

On “infra-theory” or “infra-language”: A Clarification of Actor–Network Theory via Bruno Latour’s Case Studies*

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The aim of this article is to examine the potential of Actor–Network Theory as a nonhuman social science theory through critical readings of Bruno Latour’s empirical studies. In previous studies on ANT, an important issue has been to categorize it in regard to the type of theory it represents. Following Latour’s description of ANT as an “infra-theory” or “infra-language,” this article deals with the question of the relationship of those two terms to ANT. To examine these concepts, we will review two of Latour’s case studies: the historical study on Louis Pasteur’s eradication of anthrax and the ethnography on the failure of the automated train operation system of the Paris metro. After exploring these cases, we conclude that ANT is a theory not for causal explanation but for the discovery of hidden factors.

Keywords: Actor–Network Theory, Bruno Latour, sociology of science and technology, infra-theory, empiricism

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Introduction

It has been nearly 40 years since Actor–Network Theory (ANT), which asserts that nonhumans are the missing masses of the social sciences, emerged in the sociology of science and technology. ANT’s leading theorists are two French sociologists, Bruno Latour and Michel Callon, and one British sociologist, John Law. To put it simply, ANT is a theory that considers social phenomena the result and the process of a “network” in which heterogeneous actors, both human and nonhuman, form relations with one another.

ANT has exerted considerable influence on new approaches emerging in the humanities and social sciences. For example, the social studies of finance situated within economic sociology, which asserts that the performative action of a financial theory or a financial model shapes the rational financial market, owes the idea of nonhuman agency to ANT (MacKenzie 2009; cf. Zelizer 2007). Another example of ANT’s influence is the approach of distributed cognition, which regards human cognition as a system comprising various things, such as writing materials, paper, or computer (Hutchins 1995).

Furthermore, ANT continues to be applied as a theoretical framework as well as a social theory in empirical studies. Using the notions of ANT, H el ene Mialet portrayed the genius British physicist Stephen Hawking as a cooperative system consisting of various actors, ranging from student assistants to his speech synthesizer (Mialet 2012). Likewise, Prachi More applied ANT to conduct literary analysis of urban narratives on London and Mumbai (More 2017).

Despite the various applications of ANT, some criticisms of ANT have been expressed within the field of Science and Technology Studies (STS). Frank W. Geels, one of the harshest critics of ANT, criticized ANT for being too philosophical and argued that STS as a social science requires no grand theory, but rather middle-range theory (Geels 2007, p. 633). In other words, according to Geels, the argument made by ANT that the world consists of human–nonhuman relations, is too philosophical, and social sciences do not require this kind of theory. Though we disagree with most of Geel’s interpretations of ANT, what is important here is an in-depth reading of ANT literature, and a critical assessment of what ANT can do as a social science theory (Mol 2010; Sayes 2014, 2017).

The aim of this article is to clarify ANT’s potential as a nonhuman social science theory by performing a critical reading of two of Latour’s empirical

studies.¹ First, we posit our research question through an extensive survey of Latour’s elaborations on ANT notions and previous studies (section 2). Second, we go through Latour’s historical study on Louis Pasteur’s eradication of anthrax (section 3). Third, we examine Latour’s ethnography on the failure of the automated train operation system of the Paris metro (section 4). In the course of tackling these tasks, we will conclude that ANT is a theory not for causal explanations of social phenomena, but a tool for discovering hidden factors.

On Bruno Latour’s Actor–Network Theory as “infra-language” or “infra-theory”

According to Latour, ANT is different from ordinary social science theories² (Latour 1999, p. 19). There has been criticism pointing out the conceptual ambiguity of ANT. For example, some authors argue that the concept of “actor(s)” used in ANT dismisses the fundamental distinction between humans and nonhumans and claims a naïve symmetry between the two (Knorr-Cetina 1985, p. 584; Amsterdamska 1990, p. 499; Schaffer 1991, p. 182; Pickering 1993, p. 565; Khong 2003, p. 702; Bourdieu 2004, pp. 29-30; Riis 2008, p. 295; Collins 2010, p. 140), while other scholars claim that ANT’s notion of “network” reduces the complexity of social phenomena to relationships (Hacking 1992, p. 511; Lee and Brown 1994, p. 781; Pierides and Woodman 2012, p. 676; Lynch 2013, p. 453). Following these criticisms, in interviews held in 1990 and 2000, Latour elaborated on ANT as an “infra-language” (Latour and Crawford 1993, p. 263) or “infra-theory” (Latour et al. 2003, p. 18) in which each ANT concept is less defined in order to blur the purely theoretical distinctions, such as the distinction between humans and things. Moreover, Latour emphasized the necessity of an “infra-language,” instead of only the observer’s notions, to trace the empirical construction of the phenomenon itself by the “actor(s)” (Latour 1988, p. 178; Latour 2005, p. 30). As far as overviewing Latour’s explanation on ANT, we could say that Latour himself has not clearly presented the theoretical characteristics of ANT.

¹ In the ranking of the most cited authors in the humanities in 2007, Latour was ranked number ten and ranked number three among living sociologists, following Anthony Giddens and Jürgen Habermas (Times Higher Education 2009).

² The other ANT theorists, Callon and Law, agree on Latour’s elaboration (Callon 1999, p. 194; Law 1999, p. 10).

The issue in previous studies was what ANT means as a theory. For example, there are some criticisms that consider ANT an acritical theory which merely traces the construction of social phenomena (Winner 1993, pp. 374-6; Lee and Brown 1994, p. 781; Fuller 2000, pp. 29-30; Hartwick 2000, p. 1182; Wajcman 2000, pp. 451-454; Miller 2002, p. 219; Fine 2005, p. 103). Another group regards ANT as a metaphysical theory which describes, through abstract notions, how the world emerges in the way that it does³ (Geels 2007, p. 633; Harman 2009, p. 6). Furthermore, according to some previous studies, ANT is not a causal theory, but a methodology which guides further research programs (Mol 2010, p. 261; Sayes 2014, pp. 142-143).

Based on this overview of previous studies, this article prefers to address the following research question: what does “infra-language” or “infra-theory” mean for ANT? Even if we accept that ANT is not a causal theory meant to explain social phenomena, Latour’s own elaboration on its status as an “infra-language” or “infra-theory” does not necessary provide clarification for making a judgment as to the usefulness of ANT. What became apparent as we surveyed Latour’s arguments was that ANT’s emphasis is not on abstraction, but on empiricism (Latour et al. 2011, p. 41).⁴ Thus, the key to clarifying the terms “infra-language” or “infra-theory” would be found in Latour’s empirical studies.

This article intends to shed light on Latour’s empirical studies. In previous studies addressing ANT, an emphasis was placed on Latour’s theoretical arguments (Harman 2009; de Vries 2016; Michael 2017). Specifically, we will survey two empirical studies: Latour’s historical study on Louis Pasteur’s achievement of eradicating anthrax in nineteenth-century France (Latour 1983), and Latour’s anthropological study on the failure of the automatic train operation project in 1970s Paris (Latour 1993). Examining these works, we elucidate how ANT functions in Latour’s case studies.

Bruno Latour’s Historical Study of Louis Pasteur’s Achievement Eradicating Anthrax

³ It should be noted that according to Latour, his arguments would be “completely ridiculous” (Latour, Harman and Erdélyi 2011, p. 44) if we regard his studies as metaphysical works.

⁴ This emphasis on empiricism is shared among ANT theorists. For example, Law once said that “[ANT] is not abstract but is grounded in empirical case studies” (Law 2009, p. 141). Related to these arguments, there is a previous study which suggests the necessity of examining Latour’s case studies (Hämäläinen and Lehtonen 2016, p. 21).

In this section, we analyze Latour’s descriptions in “Give me a laboratory and I will raise the world” (referred to as GI, in this article; see Table 1), published in 1983, in which Latour criticizes the interests approach of the Edinburgh School and describes the process of transformation of interests that the various related “actor(s)” go through, with regard to the case of the development of Pasteur’s anthrax vaccine. The primary focuses of GI are the processes of Pasteur’s laboratory operations and the construction of a cooperative relationship between Pasteur and the related “actor(s).”

The interests approach and laboratory studies

In GI, Latour emphasizes the importance of the laboratory in the phenomena of science and technology and presents a critique of the interests approach to the sociology of science and technology. Specifically, Latour refers to the following two approaches which address the role of actors’ interests (Latour 1983, pp. 143-144): the approach of the Edinburgh School which attributes interests to social groups and Steve Woolgar’s approach which dismisses such attribution (Woolgar 1981a).

The Edinburgh School is a proponent of the Sociology of Scientific Knowledge (SSK), which originated at the Science Studies Unit of the University of Edinburgh, and which contributed to the development of the sociology of science mainly between the late 1970s and the 1980s. The fundamental manifesto of this school was presented in David Bloor’s classical study, *Knowledge and Social Imagery* (Bloor 1976). Bloor formalized four principles underlying sociological studies of scientific knowledge, termed the “strong program”: causality to examine social conditions create a certain kind of knowledge, impartiality in analyzing both successful and unsuccessful knowledge, symmetry in applying the same types of explanations to successful and unsuccessful knowledge, and reflexivity in applying these principles to the sociological explanations themselves. Applying the research design of the sociology of knowledge proposed by Karl Mannheim to the knowledge of natural science, this manifesto marked a new start of the sociology of science (Lynch 1993: 67-9).

Because this ‘strong program’ operated as the basic guideline of SSK, the more specific framework of the interests approach became widely adopted. In particular, this approach offered the causal explanation that actions to produce, choose, and accept a certain kind of knowledge are explained by the social interests determining the human actors’ benefits. Following Bloor’s manifesto, the interests of the related human actors impartially and causally

explain any true or false knowledge.

This interests approach prompted a certain evaluation in the sociology of science, but faced harsh criticism in the early 1980s. For example, Steve Woolgar, co-author of *Laboratory Life* (Latour and Woolgar 1986), criticized the interests approach for prioritizing the construction of causal and objective notions and argued the necessity of reflexively reconsidering the observer's theory.⁵ In addition, Steven Yearley pointed out the theoretical fragility of the interests approach, arguing that this approach, which attributes the explanatory element as interests without further classification as to the explanation of the social phenomena regarding scientific knowledge, is merely a re-description of the actions performed in social phenomena (Yearley 1982).

In light of this background, we turn back to Latour's argument. In GI, Latour states that both the interests approach and Woolgar's argument missed a particular aspect: that whether interests can be defined *a priori* by observers or not, the transformation of interests and the persuasion of the other "actor(s)" are accomplished in actuality. According to Latour's case study on Pasteur, the interests of the "actor(s)" outside the laboratory in Pasteur's experiments are not the given causes, but rather the results of Pasteur's persuasion of other "actor(s)." Given this critique in the literature, Latour elaborates on Pasteur's process of identifying the anthrax microbe and developing the anthrax vaccine with a focus on Pasteur's power to persuade.

Louis Pasteur's strategy

The topic that Latour discussed is Pasteur's anthrax studies and his development of the anthrax vaccine. Anthrax caused serious loss of livestock throughout the 16th to 19th centuries in Europe. Particularly in France, the annual cost of anthrax in 1881 was approximately 20 million to 30 million francs. Pasteur's laboratory succeeded in the attenuation of anthrax bacteria and conducted a public experiment in which he vaccinated 25 sheep out of a group of 50 on a farm. Latour addressed a series of events concerning this anthrax vaccine experiment in his study.

In the first stage, Pasteur reinforced his fame as the anthrax expert by isolating the anthrax bacteria in his laboratory, and the development of its

⁵ Regarding this argument, via *Social Studies of Science*, Barry Barnes and Donald MacKenzie both replied to Woolgar's paper, and Woolgar responded in turn (Barnes 1981; MacKenzie 1981; Woolgar 1981b).

microbiology (Latour 1983, pp. 144-149). At that time, the disease was generally studied in relation to the variables of regional characteristics, such as soil, climate, and living species. Due to this, those considered anthrax experts were veterinarians experimenting on animal organisms and statisticians collecting data on the relevant variables. Thus, a laboratory scientist studying the original causes of natural phenomena was not considered as playing a significant role in the resolution of the anthrax problem at that time.

In spite of this, Pasteur analyzed the cause of anthrax, the anthrax microbe, through laboratory experimentation and successfully presented himself as the authority on its microbiology by clarifying the mechanism of epidemics. Pasteur's discovery of the anthrax bacteria through laboratory experimentation was of paramount interest to the suffering livestock ranchers who consequently realized that laboratory science was the answer to resolving the anthrax problem. Furthermore, Pasteur's success in verifying that the degree of the bacteria's infection changes in certain conditions interested veterinarians and hygienists who were involved in the emerging knowledge of the mechanics of animal epidemics. Once considered irrelevant, Pasteur found himself at the center of the "network" of various "actor(s)" as the authority who had identified and manipulated the anthrax microbe.

Subsequently, Pasteur extended his laboratory environment to French society through the cooperation of associated "actor(s)" (Latour 1983, pp. 150-153). Pasteur developed the attenuated anthrax vaccine from the anthrax bacteria cultivated in his laboratory. However, this vaccine would not work outside the laboratory until experimental research determined answers to certain questions: when and how many times should the anthrax vaccination be given, what kind of environment was required for this vaccination, and so on. Livestock ranchers prepared their land in accordance with the conditions that Pasteur's laboratory required, and veterinarians worked on disseminating the news of Pasteur's anthrax vaccine to the public.

As the result of the cooperative work of related "actor(s)," in May 1881, a public experiment of vaccinating 25 sheep of 50 total in two stages was conducted. Following the success of this experiment, the effectiveness of Pasteur's anthrax vaccine was widely recognized. Other livestock ranchers ordered and administered the anthrax vaccine, and Pasteur's discovery spread throughout the whole of France. On this stage, the artificial environment of Pasteur's laboratory where the anthrax vaccine originally worked had extended to the entirety of French livestock ranchers. After widespread

distribution of the anthrax vaccine, the French bureaucracy statistically confirmed the eradication of anthrax in France and attributed the credit to Pasteur.

Bruno Latour's Anthropological Study on the Failed Project of the Automatic Underground Railway System in Paris

This section addresses Latour's paper, published in 1993, "The ethnography of high-tech" (referred to as EH, in this article; see Table 1). In this paper, Latour criticizes the social constructivist approach to science and technology and analyzes the failed project of the automated metro operation system proposed in France.

The problem of the social constructivist approach to science and technology

According to Latour, there is a dualistic problem in the social sciences in which socio-cultural factors have been supposed in all sorts of social phenomena *except science and technology* (Latour 1993, p. 392). For this reason, it was the work of the sociology of science to reveal the causal effects of socio-cultural factors on science and technology. Especially in SSK, the social constructivist approach to infer that social factors, such as gender, social strata, and nationality, were significant in the reception of scientific knowledge expanded the framework of the sociology of knowledge to include science. Likewise, the social construction of technology (SCOT), a theory initiated by Trevor J. Pinch and Wiebe E. Bijker, applied the sociology of knowledge to the sociological analysis of technology development. In this regard, Latour reviews these constructivist sociologies of science and technology as the solution to the dualistic problem in the social sciences. However, in light of this review, Latour also criticizes these constructivist sociologies.

SCOT, by appropriating the framework of SSK, portrayed the development of artifacts as the process of how variations of artifacts multiply until one of them is selected. The first important concept of SCOT is the relevant social group. A relevant social group is one that shares the same definition or interpretation of a particular artifact (Pinch and Bijker 1987, 2011, pp. 22-23). An example of a developmental project is a sports car: if young men regard it as a manly, sharp vehicle, and women and elderly people see it as extravagant and dangerous, each group—young men, women and

the elderly—is a relevant social group. In a SCOT analysis, the relevant social group is the subject that deeply affects the developmental process of the artifact.

In addition, there are two notions which are important to SCOT: interpretive flexibility and closure and stabilization. Interpretive flexibility means that as the result of multiple definitions or interpretations assigned to an artifact by relevant social groups, variations of the artifact multiply (Pinch and Bijker 1987, 2011, pp. 33-34). With the example of the development of a sports car, on the one hand, for young men who love a fast sports car, the solution is to develop a sports car with a high-horsepower engine. On the other hand, for women and elderly people who may be more concerned with the safety of the sports car, the solution would be to engineer a sports car with high-performance braking and tires with excellent traction.

Closure and stabilization refer to the mechanism by which variations of an artifact, based on flexible interpretations attributed to it by relevant social groups, converge into a single variation (Pinch and Bijker 1987, 2011, p. 37). At this stage, closure, or redefinition of the problem, refers to the convergence of the variations manifesting an artifact that become the means to resolving a particular problem and that are useful solutions for other problems as well (Pinch and Bijker 1987, 2011, pp. 38-39). For instance, if the sports car with the high-performance tires developed for solving the safety issue also has brilliant performance in speed, a single variation of the artifact solves the problems that concerned multiple relevant social groups. In sum, as we have seen, SCOT is an approach to analyzing the developmental process of an artifact with a focus on the subjectivity of the social groups’ differing interpretations of the same artifact.

SCOT, by applying SSK to the analysis of technology development, was in the limelight in the sociology of science and technology, but there were also some criticisms of this approach. For instance, Stuart Russell pointed out that SCOT analysis lacked descriptions of the historical or economic contexts determining the power relations between relevant social groups (Russell 1986). In addition, Law, one of the three pioneers of ANT, criticized SCOT for placing relevant social groups in the privileged position of the dominant explanatory variable determining the development of an artifact, stressing the need to treat the artifact itself as an element of the “network” developing that artifact (Law 1987, 2011). Woolgar expressed the view that SCOT did not reflexively examine its own explanation as a social construct (Woolgar 1991).

Given this overview, we turn back to Latour’s argument. Both SSK and SCOT, the social constructivist sociologies of science and technology,

certainly uncovered the importance of socio-cultural factors in the controversy over scientific facts and the development of technological artifacts (Latour 1993, pp. 374-375). But sociologies of science and technology concerned with the classical dualistic problem in social sciences actually faced another dualistic problem: these constructivist approaches presuppose the effects of socio-cultural factors on the entire fields, but overlook the possibility that such socio-cultural factors are the social construct of the observer (Latour 1993, p. 376, 392). These socio-cultural categories are, by their nature, the external explanatory elements of analyzed social phenomena, but the observer establishes these categories as *a priori* analytical concepts. In this regard, Latour criticizes the construction of external explanatory notions in the sociology of science and technology and emphasizes the importance of a monistic research program to internally trace a series of “networks” between humans and non-humans.

The failure of Aramis

EH is a case study of the failed project of an automatic metro system in southern Paris called Aramis. Aramis was developed at the request of the Parisian state-owned public transport entity that operated and maintained it from 1969, and its prototype was produced at considerable expense. Despite these efforts, the suspension of Aramis was ordered in 1987 due to the excessive budget expenditure (Schmidgen 2015, p. 106). In this process, a fragile cooperative relation was formed by the various “actor(s),” particularly the engineers, the Paris mayor, and the labor union of metro conductors.

According to Latour’s interviews with those involved in the Aramis project, three interpretations of the feasibility of the project manifested themselves (Latour 1993, pp. 386-388). First, the technology of Aramis was the core of the project and was technologically ready. Second, if the Aramis project had been completed, it would have been less innovative than other alternatives. Third, the technology of Aramis was technologically feasible. As these interpretations suggest, the opinions on the possibility of the Aramis project were divergent. Thus, to investigate why Aramis failed, we must shed light on the circumstances surrounding the beginnings of the Aramis project.

In this project, apart from the leader of Aramis, there are three important “actor(s)”: the Paris mayor, the labor union of metro conductors, and the engineers (Latour 1993, pp. 388-391). The Paris mayor was interested in Aramis because it was going to make use of abandoned metro cars and rails, but the core of Aramis’ innovation was an uncoupling technology

allowing more convenient timing in serving passengers’ destinations. Thus, the existing rails did not meet the requirements for innovations envisioned for Aramis. The conductors’ union was interested in Aramis because they recognized it as high-tech and completely different from ordinary railways. If the Aramis project had decided to reuse abandoned cars and rails, the union would have seen Aramis as a threat to their jobs and withdrawn its support for Aramis. Finally, the engineers’ interest in Aramis was to develop technology that was more innovative than the alternatives.

The leader of the Aramis project had to manage these interests. This leader substantially increased the maximum number of passengers, and thus passenger liquidity, so that Aramis would resemble an ordinary metro. He then decided to equip Aramis’ cars with the uncoupling technology so that Aramis would not closely resemble the ordinary metro. Satisfying these alterations was not an easy task by any means. Although at this stage the leader of the Aramis project tried to negotiate with Aramis, the prototype was so filled with innovative technologies that it did not have adequate capacity for passengers. The engineers attempted to make the technology less sophisticated, but the Parisian state-owned public transport entity who operated and maintained the system—the entity which had requested Aramis in the first place—would not approve this downsizing, fearing protests by the conductors’ union. This stand-off ultimately resulted in the failure of the Aramis project.

Conclusion

This article has examined the use of ANT concepts in Latour’s two empirical studies to answer the research question: how do the concepts of “infra-language” and “infra-theory” relate to ANT. The summary of our analysis is outlined in the following table:

Based on the evidence presented, this article can report three findings. First, Latour referred to the various entities mentioned in the qualitative data and treated them as “actor(s)” regardless of being human or nonhuman; Latour’s focus was on each thing contributing to the organization of social phenomena. Second, Latour focused his analytical attention on the construction of the relationships between “actor(s).” In Latour’s empirical studies, the various relations, such as interests (GI) and cooperative relations (EH) were at the heart of his descriptions. Third, Latour was consistently critical of the reductionistic approaches to presupposing *a priori* the causal

TABLE 1
THE SUMMARY OF OUR ANALYSIS

The details and use of ANT notions in Latour's empirical studies	
GI	<ol style="list-style-type: none"> 1. Analysis of social factors that attributed credit to Pasteur for the scientific discovery and eradication of anthrax 2. Criticism of the interests approach of the Edinburgh School and the analytical focus on the fluid interests of Pasteur and other social groups 3. Pasteur's credit for anthrax: interests ("network") of various social groups, such as Pasteur's laboratory, veterinarians, livestock ranchers ("actor(s)") through the negotiation of their interests
EH	<ol style="list-style-type: none"> 1. Analysis of the failure of the automatic metro system project called Aramis 2. Criticism of social constructivist sociologies of science and technology, SSK and SCOT, and the analytical focus on fluid cooperative relations between humans, such as those involved in the project, and nonhumans, such as the technical specifications of Aramis 3. Aramis: the cooperative relations ("network") in which humans (the Paris mayor, the conductors' labor union and the engineer) and nonhumans (the technical specifications, the engineering skill, and the budget) interact ("actor(s)")

factors in the analysis of social phenomena. Latour sharply criticized the interests approach (GI) and the social constructivist sociologies of science and technology (EH) for reducing the empirical complexity of social phenomena to the social factors.

In light of these findings, we are able to answer the research question. According to Latour, ANT as an "infra-language" or "infra-theory" is the theory that blurs *a priori* distinctions such as human/nonhuman and traces the construction of a "network" by "actor(s)." In Latour's empirical descriptions, his analytical focus is on the process whereby the various "actor(s)," both human and nonhuman, associate as a "network" to form social phenomena. According to these analyses, this article argues that Latour's use of expression "infra" means, contrary to the theoretical/external explanation of phenomena via *a priori* analytical concepts, the empirical/internal reconstruction of the emerging process of phenomena. Furthermore, following these points, we can re-formulate ANT as *a theory consisting of abstract concepts with which one can put aside their preoccupation with the*

various factors and focus on their relations inasmuch as they contribute to the formation of social phenomena.

Based on that interpretation, this article replies to the arguments of previous studies. First, regarding previous studies which criticize ANT for being acritical, this article would point out that Latour's aim to describe the complexity of the empirical world of scientific works apart from *a priori* theory is entirely different from theirs. Second, there are some previous studies which argue that ANT is a metaphysical theory defining the construction of the world. To these arguments, we would point out that his emphasis was not on the development of an *a priori* theory, but on a description of the empirical construction of social phenomena. As shown in our overview of Latour's empirical studies, the previous studies which argue that ANT is not limited to a causal theory but open to the empirical complexity of social phenomena seem not to be in major conflict with our conclusion, but it should be noted that their arguments overlook the work of a re-formulation of ANT as a comprehensive form.

Finally, we briefly discuss the possibility of ANT in light of our evidence. Based on our argument, ANT enables us to seek the hidden factors and their relations constituting phenomena, and thus allow us to include them in our descriptions by blurring *a priori* preoccupations with these factors and relations. Thus, ANT can be rephrased as *the theory for discovering what factors are associated with and their influence on the process of social phenomena*. In other words, ANT is *not* a theory to explain social phenomena in a causal form, but rather a theory to discover new factors and their relations, which often are overlooked by observers.

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