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Force and Causality

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INTRODUCTION

There are two purposes in this paper. One is to elucidate the change of scientific thought from later 18th century to early 19th century in conformity with a conversion of one foundamental concept, causality. The other is to grasp one of the turning points in the problem-history of causality. I had showed that the concept of Kraft (force), especially of Lebenskraft was possible only in the special mode of causality.[1] In this paper, I will focus my glasses on the history of concept of Kraft and causality.

The change of intellectual framework in this period has been discussed by some people. M. Foucault pointed out the change of isomorphic structure in lingistics, economics and biology in this period.[2] And S. Yamasaki mentioned the Industrial Revolution, the French Revolution and the Romantic Philosophy.[3] In the history of science, this period is called the Scientific Revolution II, mainly in view of institutionalization of science through the French Revolution in France and the foundation of the Berlin university in Germany.[4] Certainly in this period, electromagnetics, chemistry, biology and mineralogy are in a great alteration. The foundamental transformation of views seems pregnant in the conversion of the intellectual frameworks, which some indexes point out, that is for example, atoms, organizations, the reconstruction of geological features with fire and water, the interchange

of electricity and magnetism, etc.

Then I will define the problematic. In all the papers published so far concerning the conversion of the concept of causality, there seems to be three main points: the first is transmission from dynamic cause to formal cause,[5] the second is the exclusion of cause which does not accompany time passage and its limitation on time,[6] the third is the negation of the equivalence of cause-effect.[7] And these three properties have been looked upon as have no relations to each other. The first one does not refer to time, and the third one is separate from the first or the second. But these three properties appeared in the same period. Considering this fact, it is possible to presume that there should be certain relations among them. Therefore, my purpose in this paper is to elucidate how these properties are connected wiht each other, and to show their differences are ascribed to the differences of viewpoints on a certain situation which is to be clarified in the course of discussion of my paper.

In the first section, I give an outline of the concept of causality unto later 18th century, and identify the properties of the concept. In the second section, I describe the special mode of force and causality in that period. In the third section, I discuss the viewpoints on that situation and show how these three properties become separated in that very situation.

I.

There are two turning points in the history of causality in modern science, in the mid-17th century, and in the turn of the 18th century to 19th century, which this paper treats. From ancient to the mid-17th century, formal cause is predominant. In this view, quality of things is present in things themselves and

it causes the change of things. This quality is common to all species that constitute one class. According to the classification of the class, natural phenomena can be explained.

From the mid-17th century to the late 18th century, the concept of dynamic cause is predominant. The change of the transfiguration of things does not depend on their own quality, but is possibly brought only by external agents, for example, a shock, a pressure, or an action etc. Matter has the quality of impenetrability or extension alone, and it is possible for matter to change only by external dynamic agent. In this case, the change in general is limited to the change of position in space and that of combination of things. Matter without mobility can change no other than by external cause, and then qualitative change and production or dispersion of things are excluded. Therefore, causality is grasped in the limited change in this time, that is, the change of position in space.

Here we can recognize that the quality of causality discussed in the Scholastic Philosophy reappeared in the mathematical formulation. In fact, Descartes insisted as his principle that there must be as much reality in cause as in effect.[8] And this principle was concreted into so-called the law of conservation of momentum. This principle was formulated with further exactness. Galileo regarded dynamic cause as necessary and sufficient condition for existence of the things, and insisted that what produces effect, without which effect would be lost, must be regarded as cause.[9] This opinion contains not only the principle of equivalency of cause-effect (causa aequat effectum) but also interchangibility of cause and effect. In this case mechanical events are adequate for this principle but chemical reactions or biological processes are not. We should judge that mechanism succeeded by limiting the

mode of change to the above-mentioned determinations.

In this case, Galileo regarded 'force' as the true cause of physical phenomena. And Descartes, who did not admit the concept of force at first, related it with movement foundamentally.[10] Newton enlarged the concept of force from only force of motion to dynamic cause that produces the difference of the condition of motion. This concept of force as active agent is invariable in the process of motion and can produce the change of motion. On account of it, this concept is too much different from the concept of cause in causal relations. But he transferred this concept to cause in general in his system, therefore cause in causal relation and cause as the ground of the change of motion were coexisted being named force. Certainly two kinds of force were confused in his system.[11]

But only Newton did not confuse them. In Descartes' proof of the being of God, he insisted the infinity of God himself is the cause of the being of God.[12] In these views, logical ground and cause was equated each other and in a case these two were expressed as force. After all the concept of force was generalized ultimate cause of things.

This fact was noticed in 18th century. C. Wolff insisted that ground and cause must not be mixtured, and Reimars defined the former as internal ground, the latter as external ground.[13] Eventually this confusion was habitual in 18th century. Later Kant gave one important solution to this problem.

Up to this day, mechanism and hylozoism have been listed as the main thoughts in 18th century.[14] We see the same confusion in hylozoism. Diderot, who limited change of matters to the transfiguration, put inherence with sensibility into matters. It is this principle of sensibility that produces transfiguration, and is

invariable through it. In other words, this principle is dynamic and external to the change. Even if this principle is inherent in matters, it has the same logical structure.

In sum, cause in modern science before 19th century was external agents that subsist in matters, things and conditions with or without the passage of time, and then cause and effect is equivalent in that cause-effect relation. And physical agent in such cause corresponds to force. When the concept of causality like this varies, there seemed to be huge immediate changes in all of the intellectual situations. I will study these situations referring to the concept of force.

II.

In later 18th century, so-called Romanticism raised its head in physics. It tried to regard nature not as natura naturata but natura naturans, and introduced force into physics as subsistence which is productive of natural phenomena. Force is no longer a principle inherent in matters like in hylozoism. It is generalized for all of nature. In seizing the formation of nature and unifying various natural phenomena with force, its meaning inevitably varied. For that reason, the concept has greatly various meanings. These very varieties set no other than the starting point of shift of the concept.

Herder tried to grasp the general history of nature and mankind, and starting from the history of earth, he placed all the ages and several people in the phases of the history of mankind. Herder conceived that extrapolated mental power into natural phenomena came to be this force. It is force for him that realizes productive formation of natural beings. And it is in nature that makes progress in itself.[15] But the mode of inherence is no longer

ground for the change of matter in hylozoism. In fact, though this concept of force has quality of agents, it corresponds to form in relation of matter-form.

> Bildung ist's, eine Wirkung innerer Kräfte, denen die Natur eine Masse vorbereitet hatte, die sie sich zubilden, in der sie sichtbar machen sollten.[16]
>
> Das Kraft und Organ zwar innigst verbunden, nicht aber eins und dasselbe sei. Die Materie unseres Körpers war da, aber gestalt und leblos, ehe sie die organischen Kräfte bildeten und belebten.[17]

Certainly the force as formalizing agent is not as much as mode of existence of matter and it is not cause by way of the ground of the change of matter. But Herder considered as if force, which is a formalizing agent, belongs to the dynamic relation among matters. And then, force itself is invisible and immortal, because it produces visible form and still remains after the exclusion of all forms of matter. In sum, force is invisible, immortal, formalizing agent and formal cause for Herder.

In the same period, Kant tried to investigate the conditions of possibility of matter and considered the determinations of attraction and repulsion as cause of impenetrability or extension of matter in his transcendental conception. He determined attraction and repulsion separately, and did not ask their relation. After him, metaphysics of nature, which investigates the premises of empirical natural science, in other words, studies of the principle that demonstrates the necessity of existence of matter, enlarged with two peculiarities. They are both to extend limited considerations in physics to all of natural phenomena, and to unify the different determinations of attractive force and repulsive force with a kind of relation between them. Novalis considered natural phenomena

as symbols of the hidden transcendent reality and definited pure physics researches this reality.[18] Schelling definited natural science as follows:

> Wissenschaft der Natur ist an sich selbst schon Erhebung über die einzelnen Erscheinungen und Produkte zur Idee dessen, worin sie eins sind und ausdem sie als gemeinschaftlichem Quell hervorgehen.[19]

The concept of force varied greatly in the attempt of understanding immediately various natural phenomena consolidatedly such as mechanical, thermodynamic, electromagnetic, chemical, vital phenomena. Cohesive force, affinitive force, electric force, vital force, etc. were brought forward one after another.

The Investigation of natural phenomena through attraction and repulsion developed to be unified. The most important concept was polarity. In *Metamorphose der Pflanzen* (1790), Goethe described the formation applying the dual principles of expansion and contraction in unity, and a series of pair concepts such as binding-separating, breathing in-breathing out, etc, are constructed in botany and zoology.

It is Schelling that formulated the concept of ploarity clearly. He specified two tendencies of internal structures of nature. One is the productivity that nature has essentially in itself, the other is the restriction of this productivity. The latter generates products by conditioning (bedingung) on the first. Produced nature depends on the interaction of these two tendencies. One of these bipolar tendencies becomes by turns, and in the course of this, the material object is brought about. But matter does not consists of only two forces, attractive force and repulsive force. For as far as it is not demonstrated how bipolar active force can be unified on the same subject, the third active force must be

introduced.[20] This third active force is no more than gravity that corresponds to the synthetic action of subjectivity.

From three forces is deduced the constitution of matter. The first step is that "die beiden entgegengesetzten Kräfte als in einem und demselben Punkt vereinigt gedacht werden,"[21] the second is that "die beiden entgegengesetzten Kräfte als völlig außer einander, und durch did Grenze geschieden vorstellt,"[22] the third is that "die beiden jetzt völlig getrennten Kräfte eines und desselben Punktes sind,"[23] and only through these steps three dimentions of matter is constituted.

In more details, when two opposite forces (positive and negative force) are united in the first step, the positive is the expansive force, and the negative determines the direction of the expansive force alone. On account of it, matter has the one dimentional extension, after all the length being composed. On the analogy of linear action, the forces in this case, corresponds to magnetism. In the second, there is the plane in and around the equilibrium point of two forces, then the dimention of breadth is constructed. On the analogy of electricity that runs all over the preface of matter, these forces correspond to electricity in nature. In the third, one force penetrates the other mutually, brings about impenetrability of matter, or the third dimention of thickness, which corresponds to the chemical process.

The concept of force is no longer single invariable agent, but basic existence which can be changed into various process, and become a kind of universal basis. Two things brought that concept of force to Schelling. One is the ideal of unity that urged him to find a basis which is transformative among various phenomena. The other is dynamic view of nature, in which beings in nature can transform qualitatively essentially.

In the almost same period, many studies appeared, which investigate relations of qualitatively different natural phenomena. In 1790, Davy considered the relation between magnetic action and galvanic one that was originated from sparkling convulsion of a frog's leg. He found that a strong magnet attracted, repulsed or rotated the arc between two poles (1821). Örsted showed that electricity can swing magetic needles (1820). It was found that galvanic electricity was transformed into heat or light with its high voltage. Heat producted by some handreds pairs of metal plates was as strong as to dissolve salts. And it was known that electricity was transformed into light, using carbons at the place of interruption of electricity (1815). Dalton studied the connection between temperature and cubic measure of air, and Gey-Lussac formulated it mathematically. He proved in 1802 that all kinds of gases expand at the same rate of the rising of temperature as far as other conditions are equal.

In this time, some facts of relational subsistence was clarified in biology. Knight demonstrated the relations between plant's action and gravity, moisture and light, with the experimental observations. He considered the relation of a tropistic response and gravity in *On the Direction of the Radicle and Germen During the Vegetation of Seeds* (1806), and the relation of moisture and the growing direction of a plant's root in *Pomora Herefordiensis* (1811). And in being demonstrated that natural phenomena interrelate and transform to each other, T. Saussure showed the balance of the adapted and the excreted by plants. Later in these situations Liebig postulated the law of energy conservation.[24]

In this period, Ritter was interested in the problems in physiology, chemistry, electromagnetics and optics. He postulated the problem as such what relation galvanism and electricity have

or what relation these two and chemism have. He considered objects from the foundamental bipolar forces, to make a answer to the problem. It was said that the interaction of foundamental forces was a chemical action where two objects diminisched and a new one emerged, and the interaction of them was a electric action where two touched each other as if the two opposite forces come to the equilibrium.[25] And galvanic action was brought about where two objects interact both directly and indirectly at the same time. When qualitative various phenomena related to each other and were considered to be interchangible, the concept of force also was not only the basic being but in itself interchanged from one form to another form, and after all forces come to be a penetrating through them.

The concept of force is no longer a external agent, it comes to be a universal reality lying behind different forms and sometimes appears as both cause and effect on the one hand. A separated determination such as phenomenon or its ground disperses and the ground evolutes into a phenomenon and becomes a from of phenomena, and therefore force becomes a penetrating one through phenomena in general. Thus the concept of force becomes to remain to be invariable through the time passage, or becomes to be determined in the passage of time as each form of phenomena. Therefore, it is both cause and effect, and both ground and phenomenon, and then the penetrating one through cause and effect. Later, in such conditions, elementary forms of the law of energy conservation are to be postulated.[26]

III.

As I have already mentioned, from later 18th century to 19th century, the concept of force changed into many various meanings

and the concepts of cause confused in itself. Elementary conceptions, which will become conceptional frameworks dominant in the next generation, were impregnate in immediate variety in this transitional stage of the concept. I will discuss what property the concept of force or cause has in each of the conditions, and how three properties of causality separate in these three conceptions. Of course, situations are so complex that three properties do not correspond to three conceptions with one to one.

One of these conceptios was Kant's conception and it was reinforced by Schopenhauer. They separated cause in the passage of time from cause as ground of the event, and attributed the latter to the subjectivity, or to the metaphysical region. In this case, the concept of force as a invariable ground of the change is limited in the transcendental region, and causality is considered only in the passage of time. Therefore the equivalence of cause-effect remainds to be in this conception.

In the second conception, we see that the relation of cause-effect was incorporated into a higher relation. The concept of force is both cause and effect and then one impenetrating existence to them. Each form of the force in causal series is one form of the force. As a cause or a effect itself is only abstracted from the higher relation, the equivalence of cause-effect is only abstractive and therefore is not necessary. The higher relation has not a external cause and is so called cause of itself. In this point of view, formal cause reappears widely in science (Schelling).

In the third conception, studies of ground or force were not only abondoned but also expelled positively from scientific reserch. It limited its standpoint to the tentative law or rule and made scientific methodology the only guiding principle. In this case, causality as the regularity in general made a important role

in scientific studies. Each of things in causal relations exists by itself and has its quality in itself. Here we can see that formal cause reappears widely (Positivism).

(i) Schopenhauer classified grounds into four kinds of such as generation, cognition, being and motivation in his *Über die vierfache Wurzel des Satzes vom zureichenden Grunde* (1813), and limited the concept of cause to the one in the passage of time, and then the concept of force to ground of cognition. He said that:

> das Gesetz der Causalität sich ausschließlich auf Veränderungen, d. h. auf den Ein-und Austriff der Zustände in der Zeit bezieht, als woselbst es dasjenige Verhältnis regulirt, in Beziehung auf welches der frühere Ursache, der später Wirkung heisst und ihre nothwendige Verbindung das Erfolgen.[27]

In this case, a series of causality has neither its start nor its end. Empirical investigation is concered with only the change of conditions. As far as his considerations depend on the point of view of ground, interaction of things is constructed from causality.

The concept of force as ground of the change can not be explained in causal series, and must remain not to be understood. For force products the change and is invariable through the change, and remainds behind the change, and therefore, force is not know from the studies of the change of conditions. Late in mid-19th century, so-called agnosticism was spoken by many scientists,[28] and it seems it had its origin in the above-mentioned thing.

The law of nature is the norm with which force appears in series of cause-effect, and it is the band between force and the series. He enlarged the relation of grounding-grounded

onesidedly and divined grounds in general into four kinds of grounds and limited force to the metaphysical region. The region characteristics of metaphysics appeared through it, and on the contrary the borderline of empirical sciences was definited.

(ii) Schelling made the polarity the most important relation in nature in exchange for causality. All of types of physical actions such as gravity, light, magnetism, electricity, depended on the polarity. This speclative physics conceptioned the attempt to describe in details the universal principle that empirical studies presupposed. The physics had a theme to attain to the one ideal to which each of phenomena and products are attributed. In the totality of these phenomena, the one ideal is determined by the totality, vice verse. Certainly he thought that as far as descriptions or explanations of nature are no more than the knowledges conditioned or determinated, we must know the inner structure of nature to which these conditions or determinations are to be added. We ordinally regarded only the products as the objects. Accordingly the only way to grasp the nature before conditioning is to consider the nature productive action and then empirically cognited objects its products.

In this case, he conceived the concept of force from the polarity, and the concept was not a single invariable agent, but a universal basis through natural phenomena. One step of nature makes itself with all of determinations in former steps. He presuposes the hierarchy of nature and its evolution between steps, and causality is included into a higher relation, that is, interaction. He said that:

> Es ist überhaupt kein Kausalitätsverhälthis konstruierbar ohne Wechselwirkung, denn es ist keine Beziehung der Wirkung auf die Ursache möglich,…… wenn nicht die

Substanzen als Substrate des Verhältnisses durch einander fixiert werden."[29]

Thus the concept of force is both cause and effect and then runs through the relation of cause-effect, and it is the representation of the relation itself. Causality is determined 'internally' by the higher relation. In this view, there are two important results. (1) The higher relation has not ground or cause for itself outside it. Therefore it is a cause of itself, a formal cause. For example the finality of organism can not demand its external cause, but the organism itself is final. The conception of a formal cause reappears widely in this view. (2) As far as causality is determined in a higher relation, cause or effect itself is only abstracted from the latter, and then the contrast of independent cause with independent effect is impossible. Thus the equivalence of cause-effect is not necessary.

(iii) Positivist, for example, A. Comte, made causality a main leading principle of empirical studies, and positioned a higher relation a provisional law or rule in scientific investigations. Comte recognized as a foundamental principle that propositions, which can not be reduced to simple statements of each things have no meanings. Imaginations must subordinate observations for this reason. In this case, the concept of force is supernatural and it is the concept before positivistic step and then the convenient term as a only metaphor.

The scientific law is no more than foundamental description. Each of things to be described, exists by itself, and is compared with other event. And each of things itself has its quality. For example, atom has or is its quality, the things by immediate observations is grasped formal causally. In this

conceptions, as the absolute or the necessity are excluded, scientific investigations have its rightness in the progressive view of history such as three steps, mythical, metaphysical and positivistic.

Notes

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