A Newton's Second Law Extension:
A Semi-Classical Approach With DFT Implications

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The following is a short demonstration of the power of an extension to Newton's Second Law which is a many-body solution. It is shown for the three body problem that one can derive Newton's gravitational constant when ignoring negligible masses. Then the integral formulation is shown to be applicable to the density in Density Functional Theory (DFT).

The many-body problem is well known to be a 'Holy Grail' of physics that only limited solutions have been derived by Euler, Lagrange and others. It is interesting to note that the following work has come about from the study of fluid flow of liquid in a tube wrapped around a torus. This led to the formulation of the new proposed Theorem of Semi-Classical physics which is known as the Newton's Third Law Extension.

I. NEWTON'S SECOND LAW EXTENSION

Theorem 1 *The total force acting on a system is equal to the sum of forces acting on each particle.*

Newton's 2^{nd} Law of Motion for the i^{th} particle:

$$\mathbf{F_{T_i}} = \left[\sum_j \mathbf{F_{ij}}\right] = \frac{\partial \mathbf{p_i}}{\partial t} \tag{1}$$

Where $\mathbf{F_{T_i}}$ is the total force acting on the i^{th} particle, $\mathbf{F_{ij}}$ is the j^{th} force acting on particle i. Now using the theorem (1) for the i^{th} particle:

$$\mathbf{F_T} = \sum_i \mathbf{F_{T_i}} \tag{2}$$

So then,

$$\mathbf{F_T} = \sum_i \frac{\partial \mathbf{p_i}}{\partial t} \tag{3}$$

II. DERIVATION OF NEWTON'S GRAVITATIONAL CONSTANT (TWO-BODY PROBLEM)

So we have the extension of third law theorem. Let us use it for a two body system assuming the Earth and a falling object are the two particles in the system. Where N is the gravitational constant, M is the mass of Earth, and m is the mass of the particle.

We know that $\mathbf{F_T}$ for the system is,

$$\mathbf{F_T} = -N\frac{Mm}{r^2} \tag{4}$$

Assuming Earth's momentum is constant, we have that

$$\left[\frac{\partial \mathbf{p}}{\partial t}\right]_{Earth} = 0 \tag{5}$$

and

$$\left[\frac{\partial \mathbf{p}}{\partial t}\right]_{Object} = -mg \tag{6}$$

So then we have:

$$-N\frac{Mm}{r^2} = 0 + (-mg) \tag{7}$$

or re-arranging we get:

$$N = g\frac{r^2}{M}, \tag{8}$$

which is what we expect for the gravitational constant.

III. DERIVATION OF NEWTON'S GRAVITATIONAL CONSTANT (THREE-BODY PROBLEM)

Refer to Figure (1) for the following derivation. R is the radius of the Earth, $m_1 < m_2$ are the masses of the two bodies orbiting the Earth. The interactions between the two extra masses are ignored, and it is found that the gravitational constant, N, is found to be equivalent in both $\mathbf{i}$ and $\mathbf{j}$ directions.

So

$$\mathbf{F_T} = N\frac{m_1 M}{R^2}\hat{\mathbf{i}} + N\frac{m_2 M}{R^2}\sin\theta\hat{\mathbf{i}} + N\frac{m_2 M}{R^2}\cos\theta\hat{\mathbf{j}} \tag{9}$$

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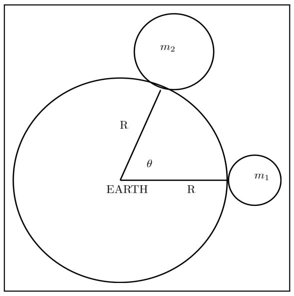

Figure 1. The three body system with Earth and two masses arranged by θ degrees apart.

also,

$$\mathbf{F_T} = (0) + (m_1\mathbf{g} + m_2\mathbf{g}sin\theta)\hat{\mathbf{i}} + (m_2\mathbf{g}\cos\theta)\hat{\mathbf{j}} \tag{10}$$

Equating and rearranging:

$$N_i = N_j = \frac{R^2 g}{M} \tag{11}$$

IV. EXTENSION TO THE INTEGRAL FORMULA

We can also do some calculus with the sum over space and use the integral form of the equation.

$$\mathbf{F_T} = -\int \frac{\partial \mathbf{p}}{\partial t} \times d\mathbf{r} \tag{12}$$

V. USING WAVE MECHANICS IN THE INTEGRAL EQUATION

There are two formulations that can be used which could depend on the system.

$$\mathbf{F_T} = -\int \frac{\partial < \mathbf{p} >}{\partial t} \times d < \mathbf{r} > \tag{13}$$

$$\mathbf{F_T} = -\int \frac{\partial < \mathbf{p} >}{\partial t} \cdot d < \mathbf{r} > \tag{14}$$

A. The Hydrogen Atom

For the Hydrogen atom we have Coulomb's law:

$$\mathbf{F_T} = -\frac{e^2}{4\pi\varepsilon_0 < r >^2} \tag{15}$$

Plugging into the wave-mechanics equation, we have:

$$\frac{e^2}{4\pi\varepsilon_0 < r >^2} = \int \frac{\partial < \mathbf{p} >}{\partial t} \times d < \mathbf{r} > \tag{16}$$

Which gives a spin vector (because of the cross product). Now we can take the derivative of both sides with respect to r and get the expectation value of the acceleration of the electron in orbit:

$$\rho V < \mathbf{a} >= -\frac{2e^2}{4\pi\varepsilon_0 < r >^3} \tag{17}$$

Using Dan Winter's[1,2] equation for Hydrogen radii: $< r >= \hbar_l \phi^{115+n}$, we get

$$\rho V < \mathbf{a} >= -\frac{2e^2}{4\pi\varepsilon_0 (\hbar_l \phi^{115+n})^3} \tag{18}$$

B. Adding in Gravity

Now for the total force acting on the system, $\mathbf{F_T}$, we can combine any number of known forces to the left hand side of equation (10).

$$\mathbf{F_T} = -\frac{e^2}{4\pi\varepsilon_0 < r >^2} + -N\frac{M_p m_e}{< r >^2} = -\int \frac{\partial < \mathbf{p} >}{\partial t} \times d < \mathbf{r} > \tag{19}$$

after using the RHS of equation (10).

Then taking the derivative again, we get the acceleration of the electron due to gravity and the coulomb potential:

$$\rho V < \mathbf{a} >= -2\left(\frac{e^2}{4\pi\varepsilon_0 < r >^3} + N\frac{M_p m_e}{< r >^3}\right) \tag{20}$$

With this we can see that we can add in any number of electron's gravity and Coulomb force to solve the many-body problem.

VI. A SMALL EXTENSION TO DFT DENSITY

In this way we define a momentum density where $\mathbf{p}$ is defined as follows (in terms of the density):

$$\mathbf{p} = \frac{\partial \rho}{\partial t} \int dm \tag{21}$$

VII. CONCLUSIONS

If it is indeed true that one can extend this many-body formulation to the integral as suggested above, then this paper is a revolutionary understanding of the many body problem. Maybe the start to the search for the 'Holy Grail' of physics has been found. Please feel free to email the author with questions and concerns, thank you.

REFERENCES

[1]D. Winter, “Implosion group - dan winter,” (2018).
[2]D. Winter, “Compressions, the hydrogen atom,and phase conjugation,” (2013).