Understanding of Forces between Atomic Particles by Introduction of a New Particle Type in Space

Ashim Saha (g.saha.ashim@gmail.com)

Research Article

Keywords:

Posted Date: June 16th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1754628/v1

Understanding of Forces between Atomic Particles by Introduction of a New Particle Type in Space

Ashim Saha

Affiliation: Individual Researcher
Address: 8, Dr. Ashutosh Sastri Road, Kolkata – 700010, West Bengal, India
Email: g.saha.ashim@gmail.com
Mob: +91 9830744453

Abstract

In this paper it has been studied how does forces act between stable atomic particles. To do the findings it has been postulated that a tiny particle type is running throughout the space with some constant velocity. The particle of that type is so tiny that those particles almost don't collide with each other and hence at any point in space if a solid atomic particle is being kept then the pressure on that atomic particle from all angles are same. However, if a second atomic particle is being brought closer to that former atomic particle, then shadows form on both atomic particles by each other atomic particles. Hence, pressure difference happens, and attraction force is being perceived. Also, it has been postulated that all atomic particles are made of this tiny particle type. As atomic particle spins it scatters those tiny particle and repulsive force is being perceived. In this paper this postulate has been verified mathematically and finally arrived at a formula of net force acting between two stable atomic particles. This mathematical model is successfully predicting change pattern of atomic radius with change in atomic numbers. Also, it is conforming that velocity of light is constant. This same model matches the Lennard-Jones potential function pattern between two atoms.

Introduction

With the understanding that two atomic particles may repel each other by throwing some tiny particle towards each other, it can be inferred that attraction between two atomic particles is probably possible if some tiny particle type is pushing those two particles from outside. Hence following postulates are made to analyze forces between atomic particles mathematically.

1. A tiny particle type is running throughout the space with constant velocity.
2. The above-mentioned particle type is so tiny that those particles do not collide with each other in free space. That is on any point in space the pressure due to this particle is same from all directions.
3. All atomic particles are made of this tiny particle and stable atomic particles got regular spin about its axis. As atomic particle spins, it scatters this tiny particle type and the tiny particles of this type coming from outside get deposited on the atomic particle.

Hence, following deduction is made for stable atomic particles.

Equation of Stability for Stable Atomic Particles

For the stable atomic particles like protons and nuclei of various atoms, it can be concluded that total absorption of that tiny particle type and total emission of that tiny particle type is equal.

Now it is being assumed that r is the radius of the atomic particle and ω is the angular velocity of spin of that atomic particle.

Hence total absorption can be formulated as –

$$Total\ Absorption = K_1 I\ \ Total\ Surface\ Area\ of\ Particle$$

$$= K_1 I\ 4\pi r^2$$

Here, K_1 is a constant and I is intensity of incoming beam of that tiny particle from any direction.

Now, the total emission of that particle is formulated as below -

$$Total\ Emmision = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} 2\pi r \cos\theta\ \ Emission_{at}(r,\theta)\ r\ d\theta$$

$$= \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} 2\pi r \cos\theta\ \ (K_2\ \omega^2 r \cos\theta)\ r\ d\theta$$

$$= K_2'\ r^3\omega^2\ \left[\frac{1}{2}\theta + \frac{1}{4}\sin 2\theta + K_3\ \right]_{-\frac{\pi}{2}}^{\frac{\pi}{2}}$$

$$= K_2''\ r^2\omega^2 r \qquad\qquad eq. 1.1$$

Here, $K_2, K_2', K_3\ and\ K_2''$ are constants.

Hence for stable atomic particle of type nuclei by equating total absorption equal to total emission this can be concluded that,

$$\omega^2 r = Constant$$

Now it is understood that, when atomic particle emits that tiny particle type that emission could be discrete and in chunk. So, it is being investigated that whether this chunk of tiny particle emission could be light particle photon.

If it is assumed mass of one such chunk of tiny particle emitted be m_{photon}, then at departing moment –

$$m_{photon}\omega^2 r = m_{photon}\ velocity_{photon}$$

That is,

$$velocity_{photon} = \omega^2 r = Constant$$

Hence,

$$\omega^2 r = c, here\ c\ is\ the\ velocity\ of\ light. \qquad\qquad eq. 1.2$$

Hence from equation 1.1 and 1.2, it is being concluded that total emission of stable nuclei is given by –

$$Total\ Emmision = K_e r^2, here\ K_e is\ a\ constant \qquad\qquad eq. 1.3$$

Now if it is being formulated for electrons in orbit then it is additionally required to consider emission of nucleus that contribute to additional absorption of electron in orbit. Similarly, an additional emission also happens in electron due to its orbital velocity. Equating these two factors to be equal, as that justifies the stability of electron by conforming equation 1.2 and 1.3, it can be obtained that –

$$\frac{K_e r_{nucleus}^2}{d^2}\ 2\pi\, r_{electron}^2 = K_4\ \omega_{orbit}^2 d\ 2\pi\, r_{electron}^2$$

Here,

$Left\ Side = Additional\ absorption\ at\ electrons\ nucleus\ facing\ surface$

$Right\ Side = Additional\ emmision\ by\ electrons\ due\ to\ orbital\ velosity$

$r_{nucleus} = radius\ of\ nucleus$

$r_{electron} = radius\ of\ electron$

$\omega_{orbit} = angular\ velosity\ of\ electron\ around\ nucleus$

$d = distance\ between\ nucleus\ and\ electron$

$K_4 = a\ constant$

Hence it can be concluded that –

$$\frac{K_e r_{nucleus}^2}{d^2} = K_4\ \omega_{orbit}^2 d \qquad eq.1.4$$

As all stable particles are spinning and scattering tiny particle type around the above equation 1.4 can be generalized as –

$$\frac{K_e r_{emitting\_particle}^2}{d^2}\ 2\pi\, r_{receiving\_particle}^2 = K_4\ \omega_{orbit}^2 d\ 2\pi\, r_{receiving\_particle}^2 \qquad eq.1.4.1$$

Equation of orbital velocity of Electrons around nucleus

Now, it is being observed that when nucleus scatters that tiny particle type, due to spin of nucleus this cloud of scattered tiny particle rotates around nucleus as well. Now due to some viscosity kind of effect of this cloud of scattered tiny particle, it can be concluded that –

$$\omega_1 d_1 = \omega_2 d_2 = \omega_n r_n \qquad eq.1.5$$

Here,

$$\omega_1 = is\ the\ perceived\ angular\ velosity\ at\ distance\ d_1$$

$$\omega_2 = is\ the\ perceived\ angular\ velosity\ at\ distance\ d_2$$

$$\omega_n = is\ the\ angular\ velosity\ of\ spin\ of\ nucleus$$

$$r_n = is\ the\ radius\ of\ nucleus$$

Further, it is concluded from equation 1.5 that it holds true for any stable particle with regular spin as follows –

$$\omega_1 d_1 = \omega_2 d_2 = \omega_{particle} r_{particle} \qquad eq.1.6$$

Here,

$$\omega_1 = is\ the\ perceived\ angular\ velosity\ at\ distance\ d_1$$

$$\omega_2 = is\ the\ perceived\ angular\ velosity\ at\ distance\ d_2$$

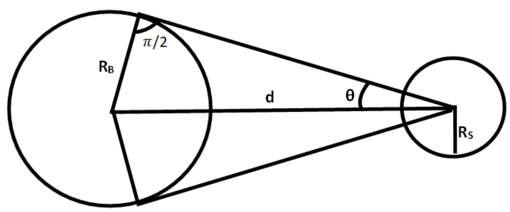
$$\omega_{particle} = is\ the\ angular\ velosity\ of\ spin\ of\ stable\ atomic\ particle$$

$$r_{particle} = is\ the\ radius\ of\ stable\ atomic\ particle$$

Finding attraction force between stable atomic particles

As that tiny particle type is running though out space with constant velocity, it creates pressure on atomic particle from all directions with equal pressure. But if another atomic particle comes close to the former atomic particle, then shadows form on those atomic particles due to each other particle. Hence, attraction force between two stable atomic particles is being perceived due to force imbalance of tiny particle pressure. Since atomic particles are solid, only the shadow effect on particles' surfaces is being considered.

Let there be two spherical particles, one bigger and one smaller of radius R_B and R_s respectively. That is $R_B > R_S$. Let d be the distance between centers of two spherical particles. Then considering the following figure a mathematical derivation is being made.



Let S_R' be the surface of the smaller atomic particle under shadow. Then S_R' can be calculated using following integral.

$$S_R' = \int_{\alpha=0}^{\theta} 2\,\pi\,R_S \sin\alpha\,R_S d\alpha$$

$$= 2\,\pi\,R_S^2 \int_{\alpha=0}^{\theta} \sin\alpha\,d\alpha$$

Now in the above integral for each angle α, only cos α component for force due to deficiency of pressure, works towards bigger particle.

Hence net force that acts on smaller atomic particle towards bigger atomic particle is given by –

$$F_{S\to B} = K_{10}\,2\,\pi\,R_S^2 \int_{\alpha=0}^{\theta} \sin\alpha\cos\alpha\,d\alpha$$

$$= K_{10}\,4\,\pi\,R_S^2 [\sin^2\alpha]_0^{\theta}$$

$$= K_{10}\,4\,\pi\,R_S^2 \sin^2\theta$$

Here K_{10} is a constant that depends on incoming tiny particle beam strength from any directions.

Also,

$$\sin^2\theta = \frac{R_B^2}{d^2}$$

Hence,

$$F_{S\to B} = K'_{10}\frac{R_S^2 R_B^2}{d^2}, where\ K'_{10} is\ a\ constant$$

Similarly,

$$F_{B\to S} = K'_{10}\frac{R_B^2 R_S^2}{d^2}, where\ K'_{10} is\ a\ constant$$

Hence total attraction force between two atomic particles of radii r_1 and r_2 is given by following equation where d is the distance between particles.

$$F_{attraction} = K_a\frac{r_1^2 r_2^2}{d^2}, where\ K_a is\ a\ constant \qquad eq. 1.7$$

Finding forces of repulsion between two atomic particles

The forces of repulsion between two stable atomic particles is being perceived because stable particles emit tiny particle type towards each other. This force of repulsion can be formulated using equation 1.3 as –

$$F_{repulsion} = \frac{K_e r_1^2}{d^2}\ 2\pi\ r_2^2 + \frac{K_e r_2^2}{d^2}\ 2\pi\ r_1^2$$

Now using equation 1.4.1, it can be written as –

$$F_{repulsion} = K_4\ \omega_{orbit1}^2 d\ 2\pi\ r_2^2\ +\ K_4\ \omega_{orbit2}^2 d\ 2\pi\ r_1^2$$

Now using equation 1.6,

$$F_{repulsion} = K'_4\left(\frac{\omega_1 r_1}{d}\right)^2 d\ r_2^2\ +\ K'_4\left(\frac{\omega_2 r_2}{d}\right)^2 d\ r_1^2$$

$$= K'_4\ \frac{r_1^2 r_2^2}{d^2}(\omega_1^2 + \omega_2^2)\ d, where\ K'_4 is\ a\ constant$$

Now, using equation 1.2, above equation can be written as –

$$F_{repulsion} = K'_4\ \frac{r_1^2 r_2^2}{d^2}\left(\frac{c}{r_1} + \frac{c}{r_2}\right)\ d$$

$$= K_r\frac{r_1^2 r_2^2}{d^2}\left(\frac{1}{r_1} + \frac{1}{r_2}\right)\ d, where\ K_r is\ a\ constant \qquad eq. 1.8$$

Finding net force acting between two stable atomic particles

So, from equation 1.7 and 1.8, the net force acting between two stable particle is formulated as –

$$F_{12} = K_a \frac{r_1^2 r_2^2}{d^2} - K_r \frac{r_1^2 r_2^2}{d^2}\left(\frac{1}{r_1} + \frac{1}{r_2}\right) d \qquad eq\ 1.9$$

This is to be noted that all nuclei including proton and electron are highly dense matter of constant density.

Hence for a such stable atomic particle it can be written –

$$r = K_{mr} m^{\frac{1}{3}},\ \ where\ K_{mr} is\ a\ constant\ and\ m\ is\ mass\ of\ the\ particle \qquad \text{eq. 1.10}$$

Since hydrogen atom is stable and only one proton and one electron interaction are involved, from equation 1.9 following can be obtained –

$$\frac{K_a}{K_r} = \frac{\frac{r_p^2 r_e^2}{d_H^2}\left(\frac{1}{r_p} + \frac{1}{r_e}\right) d_H}{\frac{r_p^2 r_e^2}{d_H^2}} = L\ , say \qquad eq\ 1.11$$

Here,

Here,

$r_p = radius\ of\ proton$

$r_e = radius\ of\ electron$

$d_H = atomic\ radius\ of\ hydrogen\ atom$

Now substituting L in equation 1.9 following equation is formulated-

$$F_{12} force\ factor = L \frac{r_1^2 r_2^2}{d^2} - \frac{r_1^2 r_2^2}{d^2}\left(\frac{1}{r_1} + \frac{1}{r_2}\right) d, \qquad eq. 1.12$$

$$where\ F_{12} = K_r\ F_{12} force\ factor$$

Understanding 3D Model of Atom

Understanding 3D model of atom is very complex to express in formulas and requires computer simulation using above basic mathematical computation. It is to be noted atom is not 2D model but for simplicity of calculation it is considered to be 2D model as one of the equilibrium states that only can be achieved by eliminating all surrounding field disturbance factor and by assuming that the atom is in isolation.

Computation of Atomic Radius

To compute the approximate radius of an orbit, forces acting on a particular electron on that orbit in a direction away from center of atom has been considered. Forces that have been equated are –

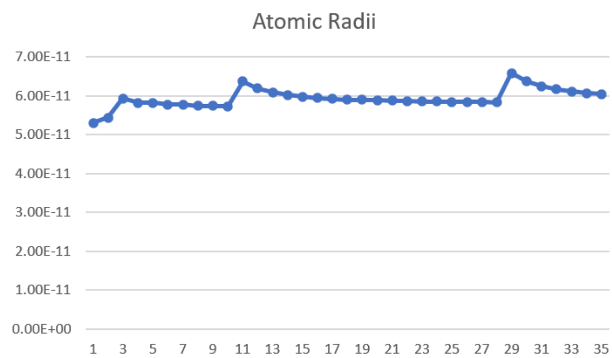
- force between that electron and nucleus

- forces between that electron and all other electrons in same orbit
- forces between that electron and all other electrons in lower orbits

To find equilibrium following equation is considered in an iterative method with varying orbital radius –

$$L\left(F_{attraction}(n,e) + \sum F_{attraction}(e,e)\right) - \left(F_{repulsion}(n,e) + \sum F_{repulsion}(e,e)\right) \approx 0$$

Result that has been found is as follows –



Here numbers in X axis are atomic number. Following things has been assumed. Mass of proton, mass of electron, atomic weight of atoms, atomic number of atoms and no of electrons in each orbit for respective atoms. Also, atomic radius of hydrogen is being assumed.

It is to be noted that there is a huge gap between any two electrons in any orbit. Hence probabilistically the perceived atomic radius is computed as –

$$atomic\ radius\ observed = \frac{\sum d_{orbit} * \frac{2\pi}{n}}{\sum \frac{2\pi}{n}}$$

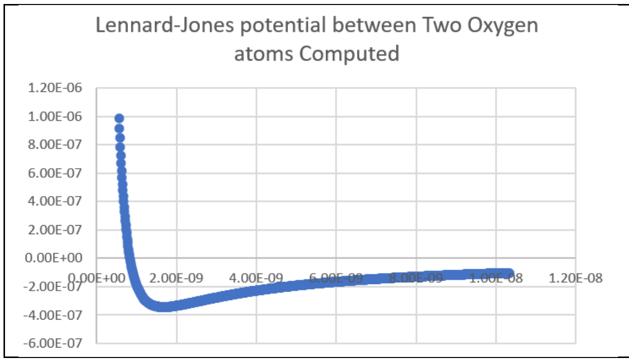
Here,

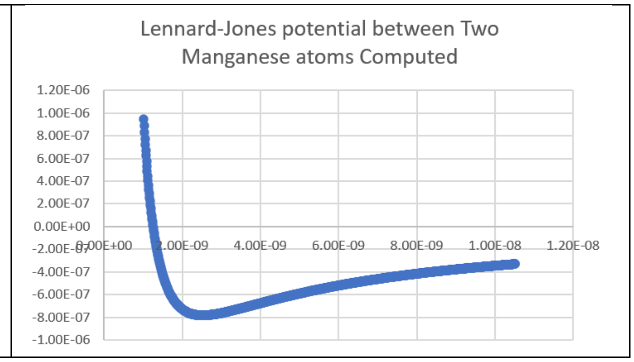
$d_{orbit} = radius\ of\ orbit\ coputed$

$n = no\ of\ electrons\ in\ that\ orbit$

Other Computations Using Force Functions

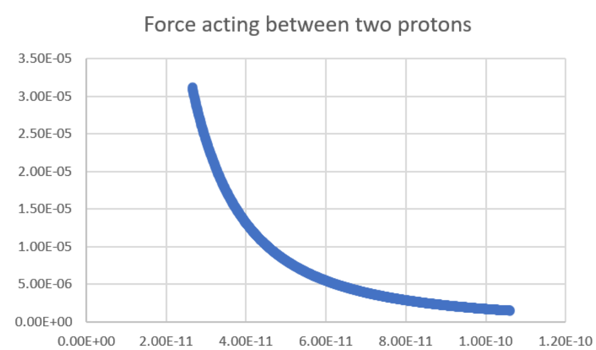
Using the above force factor function, Lennard-Jones potential has been computed.[1] For Oxygen and Manganese atoms figures are given below.

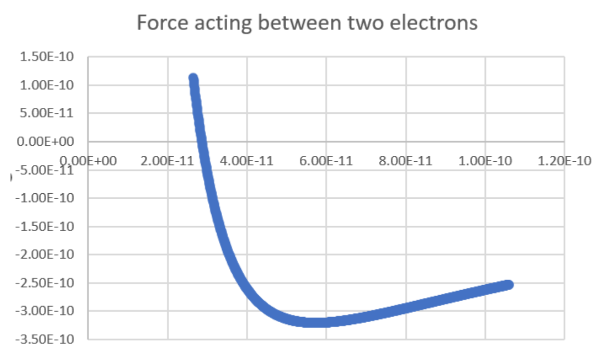


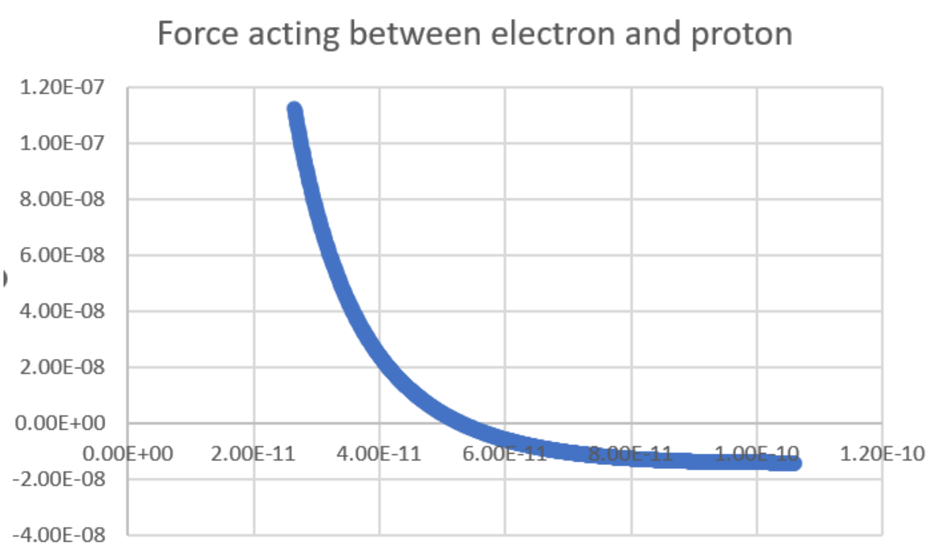


Here X axis represents distance between two nuclei and Y axis represents force factor. Here, in equation 1.9 the value of $K_r$is taken as 10^{28}. It is to be noted that net force between atoms will be attraction or repulsion that does not get influenced by this value of K_r. Only magnitude of force depends on value of K_r.

To better understand LJ potential pattern, which tells two atoms will attract and repel and stay nullified based on distance range, forces acting between proton-proton, electron-electron, and proton-electron are being plotted. Following are the figures –







In the above figure X axis is the distance between atomic particles. To obtain a comparable value with Coulomb's force between charge particles, in the above model in equation 1.9 the values of K_r is taken as 10^{28}. [2] It is to be noted that net force between particles will be attraction or repulsion that does not get influenced by this value of K_r. Only magnitude of force depends on value of K_r.

Shape of Orbit in 2D Model

To understand shape of orbit, only repulsive force factor between electron-electron and electron-nucleus are computed. As repulsive force determines the direction of tangential velocity, it can be concluded that resultant tangential velocity of electron in orbit will resultant of all those tangential velocities v(s) attributed by each repulsive force component. Now, in above mathematical model, it is found that repulsive force factor of electron-electron is of order 10^{-9} and that of electron and nucleus is of order $10^{-7}\ to\ 10^{-6}$. Hence, though shape of orbit is not exactly circular, the dominating factor of tangential velocity is attributed by electron-nucleus repulsive force factor. It is also being observed that a further study is required to better understand shape of orbit and it is beyond scope this paper.

Units of Measurements Used

For measurements following has been used –

Units of mass, length and time are respectively Kg, meter, and second. Velocity of light is taken as c = 299792000 m/sec. Mass of proton taken as 1.67262E-27 Kg, and that of electron is taken as 9.11013E-31 Kg. Atomic radius of hydrogen atom is taken as 5.3E-11 meter. Value of constant K_{mr} is computed using equation 1.10 and using atomic weight and nucleus radius of lead (Pb) atom as 207.2 and 8.874E-15 meter. It is assumed that mass of nucleus is product of atomic weight and mass of proton.

Conclusion

Lennard-Jones potential is depicting that if two atoms are very close to each other then the atoms attract each other. But after a certain distance according to LJ potential the force between atoms become repulsive. If distance increases further, then no force act between two atoms. This behavior of atoms interaction has been matched by this mathematical modeling. Also, this model able to predict atomic radii changes pattern as atomic number increases. In the course, this model also mathematically proved why velocity of light is constant. Hence, the postulates that have been assumed are probably true and that means such tiny particle type exists.

References

1. Jones J. E.. 1924 On the determination of molecular fields. — I. From the variation of the viscosity of a gas with temperature. Proc. R. Soc. Lond. A 106 441–462 http://doi.org/10.1098/rspa.1924.0081
2. Coulomb.. 1785 "Premier mémoire sur l'électricité et le magnétisme," Histoire de l'Académie Royale des Sciences, pp. 569–577