

Quantitative aspects of Newton's third law of motion in classical, astronomical phenomena.

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Summary

Main aim : Newton's third law is fundamental law used in classical mechanics, astronomical, aerospace, other dynamical phenomena. It must be regarded as true in these cases if it is quantitatively justified i.e. magnitude of action is precisely equal to reaction, the direction of action and reaction are exactly opposite. The law is not justified in many phenomena. Law is extended/generalized speculatively; some experiments may justify the same. This is theme of discussion.

Section A: (basic mechanics) Critical analysis of simple applications in rebounding bodies (rubber, super ball, sky ball etc.) in Newton's Third law of Motion, law of conservation on momentum (third application of third law), equations based on one dimensional elastic collisions involve law of conservation of momentum. In all equations the shape, characteristics of bodies are neglected.

Section B : (generalized form of third law of motion) . Reaction = -Q Action , Q takes in account shapes(spherical, semi-spherical, umbrella shaped, polygon, long pipe, flat, irregular or any feasible typical shape etc.) , characteristics (rubber, super ball, sky ball etc.) and other factors .

Section B : (basic Aeronautics) **Applications in Rockets, Airplanes, Electric planes, Solar planes , Autogyros. Trikes , Gliders, future inventions etc.**

How the circulating air by blades of propeller (fitted at various positions), is changed or transformed as backward fast-moving jet of air (action) ?

Newton implies : Reaction = - Action, in all cases universally.

Proposed perception : Reaction = -Q Action (Q, co-efficient) is applicable , can be confirmed in tests.

The aim of discussion : *Newton's law will be regarded as experimentally justified in such cases (wherever it is applicable) if action and reaction force (thrust) are precisely equal in magnitude and exactly opposite in direction. Both the conditions must be justified.*

Discussion

Section A : To critically analyze Newton's third law of motion in undiscussed rebounding bodies.

Why simple experiments have not been conducted but law is regarded as true ?

Part I

Effect of shape of bodies on rebounding bodies ; and role super ball , sky ball (which rebound many times more than rubber ball) ; in quantitative confirmation of Newton's third law of motion.

Q.1 Tell us in very simple language why do you doubt Newton's third law of motion in rebounding bodies in vacuum . Is there any valid scientific point in it ?

Ajay . Newton's third law states

Reaction = - Action (universally and absolutely) (1)

Action must be equal reaction irrespective of any other factor . But for all possible bodies there are numerous applications of the law and further emerging. In brief the proposed form of law (extended) is

Reaction = - Q Action (2)

Action and reaction may or may not be equal universally and absolutely....it is still speculation until justified experimentally. Q accounts for coefficient which accounts for various factors neglected by Newton's law. The various scientists and scientific bodies have asked for experimental observations for confirm eq.(2).

The valid scientific exposition is that action and reaction may or may not be equal; and in case of bodies of different shapes, sizes the direction may not be exactly opposite to action. The law is also applied in various flying crafts (rocket, airplane, electric planes, solar planes gliders, auto gyros, rotor planes, jetsuits drones etc.) in Section B

Consider spheres of rubber, super ball and sky ball (both discovered in USA in 1960s and 1980s) having mass 1kg . Then they are dropped from height of 1m in vacuum simultaneously on suitable floor . When bodies are thrown in in vacuum then fall down with same acceleration ($g = 9.8 \text{ m/s}^2$), then action would be force or weight or mg ($1 \times 9.8 = 9.8$ newtons)

Action = Force = $mg = 9.8$ newtons (3)

When bodies touch the floor i.e. mutually interact, then simultaneously equal reaction is generated on the bodies .

Reaction = - Action (force, mg or weight) = -9.8 newtons. (4)

Predictions : For rubber ball action and reaction are same , thus if rubber ball is dropped from height of 1m (action), then it must rebound to height of 1m, according to Newton's third law of motion. But this prediction may be justified under some conditions only.

But now the bodies of same rubber of same mass (1kg) have different shapes (**spherical, semi-spherical, umbrella shaped, triangular, square, hexagonal, polygon, cone, long pipe, flat, irregular or any feasible typical shape etc.**) are fabricated. Thus mass and characteristics of bodies become same, only *shape* is the factor which may affect results. Let these bodies freely fall under identical conditions.

Then it is general observation that bodies of different shapes do not rebound to height of 1m, the universal equality of law i.e. eq.(1) is that action must be equal to reaction in all observations.

For bodies of different shapes the bodies (artifacts) also rebound in different directions.

Thus, Newton's law is not justified in ordinary experiments **qualitatively**. So it may be quantitatively tested; the various scientists have approved such experiments

Newton had not mentioned about these experiments and even value of g (9.80066 m/s^2) is measured in France in 1888 i.e. 202 years after the enunciation of third law and law of gravitation in the Principia.

Q. 2 What do you want to say about super ball and sky ball in regard to Newton's third law ?

Ajay. Newton's law is clearly violated in third law in such cases in daily life observations, as super ball rebound to 3 m compared to rubber ball (1m) under identical conditions. Whereas sky ball rebound further more i.e. may be to height 5m or higher. Thus reaction is three to five times more in sky and super ball. It is due to inherent nature and characteristics of bodies. These deductions may be quantitatively tested, it is the theme of the discussion.

Newton's law i.e. eq.(1) rigidly and universally says, Action = -Reaction. There is no additional factor in it.

In no case reaction would be less or more than action. Both are precisely equal and exactly opposite.

There are no other factors except action and reaction in eq.(1). But in generalized form there is additional coefficient, Q . It accounts for all factors not taken in account in eq.(2).

Reaction = - Q Action (2)

The other factors which are not taken in account by eq.(1) are accounted for by Q in eq.(2), which is the extended form of law. The eq.(1) is rigid , that action and reaction are always equal and opposite.

In research or innovation in USA in amusement/sports industry in USA (1960s or 1980s) the super ball and sky balls are invented. These must be scientifically tested QUANTITATIVELY in view of third law of motion []. Furthermore, bouncy bodies may be discovered. If their rebounding is not consistent with eq.(1) they would be consistent with eq.(2), it can be experimentally confirmed scientifically.

Q.3 You claim that Newton's third law of motion or law of conservation of linear momentum is not confirmed in experiments at macroscopic level.

Ajay : Yes. It is true. The first two applications of Newton's third law, action and reaction are expressed in terms of force. Third application of third law of motion leads to law of conservation of momentum. Consider that a body A of mass m applies force and changes the motion of body B of mass M . Let initial velocity of body A is $U_{initial}$ and that of body B is $V_{initial}$. After collision the velocity of body A becomes U_{final} and that of body B, V_{final} .

Change in motion of body B when body A impinges on it = - change in motion of body A

$$MV_{final} - MV_{initial} = -(mU_{final} - mU_{initial})$$

$$mU_{initial} + MV_{initial} = MV_{final} + mU_{final} \quad (5)$$

We can measure the values of U_{final} and V_{final} from eq.(5), these values are independent of shape, size etc. of the bodies.

Likewise, equations of one-dimensional elastic collisions the law of conservation of momentum (Newton's third law of motion) and conservation of kinetic energy both are simultaneously involved. In such cases the velocities are given by

$$U_{final} = \frac{(m - M)U_{initial} + 2MV_{initial}}{(m + M)} \quad (6)$$

$$V_{final} = \frac{(M - m)V_{initial} + 2mU_{initial}}{(m + M)} \quad (7)$$

As in the previous cases (freely falling and rebounding bodies, law of conservation of momentum and its applications) the shape, size, characteristics of colliding or impinges bodies play significant role, the same is also true in case of one dimensional elastic collisions. These eqs.(2-4, 5-7) can be confirmed experimentally, but till date no such experiments are conducted however equations are regarded as true as such. The values of velocities would be confirmed under special conditions only.

Until above equations are not confirmed experimentally, these must not be regarded as true. There may be sources of errors e.g. rise in temperature during collisions, area of contact etc. these can be taken in account but eq.(1) must be satisfied.

Further equations for $U_{initial}$ and $V_{initial}$ can be written as

$$U_{initial} = [U_{final} (m+M) - 2MV_{initial}] / (m-M) \quad (8)$$

$$V_{initial} = [V_{final} (m+M) - 2mU_{initial}] / (M-m) \quad (9)$$

The eqs.(8-9) are not valid when masses of projectile and target are equal, as denominator becomes zero. Under this condition the value of $U_{initial}$ and $V_{initial}$ may become infinite. This is serious theoretical limitation of the equations which are based on Newton's third law. These equations need to be experimentally confirmed over wide range of parameters.

Section B

Generalized form of Newton's third law of motion

Is law absolutely correct of if more than three centuries old ?

Reaction = - Q Action; Q is coefficient of proportionally, accounts for shapes (spherical, semi-spherical, umbrella shaped, polygon, long pipe, flat, irregular or any feasible typical shape etc.), and other factors characteristics (rubber, super ball, sky ball etc.)

Q.4 As Newton's third law of motion does not take in account the shape, size characteristics of body etc. so you have generalized Newton's 335 years old principle. Do you have experimental evidences in this regard ?

Ans. Kindly see references below that such factors (shape , size , characteristics etc.) are found significant in critical analysis by scientists ; Council of Scientific and Industrial Research , New Delhi and Departments of Science and Technology have asked me to send experimental project for funding through researcher / academician as money cannot be given to me. I have no position or research facilities at all; retired from job. But now have more time and motivation for this research which started as students of 2nd years 1982.

These experiments can be conducted with help of ISRO , DRDO, HAL etc. easily using their equipment for short time. Newton's law is never confirmed in these cases. These experiments would change course of science and 100% chances of success.

On 31 March 2021, I am retired from the education department Shimla HP from post of Deputy Distt Education Officer (Administrative post) earlier taught physics for more than 20 years including at DAV College Chandigarh. I have no laboratory no research degree (BSc. Non-Medical , 69% marks in 1983, 62% marks MSc Physics) so unable to submit the project. **I tried but Govt Funding portal did not accept the application due to age bar and retirement from job.** The review of work indicates merit of work. From numerous people I got valuable assistance in past four decades. Some more assistance is needed for final success. I am to continue as this work (now experiments are needed) would bring highest laurels to 135 crore people of India.

Please help me in conducting such significant experiments, it is requested. I also plan to publish soon the book (about 10 Chapters , 160-180 pages)

Improved Form Of Newton's Third Law Of Motion.

The manuscript is nearly ready.

Section C (basic Aeronautics)

Motion of Rockets, Jet Engines , Airplanes, Electric planes [EP], Solar powered planes [SPP] , Gliders , Autogyros .

Section B : How the circulating or whirling air by blades of propeller (fitted at various positions), is changed or transformed as backward fast-moving jet of air (action) ?

Q5 How airfoils can be understood ?

Ans. Air foil has characteristics curved shape. It produces lift. The lift is caused due to pressure difference between upper and lower part of airfoil. Lift is necessary for flying, its value must be either equal or more than weight (mg). If mass of body is 1000kg , then lift must be equal or more than 9,800 newtons. Then thrust pushes the aircraft forward and drag pulls it backward. Thus four forces i.e. weight, lift, thrust, drag act on flying craft. Upthrust also acts due to Archimedes principle, but existing perception is completely independent of it.

Thrust is a reaction force described quantitatively by Newton's third law (action –reaction). *When a system expels mass in one direction, the system is pushed in other direction; as thrust is produced in opposite direction.*

When exhaust (fire, smoke , gas , sparks) moves backward , the rocket moves upward , it is qualitatively true. Thrust is produced in opposite direction.

The flat surfaces (rectangular) should not produce any lift, as pressure above and below would be same. Hence flying would not be possible for flat body. Due to heavy weight body will fall down. Similarly the anti-airfoil shape should produce negative lift so body will fall down. Also ultralight auto gyros, have no roof (they should not produce no lift) even then they fly. Also Ingenuity has no roof. These shapes can be critically tested experimentally. Do blades of propeller produce both lift and forward thrust ?

Practically upthrust ($V D_m g$, V volume , D_m density of medium) also acts upward must contribute to lift.

Q.6 What is Tsiolkovsky's rocket equation which utilizes Newton's third law of motion in form of law of conservation

of momentum ?

Ans. There are equations directly based on Newton's third law or equations-based on law, there are no quantitative confirmation in some cases. Thus rocket equation based on Newton's third law should also be theoretically and experimentally tested.

Tsiolkovsky theoretically derived rocket equation in 1896 but published in 1903 as

$$V = V_e \ln M_0/M \quad (8)$$

M_0 = initial mass of rocket including mass of fuel

M = M_0 – combined masses of gases, smoke etc. ejected

V_e = exhaust velocity of gases, smoke etc., it is regarded constant by Tsiolkovsky in derivation.

V = velocity of rocket at any time when in flight at any time.

It is assumed $V_e \propto I_{sp}$ or $V_e = g I_{sp}$. So scientists modified the same as by bringing g in picture.

$$V = I_{sp} g \ln M_0/M \quad (9)$$

where I_{sp} is specific impulse. I_{sp} is a measure of how efficiently a reaction mass engine (a jet engine uses air and fuel or a rocket uses propellant) creates thrust. These eqs.(8,9) are yet to be experimentally confirmed.

Q.7 How do you doubt the quantitative applications of eqs.(8,9) or point out limitations their applications ?

Ajay. Firstly, the upward velocity V of rocket or forward velocity of aircraft should not be dependent directly on acceleration due to gravity (mg), the velocity V must be inversely proportional to g . Secondly, even when exhaust is emitted these equations are not quantitatively confirmed. The motion of rockets is controlled by algorithms and first stage thrusters of Falcon 9 lands back on the earth. Thirdly,.... how the circulating or whirling air around blades of propeller (fitted at various positions i.e. top, front, back, left or right), is changed or transformed as backward fast-moving jet of air (action) ? Fourthly if there is no exhaust as in case of gliders eqs.(8-9) are not applicable; also the gliders move without exhaust and blades of propeller. It is clear example that bodies can fly without application of Newton's third law of motion.

Further, on the basis of conservation of momentum (as obeyed in Tsiolkovsky's equation) the recoil velocity of gun is given by

$$V_{gun} = - m_{bullet} v_{bullet} / M_{gun} \quad (10)$$

Here negative sign implies that direction of V_{gun} is opposite to v_{bullet} . Also,

$$\text{Reaction} = -\text{Action} \quad (1) \quad \text{or} \quad \text{Reaction} = -Q \text{ Action} \quad (2)$$

However in eqs.(8-9) there is no such negative sign between V (velocity of rocket at any instant) and V_e (velocity of exhaust). So both V and V_e should have same direction which is not true. There should be no pick and choose method when eqs.(8,9) and eqs.(1,2 10) are interpreted.

Newton's law is obeyed when action is equal to reaction, and their direction is exactly opposite. In addition, Tsiolkovsky's derivation requires that V_e (velocity of gas, fire, smoke etc.) is CONSTANT. But how it can remain constant during flight. It limits applications of eqs.(8,9).

For experimental verification of eq.(9) the parameters V_e (or I_{sp}), M are required. In rockets tons of fuel is burnt in initial stage in 6-8 minutes in typical process fuel may be solid, liquid or gas. There are no specific observations in literature e.g. what are values of velocity V_e and M ; at 4 minutes 35s or at 2minutes 23s or at 9s (after launch). The burning of fuel is controlled by process known as throttling. This increases uncertainty in measurement of V_e and M .

What is the theoretical value of velocity, V from eqs.(7-8) ? Then what would be velocity (V_{exp}) experimentally at those instants? If both theoretical values of velocity (V) and experimental value of velocity (V_{exp}) coincide i.e. $V = V_{exp}$, only then equation based on Newton's third law would be correct (in magnitude).

Q 8. Are eqs.(8,9) applicable for rockets and jet engines ?

Ajay : In rockets exhaust (gases, fire, sparks , smoke etc.) is emitted, and rocket moves ahead. Here reaction mass may be solid, liquid or in gaseous state ; it can be estimated. The equations would be experimentally true if $V = V_{exp}$ as discussed Q.7 The jet engines (turbojet, turbofan, ramjet scramjet) are air breathing engines i.e. atmospheric air continuously enters from inlet. From the engine after compression and combustion , it moves out through outlet in form of jet of fast-moving air. Thus here reaction mass is variable . In turbojet engine the thrust is sum of various contributions such as momentum thrust, pressure thrust and momentum drag. The eqs.(8,9) are not quantitatively applicable here. But definitely there must be relation between backward and forward momentum.

Q 9 How eq.(8) is not able to explain motion of electric plane (EP) and Solar powered plane (SPP) ?

Ajay: In electric plane (EP) and Solar powered planes (SPP) there is no backward exhaust (action) like rockets and airplane (jet engine). As there is no action, there would not be any reaction (or thrust) according to Newton's third law. Thrust is defined as in Q 5 as

Thrust is a reaction force described quantitatively by Newton's third law (action –reaction). When a system expels mass in one direction, the system is pushed in other direction; as thrust is produced in opposite direction.

Thus the planes should not without thrust. But they move , it means contradiction of third law. Thus eqs.(8-9) are not applicable for electric plane (EP), Solar powered planes (SPP) etc. Scientists argue that electric planes , solar powered planes tribes, auto gyros , etc. move due to motion blades of propeller. Do blades of propeller produce both lift and forward thrust ? How we can measure each , science is not approximate it is quantitative.

Q.10 Do you think thrust is produced by blades of propeller in case of electric plane (EP), solar powered planes(SPP) etc. It is argues that due to this thrust plane move forward. How ?

Ajay : We have to agree with scientists that blades of propeller produce thrust and planes move ahead.

The thrust is forward force produced when rocket expel mass backward, it is as per Newton's third law of motion. But there is no satisfactory answer to this for mechanism of thrust in this way in EP an SPP.

Experimental situation : If the blades of propeller rotate at top, front, back , left or right. The aircrafts (Electric plane, solar powered planes, auto gyros, tribes etc.) move forward. There are also vertical take and landing (VTOL) systems. It requires vertical thrust (reaction) and downward action when aircraft moves up.

Basic Question : Rocket and airplanes move ahead as exhaust and fast-moving jet of air move backward. Thus thrust (forward force) is produced hence they move ahead.

How circulating or whirling air at top or front or backward or left or right , is pushed backward or as fast-moving jet of air in backward direction i.e. action ? Which force transforms or directs whirling air as fact moving backward jet of air (action). Due to this action , the aircrafts move ahead ?

There are also VTOL systems.

How Newton's third law of motion is applicable here?

Further how to measure the backward momentum of jet of air? How to precisely measure forward momentum of plane?

There is no quantitative answer to this question in the literature. If there are quantitative calculations please let me know.

This is basic issue need to be scientifically addressed. Newton's law will be regarded as experimentally justified in such cases (including manoeuvring) if action and reaction force (thrust) are precisely equal in magnitude and exactly opposite in direction. Both the conditions must be justified.

Q 11 How do you say , the motion of gliders contradict Newton's third law of motion ?

Ajay : There is no doubt about it.

(i) Rockets and jet engines move forward as they emit exhaust and fast jet of air. The backward exhaust and jet of fast air (action); and due to this reaction force (thrust) is produced and they move ahead. Scientists teach that Newton's third law is obeyed here. But it is qualitative only.

(ii) The gliders move air without exhaust or jet of air. They did not have any blade of propeller. Gliders Perlan 2 soared into the record books by reaching **76,000 feet (23km)**, the highest altitude ever reached by a glider. Furthermore glider is heavier than air, it is filled water fitted in ballasts of wings. The flying of heavier than air gliders is not consistent with Archimedes principle. Further motion without exhaust is nor consistent with Newton's third law.

Q12 : Do you think the generalized form of third law of motion can explain the motion rockets, airplanes, gliders etc.

Ajay : Practically the motion of flying aircrafts (rockets, jet engines, electric planes, solar powered planes, auto gyros, gliders, jet suits etc.) need to be studied individually. We need to give quantitative explanation rather than qualitative. Our main aim is how thrust (reaction force), opposite to action is produced. The critical analysis and applicability of Newton's third law is main aim. According to generalized form of third law of motion, the reaction may be equal, less or more than action.

Consider motion of rocket : The backward momentum of exhaust, pushes the rocket forward (produces thrust) and forward momentum of rocket is generated. Now if

Momentum of rocket = - Momentum of exhaust

If both are equal then rocket will not move, it will only move if backward momentum of exhaust is more. This discussion is based on Newton's third law of motion. It is like tug of war.

Whereas according to generalized form of third law (Reaction = -f Action)

Momentum of rocket = - f Momentum of exhaust

It may be applied individually to all cases. The reaction may be equal and opposite to action, at present it may be speculative perception. Initially it can be justified in classical mechanics then in astronautics.

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