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Research Article

The Development of Theory and Application of Newton's Law: A Systematic Literature Review

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Abstract.
This study aims to identify research trends in the development of theories and research applications of Newton's law from 2017 to 2023. The method used is a systematic literature review SLR using the PRISMA Framework, which includes four steps: identification, screening, eligibility, and inclusion. The keyword used for the search is "Newton Law", and the article search is done in the databases Scopus, Springer, Emerald, and IEEE. From the search results, 26,494 articles were obtained, Through the screening, eligibility, and inclusion process, 13 articles met the criteria. The results and discussion show that Newton's Law theory still plays a key role in understanding physics. The scientific debate remains relevant, and applications of Newton's Law can be found in fluid physics, quantum physics, cosmology, and mathematics.

Keywords: application, newton's laws, systematic literature review, theory

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1. INTRODUCTION

This article reviews the theory development and application of Newton's laws. These laws are often considered secondary laws that apply only to classical mechanics. This is not true; on the contrary, it is the most important law of physics because it is for understanding physics [1].

Objects always move according to existing rules and do not occur freely. Stationary or moving objects in nature do not occur suddenly, but a cause triggers the movement of the object [2][3][4]. Newton discovered that three easy-to-understand laws can explain all phenomena of motion in the universe, that is :

1.1. Newton's First Law

Newton's First Law reads, "All objects tend to maintain their state: a stationary body will remain at rest, and a moving object will remain in motion at a fixed velocity". Newton's First Law describes that every object has the property of inertia, measured by mass. This property of inertia makes objects tend to maintain their state. For example, when an impulse force, such as a kick, is applied to an object, the object will continue to move at a constant velocity as long as no other force acts on the object [4].

1.2. Newton's Second Law

Newton's Second Law describes changes in an object's motion conditions. This law states that if an object acts force, then the object can experience a change in its state of motion. Where the change in motion is always proportional to the force it changes [3]. Mathematically, Newton's second law is formulated as shown in equation (1) :

$$\vec{F} = \frac{d\vec{p}}{dt} \quad with \quad \vec{p} = m\vec{v} \tag{1}$$

According to Newton's second law above, the total force affecting an object is equal to the change in momentum in each unit of time (the rate of change in momentum) [3]. The equation applies universally under all circumstances, even if the object changes in mass while moving. It can be written using a simple differential rule given equation (2) :

$$\begin{aligned} \frac{d\vec{p}}{dt} &= \frac{d\ (m\vec{v})}{dt} \\ \frac{d\vec{p}}{dt} &= \vec{v}\ \frac{dm}{dt} + m\ \frac{d\vec{v}}{dt} \\ \frac{d\vec{p}}{dt} &= \vec{v}\ \frac{dm}{dt} + m\vec{a} \end{aligned} \tag{2}$$

It can be seen from equation (2) that the size of the force depends on the rate of mass change and acceleration of the object. This is Newton's Second Law, most generally, for bodies that change mass. Especially for objects with a fixed mass, thus dm/dt = 0, the equation (2) becomes equation (3) where force equals mass times acceleration [2].

$$\vec{F} = m\vec{a} \tag{3}$$

1.3. Newton's Third Law

This law explains the existence of a reaction force equivalent to the force of action but in the opposite direction [5]. If the first body exerts a force on the second object

(action force), the second object also exerts the same force on the first object but in the opposite direction (reaction force).

The laws of motion developed by Newton study physics content, a basic concept used to understand other physics concepts [6][7][8], such as work and energy, momentum, gravity, etc. For students who need help understanding the material of Newton's laws, of course, in the next material, students will need help.

Research on literature review is quite widely found in the field of physics, such as literature review: non-Newtonian fluid [9], Particle Physics [10][11], physics and predictive modelling of oil spill evaporation [12], physics of phaco [13], Efimov physics [14], application of Newton's third law in physics [1] and many more physics literature reviews but unfortunately, literature review on the development of Newton's law theory and its application in the last seven years (2017-2023) was not found, while Newton's law is a fundamental concept in physics [6]. Based on this study, conducting an in-depth literature review of research on Newton's law and its applications is necessary. These research questions are: How is the development of theory and research applications on Newton's law in the range of 2017-2023?

This study aims to identify research trends in the development of theories and research applications of Newton's law in the range of 2017-2023. Various research literature reviews have been carried out. However, literature reviews on developing theories and applications of Newton's law in 2017 -2023 have never been done, while Newton's law is a fundamental concept in physics. The novelty of this study is that it reviews the literature on the development of Newton's law theory and its application in 2017 – 2023.

2. METHOD

The research method used is a Systematic Literature Review (SLR). SLR is a systematic method for collecting secondary data and answering formulated questions. The SLR refers to the PRISMA Framework (Preferred Reporting Items for Systematic Reviews and Meta-analyses) in this study. PRISMA [15] is a set of minimal evidence-based items for reporting in systematic reviews and meta-analyses. In general, the PRISMA Framework includes 4 PRISMA steps: identification, screening, eligibility and Included [15][16][17]. PRISMA's steps can be seen in

In this study, the keyword used for the search was "Newton Law", and the article search was conducted in the databases Scopus, Springer, Emerald, and IEEE. The search is conducted from April to May 2023. The results of searching for articles up to decent

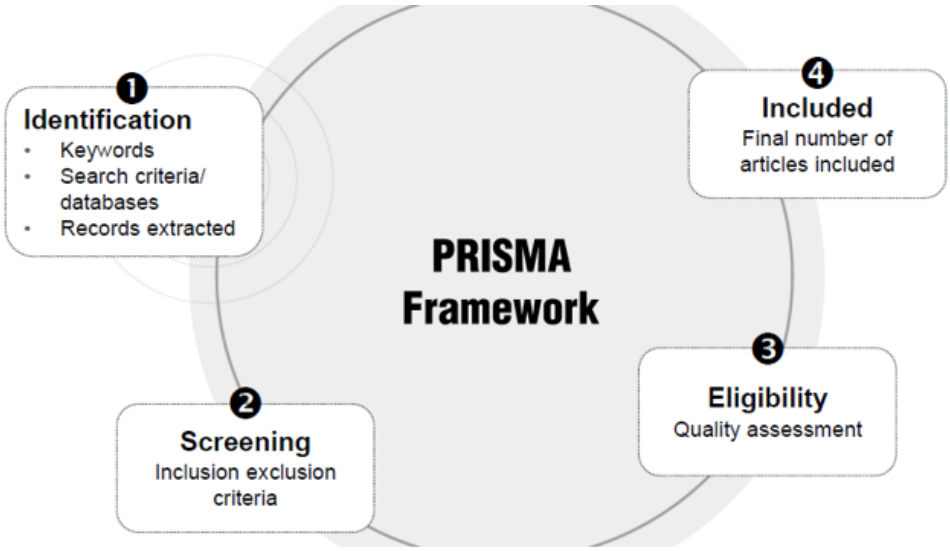

Figure 1: PRISMA Steps.

with PRISMA's 4 steps of identification, screening, eligibility and Included can be seen in Figure 2.

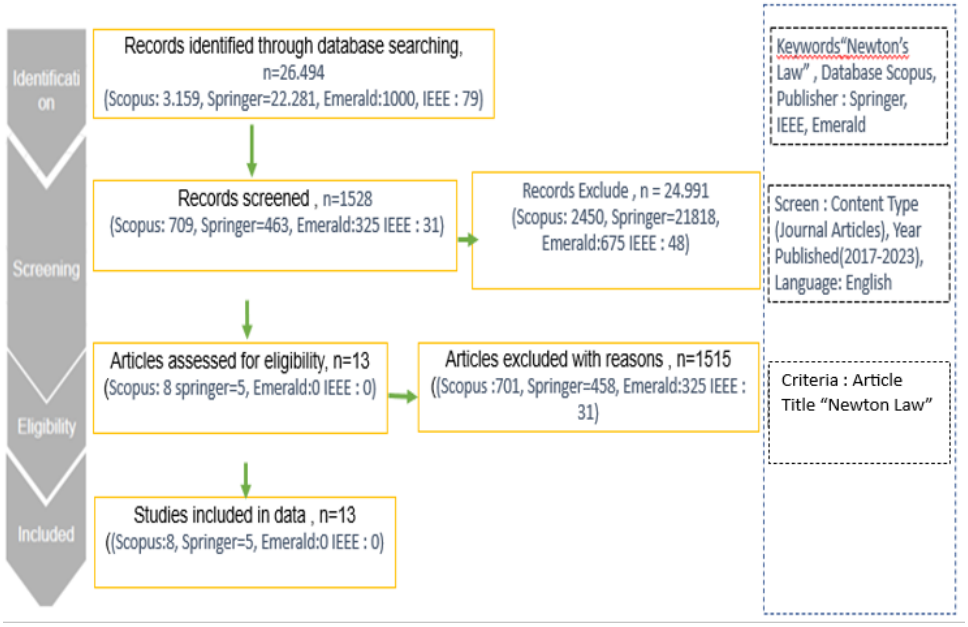

Figure 2: PRISMA Process.

3. RESULTS AND DISCUSSIONS

The article content is analyzed to determine the development of theory and application of research on Newton's law. The distribution of articles analyzed and the list of Article Results Analysis can be seen in Table 1 and Table 2.

Table 1: Article Distribution per Journal.

Journal Name	Number of Articles	Indexer			
		Scopus	SJR	Web of Science	JIF
ACS Omega	1	Q1	0.69	SCIE	0.63
Advances in Science, Technology and Engineering Systems	1	-	0	-	-
Archive for History of Exact Sciences	1	Q2	0.24	SCIE, AHCI	0.39
Archive of Applied Mechanics	2	Q2	0.59	SCIE	0.91
Communications in Mathematical Physics	1	Q1	1.41	SCIE	0.91
European Physical Journal C	1	Q1	1.53	SCIE	1.1
Frontiers in Physics	1	Q2	0.61	SCIE	0.74
Gravitation and Cosmology	1	Q3	0.29	SCIE	0.22
Monist	1	Q1	0.76	AHCI	1.59
Physical Review B	1	Q1	1.47	SCIE	0.76
Polymers	1	Q1	0.72	SCIE	0.88
Symmetry	1	Q2	0.48	SCIE	0.85

Table 2: Analysis of Theory and Application Development.

Author	Article title	Arguments/Results
Nikushchenko D.; Pavlovsky V.; Nikushchenko E. [18]	Analytical Solutions for Simple Turbulent Shear Flows on a Basis of a Generalized Newton's Law	Solutions are given for simple shear flows of the fluid when there is only one longitudinal component of the velocity, which depends on transverse coordinates only. This solution, in the form of a speed profile and a coefficient of resistance, is in satisfactory conformity with experimental data.
Won Y.-Y.; Ramkrishna D. [19]	Revised Formulation of Fick's, Fourier's, and Newton's Laws for Spatially Varying Linear Transport Coefficients	In one rectilinear dimension, the equations of Fick, Fourier, and Newton are modified to : $j = \frac{\partial(Dc)}{\partial x}$, $q = \frac{\partial(kT)}{\partial x}$, $\tau xy = \frac{\partial(\mu V y)}{\partial x}$
Kamalov T.F. [20]	Quantum correction for Newton's law of motion	Using high-time derivatives as non-local hidden variables on the equivalence principle could provide quantum correction for Newton's Laws of Motion. The stability principle was introduced to overcome the problem of the incompleteness of descriptions of physical reality. In addition, descriptive exposure and analysis provide a better understanding of using high-time derivatives as non-local hidden variables and equivalence principles in quantum physics.

Table 2: Continued.

Author	Article title	Arguments/Results
Susskind L. [21]	Complexity and Newton's Laws	Susskind showed that Newton's laws of motion can be obtained from operators' growth in time evolution. In this case, the system's complexity can be calculated using the concepts of "AdS/CFT correspondence" and "volume-complexity correspondence".In addition, it was shown that the holographic origin of ordinary gravitational attraction is the tendency of quantum mechanics for operators to grow in the evolution of time.
Lee C.H.; Li G.; Jin G.; Liu Y.; Zhang X. [22]	Topological dynamics of gyroscopic and Floquet lattices from Newton's laws	An in-depth explanation of how topological behaviour arises in mechanical systems and how Newton's laws can explain it. Edge locality and chirality of topological edge modes arise from the "hanging" nature of multiple boundary sites, a mechanism applicable to generic topological systems governed by 2nd-order ODE.
Kirillov A.A., Savelova E.P. . [23]	On Modification of Newton's Law by a Homogeneous Distribution of Wormholes in Space	The distribution of cosmological wormholes can modify Newton's law of gravity at great distances and affect the motion of objects in the universe. In addition, it was found that the mass spectrum of the wormhole is related to the average parameters of the wormhole.
Baeza-Ballesteros J., Donini A., Nadal-Gisbert S. [24]	Dynamical measurements of deviations from Newton's 1 / r2 law	The proposed experiment could provide better sensitivity than previous measurements in detecting deviations from the Newtonian distance law. This research shows that more dynamic measurements of deviations from Newtonian laws can test corrections such as Yukawa's against a potential of 1/r with power as small as α∼10∧-2 for distances as small as λ∼10 μm.
Darrigol O. [25]	Deducing Newton's second law from relativity principles: A forgotten history	The result of this article is to provide a better understanding of the history of Newton's second law and the contribution of experts in explaining it, among other things, a deeper knowledge of the principles of mechanics used from Newton to the end of the 19th century and how the principle of relative motion can be used as a constructive tool.
Katsikadelis J.T. [26]	Derivation of Newton's law of motion from Kepler's laws of planetary motion	Newton's laws of motion were successfully derived from Kepler's laws of planetary orbit.
Katsikadelis J.T. [27]	Is Newton's law of motion really of integer differential form?	The results show that for objects with constant mass, Newton's laws of motion are indeed integer-order differential equations
Uriza Gosebruch O.R.; Nu nez Martin C.A.; Rodríguez Vázquez E.E.; Mercado E.C. [28]	Mathematical model based on Newton's Laws and in first thermodynamic law of a gas turbine	Mathematical modelling of gas turbine systems is based on physical laws such as Euler's, Newton's Second, and the first law of thermodynamics. This mathematical modelling is used to obtain mass, momentum, and energy sustainability equations expressed as sustainability equations, Navier-Stokes equations, and energy preservation using Fourier's Law. This mathematical model can be applied in control applications in industry in the future by optimizing gas turbine performance through setting variables that affect gas turbine performance, such as inlet air temperature, inlet air pressure, fuel flow rate and so on.

Table 2: Continued.

Author	Article title	Arguments/Results
Ayi N. [29]	From Newton's Law to the Linear Boltzmann Equation Without Cut-Off	The goal is a derivative of the linear Boltzmann equation without the tighter, more general cut-off. In addition, a more detailed description of the motion of particles in gases is approaching global equilibrium and considers the effects of interactions between particles.
Biener Z.; Schliesser E. [30]	The certainty, modality, and grounding of newton's laws	The first tension in Newton's view of natural law can be overcome by distinguishing between Newton's belief in the certainty of his law and his commitment to the variations and contingencies of that law. The second tension could not be overcome because Newton gave the same fundamental status to the laws of nature and the bodies governed by those laws.

The distribution of analyzed articles that publish articles about Newton's laws, most published in the Archive of Applied Mechanics indexed by Scopus and included in the Q2 category (SJR 0.59), besides WoS also index it with the SCIE category (JIF: 0.91). The development of theories and applications of Newton's laws, in the article include: applications to simple shear flow of fluids [18], linear transport coefficients [19], quantum correction for Newton's Laws of Motion [20], the close relationship between system complexity and Newton's laws of motion [21], the emergence of topological behavior from Newton's laws [22], The influence of cosmological wormholes on Newton's laws [23], Detection of deviations from Newtonian distance laws by experiment [24], the principle of relative motion can be used as a constructive tool [25], Newton's laws of motion are successfully derived from Kepler's laws of planetary orbit [26], Newton's laws of motion take the form of integer-order differential equations for bodies with constant mass [27], Newton's law is used as one of the legal bases Mathematical modeling of gas turbine systems [28], From Newton's law, a derivative of the linear Boltzmann equation without the resulting cut-off can give an explanation of the motion of particles in gases [29], The first tension in Newton's view of the laws of nature can be overcome by distinguishing between Newton's belief in the certainty of his laws and his commitment to variation and contingency [30].

Based on the above study, the development of Newton's Law theory still plays a key role in understanding physics. Its applications continue to be developed and applied in various fields, such as fluid physics [18][19], quantum [20], cosmology [23], and mathematics [27] [28] [29]. In addition, the debate about the fundamental nature of Newton's Laws remains a relevant topic in scientific thought [21][22][24][25][26][30]. The debate about the nature of Newton's laws is also relevant to the research results [1], especially the debate on Newton's Third Law.

4. CONCLUSION

Based on the results and discussion, it is concluded that the development of theory and application of Newton's law in the range of 2017-2023 is as follows: a. despite several years ago, Newton's law still holds the basic key to understanding physics, b. Newton's law is fundamental and widely applied in is applied in various fields, including fluid physics, quantum physics, cosmology, and mathematics.

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