Analysis of electric dipoles interaction forces as a function of the distance and of the form of electrical force law.

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Abstract.

We demonstrated in this article orientation OR principle and attraction AT principle of electrical dipoles P1, P2.

The OR stipulates that two electrical dipoles, will be reciprocally oriented parallel in the same sense if electrical forces F are of decreasing type with distance r. If forces F are of increasing type, the dipoles will be oriented parallel but on opposite sense.

The AT principle stipulates that two dipoles will exhibit always a reciprocal force R_a of attraction in both cases of force F type and orientation.

These findings complete our work [11] where we found that F_D force, between two electrical dipoles at atomic and nuclear level, is the actual gravitation force F_N..

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1. Observations about actual explanation for the absence of electrical interactions at long distances

Today, it is largely admitted that at long distances, at astronomical scales, at planetary scale and even at building scales, the electrical forces F_C given by classical Coulomb's law of electrical forces:

$$F_C = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2} = \frac{k q_1 q_2}{r^2}\text{; with } k=1/4\pi\varepsilon_0; \qquad (1), (1')$$

are negligible and should not be taken into account as it happens today .

The only forces considered today at such long distances are the gravitational forces F_N given by classical Newton's law.

$$F_N = -G\frac{Mm}{r^2} \qquad (2)$$

This affirmation excludes the electromagnetic phenomena which consist of more complex combinations of electric and magnetic forces originated at atomic scales.

But it is unlikely that the interaction forces acting between two electrical charges *q1, q2* may be perfectly described by mathematical simple laws as in (1), at any distances *r*, and of any scales, in the micro and macro universe.

At this point of our analysis, the above affirmation is justified by the reality complexity or its infinity and also by discrepancies between calculus results of actual simple laws from (1), (2) and some experimental measurements and observations concerning these forces, reported in the past.

Discrepancies concerning the Coulomb's law are confirmed by modern experiments, which allow scientists to conclude that in the case of very short distances (such as between molecules, atoms, nuclei, particles) the law (1) is not precisely correct [1], but also it has not yet been proven in the case of long distances [2]. In such circumstances, we can conclude that the Coulomb's law in the current form (1) is not perfect and that it can be improved.

For a more accurate description of the infinite reality, including ether presence which will be considered throughout this paper, as we previously demonstrated [3, 4, 5, 6], the most appropriate (but not singular mathematical) mode of electrical forces description, will be probable, a long or infinite series of successive powers of the 1/*r* distance.

In the present, it is accepted that macroscopic bodies have a random distribution of $+q$ and $-q$ charges, which will generate a random distribution of dipoles in any direction, and all coefficients k_i from (3) are canceled [7].

$$\phi_M = \frac{k_0}{\varepsilon_0 r} + \frac{k_1}{\varepsilon_0 \quad r^2} + \frac{k_2}{\varepsilon_0 r^3} + \ldots\ldots. \qquad (3)$$

This means that starting from small distances from any neutral body to infinite distances, the influence of the electric charges from that body is considered today to be null. But we will show below that this approach isn't correctly justified.

2. Our new our hypothesis and principles, concerning the dipole interactions at long distances.

2.1. Justification of introducing the two new principles of electric dipoles interaction, OR and AT.

Despite the fact that bodies *A*, *B*……., are neutral, the $+q$ and $-q$ charges are in fact always separated in space at atomic and nuclear scale and, consequently, every charge $+q$ or $-q$ will exert its electrical interaction force F_C to infinite distance according to (1) or to a corrected Coulomb law as in [8, 9, 10, 11].

So in nature practically all the matter must be regarded as being organized always as electrical dipoles *P1*, *P2*, *P3*…..as result of Coulomb law action even at smallest scales.

We will show next, that neglecting electrical forces and their potential even for distant bodies is not correct because we can admit and demonstrate the following two principles:

a). OR principle of the reciprocal orientation of distant dipoles.

b). AT principle of the permanent attraction of oriented distant dipoles.

2.2. Presentation and justification of OR principle.

In order to demonstrate the OR principle, we can calculate the torsion moments $+M$ (clockwise) and $-M$ (counterclockwise) created by an oriented dipole *P2* upon an un-oriented dipole *P1* (disposed at 90^0). In this situation (Fig.1) we can distinguish two cases, depending on the variation mode of interaction Coulomb's forces F with the distance r.

Case 1a). of decreasing F forces. Firstly, for this calculus, we suppose the interaction forces F_a (attraction for $+q/-q$ charges when $F_a<0$, according to (1)) and F_r (rejection for $+q/+q$ or $-q/-q$ charges, $F_r>0$, according to (1)) between electrical charges $+q$ and $-q$ as being some vectors F of central orientation *decreasing* with the increasing distance $r >> l$, between body *A* and body *B* according to the law of the general type (4), generalizing (1), with n a natural number:

$$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^n} = \frac{k q_A q_B}{r^n} \qquad (4)$$

including the simple case n=1: $F = \frac{kq_A q_B}{r}$ (4a)

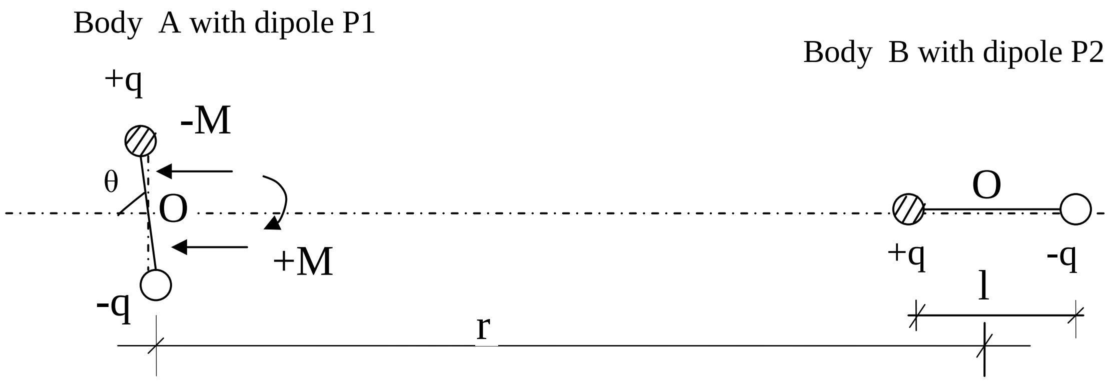

Fig. 1. Situation of two distant dipoles P1and P2 from bodies A and B, which manifest a reciprocal orientation

Product $q_A.q_B$ from (4), (4a) comprises for simplicity, also coefficients k/4πε$_0$. Utilizing (4a), we obtained from Fig.1 the clockwise torsion moment $+M$ and counterclockwise $-M$ moment, given upon *P1* dipole, by forces F from *P2* dipole, as follows:

$$M = F\frac{l}{2} = m(q_A q_B) \quad (5)$$

where function m represents the components of total M moments, given by various pairs of q charges.

$$+M = m\left(q_A^+ q_B^-\right) + m\left(q_A^- q_B^-\right) = kq^2\left[\left(\frac{1}{r+l/2}\right).\left(\frac{l}{2}\right) + \left(\frac{1}{r+l/2}\right).\left(\frac{l}{2}\right)\right] = kq^2\frac{2}{r+l/2}.\frac{l}{2} = kq^2\frac{l}{r+l/2} \quad (6)$$

$$-M = m\left(q_A^+ q_B^+\right) + m\left(q_A^- q_B^+\right) = kq^2\left[\left(\frac{1}{r-l/2}\right).\left(\frac{l}{2}\right) + \left(\frac{1}{r-l/2}\right).\left(\frac{l}{2}\right)\right] = kq^2\frac{2}{r-l/2}.\frac{l}{2} = kq^2\frac{l}{r-l/2} \quad (7)$$

The ratio r_M of the two moments results from (6) and (7):

$$r_M = \frac{+M}{-M} = \frac{kq^2\frac{l}{r+l/r}}{kq^2\frac{l}{r-l/r}} = \frac{r-l/2}{r+l/2} < 1; \rightarrow\rightarrow -M > +M; \quad (8)$$

This result of M moments ratio r_M indicates that the orientation of dipole *P1* will be in the *same* sense/direction as dipole *P2*, in this case of the *decreasing* positive forces F.

Case 1b). of decreasing F forces and sign chnge. We now must calculate what happens in the hypothetical case when the forces F from (4) and (4a) will change the sign from positive $+F$ to negative $-F$ forces, including the simple case n=1:

$$F = -\frac{kq_A q_B}{r} \tag{9}$$

In this modified Case 1b). we admit hypothetically, an inversion of the actual physical rule (attraction force $-F_a$ between $+q$ and $-q$ charges), becoming repulsion force $+F_r$ between $+q$ and $-q$ charges and attraction force $-F_a$ between $+q$ and $+q$ or between –q and –q charges.

In this modified Case 1b) the equations (6) and (7) becomes, considering the same senses of rotation of $+M$ and $-M$ moments, as in Fig. 1:

$$+M = m\left(q_A^+ q_B^+\right) + m\left(q_A^- q_B^+\right) = kq^2\left[\left(-\frac{1}{r-l/2}\right)\cdot\left(\frac{l}{2}\right) + \left(-\frac{1}{r-l/2}\right)\cdot\left(\frac{l}{2}\right)\right] = -kq^2\frac{2}{r-l/2}\cdot\frac{l}{2} = -kq^2\frac{l}{r-l/2} \tag{10}$$

$$-M = m\left(q_A^+ q_B^-\right) + m\left(q_A^- q_B^-\right) = kq^2\left[\left(-\frac{1}{r+l/2}\right)\cdot\left(\frac{l}{2}\right) + \left(-\frac{1}{r+l/2}\right)\cdot\left(\frac{l}{2}\right)\right] = -kq^2\frac{2}{r+l/2}\cdot\frac{l}{2} = -kq^2\frac{l}{r+l/2} \tag{11}$$

The ratio r_M of the two moments results:

$$r_M = \frac{+M}{-M} = \frac{-kq^2\dfrac{l}{r+l/r}}{-kq^2\dfrac{l}{r-l/r}} = \frac{r-l/2}{r+l/2} < 1; \rightarrow\rightarrow -M > +M; \tag{12}$$

This result of the M moments ratio r_M indicates that the orientation of dipole *P1* is in the *same* sense/direction as dipole *P2*, also in the case of inverse sign of *decreasing* forces F (as in Case 1a). of *decreasing* actual forces F).

So we conclude that changing the sign of F force, have no influence upon the orientation rule of dipoles *P1* and *P2*.

Case 2a). of increasing F forces. Secondly, for this calculus, we suppose the interaction force F_a (attraction) and F_r (rejection) between electrical charges q as being some vectors of central orientation *increasing* with the distance $r >> l$, according to the laws of the general type (13), with n a natural number:

$$F = k_1 q_A . q_B . r^n \qquad (13)$$

including the simple case n=1 or the limit power case of ln$r$, both cases increasing with r:

$$F = k_1 q_A . q_B r; \qquad or: \qquad F = k_1 q_A . q_B \ln r \qquad (13a), (13b)$$

Utilizing (13b) we obtain from Fig.1:

$$+M = m\left(q_A^+ q_B^-\right) + m\left(q_A^- q_B^-\right) = k_1 q^2 \left[\left(r + \frac{l}{2}\right).\left(\frac{l}{2}\right) + \left(r + \frac{l}{2}\right).\left(\frac{l}{2}\right)\right] = k_1 q^2 2\left(r + \frac{l}{2}\right).\frac{l}{2} = k_1 q^2 \left(r + \frac{l}{2}\right).l \qquad (14)$$

$$-M = m\left(q_A^+ q_B^+\right) + m\left(q_A^- q_B^+\right) = k_1 q^2 \left[\left(r - \frac{l}{2}\right).\left(\frac{l}{2}\right) + \left(r - \frac{l}{2}\right).\left(\frac{l}{2}\right)\right] = k_1 q^2 2\left(r - \frac{l}{2}\right).\frac{l}{2} = k_1 q^2 \left(r - \frac{l}{2}\right).l \qquad (15)$$

The ratio r_M of the two moments results:

$$r_M = \frac{+M}{-M} = \frac{k_1 q^2 \left(r + \frac{l}{2}\right).l}{k_1 q^2 \left(r - \frac{l}{2}\right).l} = \frac{r + \frac{l}{2}}{r - \frac{l}{2}} > 1; \rightarrow\rightarrow +M > -M; \qquad (16)$$

This result of M moments ratio r_M indicates that the orientation of dipole *P1* is in the *opposite* sense/direction as dipole *P2*, in case of *increasing positive* forces.

In Case 2b). of increasing *F* forces and sign change. when the force *F* is also as increasing with *r* type, but of reversed sign, is similar to the Case 1b). And hence the result of the calculus of r_M ratio will be similar: indicating that the orientation of dipole *P1* is in the *opposite* sense/direction as dipole *P2.* (as in Case 1b). in this case of inc*reasing* positive forces *F*.

And so at points Case 1). and Case 2)., the OR principle was demonstrated.

The OR principle stipulate that in case of decreasing electrical forces F with *r* the orientation of dipole *P1* is in the *same* sense/direction as dipole *P2* irespective of sign of *F.]*

But in case of increasing electrical forces *F* with *r*, the orientation of dipole *P1* is in the *opposit* sense/direction as dipole *P2* irespective of sign of *F.*

2.3. Presentation and justification of AT principle.

In order to demonstrate the AT principle, will be calculated forwards the resultant force *R*, appearing between two oriented dipoles, *P1A* and *P1B*, according to OR principle, given by forces of attraction F_a and by forces of repulsion F_r existing between $+q$ and $-q$ charges, as in actual F_C or completed *F*, Coulomb's law.

It must determine if the force *R* is the attraction or repulsion force, as a function of the form of the electric force law *F*.

The situation of two dipoles *P1A* and *P1B* originated in A body and in B body respectively, identically oriented and equal to each other, with polar moment value $r=q.l$, is presented in Fig.2. The two possible cases of the F force variation with the distance r between two electric charges will be analyzed below: Case 1). the *decreasing* variation and Case 2). the *increasing* variation of F force with r.

But we must remind that first calculus concerning the attraction force F_a and the rejection force F_r between two farther electrical dipoles was performed by us in [8, 11], but without presenting there the significance of the result of that calculus, consisting in the sign of resultant force R.

Also there was made a simplification of calculus by introducing a substitution: $\alpha=kq_A q_B$.

But here we will emphases that such result, will conduct at a new important principle, the AT principle of permanent attraction of electric dipole, described firstly here below.

In order to better understand the origin of AT principle we will resume here without the above substitution, the calculus of forces F_a and of F_r from [8, 11] performed in the two cases, Case 1 and Case 2, of the F force variation with the distance r.

<u>Case 1). of decreasing *F* forces.</u> Firstly, we suppose the interaction force F_a (attraction) and F_r (rejection) between electrical charges $+q$ and $-q$ as being some vectors of central orientation *decreasing* with the distance $r >> l$, according to the laws of the general type, from eqs. (4) or (4a).

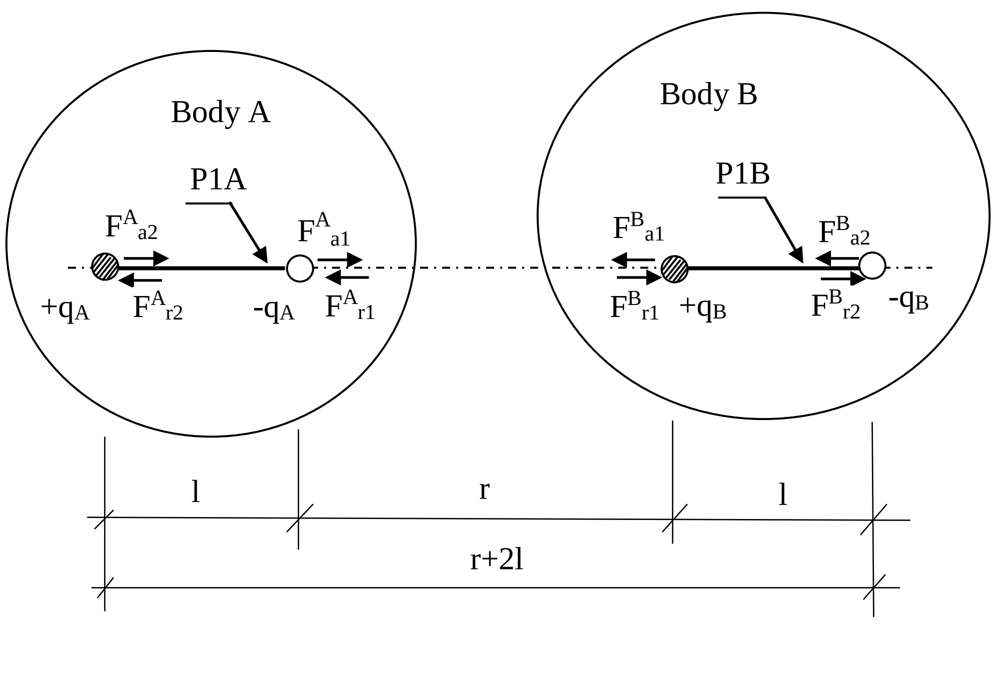

Fig. 2. Forces F acting between a pair of identical oriented dipoles P1A and P1B considered at atomic and nuclear level, from A and B bodies

From Fig.2, we now can calculate *directly* by simple algebra, utilizing eq. (4b), the total force upon each dipole, exerted by the other dipole. Here in calculus, we consider the + sign for force values having the sense of real force as in Fig.2. which corresponds to the attraction force F_a ($F_a<0$) and to repulsion force F_r ($F_r>0$), forces exerted by the charges $+q$, $-q$, as in Coulomb law (4).

From Fig. 2 notating $-q_A \rightarrow q^-_A$ and having $q^-_A\, q^+_B = q^+_A\, q^-_B$, we consider first, the forces exerted upon *P1A* dipole by a *P1B* dipole. Utilizing the simple case (4b) the resultant forces F_a and F_r values results as follows:

$$F_A = F^A_{a1} + F^A_{a2} = \frac{kq^-_A q^+_B}{r} + \frac{kq^+_A q^-_B}{r+2l} = kq^-_A q^+_B \frac{2r+2l}{r\left(r+2l\right)} \qquad (17)$$

$$F_R = F^A_{r1} + F^A_{r2} = \frac{kq^-_A q^-_B}{r+l} + \frac{kq^+_A q^+_B}{r+l} = 2kq^-_A q^-_B \frac{1}{\left(r+l\right)} \qquad (18)$$

If we rewrite the expression from the denominator from (17), one obtains:

$$r\left(r+2l\right) = \left(r+l\right)^2 - l^2 \qquad (19)$$

From (19) and admitting $r>>l$ it results:

$$r(r+2l) < (r+l)^2 \qquad (20)$$

Introducing (20) in (17) and comparing with (18) it results:

$$\left|F_a\right| = \left|kq^+_A q^-_B \frac{2r+2l}{r\left(r+2l\right)}\right| > \left|kq^-_A q^-_B \frac{2r+2l}{\left(r+l\right)^2}\right| = \left|F_r\right| \qquad (21)$$

$$\left|F_a\right| > \left|F_r\right| \qquad (22)$$

From (22) it results that in the case of forces F of the type as in eqs. (4), (4b) *decreasing* (n= +1) with the r distance, the attraction force F_a will be greater than the repulsion force F_r and finally an <u>attraction</u> force $R_a = F_a - F_r > 0$ between the two identically oriented dipoles *P1A, P1B* results. This result is correct even if the power of r is any $n > 1$, as can easily be demonstrated.

<u>Case 2) of increasing F forces.</u> Let's suppose the force F *increases* with the distance r, including a law of the form (13b).

$$F = k_1 q_A . q_B \ln r \qquad (23)$$

with coefficient k_1 being similar with coefficient k from eq. (4a) but having the appropriate measure units considering that the term $ln\ r$ must be adimensional.

Again from Fig.2, for identically oriented dipoles *P1A, P1B* (Fig.2), the total forces upon *P1A* dipole utilizing (23) will be:

$$F_a = F_{a1}^A + F_{a2}^A = k_1 q_A^- q_B^+ \ln r + k_1 q_A^+ q_B^- \ln\left(r+2l\right) = k_1 q_A^- q_B^+ \ln\left[r\left(r+2l\right)\right] \qquad (24)$$

$$F_r = F_{r1}^A + F_{r2}^A = k_1 q_A^- q_B^- \ln\left(r+l\right) + k_1 q_A^+ q_B^+ \ln\left(r+l\right) = k_1 q_A^- q_B^- \ln\left(r+l\right)^2 \qquad (25)$$

Comparing F_a and F_r from eqs. (24) and (25), and considering eq. (20) it results:

$$\left|F_a\right| = \left|k_1 q_A^- q_B^+ \ln\left[r\left(r+2l\right)\right]\right| < \left|k_1 q_A^- q_B^- \ln\left(r+l\right)^2\right| = \left|F_r\right| \qquad (26)$$

$$\left|F_a\right| < \left|F_r\right| \qquad (27)$$

From (27) it results that in the case of *increasing F* forces of the type from (23), the repulsion force F_r between two identically oriented dipoles *P1A*, *P1B*, will be greater than the attractive force F_a and the resultant force $R_r = F_r - F_a > 0$, will be a *repulsion* force. This result is correct even if the *increasing* variation has the general form $F = \alpha' r^n$ with $n>1$, as it can easily be demonstrated.

But in this Case 2 of *increasing F* forces (23), the natural orientation of two dipoles becomes reverted compared with those from Fig.2, according to the OR principle from Sec 2.2., and the interaction force between the two dipoles *P1A* and *P1B* will be again an attraction force $R_a = F_r - F_a < 0$ as for *decreasing* forces.

So, the <u>AT principle</u> stipulate that in case of decreasing electrical forces F with *r* an <u>attraction</u> force R_a between the two identically naturally oriented dipoles *P1A, P1B* results.

Also in case of increasing electrical forces F with *r*, because the two dipoles *P1A*, *P1B* will be naturally inverse oriented accordingly to OR principle, <u>AT principle</u> stipulate that again an <u>attraction</u> force R_a between the two dipoles *P1A, P1B* results.

And so, the simultaneous action of OR principle and of AT principle, will give birth of a permanent attraction between two any electrical dipoles irrespective of *F* force type.

The above analytical calculus and its results, yields the above OR principle and AT principle, whose result must be real.

This effect of permanent attraction of electrical dipoles *P1A, P1B* can be observed also in case of a group in any number of usual magnets m_i as spheres of about 2cm radius, which being separated initially, they will tend permanently to gather together as a clew, at a final natural free equilibrium position. Indeed they not separate or move away in space towards an alternate natural equilibrium position in our laboratory scale. Such magnets m_i may constitute a correct intuitive physical model of atomic or nuclear electric dipoles.

3. Conclusions and consequences

This article is intended to complete our previous series of articles and conference presentations, concerning the gravitation and ether [8, 9, 10, 11, 12].

Consequently, this paper analysis considered the interactions of electrical charges from the matter, which may really appear at very long distances as terrestrial or astronomical ones, in fact in the range of common gravitational forces. These were logical and in accordance with Coulomb's law (actual or corrected as in [11]), that in the presence of the electrical distinct *+q/-q* charges acting at an infinite distance, anywhere in space will appear some interactions between ever distinct electrical *+q/-q* charges because always electrical *+q/-q* charges will be grouped as electrical dipoles *P1, P2, P3*…..

Based also on the above observations from Sec. 1, we have demonstrated in the current article that no matter the form of electrical force law *F*, and accordingly to OR principle and to AT principle, between any distant two dipoles will act always an attraction dipole force F_D which we have proved in [11] to by even the so-called gravitation Newton force F_N.

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