The matter's inertia and interaction in an isolated system

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Abstract: The intrinsic inertia and interaction of matters with unchanged density in an isolated system are studied. It is shown that the matters have a proved inertia of spin with the angular velocity $\vec{\boldsymbol{\omega}}_{\boldsymbol{n}} = \frac{d\theta}{dt}\hat{\boldsymbol{n}} = \boldsymbol{\nabla} \times \vec{\boldsymbol{u}}$ of isolated system. The conclusive proof can reinforce Newton's the first law, taking into account the non-zero volume of point close to zero without limitation, and can explain the matter wave and seismic waves. A fundamental isolated system with two coupling matters has studied further. The revealed coupling characterizations have been used to explain the DNA structure, Time Cone and topological sphere of moving trace. The proven interaction within two matters is the coupling result of uniform rectilinear motion and spin of isolated system, which may be helpful to uniform the gravitation and electromagnetic force.

Introduction.—The conservation laws of matters can be classified as two distinct categories: those that are scalar including of mass, energy [1], electric charge; and those that are vector including of momentum, angular momentum, acceleration, angular acceleration, and spin of quantum particles as electron or atom [2,3]. Based on the viewpoint of the matters depending on ascertained space-time rather than mass point without any

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chinaXiv:202302.00043v1

volume [4], the systems could be analyzed as followed.

Model.—A infinitesimal even isolated system is used as the physical model, and its continuous equation of matters can be deduced using Lagrangian method. According to the conservation law, the matters of infinitesimal system keep constant as the product of density $\boldsymbol{\rho}$ and volume $\boldsymbol{V}$, $T=\boldsymbol{\rho V}=\boldsymbol{C}$, and its differential coefficient to the time parameter $\boldsymbol{t}$ is listed as follows:

$$\left.\frac{\mathrm{d}\rho}{\mathrm{d}t}\right|_V+\rho\left.\frac{\mathrm{d}V}{V\mathrm{d}t}\right|_\rho=0 \qquad (1)$$

The centre of infinitesimal even isolated system is set up as the origin of proprio-coordinate system to characterize its intrinsic properties, similarly to the centre of mass. The velocity of any point in the system is described by $\vec{u}=\frac{d\vec{l}}{dt}$, here $\mathrm{d}\vec{l}$ for the displacement vector within time quantum dt, and its divergence noted firstly in Chinese by Mohist Canon is listed as follows,

$$\operatorname{div}\ \vec{u}=\frac{1}{V}\lim_{V\to 0}\oiint_{\partial V}\vec{u}\cdot d\vec{S}=\frac{1}{V}\lim_{V\to 0}\oiint_{\partial V}\left(\frac{d\vec{l}}{dt}\right)\cdot \mathrm{d}\vec{S}$$

$$=\frac{1}{Vdt}\lim_{V\to 0}\oiint_{\partial V}d\vec{l}\cdot d\vec{S}$$

$$=\frac{1}{Vdt}\lim_{V\to 0}\oiint_{\partial V}d\left(\vec{l}\cdot\vec{S}\right)=\frac{1}{Vdt}\lim_{V\to 0}V=\frac{dV}{Vdt}$$

i. e.

$$\operatorname{div}\ \vec{u}=\frac{\boldsymbol{dV}}{\boldsymbol{Vdt}} \qquad (2)$$

Substitute equation (2) into equation (1), then

$$\left.\frac{d\rho}{dt}\right|_V+\rho\operatorname{div}\ \vec{u}|_\rho=0 \qquad (3)$$

As the most important and fundamental theory during the transport

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process in mechanics, the law of matter conservation with differential form is obtained, in which the density $\boldsymbol{\rho}$ or velocity $\boldsymbol{u}$ is variable for time $\boldsymbol{t}$ with constant volume $\boldsymbol{V}$ or constant density $\boldsymbol{\rho}$, respectively.

The following analysis can be conducted from equations (1-3):

***Part* (Ⅰ)*: Kinematics of a single homogeneous matter within an isolated system.*—** If there is a single homogeneous matter T_1 in the isolated system as shown in Dao De Jing, like deformable soft-body [5] water or rigid top, and its volume V_1 fills all space of the system [6].

$$T_1 = \lim_{V_1 \to 0} \rho_1 V_1 = \rho_1 \lim_{V_1 \to 0} V_1$$

$$\rho_1 = \frac{T_1}{\mathrm{V}_1} = \lim_{V_1 \to 0} \frac{T_1}{\mathrm{V}_1} = \frac{dT_1}{dV_1} = C_{1(t)}$$

From equation (3), then

$$\left.\frac{d\rho_1}{dt}\right|_{V_1} = \left.\frac{d\left(\frac{dT_1}{dV_1}\right)}{dt}\right|_{V_1} = \left.\frac{d^2T_1}{dV_1 dt}\right|_{V_1} = \left.\frac{dC_{(t)}}{dt}\right|_{V_1} = -\rho_1 \mathrm{div}\ \vec{u}_1|_{\rho_1} \qquad (4)$$

While $C_{1(t)}$ equals a non-zero and non-infinity constant to the physical meaning, $\rho_1 \mathrm{div}\ \vec{u}_1|_{\rho_1} = 0$ or $\mathrm{div}\ \vec{u}_1|_{\rho_1} = 0$ can be obtained from equation (4), and integrated further as

$$\vec{u}_1 = \vec{C}'(C' \neq \pm\infty) \qquad (5)$$

While the single homogeneous matter T of the system isn't fill space V fully, the rest space has the volume V', density ρ'=0, matter T'=0 and velocity $\vec{u}' = 0$. So, T=T_1+T'=$T_1 \neq 0$, $\boldsymbol{V}$=$\boldsymbol{V_1}$+V' $\neq 0$ and from equation (3),

$$\rho_1 = \frac{T_1}{\mathrm{V}_1} = \lim_{V_1 \to 0} \frac{T_1}{\mathrm{V}_1} = \frac{dT_1}{dV_1} = C_{1(t)}$$

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$$\rho' = \frac{T'}{V'} = \lim_{V' \to 0} \frac{T'}{V'} = \frac{dT'}{dV'} = C'_{(\mathrm{t})} = 0$$

$$\bar{\rho} = \frac{T}{V} = \frac{T_1 + T'}{V} = \frac{\rho_1 V_1 + \rho' V'}{V} = \frac{C_{1(t)} V_1 + C'_{(t)} V'}{V} = \frac{V_1}{V} C_{1(t)} = \frac{V_1}{V} \rho_1$$

For the system,

$$\left.\frac{d\bar{\rho}}{dt}\right|_V + \bar{\rho} \mathrm{div}\ \left.\bar{\vec{u}}\right|_{\bar{\rho}} = 0$$

$$\left.\frac{dT}{dt}\right|_V + T \mathrm{div}\ \left.\bar{\vec{u}}\right|_{\bar{\rho}} = 0$$

$$\because \left.\frac{dT}{dt}\right|_V = 0 \qquad \therefore \mathrm{div}\ \left.\bar{\vec{u}}\right|_{\bar{\rho}} = -\left.\frac{dT}{Tdt}\right|_V = 0 \qquad (4')$$

Therefore $\bar{\vec{u}} = \frac{\vec{u}_1 T_1 + \vec{u}' T'}{T_1 + T'} = \vec{C}' = \vec{u}_1 (C' \neq \pm\infty)$ (5)

Above equation revealed that the velocity of even matter keeps the same constant as the average velocity of the isolated system with single homogenous matter filled fully or not. If the matter is mass, the total momentum for the system keeps invariantly with the product of its mass and velocity.

Suppose that $\vec{\boldsymbol{l}}_{\mathbf{1}} = l_1 \hat{\boldsymbol{r}}$ at the moment $\boldsymbol{t}$,and in polar coordinate system with the same centre,

$$\vec{\boldsymbol{u}}_1 = \frac{d\vec{\boldsymbol{l}}_{\mathbf{1}}}{dt} = \frac{dl_1}{dt}\hat{\boldsymbol{r}} + l_1 \frac{d\hat{\boldsymbol{r}}}{dt} = \frac{dl_1}{dt}\hat{\boldsymbol{r}} + l_1 \frac{d\boldsymbol{\theta}}{dt}\hat{\boldsymbol{\tau}} = \frac{dl_1}{dt}\hat{\boldsymbol{r}} + \omega_n l_1 \hat{\boldsymbol{\tau}}$$

$$= \vec{\boldsymbol{u}}_r + \vec{\boldsymbol{u}}_\tau + \vec{\boldsymbol{u}}_n = \vec{\boldsymbol{u}}_r + \vec{\boldsymbol{u}}_\tau \qquad (\vec{\boldsymbol{u}}_n = 0\hat{\boldsymbol{n}} = 0) \quad (6)$$

Here the displacement vector $\hat{\boldsymbol{r}}$ is the unit vector for any point to the centre of system; vector $\hat{\boldsymbol{\tau}}$ is the unit vector perpendicular to the $\hat{\boldsymbol{r}}$ and lies in the plane consisted by the centre of system and unit vector $\hat{\boldsymbol{r}}$, $\hat{\boldsymbol{\tau}} \perp \hat{\boldsymbol{r}}$;

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$\vec{\boldsymbol{\omega}}_{\boldsymbol{n}} = \frac{d\theta}{dt}\hat{\boldsymbol{n}} = \boldsymbol{\nabla} \times \vec{\boldsymbol{u}}_1$ is the angular velocity of spin and its direction lines in unit vector $\hat{\boldsymbol{n}}$ which is perpendicular to unit vectors $\hat{\boldsymbol{\tau}}$ and $\hat{\boldsymbol{r}}$, simultaneously.

$$|\vec{\boldsymbol{u}}_1| = \sqrt{\left(\frac{dl_1}{dt}\right)^2 + \left(l_1\frac{d\boldsymbol{\theta}}{dt}\right)^2} = |\vec{C}'|$$

$$= \left|\sqrt{\left(\frac{dl_1}{dt}\right)^2 + \left(l_1\frac{d\boldsymbol{\theta}}{dt}\right)^2}\left[\frac{\frac{dl_1}{dt}}{\sqrt{\left(\frac{dl_1}{dt}\right)^2 + \left(l_1\frac{d\boldsymbol{\theta}}{dt}\right)^2}}\hat{\boldsymbol{r}} + \frac{l_1\frac{d\boldsymbol{\theta}}{dt}}{\sqrt{\left(\frac{dl_1}{dt}\right)^2 + \left(l_1\frac{d\boldsymbol{\theta}}{dt}\right)^2}}\hat{\boldsymbol{\tau}}\right]\right|$$

Given α as the angle between $\vec{\boldsymbol{u}}_1$ and $\hat{\boldsymbol{r}}$ is equal to the product of ω_n and some parameter Δ, then

$$\sin\alpha = \frac{l_1\frac{d\boldsymbol{\theta}}{dt}}{\sqrt{\left(\frac{dl_1}{dt}\right)^2+\left(l_1\frac{d\boldsymbol{\theta}}{dt}\right)^2}}, \quad \cos\alpha = \frac{\frac{dl_1}{dt}}{\sqrt{\left(\frac{dl_1}{dt}\right)^2+\left(l_1\frac{d\boldsymbol{\theta}}{dt}\right)^2}}$$

$$\tan\alpha = \frac{l_1\frac{d\boldsymbol{\theta}}{dt}}{\frac{dl_1}{dt}} = l_1\frac{d\boldsymbol{\theta}}{dl_1}, \quad \alpha = \tan^{-1}\left(l_1\frac{d\boldsymbol{\theta}}{dl_1}\right) = \omega_n\Delta$$

Thus $\vec{\boldsymbol{u}}_1 = \sqrt{\left(\frac{dl_1}{dt}\right)^2 + \left(l_1\frac{d\boldsymbol{\theta}}{dt}\right)^2}\,[(\cos\alpha)\hat{\boldsymbol{r}} + (\sin\alpha)\hat{\boldsymbol{\tau}}]$

$$= A\omega_n[(\cos\omega_n\Delta)\hat{\boldsymbol{r}} + (\sin\omega_n\Delta)\hat{\boldsymbol{\tau}}] = \vec{C}'$$

(7)

Here $A=\sqrt{\left(\frac{dl_1}{d\theta}\right)^2 + l_1^2}$, the velocity $\vec{\boldsymbol{u}}_1$ can be identified as the wave with spin of ω_n in the space field.

Discussions:

1)If l_1 keeps constant, then $\alpha = 90^{o}$,$\vec{\boldsymbol{u}}_1 \perp \hat{\boldsymbol{r}}$,$\vec{\boldsymbol{u}}_1 // \hat{\boldsymbol{\tau}}$,the circling motion of matter can be observed on an axis lining with unit vector $\hat{\boldsymbol{n}}$ and crossing the centre of system. Considering the space volume of system is close to zero without limitation, V→0 and V≠0, the conclusion of the spin of matter can drown with uniform angular velocity.

$$\vec{\boldsymbol{u}}_1 = \vec{\boldsymbol{u}}_\tau = l_1 \frac{d\boldsymbol{\theta}}{dt} \hat{\boldsymbol{\tau}} = \omega_n l_1 \hat{\boldsymbol{\tau}} = \vec{C}' \qquad (8)$$

2) If $\boldsymbol{\theta}$ keeps constant, then $\alpha = 0^{o}$, $\vec{\boldsymbol{u}}_1 \perp \hat{\boldsymbol{\tau}}$, $\vec{\boldsymbol{u}}_1 // \hat{\boldsymbol{r}}$, the uniform rectilinear motion of matter can be observed lining with unit vector $\hat{\boldsymbol{r}}$ and crossing the centre of system.

$$\vec{\boldsymbol{u}}_1 = \vec{\boldsymbol{u}}_r = \frac{d\vec{\boldsymbol{l}}_1}{dt} = \frac{dl_1}{dt} \hat{\boldsymbol{r}} = \vec{C}' \qquad (9)$$

3) If l_1 and $\boldsymbol{\theta}$ keep constant, then the matter of system keep static with $\vec{\boldsymbol{u}}_1 = 0$. (10)

Supposing the matter is mass, the contents of equations (8), (9) and (10) are the proved and reinforced Newton's the first law [4], not for mass point with zero volume in space, but for the single homogeneous system with its non-zero volume close to zero with no limitation, and its density keeps a constant of neither zero nor infinity. The inertia of motive matter of an isolated homogeneous system including quantum particle, is to keep static state, uniform rectilinear motion or uniform angular spin [7].

4)If l_1 and $\boldsymbol{\theta}$ are all changing, and α may be some ascertained value of 0^{o} to 90^{o}, the matter performs the collective motive state of uniform rectilinear motion and uniform angular spin along the directions of $\hat{\boldsymbol{r}}$

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and $\vec{\boldsymbol{\tau}}$, respectively, liking two types of seismic waves. As expressed in the equation of (7), the velocity $\vec{\boldsymbol{u}}_1$ shows the motion of polarized transverse wave, where the properties of wave can be explained as the extension of uniform angular spin along the direction of uniform rectilinear motion, and its properties of particle can be explained as the uniform rectilinear motion, as the same as the matter wave in de Broglie hypothesis [8].

Part* (Ⅱ)*:* *Kinematics and dynamics of two homogeneous matters within an isolated system.—If two homogeneous matters T_1 and T_2 in an isolated system as noted in The Book of Changes, their volumes V_1 and V_2 are not filled all space of the system. At the initial time t_0, an the origin ***O*** of proprio-coordinate system is signed by the centre of infinitesimal isolated system, and it will change to $\boldsymbol{O}_1$ at time t_1 and further change to $\boldsymbol{O}_d$ at time t with a range of $dt=t-t_1$. As for the spins of matters T_1 and T_2 can be ignored, considering that the supposed distances between matters and the centre of isolated system are very larger than their dimensions, all the movement about the integral system is discussed for the two-point model of matters T_1 and T_2 as shown in Dao De Jing. For the matter point of T_1, its location can be described as a vector $\vec{r}_{11}$ to the centre of $\boldsymbol{O}_1$ and anther vector $\vec{r}_1$ to the centre of $\boldsymbol{O}_d$. The similar vectors $\vec{r}_{21}$ and $\vec{r}_2$ can be listed for matter point of T_2. Therefore, the points of centres***O***, $\boldsymbol{O}_1$ and $\boldsymbol{O}_d$ can mark a plane of $\overline{\boldsymbol{OO_1O_d}}$, $\vec{l} = \overrightarrow{OO_1}$ and $d\vec{l} = \overrightarrow{O_1O_d}$ are defined

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as the displacement and unit one of the whole isolated system, as shown in **Fig. 1**. The characters of matters T_1, T_2 and rest space in the isolated system are shown as (T_1, V_1, ρ_1, $\vec{r}_{11}$, $\vec{r}_1$, $\vec{u}_1$; T_2, V_2, ρ_2, $\vec{r}_{21}$, $\vec{r}_2$, $\vec{u}_2$; T_3=0, V_3, ρ_3=0, $\vec{u}_3 = 0$), and their relationships are T=T_1+T_2+T_3=T_1+T_2=C≠0 and $\boldsymbol{V} = \boldsymbol{V_1}+\boldsymbol{V_2}+\boldsymbol{V_3}$≠0.

FIG. 1. The geometric graph of moving matters T_1 and T_2 in an isolated system.

Therefore, from equation (3),

$$\rho_1 = \frac{T_1}{V_1} = \lim_{V\to 0}\frac{T_1}{V_1} = \frac{dT_1}{dV_1} = C_{1(t)}$$

$$\rho_2 = \frac{T_2}{V_2} = \lim_{V\to 0}\frac{T_2}{V_2} = \frac{dT_2}{dV_2} = C_{2(t)}$$

$$\rho_3 = \frac{T_3}{V_3} = \lim_{V\to 0}\frac{T_3}{V_3} = \frac{dT_3}{dV_3} = C_{3(t)} = 0$$

$$\overline{\rho} = \frac{T}{V} = \frac{T_1 + T_2 + T_3}{V} = \frac{\rho_1 V_1 + \rho_2 V_2 + \rho_3 V_3}{V} = \frac{C_{1(t)}V_1 + C_{2(t)}V_2}{V}$$

Put above parameters into the equation (3) for all isolated system

$$\left.\frac{d\overline{\rho}}{dt}\right|_V + \overline{\rho}\,\mathrm{div}\ \left.\overline{\vec{u}}\right|_\rho = 0$$

$$\left.\frac{d(T_1+T_2)}{dt}\right|_V + (T_1+T_2)\mathrm{div}\ \left.\overline{\vec{u}}\right|_\rho = 0$$

$$(T_1+T_2)\mathrm{div}\ \left.\overline{\vec{u}}\right|_\rho = 0$$

That is $$\overline{\vec{u}} = \vec{C}'(C' \neq \pm\infty) \quad (5)$$

Above equation implied that the average velocity $\overline{\vec{u}}$ of two-matter isolated system keeps constant vector $\vec{C}'$. If the matters are mass, the total momentum $\vec{P}$ of the system also keeps invariantly named the

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conservation law of momentum as listed.

$$\vec{P} = T_1\vec{u}_1 + T_2\vec{u}_2 = (T_1 + T_2)\overline{\overline{\vec{u}}} = (T_1 + T_2)\vec{C}' \quad (C' \neq \pm\infty) \qquad (11)$$

And the average velocity of the whole isolated system is

$$\overline{\overline{\boldsymbol{u}}} = \frac{T_1\vec{u}_1 + T_2\vec{u}_2}{T_1 + T_2} \quad = \frac{T_1\vec{u}_1}{T_1 + T_2} + \frac{T_2\vec{u}_2}{T_1 + T_2} = \vec{C}'$$

$$T_1\vec{u}_1 + T_2\vec{u}_2 = (T_1 + T_2)\vec{C}'(C' \neq \pm\infty)$$

As the same as equation (6), here $\overline{\overline{\boldsymbol{u}}}$ presents the collective motive state of uniform rectilinear motion and angular spin of the whole system's centre. Get derivative with respect to time, above equation comes into

$$\frac{d(T_1\vec{u}_1 + T_2\vec{u}_2)}{dt} = T_1\frac{d\vec{u}_1}{dt} + T_2\frac{d\vec{u}_2}{dt} = \frac{d(T_1 + T_2)\vec{C}'}{dt} = (T_1 + T_2)\frac{d\vec{C}'}{dt}$$

Define $\vec{a}_1 = \frac{d\vec{u}_1}{dt}$ and $\vec{a}_2 = \frac{d\vec{u}_2}{dt}$, then

$$T_1\vec{a}_1 + T_2\vec{a}_2 = 0$$

Further define $\vec{F}_1 = T_1\vec{a}_1$ and $\vec{F}_2 = T_2\vec{a}_2$, similarly as Newton's the second Law [4], therefore $\vec{F}_1 + \vec{F}_2 = 0$ i.e. $\vec{F}_1 = -\vec{F}_2$ has obtained as Newton's the third Law [4].

Based on the system centre ***O*₁**, the respective proper orthogonal decompositions of $\vec{u}_1$, $\vec{u}_2$, $\overline{\overline{\boldsymbol{u}}}$, and $\vec{C}'$ vectors along $\hat{\boldsymbol{r}}$, $\hat{\boldsymbol{\tau}}$, and $\hat{\boldsymbol{n}}$ unit vectors, can be substituted into Equation (11) as followed.

$$\begin{aligned}\vec{P} &= T_1(\vec{u}_{1r} + \vec{u}_{1\tau} + \vec{u}_{1n}) + T_2(\vec{u}_{2r} + \vec{u}_{2\tau} + \vec{u}_{2n}) \\ &= (T_1 + T_2)\left(\overline{\overline{\vec{u}}}_r + \overline{\overline{\vec{u}}}_\tau + \overline{\overline{\vec{u}}}_n\right) \\ &= (T_1 + T_2)(\vec{C}'_r + \vec{C}'_\tau + \vec{C}'_n) \qquad (C' \neq \pm\infty) \qquad (11')\end{aligned}$$

Therefore, the components of system along the $\hat{\boldsymbol{r}}$, $\hat{\boldsymbol{\tau}}$ and $\hat{\boldsymbol{n}}$ directions

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are shown, following the same conservation law

$$\vec{P}_r = T_1\vec{u}_{1r} + T_2\vec{u}_{2r} = (T_1 + T_2)\overline{\vec{u}}_r = (T_1 + T_2)\vec{C}_r' \qquad \text{(11-1)}$$

$$\vec{P}_\tau = T_1\vec{u}_{1\tau} + T_2\vec{u}_{2\tau} = (T_1 + T_2)\overline{\vec{u}}_\tau = (T_1 + T_2)\vec{C}_\tau' \qquad \text{(11-2)}$$

$$\vec{P}_n = T_1\vec{u}_{1n} + T_2\vec{u}_{2n} = (T_1 + T_2)\overline{\vec{u}}_n = (T_1 + T_2)\vec{C}_n' \qquad \text{(11-3)}$$

For $\vec{u}_n$ is zero in equation (6), the equation (11-3) is transformed to

$$\vec{P}_n = T_1\vec{u}_{1n} + T_2\vec{u}_{2n} = 0 \qquad \text{(11-3')}$$

and further analyzed as, that the centre of two-matter isolated system has no translation or rotation, but only harmonic vibration of two matters as two spring oscillators around the centre and along direction $\hat{\boldsymbol{n}}$ for astringency, their velocities follow the equation as

$$\vec{u}_{1n} = -\frac{T_2}{T_1}\vec{u}_{2n} \qquad \text{(12-1)}$$

and it performs the collective motive state of uniform rectilinear motion and uniform angular spin in the plane of $\overline{\boldsymbol{OO_1O_d}}$ consisted by $\hat{\boldsymbol{r}}$ and $\hat{\boldsymbol{\tau}}$ unit vectors. Therefore, the translation, spin and vibration are orthogonal along the $\hat{\boldsymbol{r}}$, $\hat{\boldsymbol{\tau}}$ and $\hat{\boldsymbol{n}}$ directions, respectively.

And the similar equations to equation (12-1) can be deduced as

$$\vec{u}_{1r} = -\frac{T_2}{T_1}\vec{u}_{2r} + \left(1 + \frac{T_2}{T_1}\vec{C}_r'\right) \qquad \text{(12-2)}$$

$$\vec{u}_{1\tau} = -\frac{T_2}{T_1}\vec{u}_{2\tau} + \left(1 + \frac{T_2}{T_1}\vec{C}_\tau'\right) \qquad \text{(12-3)}$$

If the angles between directions of vector $\hat{r}$, $\hat{\tau}$ or $\hat{n}$, and the line crossing two matters and the centre of isolated system, are defined as α, β or γ $(\alpha, \beta$ or $\gamma \in [0, \pi/2])$, the projection in direction $\hat{r}$ of vector $\vec{r}_1$ is $\vec{r}_{1\perp} = \vec{r}_1\cos\alpha$. Considering the same angular velocity $\vec{\omega}_n$ of spin and

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the same line of $\vec{r}_1$ and $\vec{r}_2$ with the opposite direction for the centre of two-mater isolated system, the directions of velocities $\vec{u}_{1\tau}$ and $\vec{u}_{2\tau}$ are opposite, and their values fit the equation $\vec{u}_\tau = r_\perp \omega_n \hat{\tau}$ from $\vec{u}_\tau = \vec{\omega}_n \times \vec{r}_\perp$, and the equation (11-2) is transformed to

$$\begin{aligned}\vec{P}_\tau &= T_1 r_{1\perp}\omega_n\hat{\tau} - T_2 r_{2\perp}\omega_n\hat{\tau} = (T_1 r_{1\perp} - T_2 r_{2\perp})\omega_n\hat{\tau} \\ &= (T_1 r_1 cos\alpha - T_2 r_2 cos\alpha)\omega_n\hat{\tau} = (T_1 r_1 - T_2 r_2)\omega_n cos\alpha\hat{\tau} \\ &= (T_1 + T_2)\vec{C}'_\tau = (T_1 + T_2)C'_\tau\hat{\tau}\end{aligned}$$

Therefore $$\omega_n = \frac{(T_1+T_2)C'_\tau}{(T_1 r_1 - T_2 r_2)cos\alpha} \qquad (12\text{-}4)$$

Discussions:

1) When $\alpha=\pi/2$, $\vec{P}_\tau = 0$, $\vec{C}'_\tau = 0$, the equation (11-2) changes into the same form as equation (11-3), and equation (12-4) is to be meaningless. The collective motive states of polarizing motion with contrary phases both in $\hat{n}$ and $\hat{\tau}$ directions, and of motionless or uniform rectilinear motion in $\hat{r}$ direction, should shape the moving traces similar to the figures of Lissajous or twisted vines of plants [9].

2) When $\alpha \neq \pi/2$, $\omega_n = \frac{(\Delta T_1+\Delta T_2)C'_\tau}{(\Delta T_1 r_1 - \Delta T_2 r_2)cos\alpha}$, especially for α=0, then cosα=1 and the minimum value $\omega_n = \frac{(\Delta T_1+\Delta T_2)C'_\tau}{(\Delta T_1 r_1 - \Delta T_2 r_2)}$. The collective motive states of polarizing motion with contrary phases in direction $\hat{n}$, of spin with uniform the same angular velocity $\vec{\omega}_n$ in direction $\hat{\tau}$, and of motionless or uniform rectilinear motion in direction $\hat{r}$, should shape the moving traces similar to the familiar figures of double helix like DNA structure which physical mechanism has not been revealed

before [10] or of funnel shape like Time Cone revealed by Einstein [11].

3) When $\vec{C}_r' = \vec{C}_\tau' = 0$, three equations of (11-1,2,3) are in the same formation returning to equation (11) after vector overlay operation. The collective motive states of polarizing motion with contrary phases in $\hat{n}$, $\hat{\tau}$ and $\hat{r}$ directions should shape the moving trace of topological sphere, and the spins with contrary direction of two matters are both perpendicular to the surface of sphere [12].

4) Get derivative with respect to time, equations (12-1, 2, 3) become

$$\vec{a}_{1r} = -\frac{T_2}{T_1}\vec{a}_{2r} \;;\; \vec{a}_{1\tau} = -\frac{T_2}{T_1}\vec{a}_{2\tau} \;;\; \vec{a}_{1n} = -\frac{T_2}{T_1}\vec{a}_{2n} \qquad (13)$$

The respective proper orthogonal decomposed equations (13) announce the relationship of $\vec{a}_1 = -\frac{T_2}{T_1}\vec{a}_2$ in the line of matters T_1 and T_2, based on the centre ***O*₁** of isolated system rather than that of matter T_1 or T_2.

From equation (6), the velocities of matters T_1 and T_2 are listed as

$$\vec{\boldsymbol{u}}_1 = \frac{d\vec{\boldsymbol{r}}_1}{dt} = \frac{dr_1}{dt}\hat{\boldsymbol{r}}_1 + r_1\frac{d\hat{\boldsymbol{r}}_1}{dt} = \frac{dr_1}{dt}\hat{\boldsymbol{r}}_1 + r_1\frac{d\boldsymbol{\theta}}{dt}\hat{\boldsymbol{\tau}}_1 = \frac{dr_1}{dt}\hat{\boldsymbol{r}}_1 + \omega_n r_1\hat{\boldsymbol{\tau}}_1$$

$$= \vec{\boldsymbol{u}}_{r1} + \vec{\boldsymbol{u}}_{\tau1} + \vec{\boldsymbol{u}}_{n1} = \vec{\boldsymbol{u}}_{r1} + \vec{\boldsymbol{u}}_{\tau1} \qquad (\vec{\boldsymbol{u}}_{n1} = 0\hat{\boldsymbol{n}}_1 = 0) \quad (6\text{-}1)$$

$$\vec{\boldsymbol{u}}_2 = \frac{d\vec{\boldsymbol{r}}_2}{dt} = \frac{dr_2}{dt}\hat{\boldsymbol{r}}_2 + r_2\frac{d\hat{\boldsymbol{r}}_2}{dt} = \frac{dr_2}{dt}\hat{\boldsymbol{r}}_2 + r_2\frac{d\boldsymbol{\theta}}{dt}\hat{\boldsymbol{\tau}}_2 = \frac{dr_2}{dt}\hat{\boldsymbol{r}}_2 + \omega_n r_2\hat{\boldsymbol{\tau}}_2$$

$$= \vec{\boldsymbol{u}}_{r2} + \vec{\boldsymbol{u}}_{\tau2} + \vec{\boldsymbol{u}}_{n2} = \vec{\boldsymbol{u}}_{r2} + \vec{\boldsymbol{u}}_{\tau2} \qquad (\vec{\boldsymbol{u}}_{n2} = 0\hat{\boldsymbol{n}}_2 = 0) \quad (6\text{-}2)$$

Their accelerations are listed as

$$\vec{\boldsymbol{a}}_1 = \frac{d\vec{\boldsymbol{u}}_1}{dt} = \left[\frac{d^2r_1}{dt^2} - r_1\omega_{n1}^2\right]\hat{\boldsymbol{r}}_1 + \left(2\omega_{n1}\frac{dr_1}{dt} + r_1\frac{d\omega_{n1}}{dt}\right)\hat{\boldsymbol{\tau}}_1 + 0\hat{\boldsymbol{n}}_1$$

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$$\vec{\boldsymbol{a}}_{\boldsymbol{2}} = \frac{d\vec{\boldsymbol{u}}_2}{dt} = \left[\frac{d^2 r_2}{dt^2} - r_2\omega_{n2}^2\right]\hat{\boldsymbol{r}}_2 + \left(2\omega_{n2}\frac{dr_2}{dt} + r_2\frac{d\omega_{n2}}{dt}\right)\hat{\boldsymbol{\tau}}_2 + 0\hat{\boldsymbol{n}}_2$$

The relationship of unit vectors $(\hat{\boldsymbol{r}}_1, \hat{\boldsymbol{\tau}}_1, \hat{\boldsymbol{n}}_1)$ and $(\hat{\boldsymbol{r}}_2, \hat{\boldsymbol{\tau}}_2, \hat{\boldsymbol{n}}_2)$ has been listed as followed,

$$\begin{gathered}\hat{\boldsymbol{r}}_2 = -\hat{\boldsymbol{r}}_1 \\ \hat{\boldsymbol{\tau}}_2 = -\hat{\boldsymbol{\tau}}_1 \\ \hat{\boldsymbol{n}}_2 = \hat{\boldsymbol{n}}_1\end{gathered}$$

Considering the isolated system has the same angular velocity with that of matters T_1 and T_2, therefore, those angular velocities have the same value $\omega_{n1} = \omega_{n2} = \omega_n$ of binary system [13].

The forces $\vec{\boldsymbol{F}}_1$ and $\vec{\boldsymbol{F}}_2$ along and/or across the line between matters T_1 and T_2 are

$$\vec{\boldsymbol{F}}_{\boldsymbol{1}} = \boldsymbol{T}_{\boldsymbol{1}}\vec{\boldsymbol{a}}_{\boldsymbol{1}} = \boldsymbol{T}_{\boldsymbol{1}}\left[\frac{d^2 r_1}{dt^2} - r_1\omega_{n1}^2\right]\hat{\boldsymbol{r}}_1 + \boldsymbol{T}_{\boldsymbol{1}}\left(2\omega_{n1}\frac{dr_1}{dt} + r_1\frac{d\omega_{n1}}{dt}\right)\hat{\boldsymbol{\tau}}_1$$

$$\vec{\boldsymbol{F}}_{\boldsymbol{2}} = \boldsymbol{T}_{\boldsymbol{2}}\vec{\boldsymbol{a}}_{\boldsymbol{2}} = \boldsymbol{T}_{\boldsymbol{2}}\left[\frac{d^2 r_2}{dt^2} - r_2\omega_{n2}^2\right]\hat{\boldsymbol{r}}_2 + \boldsymbol{T}_{\boldsymbol{2}}\left(2\omega_{n2}\frac{dr_2}{dt} + r_2\frac{d\omega_{n2}}{dt}\right)\hat{\boldsymbol{\tau}}_2$$

With the formula $|\boldsymbol{\nabla} \times \vec{\boldsymbol{u}}|$ to instead of $\boldsymbol{\omega}_{\boldsymbol{n}}$, the uniformity from the centre of isolated system is

$$\begin{aligned}\vec{\boldsymbol{F}} = \boldsymbol{T}\vec{\boldsymbol{a}} &= \boldsymbol{T}\left[\frac{d^2 r}{dt^2} - r\omega_n^2\right]\hat{\boldsymbol{r}} + \boldsymbol{T}\left(2\omega_n\frac{dr}{dt} + r\frac{d\omega_n}{dt}\right)\hat{\boldsymbol{\tau}} \\ &= \boldsymbol{T}\left[\frac{d^2 r}{dt^2} - r|\nabla \times \vec{u}|^2\right]\hat{\boldsymbol{r}} + \boldsymbol{T}\left(2|\nabla \times \vec{u}|\frac{dr}{dt} + r\frac{d|\nabla\times\vec{u}|}{dt}\right)\hat{\boldsymbol{\tau}} \quad (14)\end{aligned}$$

The previous equation (14) reveals that the interaction between two matters in composed isolated system has existed along and across the radius at the same time, especially containing attractive force [14]. And the equation (14) can be changed into quantum form, if the vectors of $\vec{r}$

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and $\vec{u}$ have been changed into wave functions. As the simplest fundamental model of the motive matters' interaction in view of spin identified, it may be helpful to unite the four interactions in the field of space and velocity, which needs to be proved by experiments in future.

Conclusions.— The inertia and interaction have been studied for the matters with unchanged density in an isolated system. The inertia of spin with the angular velocity $\vec{\boldsymbol{\omega}}_{\boldsymbol{n}} = \frac{d\theta}{dt}\hat{\boldsymbol{n}} = \boldsymbol{\nabla} \times \vec{\boldsymbol{u}}$ has been revealed and added into the Newton's the first law, for the matter of isolated system, by considering the point with non-zero volume but close to zero. The inertias of uniform angular spin and uniform rectilinear motion can be used to explain wave-particle duality and seismic waves. Further, the coupling isolated system with double matters has been chosen as the second fundamental model. The coupling characterizations inner two matters can be used to prove Newton's the second and third laws, to explain the structure of DNA, the shapes of Time Cone and topological sphere of moving trace. The force of two coupling matters has been expressed as a united formula $\vec{\boldsymbol{F}} = \boldsymbol{T}\left[\frac{d^2r}{dt^2} - r|\nabla \times \vec{u}|^2\right]\hat{\boldsymbol{r}} + \boldsymbol{T}\left(2|\nabla \times \vec{u}|\frac{dr}{dt} + r\frac{d|\nabla\times\vec{u}|}{dt}\right)\hat{\boldsymbol{\tau}}$, in which r and $\vec{u}$ have the same origin of isolated system centre and can be instead of wave function to fit quantum mechanics, as shown in the literatures [15,16]. The interaction of coupling matters may be helpful to uniform the gravitation and electromagnetic force in future.

Acknowledgement

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Zhengfa Li thanks financial supports supported by the National Natural Science Foundation of China (Grant No. 12164039) and by Scientific Research Foundation for Advanced Scholars of Shihezi University (Grant No. RCZK202009).

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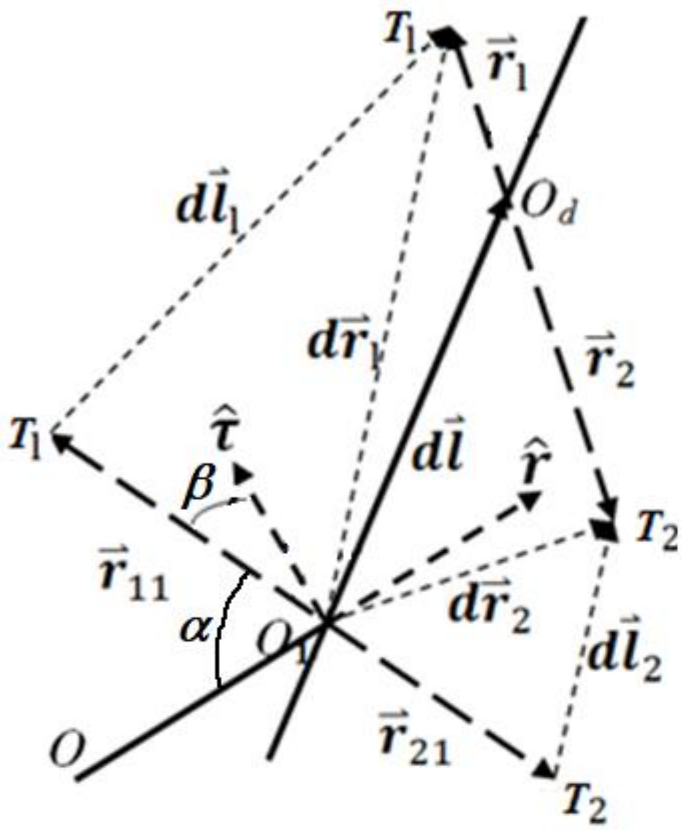

Figure 1