalls the vision of the ancient world which considered that the sub-lunar world would behave differently from the supra-lunar world. Newtonian mechanics reconciled the movement of the moon with the fall of the apple.

2.4) The Neo-Newtonian Mechanics

Neo-Newtonian Mechanics is Newtonian mechanics without the principle of equivalence, that is to say without postulating that the inert mass would be strictly equal to the gravitational mass. Isaac Newton had distinguished these two masses qualitatively before finally postulating their quantitative equality. In Newton's time in the 17th century, it was only discovered that the speed of light was not infinite. The highlighting of phenomena at very high speed, with the Lorentz factor applied to mass, dates from the 1900s. To integrate these phenomena, it would be possible to develop Newtonian mechanics, and this is what Neo-Newtonian Mechanics proposes.

This mechanism thus explains the increase in the inert mass of electrons, the precession of the perihelion of Mercury, the existence of a limit speed, the expression of force in a synchrotron, the measurement of the dispersion of pulsars. , etc. The article references are given in the appendix. And it is compatible with Quantum Mechanics.

Just as the composition of speeds in the theory of Relativity is not the foundation of this theory but is a consequence, in Neo-Newtonian Mechanics the composition of speeds is not a foundation but is a consequence. This is how it was studied in previous papers:

- A composition of speeds based on kinetic energy and a transfer function

- A composition of speeds based on the momentum

Reflection evolves over time and research work. In this paper, it is considered

- A composition of speeds based on kinetic energy and on a transfer function including the momentum.

3. DEMONSTRATION OF THE COMPOSITION OF VELOCITIES

3.1) Addition of speeds & Composition of velocities

In this paper we will distinguish two concepts which are considered equivalent both in the theory of Relativity and in classical Newtonian mechanics.

• Addition of speeds: this is the operation to find the speed of a body in a second frame of reference when we know the speed of this body in a first frame of reference. The speed of the second frame of reference must be brought into play in relation to the first frame of reference. For example, if we know the speed of a ball (the body) in a train (1st frame of reference), and the speed of the train relative to the platform (2nd frame of reference), this is to define the speed of the ball in relation to at the platform. It's a kinetic approach.

• The composition of velocities: this is the operation that defines the speed acquired by a body in a moving frame of reference relative to another frame of reference. For example, if you throw a ball into a train with some energy, it is to define the speed it can acquire in the train as a function of the speed of the train relative to the platform. A train at 100 km/h does not have the same inertia with

respect to the platform as a train at 1,000,000,000 km/h. It's a dynamic approach.

3.2) In Newtonian mechanics

Newtonian mechanics proceeds for velocities by mathematical addition whatever the situation. Let us point out a property of kinetic energy (see Appendix I):

$$\Delta Ec(A)_{/R2} = \Delta Ec(A)_{/R1} + p(A)_{/R1} * w_{R1/R2} \quad (3)$$

With

• R1: a first frame of reference, for example a train

• R2: a second frame of reference, for example the platform

• A: the moving object

• ΔEc(A): variation of kinetic energy of A (respectively in R1 and in R2)

• p(A): momentum (in R1)

• w: speed of the reference frame R1 (the train) compared to R2 (the platform)

Let's call the term $p(A)_{/R1} * w_{R1/R2}$: transfer function

3.3) Addition of speeds in Neo-Newtonian Mechanics

When the observer changes the reference frame, the addition of speeds is done according to the rules of Newtonian mechanics. Let's take an example :

• Let a (mathematical) point A which is already moving at speed v in the train R1

• This train travels at speed w relative to platform R2

• Then this point A moves at speed u_A relative to the platform R2

With, as in Newtonian mechanics (see Figure 1)

$$u_A = v + w \quad (4)$$

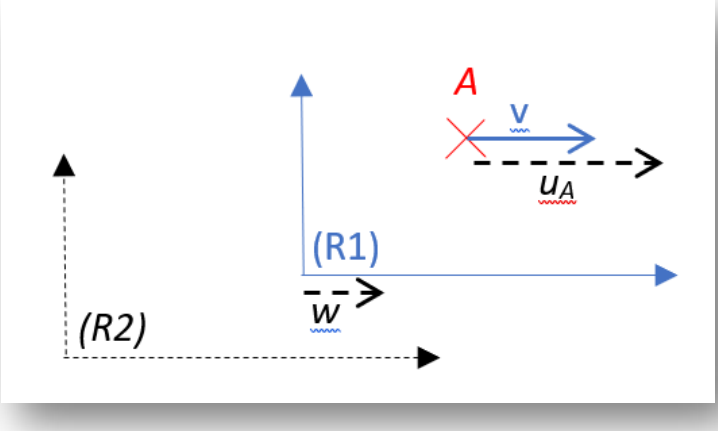

Figure 1: Addition of velocities

3.3) Composition of velocities in Neo-Newtonian Mechanics

When an object is set in motion from a reference point but seen from another, we need to proceed to the speed composition rule. Let's take an example

- Let a (physical) body A, for example une ball, at rest in a train.
  This train travels at speed w relative to platform R2
- Launch this ball A from train R1 with some kinetic energy. Ball A will acquire speed v in train R1

In Neo-Newtonian Mechanics as in Newtonian mechanics, energy is conserved. But the kinetic energy depends on the reference frame, more precisely on its speed compared to the reference frame. And in Neo-Newtonian Mechanics, the inert mass depends on the speed.

Thus this overall energy must be divided between variation in speed and variation in inert mass. This means that there is neither conservation of "kinetic" energy by going from one repository to another, nor conservation of the variation of kinetic energy, only conservation of global energy.

- Seen from platform R2, following the addition of the speeds by change of reference frame, this ball A will go from the initial speed w to the speed $u(A) = v + w$

Ball A will have acquired energy from R2: $\Delta Ec(A_{/R2})$

We can thus establish that according to neo-Newtonian mechanics (see Annex II)

$$\Delta Ec(A_{/R2}) = \Delta Ec(A_{/R1}) + p(A_{/R1}) * w_{R1_{/R2}} \quad (5)$$

We find again the expression of the variation of the kinetic energy of Newtonian mechanics (cfEq. (3)).

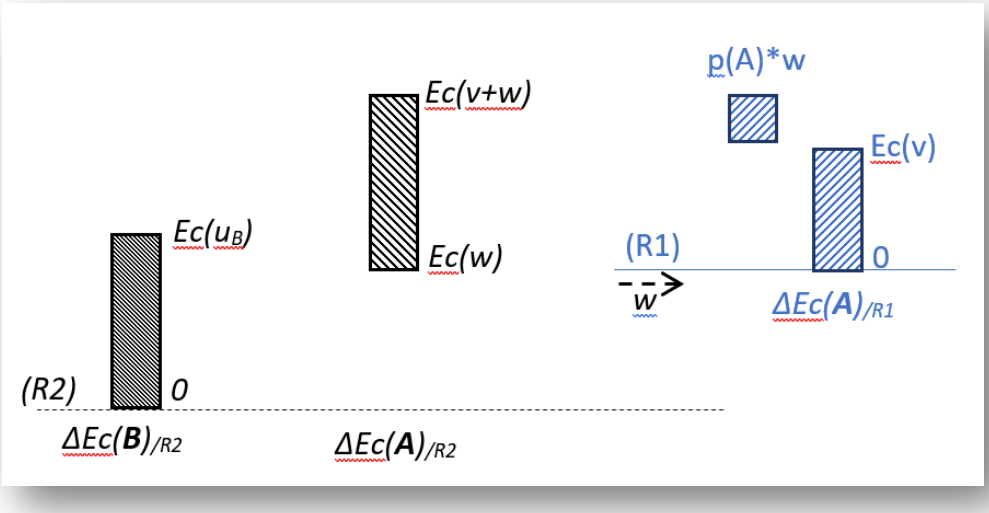

Figure 2 : Compound of Energies

In the second frame of reference (R2), we are interested in the energy variation of a ball A passing at speed $(v + w)$ from an initial speed w. That is not very practical. Let's look in this same frame of reference (R2) what would be, for the same energy variation, the speed acquired by a ball B initially at rest. That is to say :

$$\Delta Ec(B_{/R2}) = \Delta Ec(A_{/R2}) \quad (6)$$

We can deduce the general expression:

$$\boldsymbol{Ec(B_{/R2}) = Ec(A_{/R1}) + p(A_{/R1}) * w_{R1/R2}} \quad \textbf{(7)}$$

Then we get the velocity composition law (see Annex II)

$$\boldsymbol{u_{(B/R2)} = v_{(A/R1)} + \frac{w_{R1/R2}}{\gamma_v^2}} \quad \textbf{(8)}$$

This means that for the same kinetic energy, a body at rest will acquire the speed $\boldsymbol{u_{(B/R2)}}$ in the reference frame R2 or the speed $\boldsymbol{v_{(A/R1)}}$ in the reference frame R1, these two speeds being linked by the above relationship. Its mathematical expression is clearly different from the addition of velocities. The increase in inert mass had to be taken into account with the Lorentz factor γ_v

3.4) Application and discussion

3.4.1) Fizeau's experiment

Fizeau's experiment seeks to show the link of speed that exists between

• The speed of light in a reference frame (R1) with water at rest (refractive index n_0)

• The speed of light in an (R2) reference frame with moving water (refractive index n')

For reasons which are explained in more detail in Appendix III, part a), we are not precisely in the case of a change of reference frame, firstly because the observer remains in the only terrestrial reference frame (R2).

To be able to establish a link between the law of refraction applied in one case and in another, we must distinguish two cases:

• The speed of a photon A, from a fixed light source in (R1), in water at rest in (R1)

• The speed of a photon B 'coming from a fixed light source in (R2), in moving water with respect to (R2)

Then we can establish (see Annex III) from equation (8), that

$$u_{B'/R2} = v_{A/R1} + w_{R1/R2}(1 - \frac{1}{n^2}) \quad (9)$$

The physical composition of the velocities of Neo-Newtonian Mechanics is consistent with the results of Fizeau's experiment.

3.4.2) Extrapolation to photon

We had estimated in a previous paper that the Lorentz factor of a photon in the visible range is of about 2.10^5. By extrapolating the domain of validity of the law of composition Eq.(8) up to the speed of a photon in vacuum, for a system moving with respect to our terrestrial frame of reference at the speed w of light, the ratio w/γ^2 would remain less than 1 m/s, that is to say less than the measurement uncertainty on the speed of light. This would make it possible to consider that whatever the speed of the light source, the launched speed of the photon is in practice constant ... to within the measurement uncertainty (less than 1 m/s). On the other hand, once launched, the speed of light would remain variable compared to the observer if the observer starts to move.

3.4.3) Comparative

In order to be able to distinguish visually the relativistic curve from the neo-Newtonian curve let us take the very important value of $w/c = 0.3$ or 100,000 km/s. For comparison, the fastest man-made object, the Helios 2 probe, did not exceed a w/c of 0.0002. We get the following graph (see Figure 3)

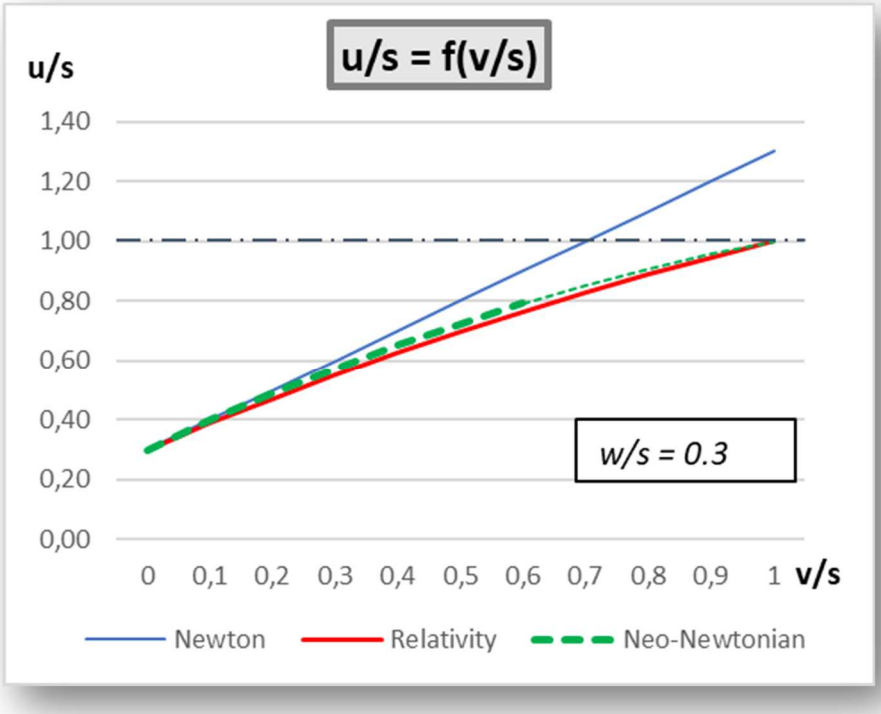

Figure 3 : Comparison of velocities according to the theories

From this graph, we can deduce that the Neo-Newtonian velocity composition predictions are very slightly superior to the relativistic predictions.

To be sure, it would be necessary to make more precise measurements of Fizeau's experiment, which proceeds by speed difference. The uncertainty about this experience comes from the inhomogeneous medium used as can be a moving fluid. The proposal is to replace this fluid with a transparent solid, for example a rapidly rotating glass disc 3. This would make it possible to more precisely measure the law of composition of the speeds in order to confirm, or not, the above theories.

4. CONCLUSION

Neo-Newtonian Mechanics is characterized by an inert mass essentially variable at very high speed according to the Lorentz factor. Unlike classical Newtonian mechanics, this makes it possible to establish an impassable limit speed, called the asymptotic limit ‘s’.

First, we distinguished the addition of speeds with change of reference from that without change of reference. We then established the correlation of variation of kinetic energy which exists between two reference frames. It is the same as that which exists in classical Newtonian mechanics (see Eq.3):

$$\Delta Ec_{/R2} = \Delta Ec_{/R1} + p_{/R1} * w_{R1/R2}$$

Secondly, we have demonstrated the law of composition of velocities for material bodies as a function of the Lorentz factor (see Eq.8):

$$u_{/R2} = v_{/R1} + \frac{w_{R1/R2}}{\gamma_v^2}$$

Applied to the case of the photon, we find very exactly the results of the Fizeau experiment with moving water (see Eq.9):

$$u_{/R2} = v_{/R1} + w_{R1/R2} * (1 - \frac{1}{n^2})$$

This result makes it a possible alternative to the interpretation of the theory of Relativity.

In order to properly discriminate the two approaches between Theory of Relativity and Neo-Newtonian Mechanics, we mention the small differences that we could observe with a more precise experiment that we had previously proposed. This involved replacing the transparent fluid in translation with a transparent solid in rotation. This would support one or the other of these two theoretical approaches.

5. ACKNOWLEGMENT

I would like to thank BGD for the reading

6. REFERENCES

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3. Einstein A., Relativity the special and general theory (1920), https://ibiblio.org/ebooks/Einstein/Einstein_Relativity.pdf
4. Serret O., An improvement of the accuracy of **Fizeau**'s experiment, GSJ (2018), http://gsjournal.net/Science-Journals/Research%20Papers-Relativity%20Theory/Download/7247

APPENDIX 0 : RELATED ARTICLES ABOUT NEO-NEWTONIAN ARTICLES

PRESENTATION		
a	Let's free **Newtonian Mechanics** from the equivalence 'principle'!	https://www.gsjournal.net/Science-Journals/Research%20Papers/View/7499
EXPERIMENTS ON EARTH:		
b	How to Demonstrate **the Lorentz Factor**: Variable Time vs. Variable Inertial Mass	http://file.scirp.org/pdf/JMP_2015022510573131.pdf
c	**Velocity Addition** Demonstrated from the Conservation of Linear Momenta, an Alternative Expression	http://file.scirp.org/pdf/JMP_2015050609513342.pdf
d	Mass of Inertia and Kinetic Energy	http://gsjournal.net/Science-Journals/Research%20Papers-Relativity%20Theory/Download/4113
e	The new velocities compound $\boldsymbol{u} = \boldsymbol{v} + \boldsymbol{w}/\boldsymbol{\gamma^2}$ conformed to Fizeau's experiment	*Present one*
f	Net Force F = $\boldsymbol{\gamma^3 ma}$ at High Velocity	http://file.scirp.org/pdf/JMP_2016042814580505.pdf
g	An improvement of the accuracy of **Fizeau**'s experiment	http://gsjournal.net/Science-Journals/Research%20Papers-Relativity%20Theory/Download/7247
h	A Non-Relativistic Explanation of the Sagnac Effect	https://www.scirp.org/journal/paperinformation.aspx?paperid=91858
i	Which derivation for the result of the MMX (**Michelson & Morley Experiment**) in translation with respect to the observer?	https://www.gsjournal.net/Science-Journals/Research%20Papers/View/7808
COSMOLOGICAL OBSERVATIONS:		
j	About the ovoid orbits in general, and **perihelion precession of Mercury** in particular (2)	http://www.mrelativity.net/Papers/51/Mercury%20Millennium%20Serret%205%20janvier%202018.pdf
k	Hipparcos did not measure directly **the light bending!**	http://gsjournal.net/Science-Journals/Research%20Papers-Mechanics%20/%20Electrodynamics/Download/6998

l	The **flat rotation curve of our galaxy** explained within Newtonian mechanics	https://physicsessays.org/browse-journal-2/product/1240-7-olivier-serret-the-flat-rotation-curve-of-our-galaxy-explained-within-newtonian-mechanics.html
m	**Gravity vs. Dark Energy**, about the Expansion of the Universe	http://file.scirp.org/pdf/JMP_2018011714405269.pdf
n	**Gravitational waves or particle radiation?**	https://www.physicsessays.org/browse-journal-2/product/1588-12-olivier-serret-gravitational-waves-or-particle-radiation.html
o	The **Pioneer Anomaly** explained by the Processing of the Doppler Effect	http://gsjournal.net/Science-Journals/Research%20Papers-Relativity%20Theory/Download/7330
p	**Shapiro time delay** derivates from refraction	http://www.mrelativity.net/Papers/51/Shapiro%20SERRET%20Millennium%20juillet%202018.pdf
CRITICISM OF RELATIVITY:		
q	**Reply to** "A Simple Derivation of the Lorentz Transformation"	http://file.scirp.org/pdf/JMP_2017121915203275.pdf
r	4.**Lorentz transformation** derivation	https://www.youtube.com/watch?v=koPnW0mXcvI

APPENDIX 1 – IN NEWTONIAN MECHANICS

Hypotheses :

• In Newtonian mechanics, the kinetic energy in a reference frame (R) is worth:

$$Ec_{/R} = \frac{1}{2}m\left(v_{/R}\right)^2 \tag{I.1}$$

• The law of speed addition is:

$$u = v + w \tag{I.2}$$

Demonstration :

In the frame of reference (R1), a body A passes from zero speed to speed. Its variation in kinetic energy is written, according to Eq. (I .1)

$$\Delta Ec_{/R1} = \frac{1}{2}m\left(v_{A/_{R1}}\right)^2 - \frac{1}{2}m(0)^2 \tag{I.3}$$

$$\Delta Ec_{/R1} = \frac{1}{2}m\left(v_{A/_{R1}}\right)^2 \tag{I.4}$$

In another frame of reference (R2) in translation with respect to (R1), the speed of the frame of reference (R1) in (R2) is $w_{R1/_{R2}}$.

The addition of speeds gives, according to Eq. (I.2)

$$\begin{cases} at\ initial\ time : 0 + w_{R1/_{R2}} = w_{R1/_{R2}} \\ at\ final\ time : v_{A/_{R1}} + w_{R1/_{R2}} = u_{A/_{R2}} \end{cases} \tag{I.5a-b}$$

In (R2), the variation of kinetic energy of the body A gives:

$$\Delta Ec_{A/_{R2}} = \frac{1}{2}m\left(u_{A/_{R2}}\right)^2 - \frac{1}{2}m\left(w_{R1/_{R2}}\right)^2 \tag{I.6}$$

$$\Delta Ec_{A/_{R2}} = \frac{1}{2}m\left(v_{A/_{R1}} + w_{R1/_{R2}}\right)^2 - \frac{1}{2}m\left(w_{R1/_{R2}}\right)^2 \tag{I.7}$$

$$\Delta Ec_{A/_{R2}} = \frac{1}{2}m\left(v_{A/_{R1}}\right)^2 + \frac{2}{2}m.v_{A/_{R1}}.w_{R1/_{R2}} \tag{I.8}$$

$$\boxed{\Delta Ec_{A/_{R2}} = \Delta Ec_{A/_{R1}} + p_{A/_{R1}}.w_{R1/_{R2}}} \tag{I.9}$$

APPENDIX II - MAIN DERIVATION

Hypotheses :

• In Newtonian mechanics, the kinetic energy in a reference frame R is worth:

$$Ec_{/R} = (\gamma_{v_{/R1}} - 1)ms^2 \quad \text{(II.1)}$$

• The law for adding speeds by changing the reference system is:

$$u = v + w \quad \text{(II.2)}$$

Part 1

- In (R1), the variation of kinetic energy acquired by the body A at the speed v is according to Eq. (II.1):

$$\Delta Ec_{A/R1} = (\gamma_{v_{A/R1}} - 1)ms^2 - (\gamma_{0_{/R1}} - 1)ms^2 \quad \text{(II.3)}$$

And

$$\gamma_0 = 1 \quad \text{(II.4)}$$

$$\Delta Ec_{A/R1} = (\gamma_{v_{A/R1}} - 1)ms^2 \quad \text{(II.5)}$$

- In (R2), the speeds are different, it is necessary to apply the law of addition of speeds by change of reference frame according to Eq. (II.2):

	/R2	/R1
Initial A	$v + w$	v
Final A	w	0

Chart of addition of velocities (II.6)

In (R2), the variation of kinetic energy acquired by the body A:

$$\Delta Ec_{A/_{R2}} = (\gamma_{v+w} - 1)ms^2 - (\gamma_w - 1)ms^2 \quad \text{(II.7)}$$

$$\Delta Ec_{A/_{R2}} = (\gamma_{v+w} - \gamma_w)ms^2 \quad \text{(II.8)}$$

$$\frac{\Delta Ec_{A/_{R2}}}{ms^2} = \gamma_{v+w} - \gamma_w \quad \text{(II.9)}$$

$$\frac{\Delta Ec_{A/_{R2}}}{ms^2} = \frac{1}{\sqrt{1-\frac{(v+w)^2}{s^2}}} - \frac{1}{\sqrt{1-\frac{(w)^2}{s^2}}} \quad \text{(II.10)}$$

Equation valid if the square root is positive, i.e. if

$$(v + w) < s \quad \text{(II.11)}$$

$$\frac{\Delta Ec_{A/_{R2}}}{ms^2} = \frac{s}{\sqrt{s^2-(v+w)^2}} - \frac{s}{\sqrt{s^2-(w)^2}} \quad \text{(II.12)}$$

$$\frac{\Delta Ec_{A/_{R2}}}{ms^2} = s\frac{\sqrt{s^2-(w)^2}-\sqrt{s^2-(v+w)^2}}{\sqrt{s^2-(v+w)^2}\sqrt{s^2-(w)^2}} \quad \text{(II.13)}$$

$$\frac{\Delta Ec_{A/_{R2}}}{ms^2} = s^2\frac{\sqrt{1-w^2/s^2}-\sqrt{1-v^2/s^2-w^2/s^2-2vw/s^2}}{\sqrt{(s^2-v^2-w^2-2vw)(s^2-w^2)}} \quad \text{(II.14)}$$

$$\frac{\Delta Ec_{A}/_{R2}}{ms^2} = s^2 \frac{\sqrt{1-w^2/s^2}-\sqrt{1-v^2/s^2-w^2/s^2-2vw/s^2}}{\sqrt{s^4-v^2s^2-w^2s^2-2vws^2-w^2s^2+v^2w^2+w^4+2vw^3}} \quad \text{(II.15)}$$

$$\frac{\Delta Ec_{A}/_{R2}}{ms^2} = \frac{s^2}{s^2} \frac{\sqrt{1-w^2/s^2}-\sqrt{1-v^2/s^2-w^2/s^2-2vw/s^2}}{\sqrt{1-v^2/s^2-w^2/s^2-2vw/s^2-w^2/s^2+v^2w^2/s^4+w^4/s^4+2vw^3/s^4}} \quad \text{(II.16)}$$

$$\frac{\Delta Ec_{A}/_{R2}}{ms^2} = \frac{\sqrt{1-w^2/s^2}-\sqrt{1-v^2/s^2-2vw/s^2-w^2/s^2}}{\sqrt{1-v^2/s^2-2vw/s^2-2w^2/s^2+v^2w^2/s^4+2vw^3/s^4+w^4/s^4}} \quad \text{(II.17)}$$

$$\frac{\Delta Ec_{A}/_{R2}}{ms^2} = \frac{\sqrt{\mathbf{1}-\boldsymbol{w^2/s^2}}-\sqrt{1-v^2/s^2-2vw/s^2-\boldsymbol{w^2/s^2}}}{\sqrt{1-v^2/s^2-2vw/s^2+\boldsymbol{w^2/s^2}(-2+v^2/s^2+2vw/s^2+w^2/s^2)}} \quad \text{(II.18)}$$

1st approximation: $w^2 \lll s^2$ hence

$$1 \pm \frac{w^2}{s^2} \approx 1 \quad \text{(II.19)}$$

$$\frac{\Delta Ec_{A}/_{R2}}{ms^2} \approx \frac{\sqrt{1}-\sqrt{1-v^2/s^2-2vw/s^2}}{\sqrt{1-v^2/s^2-2vw/s^2}} \quad \text{(II.20)}$$

2nd approximation: $v^2 \ll s^2$ hence

$$(1 \pm \frac{v^2}{s^2})^{1/2} \approx 1 \pm \frac{1}{2}\frac{v^2}{s^2} \quad \text{(II.21)}$$

And $w \ll v < s$, so

$$(1 \pm 2\frac{vw}{s^2})^{1/2} \approx 1 \pm \frac{2}{2}\frac{vw}{s^2} \quad \text{(II.22)}$$

$$\frac{\Delta Ec_{A}/_{R2}}{ms^2} \approx \frac{1-(1-\frac{1v^2}{2s^2}-\frac{2vw}{2s^2})}{1-\frac{1v^2}{2s^2}-\frac{2vw}{2s^2}} \quad \text{(II.23)}$$

$$\frac{\Delta Ec_{A}/_{R2}}{ms^2} \approx (\frac{1}{2}\frac{v^2}{s^2}+\frac{vw}{s^2})(1+\frac{1}{2}\frac{v^2}{s^2}+\frac{vw}{s^2}) \quad \text{(II.24)}$$

$$\frac{\Delta Ec_{A}/_{R2}}{ms^2} = \frac{1}{2}\frac{v^2}{s^2}+\frac{vw}{s^2}+\frac{1}{4}\frac{v^4}{s^4}+\frac{1}{2}\frac{v^3w}{s^4}+\frac{1}{2}\frac{v^3w}{s^4}+\frac{v^2w^2}{s^4} \quad \text{(II.25)}$$

$$\frac{\Delta Ec_{A}/_{R2}}{ms^2} = \frac{1}{2}\frac{v^2}{s^2}+\frac{vw}{s^2}+\frac{1}{4}\frac{v^4}{s^4}+\frac{v^3w}{s^4}+\frac{v^2w^2}{s^4} \quad \text{(II.26)}$$

$$\frac{\Delta Ec_{A}/_{R2}}{ms^2} = \frac{1}{2}\frac{v^2}{s^2}(1+\frac{1}{2}\frac{v^2}{s^2})+\frac{vw}{s^2}(1+\frac{v^2}{s^2}+\frac{vw}{s^2}) \quad \text{(II.27)}$$

$$\frac{\Delta Ec_{A}/_{R2}}{ms^2} = \frac{1}{2}\frac{v^2}{s^2}\gamma_v+\frac{vw}{s^2}(\gamma_v+\frac{1}{2}\frac{v^2}{s^2}+\frac{vw}{s^2}) \quad \text{(II.28)}$$

According to the 1st and 2nd approximation:

$$\frac{vw}{s^2} < \frac{1}{2}\frac{v^2}{s^2} < 1 < \gamma_v \quad \text{(II.29)}$$

$$\gamma_v+\frac{1}{2}\frac{v^2}{s^2}+\frac{vw}{s^2} \approx \gamma_v \quad \text{(II.30)}$$

And according to the 2nd approximation:

$$\gamma_v = (1-\frac{v^2}{s^2})^{-1/2} \approx \frac{1}{1-\frac{1v^2}{2s^2}} \quad \text{(II.31)}$$

$$\gamma_v\left(1-\frac{1}{2}\frac{v^2}{s^2}\right)=1 \tag{II.32}$$

$$\left(\frac{1}{2}\frac{v^2}{s^2}\right)\gamma_v=\gamma_v-1 \tag{II.33}$$

Then

$$\frac{\Delta Ec_{A/R2}}{ms^2}\approx(\gamma_v-1)+\frac{vw}{s^2}(\gamma_v) \tag{II.34}$$

$$\Delta Ec_{A/R2}\approx(\gamma_v-1)ms^2+(\gamma_v mv)w \tag{II.35}$$

$$\boxed{\Delta Ec_{A/R2}\approx\Delta Ec_{A/R1}+p_{A/R1}w_{R1/R2}} \tag{II.36}$$

Part 2

Let body B initially at rest such that

$$\Delta Ec_{(B/R2)}=\Delta Ec_{(A/R2)} \tag{II.37}$$

$$\Delta Ec_{(B/R2)}=Ec_{(u/R2)}-Ec_{(0/R2)} \tag{II.38}$$

$$Ec_{(0/R2)}=0 \tag{II.39}$$

$$\Delta Ec_{(B/R2)}=Ec_{(u/R2)} \tag{II.40}$$

But

$$\Delta Ec_{(A/R2)}=\Delta Ec_{(A/R1)}+p_{(A/R1)*}w_{R1/R2} \tag{II.41}$$

$$\Delta Ec_{(A/R2)}=Ec_{(v/R1)}-Ec_{(0/R1)}+p_{(A/R1)}*w_{R1/R2} \tag{II.42}$$

$$Ec_{(0/R1)}=0 \tag{II.43}$$

$$\Delta Ec_{(A/R2)}=Ec_{(v/R1)}+p_{(A/R1)*}w_{R1/R2} \tag{II.44}$$

So

$$\Delta Ec_{(B/R2)}=Ec_{(v/R1)}+p_{(A/R1)}*w_{R1/R2} \tag{II.45}$$

From where

$$\boxed{Ec_{(u/R2)}=Ec_{(v/R1)}+p_{(A/R1)}*w_{R1/R2}} \tag{II.46}$$

APPENDIX III – FIZEAU EXPERIMENT

1) CRITICISM OF RELATIVIST INTERPRETATION

A characteristic of Fizeau's experience is that it is done only from the terrestrial frame (R2). There is no observer in the moving reference frame (R1). It is only deduced what one should see an observer if he was in (R1).

What is the concern? In this experiment, the light source B is fixed in the terrestrial frame of reference (R2). In the reference frame (R1), the light source B is in motion. The usual interpretation of Fizeau's experience is therefore to assume that you know what is happening in calm water with a moving light source.

According to the theory of Relativity, this does not make a difference because it postulates that the photon will arrive whatever the speed of the light source at speed c. But that remains a postulate, it is not the result of a measurement or a demonstration.

In the following, the photon B' coming from the source B in motion with respect to (R1) is calculated according to Neo-Newtonian Mechanics traveling at the speed $(c - w)$ in (R1), speed conforming to the Newtonian law of addition of speeds by change of reference frame (see figure 3)

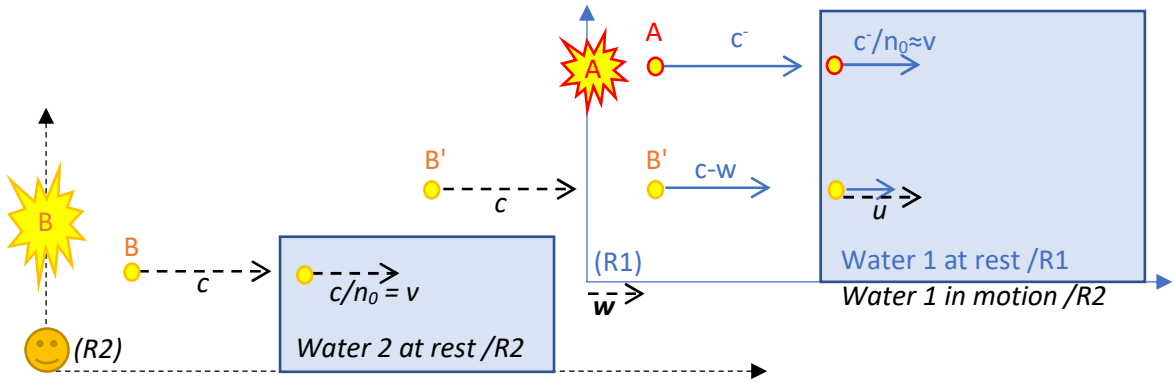

Figure 3 : Compound of velocities in Fizeau's experiment

2) NEO-NEWTONIAN INTERPETATION

a) Hypotheses in Neo-Newtonian Mechanics:

- Photons B et B' are emited by the fix light source in (R2) at the velocicty c in (R2)
- Photon A is emited by the fix light source in (R2) at the velocicty c in (R2)
- Refractive index of the light in water at rest is:

$$n_0 = \frac{c}{v} \qquad \text{(III.1)}$$

and in water in motion:

$$n' = \frac{c}{v'} \qquad \text{(III.2)}$$

b) Application of the composition of velocities

- In (R1), the photon A in water at rest goes by applying the refractive index to the velocity

$$v = c^{-}/n_0 \tag{III.3}$$

Note: the initial celerity c^{-} being equal to c in theory of Relativity, very close but nevertheless very slightly different in Neo-Newtonian Mechanics.

- In (R2), the law of speed addition by change of reference frame must be applied:

	A/R2	*A/R1*
Water	*In motion*	*At rest*
Initial	w	0
Final	$v + w$	$v = c^{-}/n_0$

Chart of addition of velocities

In (R2), the kinetic energy variation of photon A becomes:

$$\Delta Ec_{A/R2} = \Delta Ec_{A/R1} + p_{A/R1} w_{R1/R2} \tag{III.4}$$

The speed variation of A in (R2) is from w to $v + w$, which is not usual

Let us then take a field B'which in (R2) passes from 0 to u (u remaining to be determined) with:

$$\Delta Ec_{(B'/R2)} = \Delta Ec_{(A/R2)} \tag{III.5}$$

	A/R2	*B'/R2*
Water	*In motion*	*In motion*
Initial	*w*	*0*
Final	*v+w*	*u*

Chart of velocities

Note that

$$\Delta Ec_{A/R1} = Ec_{A/R1} \tag{III.6}$$

$$\Delta Ec_{(B'/R2)} = Ec_{(B'/R2)} \tag{III.7}$$

So

$$Ec(B'_{/R2}) = Ec(A_{/R1}) + p(A_{/R1}) * w_{R1/R2} \tag{III.8}$$

Using the velocity composition law

$$u_{B'/R2} = v_{A/R1} + \frac{w_{R1/R2}}{\gamma_{v_A}^2} \tag{III.9}$$

c) Value of the Lorentz factor:

In Neo-Newtonian Mechanics

$$\gamma_{v_A}^2 = \frac{1}{1 - \frac{{v_A}^2}{s^2}} \tag{III.10}$$

Within measurement uncertainty, with s asymptotic limit

$$c \approx s \tag{III.11}$$

$$\gamma_{v_A}^2 = \frac{1}{1-\frac{{v_A}^2}{c^2}} \tag{III.12}$$

It has been shown that the speed of a body cannot exceed the speed limit s. Under these conditions, whether by summing or subtracting, as long as the speed w remains relatively low:

$$\bar{c_{A/R1}} \approx c_{B/R2} \tag{III.13}$$

$$\frac{\bar{c_{A/R1}}}{n_0} \approx \frac{c_{B/R2}}{n_0} \tag{III.14}$$

$$v_{A/R1} \approx v_{B/R2} \tag{III.15}$$

$$\gamma_{v_A}^2 = \frac{1}{1-\frac{{v_B}^2}{c^2}} \tag{III.16}$$

By definition of the refractive index (cf. Eq. (III.1):

$$\frac{v_{B/R2}}{c} = \frac{1}{n_0} \tag{III.17}$$

$$\gamma_{v_A}^2 = \frac{1}{1-\frac{1}{{n_0}^2}} \tag{III.18}$$

$$\frac{1}{\gamma_{v_A}^2} = 1 - \frac{1}{{n_0}^2} \tag{III.19}$$

$$u_{B\prime/R2} = v_{A/R1} + w_{R1/R2}\left(1 - \frac{1}{{n_0}^2}\right) \tag{III.20}$$

<u>d) expression of Fizeau :</u>

In his experiment, Fizeau found the difference of speed:

$$u^+ - u^- = 2 * w * \left(1 - \frac{1}{{n_0}^2}\right) \tag{III.21}$$

We had seen in the Eq. (III.15)

$$v_{A/R1} \approx v_{B/R2}$$

Now in water at rest, see Eq. (III.1)

$$v_{B/R2} = \frac{c}{n_0} \tag{III.22}$$

And in water in motion, see Eq. (III.2)

$$v_{B\prime/R2} = \frac{c}{n\prime} \tag{III.23}$$

Hence using Eq. (III.20)

$$\frac{c}{n\prime} = \frac{c}{n_0} + w\left(1 - \frac{1}{{n_0}^2}\right) \tag{III.24}$$

This means that the speed of a photon (B') in moving water is made up of the speed of a photon (B) in water at rest and the speed of water w with the coefficient $\left(1 - \frac{1}{n^2}\right)$.

➔ **We find the experimental result of the Fizeau experiment.**