

Taketani's "Three-Stage Theory"*)

Shoichi SAKATA

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Since that time Taketani frequently made calls on our seminar.***) Although he was my junior in the university by one year, I had no conversation with him at all in my student days. But I gradually came to have a close association with him since Yamanashi chanced to introduce me to him while I was a member of the Institute of Physical and Chemical Research. Every time Taketani, who was a sub-assistant of Kyoto University, called on our seminar, he expressed various excellent opinions on nuclear theory. Occasionally he made talks about Hegel's logic. Yukawa also listened to his talks with much interest. On one of those days Taketani stated that he began to edit a journal *Sekai-Bunka* with progressive research workers (Shoichi Nakai, Takeshi Shimmura, Shin-ichi Mashita et al.) of the Faculty of Literature, Kyoto University. This journal had the character of the people's front fighting in the course of people's culture against the offensive Fascist movement growing more and more violent.

To the journal, Taketani contributed an article titled "On Quantum Mechanics". At that time fashionable philosophers, who were so eager to justify the Fascist ideology, spread the notion as if quantum mechanics were a friend of irrationalism and mysticism. Indeed, it was by no means an easy task even for professionals of quantum mechanics to comprehend the theory without leaving room for irrationalism. Many of them misunderstood the difficulties of the task as to the limitation of rationalism and was converted to mysticism, and some of them even revealed themselves as preachers of the Fascist ideology at last. "The rebellion against reason" cannot but lead to the denial of every rational spirit, including science after all. Grieving such tendency and believing unshakably that "whatever difficulties human reason may encounter, it always cuts a way through them", Taketani performed the difficult task and grasped quantum mechanics rationally, which damaged deeply the camp of reactionary philosophy.

*) This content is the third section of Sakata's article, "Course of the Development of the Yukawa Theory", written in 1948; published in *Shizen* (Nature) (1949); included in *Butsurigaku to Hōhō* (Physics and Methodology) (1951), Iwanami (Tokyo).

**) (Translator's note) In spring of 1934 Sakata moved from the Institute of Physical and Chemical Research in Tokyo to Osaka University. Yukawa, who was a staff member of this university at that time, proposed the theory of Yukawa field in October, 1934. "That time" means the time when Yukawa and Sakata were completing their theory of nuclear transformation by orbital electron capture in 1935.

Quantum mechanics reveals such inner and essential interconnections of the microscopic world that advanced logic is inevitably required to grasp it correctly. He made an exhaustive analysis with stereoscopic logic from the standpoint of materialistic dialectic, and succeeded in giving direction to the rational interpretation of quantum mechanics. Further, through this study he arrived at his “three-stage theory”, which is considered to be the highest level that dialectic of nature has attained. The discovery of “the three-stage theory” played an important role, such as a compass for our research thereafter.

According to “the three-stage theory” of Taketani, cognition of nature develops spirally through the following three characteristic stages. The first is the phenomenological stage in which the phenomenon is described as it is. The second is the substantialistic stage in which it is investigated what structure the object has. The third is the essentialistic stage in which it is clarified by what interactions and under what laws of motion the object moves. Taketani clarified through his detailed, scientific-historical studies that physics, in the case not only of quantum mechanics but of Newton mechanics and also in the case of the theory of relativity, develops always through the above stages. Such courses of the development of cognition of nature originate from the fact that nature itself has the dialectic structure. The course of the development of cognition along “the three-stage theory”, therefore, realizes itself as *logic of Nature* in every branch of science once it is discovered, although it firstly revealed itself through the study of quantum mechanics.

Taketani, who began to study nuclear theory with us, analyzed the stage of the development of the theory from the viewpoint of “the three-stage theory”, and proved that the nuclear theory lied in “the step at which one searches how to pass on to the essentialistic stage through the process of ordering things in the substantialistic way”. The starting of the theory of nuclear structure that took the discovery of the neutron at the moment, the development of the theory of beta decay that started from the introduction of the neutrino and so on, made remarkable successes based on substantialistic ordering of things. The Yukawa theory previously proposed was considered also as the development along the line of ordering in the substantialistic way. Standing on the viewpoint of “the three-stage theory”, we found the most vigorous character of the Yukawa theory in the very adventure is to *introduce a new particle*, for which conservative physicists had a hatred.

All the great theories developed up to now had been trained through failures and successes of adventures. Any theory that makes neither failures nor successes or that makes no adventures limits itself merely to a description of phenomena and belongs to the lowest stage. If the theory ceases to develop at this stage, it has no ability of prediction, that is, however, the

fundamental role of the theory. Newton, who in his later years said, "I frame no hypotheses", did introduce many hypotheses such as universal gravitation in his active days. As Taketani noted repeatedly, we must clearly distinguish physics itself from interpretations of physics given by physicists. They often state things which are different from what they have done.

An adventure lacking in prospect or a rush made blindly, however, would in most cases end in failure. The adventure that really trains the theory and leads to correct cognition must have an accurate prospect more than anything else. The perspective adventure, even if it fails, is able to teach certainly lessons from the failure and secures the success in the next adventure. What is the compass to give such prospect is scientific philosophy on the top of which "the three-stage theory" stands.