

Can be reflexion and Newtonian mechanics related? If so, what is the relation?

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Abstract. The article is focused on the explanation of reflexion in its traditional philosophical and psychological understanding as well as in its complete understanding. In this article, a reflexive system is explained as a social and psychological phenomenon on the example of falling pencil those trajectory is reflected in mirrors arranged in the room. As the article tries to answer a question whether reflexion and Newtonian mechanics, being poles apart, are related, complete understanding of reflexion and reflexive system as a social and psychological phenomenon is explained by applying principles of Newtonian mechanics in this article. In conclusion, the article analyses the economic system as a reflexive system by applying principles of Newtonian mechanics.

1 Introduction

In traditional philosophical and psychological understanding, reflexion is defined as a capability to take the position of observer, researcher or inspector in relation to his body, acts and ideas. Vladimir Lefevre expanded traditional understanding of reflexion with a capability to take the position of researcher in relation to other person, his acts and ideas. The expanded understanding of reflexion gives a possibility to construct whole object of research and to reveal reflexive processes as independent phenomena determining specific features of objects-researchers mutual relations. Penetration to private world of other person can be committed both by the psychologist, for which this action is end in itself, and any subject entering to natural dialogue with other subject. On their structure these attitudes are indiscernible. They are different by directivity and penetration purpose.

To define a reflexive system, Vladimir Lefevre took advantage of analogy with falling pencil whose drop reflects in mirrors placed under some angles in the laughter room. Pencil drop is reflected fantastical in mirrors, the mirrors reflect in each other. Already distorted drop trajectories reflect with various distortions. In this analogy, reflexive system is the system of mirrors repeatedly reflecting each other. Each mirror is the analogue of character allocated one's specific position. All complex flow of reflections of mirrors in each other is the analogue of reflexive process. Pencil drop represents physical process in the analogy. If not only this drop is interesting, and all flow of reflections accomplished by the characters, then we deal with a socially-psychological phenomenon.

2 Newtonian mechanics

Newtonian mechanics is the study of the causal relationship between force, mass, and motion in the natural world.

2.1 Newton's first law of motion: law of inertia

Newton's first law of motion states that, in inertial frame of reference, i.e. in any system at rest or moving with constant velocity, a body remains at rest or keeps moving in a straight line at constant speed unless it is acted upon by other bodies.

$$f = 0 \quad (1)$$

2.2 Newton's second law of motion: law of force

Newton's second law of motion states that force is directly proportional to a product of mass of a body m and acceleration of a body a .

$$f = ma \quad (2)$$

2.3 Newton's third law of motion: action-reaction law

Newton's third law of motion states that every action f_{12} calls a reaction f_{21} that is equal in magnitude and opposite in direction.

$$f_{12} = - f_{21} \quad (3)$$

2.4 Impuls and momentum

Impuls I , i.e. time impact of force f , is generally defined by integral.

$$I = \int f dt \quad (4)$$

Momentum H of a body is a vector that is defined by a product of mass m and velocity v .

$$H = mv \quad (5)$$

Principle of impuls I and momentum H states that impuls is equal to a time change of momentum, i.e. subtraction between momentums at the beginning H_1 and the end H_2 of force action.

$$I = H_2 - H_1 \quad (6)$$

3 Newtonian mechanics and traditional philosophical and psychological understanding of reflexion

Returning to the definition of reflexive system through the analogy with the pencil drop, the parallel with Newtonian mechanics arises.

Let's analyze this parallel in terms of Newton's laws of motion that precisely address the link between the motion and forces that cause it.

Let's describe the pencil drop that reflects in mirrors placed under some angles in the room in terms of Newtonian mechanics.

It is necessary to highlight that the force itself does not exist in the nature. De facto, it is only interaction that exists. Action and reaction force pairs are equal in magnitude and opposite in direction. They are in the same relation as the subject and its image in the mirror. It is also necessary to highlight that balanced forces cannot be confused with action and reaction force pairs. Balanced force is when two equal and opposite forces are applied on a body in two exactly opposite directions.

3.1 System of bodies

The falling pencil and the mirrors in the laughter room form a system of bodies. Bodies interact with each other, and the interaction and its impact change with time.

3.2 Newton's laws of motion and reflexion

Newton's second law of motion defines force by product of mass of body and its acceleration. However, there is neither mass nor acceleration to define the force in the parallel with falling pencil. So, what is the analogue of the force that the falling pencil acts upon the mirrors and vice versa? The falling pencil acts upon the mirrors by its trajectory. On the other hand, the mirror acts upon the trajectory of the pencil by its image in the mirror. So, the trajectory and its image in the mirror are the analogues of the force that the trajectory acts upon the mirror and vice versa, i.e. action and reaction forces. Except for interaction between the falling pencil and the mirrors, there is the interaction between the mirrors. The mirrors act upon one another by the images of the trajectory, i.e. the images of the trajectory are the analogues to the forces that the mirrors act upon one another, i.e. action and reaction forces. It is important to realize that the behavior of the system is set up by the angles that the mirrors are placed under. Change of the angles that the mirrors are placed under alters the behavior of the system. As there is a variety of plane and curved mirrors in the laughter room, an objection that curved reflexive surface changes the shape of the trajectory and therefore changes the behavior of the system, can arise. This is not true because curved reflexive surface is a feature of the mirror that is given and cannot be changed therefore the behavior of the system cannot be modified by changing the surface of the mirrors. If we want to modify the behavior of the system by changing the surface of the mirrors, the mirror has to be replaced by another one. Replacement of a mirror causes that the new system is formed.

3.3 Reflexive system in terms of Newton's law of motions

Let the pencil remains at rest in time t_0 , i.e. the trajectory has no contact with the mirrors, therefore the trajectory cannot be reflected in the mirrors. In terms of Newton's law of motion, there is no interaction between bodies so they remain at rest that corresponds to Newton's first law of motion – law of inertia.

Let the pencil is put into motion in time t_1 which causes that there is a contact between the falling pencil and the mirrors, i.e. interaction between bodies. In fact, there are two interactions between bodies that occur with a delay. The first one is between the mirrors that are in direct contact with the falling pencil. The second one is between the mirrors that are in direct contact with each other.

It is important to note that the second interaction is the consequence of the first one. If the result is transposed in terms of Newton's laws of motion, the second interaction is the analogue of impulse.

Action and reaction forces are to each other as a subject and its image in a mirror, i.e. the trajectory of the falling pencil and its image in the mirror are rotated 180 degree. This explanation corresponds to Newton's third law of motion – action-reaction law. Someone can argue that the image of the trajectory in the mirror can be distorted. That is true but the deformation is caused by the curved reflexive surface of the mirror. It is not caused by the nullity of Newton's third law of motion. Moreover, all deformations can be eliminated by the settings of the system.

4 Newtonian mechanics and economic system

An economic system is the type of rules and schemes used by a group of people to exchange valued goods and services between different parties. Having a system that this group agrees upon is necessary for the relative success of trade.

A market is a mechanism by which buyers and sellers interact to determine the price and quantity of a good or service. In a market system, everything has a price, which is the value of the good in terms of money. Prices represent the terms on which people and firms voluntarily exchange different commodities.

4.1 Economic system as reflexive system

Let's examine the economic system in terms of the parallel with the pencil drop reflects in the mirrors. What is the analogue of the laughter room, the mirrors and the pencil drop in economic system? A market is the analogue of the laughter room. Market participants are analogues of the mirrors and the decisions of market participants are analogues of the pencil drop. Every decision of a participant is reflected in the decisions of the others. All complex flow of reflections in the decisions of the participants operating on the market is the analogue of reflexive process. Market participants as well as the mirrors in the parallel of Vladimir Lefevre have their characteristics. Characteristics of both, the mirrors as well as market participants, cannot be changed. What is the analogue of the angles that the mirrors are placed under in the parallel of Vladimir Lefevre? Economic system has its own rules to control the behavior of market participants and itself. The behavior of the market as well as the market participants can be altered by changing the rules of economic system therefore the economic rules are the analogues of the angles in the parallel of Vladimir Lefevre.

4.2 System of bodies in economic system

As market participants interact with one another and the interaction and its impact change with the time, market participants form the system of bodies.

4.3 Reflexion in economic system in terms of Newtonian mechanics

We described the pencil drop and its images in the mirror that were placed in the room in terms of Newtonian mechanics. Let's try to describe the interactions among market participants in terms of Newtonian mechanics.

Market participants can control their activities by taking decisions so the decision is the analogue of the force. The decision that initiates the flow of interactions among market participants is called action force. The decision that the other participants are responsive to the initial decision is called reaction force.

Let no decision is taken that affects the other market participants in time t_0 . As there is no decision, the behavior of the system does not change.

Referring the above mentioned, a decision is the analogue of the force. If no decision is taken, no force acts upon a body by other bodies and the behavior of the system remains unchanged that corresponds to Newton's first law of motion – law of inertia.

Let the market participant takes a decision that affects on the others in time t_1 . Let's examine the interaction that begins and verify whether the interaction is identical with the interaction described in the parallel of Vladimir Lefevre.

This market participant is in direct contact with a group of the other market participants so his decision begins to affect decisions of the other market participants, i.e. the interaction among bodies begins. Some participants adopt new decision and some not, i.e. contrasting decisions are taken. New and contrasting decisions

are to each other as a subject and its image in the mirror. New decision is the analogue of action force and contrasting decision is the analogue of reaction force. Such interaction can be expressed by the formula (3).

Anyone can raise objections that the decision accepted by the majority of the market participants is more significant. This is not true because decisions of market participants are neither added up nor multiplied. Regardless what decision is accepted by the majority, there are always two decisions that have equal importance and opposite meaning.

Applying the principles of Newton's laws of motion, we can find to deal with the third Newton's law of motion – action and reaction law.

The group of market participants from preceding interaction can be in direct contact with the other group of market participants in time t_1 . In this interaction, new decision is transferred to the other group of market participants through the group of market participants from preceding interaction. Some market participants adopt new decision, some not, so contrasting decisions are taken again. The chain of interactions, started in time t_1 , will finish in time $t_1 + \Delta t_1$.

Changes made in decisions of market participants are time impact of a new decision. As a new decision is the analogue of the force, the time impact of a new decision is the analogue of impuls. Changes in decisions of market participants resulting from a new decision can be expressed by the formula (4).

Principle of impuls and momentum states that impuls is equal to a time change of momentum. When a new decision of the market participants begins to affect the decisions of the other market participants, the analogue of the collision of bodies arise. Let's imagine that two clay balls collide. As a consequence of the collision, the balls get stuck and continue to move together. When two decisions collide, they also "get stuck" and they are passed together to the other market participants. As two decisions cannot get stuck, it is necessary to explain the meaning of "two decision get stuck". The answer is that one decision is absorbed by the other one. Which decision is absorbed depends on the knowledge and the model of evaluating the facts of individual market participants. The winning decision influence decisions of the market participants through their interaction.

In economic system, momentum is defined by the knowledge and the model of evaluating the facts. Any new decision that appears in time t_1 is an example of a new information that influences the decision of every market participant by changing the knowledge and the model of evaluating facts. Any change in rules of the system is an example of a new information, too. Such change in existing rules influences also the decision of every market participant by changing the knowledge and the model of evaluating facts.

Impuls is equal to a time change of momentum, i.e. subtraction between the level of the knowledge and the state of adopted model of evaluating facts at the beginning and at the end of the interaction. This can be expressed by the formula (6).

Interaction is not only the means to transport the decision from one market participant to another. It is also an analytical tool allowing to study the knowledge, models of evaluating facts, acts and ideas of the market participants. Interaction is the analogue of reflexion.

If any new decision is taken in time t_2 , the process of interactions between market participants will repeat.

4.4 Inertial frame of reference

Newton's laws of motion are valid in any system at rest or moving with constant velocity. Such a system is known as inertial frame of reference. Inertial frame of reference ensures that observer's position and the examined system act according to the same rules.

Any economic system has the rules that make its behavior constant. Every participant in economic system and economic system itself act according to the same rules. The set of rules is a key element of each system because it determines whether the system is oriented on its sustainable development or its collapse. Economic system has to be analyzed in detail before defining the rules. If an observer wants to examine the behavior of economic system, his position has to become integral part of economic system to ensure that the same rules are applied for economic system as well as for observer's position. It is necessary to highlight that only observer's position is important. The observer himself is unimportant.

The Earth forms inertial frame of reference for its citizens as well as economic system forms inertial frame of reference for its subjects. Every moving object on the Earth, i.e. a train or a ship is inertial frame of reference as well as each subject acting in economic system, i.e. a company, a factory, even an individual is inertial frame of reference.

5 Conclusion

The article tries to explain the relation between reflexion and Newtonian mechanics. The relation is the interaction between bodies because reflexion is the analogue of the interaction between bodies.

Moreover, the article explains the relation between force, impuls and momentum in economic system. The decision is the analogue of the force. Change in decision is the analogue of impuls. Subtraction between the level of the knowledge and the state of the model of evaluating facts at the beginning and at the end of the interaction is the analogue of momentum.

Any system, not only economic, can be described by Newton's laws of motion. Why? Because each system is formed by subjects that interact. The only task is to define the relation between terms used in the system and those used in Newtonian mechanics.

Literature

1. Лефевр, В. А.: *Рефлексия*. Когито-Центр, Москва, 2003.
2. Krempaský, J.: *Fyzika*. Alfa SNTL, Bratislava, 1987.

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