2 - AETHER DRAG FORCE

Abstract:

The aetherinical force suffered by an elementary particle that moves at a velocity **u** relative to the aether is calculated. Assuming that the distribution of speeds v of the aetherinos (in the reference frame associated to the aether "at-rest") is of the Maxwell-Boltzmann type $k_1 v^2 Exp[-k_2 v^2]$ and assuming that *when* an aetherino collides with the particle with a relative velocity $\mathbf{v_R}$ it gives to it an aetherinical impulse equal to $\mathbf{i}_1 = h_1 \mathbf{v_R}$ (where h_1 is a constant) it is found that the aetherinical force (net impulse per unit time) exerted by the aether on the particle is approximately:

$\mathbf{F}_{DRAG} = - k_D \mathbf{u}$ for $u <<$ average speed of the aetherinos in the reference frame of the aether.

where k_D is a constant that depends on the distribution of speeds of the aetherinos in an undisturbed aether at rest and is directly proportional to the total cross section σ of the particle to aetherino collisions.

Interpreting that the inertial mass m of a material particle is proportional to the *total* cross section σ that it presents to the aetherinos then it can also be written

$\mathbf{F}_{DRAG} = - k_{D2} \; m \; \mathbf{u}$

Assuming the hypothesis that "the velocity increase suffered by an elementary particle, when an aetherino collides with it, is $\Delta\mathbf{u} = k_m \mathbf{v_R}$ (where k_m is a positive constant specific of the collided particle inversely proportional to its inertial mass)" then the approximately linear drag force implies that all *free* (of other forces) material particles moving relative to the aether decrease their speed according to the same exponential law.

Aether Drag force on a moving particle.

When an elementary particle moves at speed u relative to an undisturbed standard (canonical) aether it suffers the collisions of the surrounding aetherinos that exert on it an *aetherinical* net *force* that will be called *aether drag*.

(Note: the concept of “aether drag” as a *force* used in this work should not to be confused with the concept of “matter dragging the aether” that was invoked by some authors to explain the null result of the Michelson & Morley experiment).

Let S be the reference *frame in which the pertinent local aether can be considered at rest* and has a “canonical” distribution (of aetherino speeds).

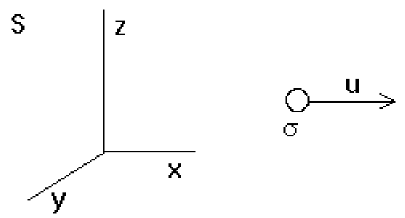


Fig [2-1]

Let **u** be the instantaneous velocity of the particle in the reference frame S. The direction of **u** is chosen to be that of the axis x.

Since the aether in S is the so called "canonical", it has by hypothesis an isotropic distribution of aetherino velocities that can be described by a scalar function $\rho_o[v]$ of the speed v of the aetherinos. Let

$\rho_o[v]$ dv = number of aetherinos in unit volume with speeds in the interval {v, v+dv}.

Due to symmetry reasons the y and z components of the aetherinical net force suffered by the moving particle will cancel and need not be considered.
Consider first only those aetherinos that travel in a given semi direction of space and whose speed belongs to the interval {v, v+dv}. Let θ be the angle that such semi direction makes with axis x (in reference frame S).

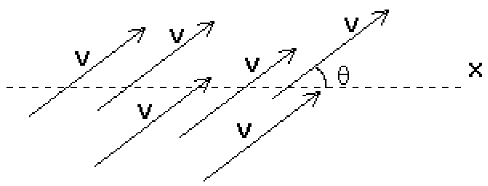


Fig [2-2]

The density (number per unit volume) of the *selected* aetherinos is ($\rho_o[v]$ dv) / k where k is a big number of equal parts in which the totality of semi directions of 3D space can be supposed to be divided for calculation purposes.
If it is supposed that an elementary particle occupies a volume of space that can be described assigning to such particle a geometric cross section σ then the number of aetherinos of the selected type that collide per unit time with the particle can be obtained calculating the volume of the virtual cylinder swept by the particle in unit time in the reference frame in which *the selected aetherinos* are at rest.

Calling v_R the speed of these aetherinos *relative to the particle*:

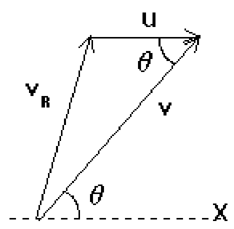


Fig [2-3]

[2-4] $v_R = (u^2 + v^2 - 2\, u\, v\, \text{Cos}\, \theta\,)^{1/2}$

the number of collisions per unit time suffered by the particle (that moves relative to the aether at a velocity **u**) with aetherinos of speed in the interval {v, v+dv} and a given semi-direction that makes an angle θ with the semi-direction of **u** (that has been called x) is therefore:

[2-5] $$n_k = \sigma\, v_R \frac{\rho_0[v]dv}{k}$$

But, according to the hypothesis proposed in other sections of this work, *the collision cross section* of an elementary particle with an aetherino is not given simply by a constant σ but depends on the speed v_R of the aetherino relative to the particle.
It will be supposed that the collision cross section of an elementary particle with an aetherino of relative speed v_R is by hypothesis (to account for other facts):

[2-5b] $\sigma_I[v_R] = a_I\ \text{Exp}[-b_I\ v_R{}^2]$ = cross section of an elementary particle to impulsion aetherino collisions

where:
v_R is the speed of the incident aetherino relative to the particle
a_I is a constant with the dimension of area (L^2) that depends on the type of elementary particle
b_I is a constant with the dimension of speed $^{-2}$ ($T^2\, L^{-2}$) that is the same for all elementary particles

then the sought number of collisions will be given by:

[2-5c] $$n_k = \frac{\rho_0[v]}{k}\ a_I\ \text{Exp}\left[-b_I\ v_R{}^2\right] v_R\ dv$$

Note: the model is still open about the precise form of the hypothesis that should be assigned to the cross section to aetherino collisions of an elementary particle and therefore in most of the following expressions such cross section will not be made explicit.

Definition of *elementary aetherinical impulse*.

(See more in the Section 1 of this work)

(The word "elementary" is to remark that the aetherinical impulse is due to the collision of a *single* aetherino).

By definition, when an aetherino collides with a particle at a relative velocity $\mathbf{v}_R$ it gives to it an *aetherinical impulse* given by the following vector quantity:

[2-5d] $$\mathbf{i_1} = h_1 \ \mathbf{v_R}$$

where h_1 is a universal, positive constant with the dimension of mass (but is not the mass of the particle. See below).

All the material bodies are supposed to be made of elementary particles that are the ones that ultimately collide with the aetherinos. A material body is said to be collided by an aetherino when the aetherino collides with any of its elementary particles. The magnitude of the aetherinical impulse received by a piece of matter (as a whole) when collided by an aetherino is assumed to have the same value as the elementary aetherinical impulse received by the specific elementary particle that suffered the collision. (See more in the Section 3 of this work).

The constant h_1 is introduced for dimensional compatibility between the definition of aetherinical force and the mainstream concept of force.

As explained elsewhere this work, the so called *aetherinical impulse* is just an *auxiliary concept* with which to define the *aetherinical force* as the net aetherinical impulse by unit time suffered by a material particle.

Note: a fundamental hypothesis of the model asserts that when an aetherino collides with an elementary particle with a relative velocity $\mathbf{v}_R$, **the particle suffers a velocity change** given by:

[2-5e] $$\Delta\mathbf{u}_1 = \mathbf{i}_1 / \mu_P = h_1/ \mu_P \ \mathbf{v_R}$$

where μ_P is a positive constant, specific of the collided particle, that the model identifies as its *inertial mass*.

Note: As is explained with more detail in the paper https://www.eterinica.net/redistribs_eterinicas_en.pdf the model postulates the existence of two types of aetherinos (p-type and n-type), two types of matter (p-type and n-type) and two types of collisions between aetherinos and matter (switch collisions and impulsion collisions). The collided particle only increments its velocity in the *impulsion collisions* (according to [2-5e]) that are those collisions in which an aetherino of a give type collides with matter of the same type.

Note: according to the model, the *inertial mass* of a material body *is a different concept* from its *gravitational mass* (as explained in the Section G of this work at http://www.eterinica.net/EVEG/Force_between_neutral_bodies.pdf) although their values tend to be directly proportional in the case of common (made of atoms) macroscopic bodies.

Returning to the calculus of the aether drag force, the x-component of the elementary impulse given to the particle by a *single* aetherino (see Figs[2-2] & [2-3]) of direction θ is:

[2-6] $$i_{1X} = h_1\ v_{RX} = h_1\,(v\,\mathrm{Cos}\,\theta - u)$$

and the x-component of the impulse of *all* the aetherinos of the selected pencil of semi directions (labeled *k*) that collide with the SP in unit time is then:

[2-7] $$i_{kX} = n_k\, i_{1X} = h_1\,(v\,\mathrm{Cos}\,\theta - u)\ \frac{\rho_0[v]}{k}\ \sigma_I[v_R]\ v_R\ dv$$

Considering that the "number" of semi directions included between the two cones of angles (with the x axis) θ and θ+dθ is k/2 Sin[θ] dθ and considering that they all make the same contribution to the x component of the total impulse, then the x component of the impulse received in unit time by the particle due to the collisions of aetherinos with speeds in {v, v+dv} and semi directions in {θ, θ+dθ} is

[2-8] $$i_X[v,\theta]\,dv\,d\theta = h_1\,(v\,\mathrm{Cos}\,\theta - u)\ \frac{\rho_0[v]}{k}\ \sigma_I[v_R]\ v_R\ dv\ \frac{k}{2}\mathrm{Sin}\,\theta\ d\theta$$

Integrating [2-8] for all possible speeds and directions, the total impulse along the x axis suffered in unit time by a SP moving at the velocity **u** along the x axis is:

[2-9] $$F_{DRAG} = \frac{h_1}{2}\int_0^{\infty}\int_0^{\pi}(v\,\mathrm{Cos}\,\theta - u)\ \sigma_I[v_R]\ v_R\ \rho_o[v]\ \mathrm{Sin}\,\theta\ d\theta\, dv$$

The sub index X has been dropped since, as said above, by symmetry (see Fig [2-1]), the x-component of that force is the only one that does not cancel.

Notice that the expression [2-9] gives the "*modulus*" of the aether drag force. The aether drag ***force*** is of course obtained from that expression multiplying it by a unit vector whose direction is that of the velocity **u** of the particle relative to the aether.

It will be supposed that the *canonical distribution* of the aetherino's speeds of a standard, at-rest, undisturbed aether is of the Maxwell-Boltzmann type. It can be written in a convenient way as:

[2-10] $$\rho_0[v] = \frac{4\,N_0}{\sqrt{\pi}\,V_M^{\ 3}}\ v^2\, e^{-(v/V_M)^2}$$

where

$\rho_0[v]$ gives the number of aetherinos with speed v in unit volume (of standard undisturbed vacuum).
V_M is the speed for which there is a maximum number of aetherinos (i.e. for which the distribution reaches its maximum).
The total number of aetherinos in unit volume is N_0 and notice that due to the election of the constants and numerical factors, this net number N_0 is independent of V_M :

$$\int_0^{\infty}\rho[v]dv = N_0$$

(the constant N_0 has the dimensions L^{-3})

Note: The supposition that the undisturbed aether has a Maxwell-Boltzmann distribution of aetherino speeds seems "reasonable" but it is *not* at all a *necessary* election to imply the results obtained so far in this work. It can be seen that many other speed distribution functions, qualitatively similar (e.g. functions with different powers of v like for example: $k_1 v^3 Exp[-k_2 v^2]$, $k_3 v^2 Exp[-k_4 v]$, …), produce very similar predictions of the aether drag force and of the other forces described by the model.

NOTE: It is lately being assumed in this model that there exist two types of matter: p-type matter and n-type matter. It is also assumed that the aether is made of two types of aetherinos (p-type and n-type aetherinos) that in an undisturbed canonical aether are present in approximately the same proportion and with the same speed distribution. The p-type aetherinos are able to give impulse to the p-type matter but not to the n-type matter. Similarly the n-type aetherinos are able to give impulse to the n-type matter but not to the p-type matter.
An elementary particle can be made either by both types of matter or by only one type of matter. A particle that has a bigger amount of positive than negative matter is identified as a particle of positive electric charge. Similarly, a particle that has a bigger amount of negative than positive matter is identified as a particle of negative electric charge. A particle made by an equal amount of positive and negative matter is identified as a particle of zero electric charge.

Since it is assumed that there are two types of aetherinos (that in an undisturbed canonical aether are present in approximately the same proportion) then to calculate the aether drag force it will be assumed that the distribution of each type of aetherinos (p-type or n-type aetherinos) is $\rho_0[v]/2$ (i.e. half of the distribution given in [2-10] that includes both types of aetherinos). For this reason, introducing this 1/2 factor in the expression [2-9], it will be considered in what follows that the corrected expression of the aether drag force suffered by an elementary particle is:

[2-9b] $$F_{DRAG} = \frac{h_I}{2} \int_0^{\infty} \int_0^{\pi} (v \, Cos\theta - u) \; \sigma_I[v_R] \; v_R \; \frac{\rho_o[v]}{2} Sin\theta \; d\theta \, dv$$

where $\rho_0[v]$ is given in [2-10].

When calculating the drag force on a particle made of both types of matter it must be supposed that the cross section $\sigma_I[v_R]$ of the particle entering the equation [2-9b] is the sum of the cross sections of its both types of matter, i.e. $\sigma_I[v_R] = (a_{Ip} + a_{In}) \; Exp[-b_I \; v_R{}^2]$

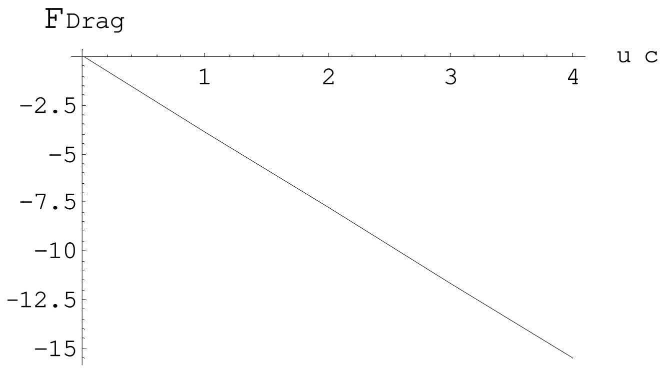
Example:
If it is supposed that the impulse-collision cross section of a particle with the pertinent aetherinos is given, as said above, by

[2-5b] $$\sigma_I[v_R] = a_I \; Exp[-b_I \; v_R{}^2]$$

then, replacing v_R and $\rho_0[v]$ by their values given respectively in [2-4] and [2-9b], the aether drag force takes the form:

[2-9c]
$$F_{DRAG} = \frac{h_I \, N_0 \, a_I}{\sqrt{\pi} \, V_M{}^3} \int_0^{\infty} \int_0^{\pi} (v \, Cos\theta - u) \; \frac{Exp\left[-b_I \; (u^2 + v^2 - 2 \, u \, v \, Cos\theta)\right]}{(u^2 + v^2 - 2 \, u \, v \, Cos\theta)^{-1/2}} \; v^2 \, e^{-(v/V_M)^2} \; Sin\theta \; d\theta \, dv$$

for which no analytical expression has been obtained due to the difficulty of solving its integrals. But assigning specific values to the parameters and performing numerical integrations, graphics can be obtained that give an idea of how the drag force depends on the absolute speed u of the particle through the aether. For example:



Fig[2-4]

The drag force shown in Fig[2-4] (for different values of the absolute speed u of the particle) corresponds to:
$c=1$; $V_M = 10^4$ c ; $N_0 = 10^{22}$; $h_I=1$; $a_I=1$; $b_I = 1.255/c^2$

It can be seen that, as long as u and c are significantly smaller than V_M, the modulus of the drag force increases linearly with u.

[2-11] $$F_{Drag} = - k_D \; u$$

where k_D is a positive constant.

Therefore the hypothesis [2-5e] implies that all moving *free* material bodies *decrease* their speed relative to the aether due to the drag force.
(A *free* material body is by definition a body that is only subject to the drag force due to its movement through the local aether but not to any other significant external force originated at other material bodies).

Numerical integrations and "function fits" (using a "guess and check" method) have been done to deduce how does the aether drag force depend on the constant V_M of the aether and on the speed c of light. (Note: The software Mathematica of Wolfram Research is able to obtain an exact expression for the θ integral but not for the v part). It has been found that assuming that the constant b_I (of the impulsion cross section of an elementary particle to aetherino collisions) is always (whatever the value of c) $b_I = 1.255/c^2$ (value consistent with other features of the model) then the aether drag force can be approximated by:

[2-12] $$F_{Drag} \cong - \frac{h_I \, a_I \, N_0}{\sqrt{\pi} \, V_M^{\;3}} \, 0.68 \, \frac{c^6}{V_M^{\;2}} u \;=\; - \; 0.38 \, \frac{h_I \, a_I \, N_0 \, c^6}{V_M^{\;5}} \, u$$

that may be considered valid for: $c << V_M$, $b_I = 1.255/c^2$ and u not much bigger than, say, u = 10c

Note: The approximation [2-12] has only been verified for $V_M \leq 10^5$ c. For higher values of V_M the author has been unable to obtain consistent results (numerical integrations of [2-9b]) with his mathematical tools and skills.

Inertial mass.

Considering that the model defines the *elementary aetherinical impulse* (due to the collision of a *single* aetherino on a material particle) as (see [2-5d]) $\mathbf{i_1} = h_1 \mathbf{v_R}$ and that the model defines the concept of *force* as the sum (vector sum) of the elementary aetherinical impulses suffered by a particle in unit time, then the hypothesis [2-5e] $\Delta\mathbf{u}_1 = \mathbf{i}_1 / \mu_P$ (about the velocity change $\Delta\mathbf{u}_1$ suffered by a particle when collided by an aetherino) implies that a particle suffering a force **F** will acquire an acceleration $\mathbf{a} = \mathbf{F}/\mu_P$ where μ_P is a constant specific of the particle suffering the force. Therefore, to be consistent with the Newton's second law of mainstream Physics, the model must call the constant μ_P the *inertial mass* of the particle.

Consider now a composite body made of *n* equal elementary particles. It is natural to consider that the velocity **u** of the composite body is the average velocity of its *n* particles.
Suppose that an aetherino (that will necessary must be considered part of the force suffered by the body) collides with one of the particles of the body. The particle hit by the aetherino will suffer a velocity increment $\Delta\mathbf{u}_1 = \mathbf{i}_1 / \mu_P$ The composite body can then be considered to acquire an increment of velocity $\Delta\mathbf{u} = \Delta\mathbf{u}_1/n = \mathbf{i}_1 / (n\,\mu_P)$ and, when considering many aetherinical collisions by unit time suffered by the particles that compose the body, an implication is that the acceleration suffered by the composite body will be given by $\mathbf{a} = \mathbf{F}/(n\,\mu_P)$. That means that the mass of a composite body made by many equal particles must be considered to be given by the sum of the masses of its component particles. But another extensive magnitude of the composite body that is directly proportional to its number *n* of particles is the *total* cross section A_I that it presents to the aetherinos that (as long as the component particles do not screen each other from the incoming aetherinos) is given by the sum of the individual cross sections a_I of its component particles, i.e. $A_I = n\, a_I$
Observing the expressions [2-9c] or [2-12] of the aether drag force, they contain only one constant magnitude that is specific of the particle suffering the force and that magnitude is the cross section a_I of the particle (notice that h_1 and c are universal constants while V_M and N_0 are quasi universal constants that characterize the local aether). Therefore it can be considered that the cross section a_I appearing in the expression of the aether drag force can be replaced (except for a conversion factor) by that other magnitude (the mass μ_P of the particle) that behaves in the same extensive (accumulative) way.
The approximation [2-12] for the aether drag force suffered by a single particle can then also be written as:

$$[2\text{-}12b] \qquad F_{Drag} \cong -\,0.38\,\frac{h_1\, a_I\, N_0\, c^6}{V_M^{\;5}}\, u = -k_{D1}\, a_I\, u = -k_{D2}\, \mu_P\, u$$

where
μ_P is the mass of the particle
k_{D2} is a positive constant, that does not depend on the type of particle but only on quasi fundamental constants related with the aether.

The strength of the aether drag force can be compared with the strength of the electrodynamic force. In the paper https://www.eterinica.net/redistribs_eterinicas_en.pdf it is shown that the force that a unit charge particle (e.g. a proton) exerts on another unit charge particle at rest (u=0) relative to the first and placed at a distance *d* is given by:

[2-14] $$F_{EE}[0] = \frac{1}{d^2}\int_0^{\infty} \sigma_S[v]\ \frac{\rho_0[v]}{2}\ \frac{v}{4\pi}\ \sigma_I[v]\ h_1\ v\ dv$$

where $\sigma_S[v]$ is the net cross section of the particle to *switch interactions* with aetherinos.
The model makes the hypothesis that the cross section of an elementary particle to *switch interactions* is:

[2-15] $$\sigma_S[v_R] = a_S\ \mathrm{Exp}[-b_S\ v_R^{\,2}]$$ = *cross section of a particle to collisions in which the aetherino switches its type.*

i.e. *the same function* assumed by hypothesis for the cross section to impulsion interactions (see [2-5b]) and where their constants are related as follows:

[2-15b] $b_S = b_I$

[2-15c] $a_S = \kappa\ a_I$

where κ is a positive numerical constant that is the same for all ordinary elementary particles.

The constant h_1 appearing in [2-14] is the same constant that appears as a factor in the expression of the aether drag force and has therefore no influence in the comparison of forces that is being done.
The total number N_0 of aetherinos in unit volume of "standard (non-disturbed) space" (included in the expression of $\rho_0[v]$) is also a common factor of the electric force and the drag force and does neither affect the comparison.
It can be shown that the "electric" force of the model is proportional to $1/V_M^3$ while the drag force (see Eq[2-12]) is proportional to $1/V_M^5$. Therefore the comparison between the strength of the electric force (for a given distance) and the strength of the drag force (for a given absolute speed) will depend on the value that the model assigns to V_M (As said above, V_M is the speed for which a *standard undisturbed aether at rest* has a maximum number of aetherinos).
See more at https://www.eterinica.net/redistribs_eterinicas_en.pdf

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The electrons orbit the nuclei of atoms with high speeds and suffer therefore a strong aether drag force. One might be tempted to think that those atomic orbits are inconsistent with such drag force and that therefore the model is unable to explain the main features of the atoms. But on the contrary, it can be seen (e.g. in the AOE.nb *Mathematica* notebook included in the Annex A of this work) that the model predicts stable (closed) atomic orbits *only if* there exists such aether drag. This is so because a nucleus exerts on an orbiting electron also a "forward force" that would make the electron increase continuously its orbiting radius if the aether drag force were absent. It can be seen that the model predicts closed stable atomic orbits when the aether drag force is, on the average approximately equal and opposite to the so called "forward force" suffered by the orbiting electron.

NOTE: Notice that in the model, the force that the nucleus exerts on an orbiting electron does not have strictly the semidirection *electron-nucleus* but has a small component along the semidirection of the electron's velocity. The reason is that the attraction force exerted by the nucleus is carried by aetherinos of finite velocity that are therefore seen in an aberrated direction by the moving electron. The average speed of the aetherinos carrying the gross part of the force originated by the protons of a nucleus is of the order of c and, since the proton "sends" to the electron a *deficit* number of aetherinos (compared to the aetherinos of the aether reaching the electron from all other directions), then the component of the nucleus force along the direction of the electron's velocity is a *forward* force that tends to increase the electron's speed.

In what respects the orbits of bodies bound by *gravitation* forces, the model shows that both the "forward force" and the drag force suffered by the orbiting body are much weaker than the ones suffered by the electrons in the atoms (compared with the force joining the central and the orbiting body) because, in the case of gravitation, the orbital speeds are much slower. Therefore although in general the gravitation orbits are not strictly closed orbits (the body follows instead a spiraling trajectory that either decreases or increases its distance to the attracting body approaching the "stable orbit"), it happens that in gravitation the tangential force (forward force + drag force) is so weak compared with the central force that the changes of the orbital radius are very slow.

NOTE: Gravitation (see the paper force_between_neutral_bodies.htm), is interpreted by the model as a residual effect of the incompletely balanced electric forces between ordinary neutral bodies (in which the negative charges have higher average speeds than the positive ones).

It is interpreted that most material bodies do not slow down due to the aether drag force because the vast majority of material bodies are bound by attraction forces that make them orbit around some center of force (electrons around nuclei, planets around stars, stars around inner masses of galaxies,...) in which the *forward force* plays an important role to counteract the drag force and allow quasi-stable orbits whose speed is sustained in time.

- <u>Aether Drag force on a Composite Particle</u>.

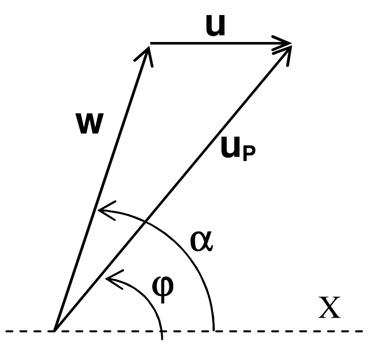

Fig [2-31]

Consider now a Composite Particle (CP), i.e. an aggregation of smaller particles.
Suppose that the CP is moving through the aether with a speed *u* along the x axis.
It will be assumed that the Aether Drag force on a CP is given by the sum of the aether drag forces on its components particles. This supposition seems reasonable if the component particles are small enough and are distant enough from each other so that they don't screen themselves sensibly from the incoming aetherinos of the aether.

Let w be the internal average speed of the component particles *relative to the CP* formed by them.
Let α be the direction of internal movement *of a given* particle in the reference frame of the CP. More precisely, α is the angle that the velocity **w** *relative to the CP* of a given particle, makes with the X axis of the reference frame associated with the CP. This axis X of the CP is supposed to remain parallel to the axis x of the aether-at-rest description reference frame S.
The velocity of a given particle *relative to the aether* will be called $\mathbf{u_P}$.

Two cases/assumptions can be distinguished:

(a) The speeds of all the component particles relative to the aether are small enough so that the aether drag force acting on every particle can be considered directly proportional to its net (or absolute) speed (i.e. the above approximation $\mathbf{F_D} = - k_D \mathbf{u_P}$ is valid for all the particles). Notice that if the velocity of a particle *relative to the* CP is **w** and the global velocity of the CP relative to the aether is **u**, then the net velocity of the particle relative to the aether is $\mathbf{u_P = w+u}$ and its net speed is $|\mathbf{w+u}|$.

(b) The net speeds of some (or all) of the component particles cannot be considered small enough to make the approximation $\mathbf{F_D} = - k_D \mathbf{u_P}$ In this case the net drag force acting on the CP must be evaluated adding the aether drag forces acting on each of its particle using the *exact* expression [2-9b].

- **The <u>case (a)</u>** can be evaluated as follows:
Since the aether drag force on any given particle is here considered to depend linearly on the absolute speed of the particle, then the drag force acting on a specific particle is given by the vector:

[2-32] $$\mathbf{F_{D1}} = - k_D \mathbf{u_P}$$

and its X-component, see Fig [2-31], is:

[2-33] $$F_{D1X} = - k_D u_{PX} = - k_D u_P \operatorname{Cos} \varphi = - k_D (w \operatorname{Cos} \alpha + u)$$

Supposing that the CP is made of *n* particles that have an isotropic distribution of velocities relative to the CP and supposing that all the particles have the same *speed* w relative to the CP, then, adding the X-component of their drag forces for all the particles (i.e. for all possible directions α of their velocities **w**):

[2-34] $$F_{CPX} \equiv F_{DRAG} = \int_0^{\pi} \frac{n \operatorname{Sin}\alpha}{2} (-k_D)(w \operatorname{Cos}\alpha + u)\, d\alpha = -k_D \; n \; u$$

which is also the final expression for the aether drag force on a CP moving at speed u relative to the aether (since by symmetry reasons the other two components of the force need not be considered).

NOTE.
The calculus of [2-34] has assumed that all the *n* particles have *the same speed* w relative to the CP. But since the resultant drag force does not depend on w it is seen a posteriori that a CP made of particles having a *plurality* of internal speeds isotropically distributed relative to the CP would give the same net drag force expressed in Eq[2-34].
The calculus of the aether drag force on an elementary particle shows that the constant k_D is proportional to the constant a_I that characterizes the cross section (see Eq[2-5b]) of the particle to impulsion aetherino collisions. The expression Eq[2-12] is an example. Therefore the result [2-34] of

the aether drag force suffered by a body (the CP) made of n equal particles (of isotropically distributed internal velocities) can be rewritten as:

[2-34b] $$\mathbf{F}_{DRAG} = -k_D \; n \; \mathbf{u} = -k_{D1} \, a_I \; n \; \mathbf{u}$$

where

a_I is the cross section of each of the component particles

k_{D1} is a positive constant, that does not depend on the type of particle but only on quasi fundamental constants related with the aether.

But suppose now that the composite particle (that can be a macroscopic material body) is composed by *more than one type* of particle and suppose that all given types have an isotropic distribution of internal speeds. Suppose that there are n_1 particles of cross section a_{I1}, n_2 particles of cross section a_{I2}, ...etc, then the total aether drag force suffered by the material body will be the sum of the aether drag forces exerted on each group of particles and it can be written

[2-34c] $$\mathbf{F}_{DRAG} = -k_{D1} \, (n_1 \, a_{I1} + n_2 \, a_{I2} + ...) \; \mathbf{u} = -k_{D1} \, A_I \; \mathbf{u}$$

where

A_I is the sum (i.e. the total) cross section of the composite particle or body.

u is the velocity of the composite particle (or macroscopic body) relative to the aether.

Interpreting, as reasoned above, that the inertial mass μ of an elementary particle is directly proportional to the impulsion cross section that it presents to the aetherinos then, calling k the constant of proportionality, the aether drag force suffered by a body made of several types of particles, can also be written

[2-34d] $$\mathbf{F}_{DRAG} = -k_{D1} \, (n_1 \, k \mu_1 + n_2 \, k \mu_2 + ...) \; \mathbf{u} = -k_{D2} \; m \; \mathbf{u}$$

where

m is the sum of the inertial masses μ_1, μ_2, ... of the particles composing the body and is therefore the mass of the body.

k_{D2} is a positive constant, that does not depend on the type of particle but only on quasi fundamental constants related with the aether.

Applying Newton's second law (a = F/m) then the approximately linear drag force implies that all *free* (of other forces) material particles moving relative to the aether decrease their speed according to the same exponential law:

[2-34e] $F_{DRAG} = - k_{D2} \; m \; u$ = (Newton's 2nd law) = m du/dt =>

[2-34f] $$u = u_0 \; e^{- k_{D2} \, t}$$

Floating reference system.

Suppose a body B, with mass, “floating in space”. This must be understood as meaning that the body B is acted only by (1) the gravitation force due to the rest of the bodies of the universe (mainly those that exert on B a stronger gravitation force) and (2) by the aether drag force due to its speed relative to the reference frame in which the aether can be considered at rest (i.e. due to its absolute speed), but the body B is not acted by any other external force (e.g. radiation forces, electric or magnetic forces, cosmic radiation, etc…)

Suppose next a small region R of space that “moves” with B (e.g. having at all epochs the body B at its center). The region R can be considered defined by the space contained within some imaginary walls. Suppose that the mass of B is so small that it has a negligible gravitational influence on any other test body that might be placed inside R or, better still, suppose that the body B, that has only been invoked to define the “floating” of R in space, is removed from R. Furthermore,

- Suppose that the floating region R is small enough so that all its parts suffer approximately the same gravitational influence from the exterior bodies of the universe, and

- Suppose that the region R does not rotate (or more precisely, has a negligible rotation) relative to the *rectilinear reference frames*. (Note: The rectilinear reference frames are those relative to which all the aetherinos move in straight lines at constant speeds. It is an hypothesis of the model that they exist). Such non-rotation can be assumed when, in the reference frame of the region R, the distant celestial bodies (e.g. galaxies) do not change noticeably their direction.

With those two (spatial and temporal) validity restrictions, the floating region R will be said to define a “*floating reference system*”

It can then be asserted that any neutral body B’, with mass, placed inside R at rest relative to its walls will remain at rest (relative to R). The reason is that the only forces acting on B’ are the gravitational force (from the other bodies of the universe) and the aether drag force (due to its absolute speed through the aether) and both forces are directly proportional to the mass of a body. And therefore any body B’ (with mass and initially at rest in R) will suffer the same acceleration **a** (relative to a rectilinear reference frame) suffered by the body B used to define the floating reference frame R.

But if a body A, with mass, is placed inside R with an initial velocity $\mathbf{v}_{RA}$ relative to R, the body A will suffer a different aether drag force than a body B at rest in R. (It is supposed that the gravitation force suffered by a body due to the attraction of another body with mass (e.g. the gravitation force suffered by A or B due to the other bodies outside R) does not depend significantly (for relative speeds much smaller than c) on the relative speed of the gravitationally interacting bodies.

Consider what happens from the point of view of the rectilinear reference frame S in which the aether can be considered at rest. Suppose that the velocity, *relative to* S, of the region R is $\mathbf{V}_R$. Therefore the body B (at rest in R) will be suffering an aether drag force $\mathbf{F}_{DB} = - m_B\, k\, \mathbf{V}_R$ (where m_B is the mass of B). The body A will be suffering an aether drag force $\mathbf{F}_{DA} = - m_A\, k\, (\mathbf{V}_R + \mathbf{v}_{RA})$ (where m_A is the mass of A). The gravitation forces (due to the massive bodies outside R) suffered respectively by B and A will be: $\mathbf{F}_{GB} = m_B\, \mathbf{g}$ and $\mathbf{F}_{GA} = m_A\, \mathbf{g}$ where the vector **g** is the same at both bodies and depends on the distribution of masses, relative to R, of the other bodies of the universe. Due to those forces, the accelerations (observed in the "at rest" reference frame S) of the bodies B and A are respectively:

$\mathbf{a}_B = (\mathbf{F}_{DB} + \mathbf{F}_{GB})/m_B \;=\; - k\, \mathbf{V}_R \;+\; \mathbf{g}$

$\mathbf{a}_A = (\mathbf{F}_{DA} + \mathbf{F}_{GA})/m_A \;=\; - k\, (\mathbf{V}_R + \mathbf{v}_{RA}) \;+\; \mathbf{g}$

and (in the “Galilean absolute-time” scenario of the model) the acceleration of the body A relative to the floating reference frame R (defined by B) is therefore:

$\mathbf{a}_R = \mathbf{a}_A - \mathbf{a}_B = - k\, \mathbf{v}_{RA}$

i.e. in other words, a body A with mass, set with an initial velocity **v** in a floating reference frame, behaves in the same way as if it were moving with a velocity **v** relative to the absolute reference frame in which the aether can be considered at rest. The laws of mechanics are therefore the same in any floating reference system and equal to the laws of mechanics valid in the absolute reference frame associated with the aether at rest. This equivalence between the floating reference systems of the model is similar to the equivalence between the *inertial* reference systems of mainstream Physics (or more precisely of General Relativity). The model also predicts that a reference system that moves at constant velocity relative to a “floating reference system” is not a floating reference system.

In another section of this work it is shown that, supposing a nucleus at rest in the absolute reference frame, closed orbits of electrons around such nucleus are possible precisely due to the contribution of the aether drag force suffered by the electron (i.e. the electric attraction force exerted by the nucleus on the electron is by itself unable to predict a closed orbit). Now it can be expected that the same stable electronic orbits (and hence the same atoms) will be possible in all “floating reference systems”.

Note: these assertions about the "floating reference systems" are a consequence of having assumed that the aether drag force has a linear dependence on the speed of the body relative to the aether. But this linearity is an approximation for body speeds significantly smaller than the average speed of the aetherinos in the aether-at-rest. On the other hand, this average speed of the aetherinos is believed to be many orders of magnitude bigger than the speed of light c.

Paddling the aether.
(proposed experiment)

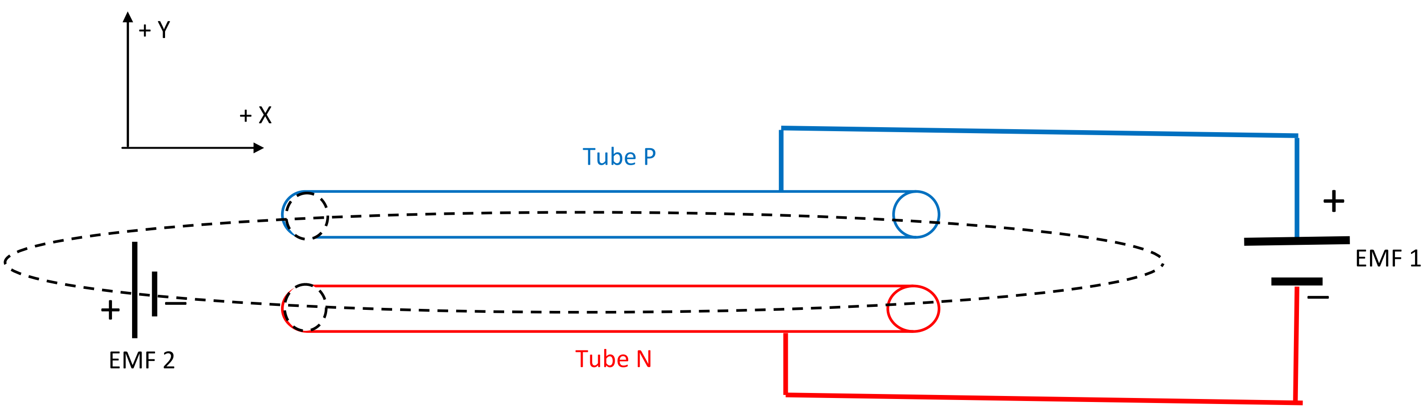

Fig 2-5

Fig 2-5 represents:
Two metal tubes (or pipes), P and N, that due to the battery and corresponding electromotive force (EMF) #1 are electrically charged so that tube P has a positive charge (deficit of electrons) while tube N has a negative charge (excess of electrons).
A current carrying wire (dotted line) passes through the inside of the tubes. The wire carries an electric current due to the battery and corresponding electromotive force (EMF) #2 so that the (carrier) electrons of the wire move along semidirection +X in tube N and in semidirection -X in tube P.
All the elements (tubes, wires, batteries,..) are anchored to some platform.
The thesis is that such platform (with all its elements) will suffer a net force along the semidirection -X. This force is not contemplated by mainstream physics that would only invoke the laws of electromagnetism, together with Newton's laws (including the 3rd) to describe the experiment.
Such force (adequately enhanced with more effective electrical devices) would be able to move the platform (or more generally the attached bodies) in space, oppose the force of gravity, etc.
The aether-model explanation of such net force would be that inside the tube N the electrons of the current will suffer a significantly bigger aether drag force than the aether drag force that they suffer when passing through tube P. The reason is that inside tube N (negatively charged) there will be a high density of n-type aetherinos (emerged from the negative charges of the tube N walls) together with the fact that the electrons only suffer impulses (and hence forces) when colliding with the n-type aetherinos. On the contrary, inside the tube P there will be a lower density of n-type aetherinos (since the positive charges of the tube P transform n-type aetherinos into p-type aetherinos) and therefore the electrons of the conducting wire will suffer a smaller aether drag force when passing through this tube.
The total aether drag force suffered in tube N by the electrons of the wire is expected to increase when increasing: (1) the negative charge of the tube (and hence the density of n-type aetherinos flying between its walls), (2) the length of the tube, 3) the intensity of the current, (4) the speed of the current carrying electrons…
(Notice that, inside the tube N, the *average* direction in which the n-type aetherinos travel between the walls of the tube has a zero component along the tube. The component along the direction X of the velocity of such average aetherinos *relative to* the electrons of the wire depends then fully on the speed of the electrons along the direction X (i.e. along the wire). The impulse along the direction X suffered by the electrons (and hence the net drag force) is proportional to such X component. But it is known that in standard conducting wires the speed of the electrons responsible of the current along the wire is extremely slow which implies a very weak average drag force *by electron*. But on the other hand it can be arranged that a very big number of electrons suffer at the same time such weak force adding to a measurable net force on the apparatus).

It could be asked: why not simply replace the tube N by a standard electric resistance? since such resistance would also exert a braking force on the conducting electrons of the wire. But in this case those conducting electrons would on its turn exert a reaction force (3rd Newton's law) on the material of the resistance that would cancel the other force so the platform would suffer no net force. On the contrary when it is the n-type aetherinos (of which there is a high number inside the tube N) that are responsible of the braking force suffered by the conducting electrons then the reaction force (if any) exerted by the electrons on those aetherinos is not transmitted to the platform since the *majority* of those aetherinos (in similarity with neutrinos) will continue its flight without colliding with matter.

The proposed experiment just described will require very sensible detectors of the forces suffered by the platform since it is expected that (with the arrangement described) these forces will be extremely weak.