

Paradox East and West:
Some Parallels Between Zen Buddhism and Western Philosophy

by

Richard F. Plzak, Jr.

Submitted in Partial Fulfillment
of the Requirements for the
Degree of Bachelor of Science
at the
Massachusetts Institute of Technology
February, 1973

Signature redacted

Signature of Author.

Department of Humanities, January 25, 1973

Signature redacted

Certified by.....

Signature redacted

Thesis Supervisor

Accepted by.....

Chairman, Departmental Committee on Theses

Archives



Abstract

Zen Buddhism displays many surprising similarities to certain aspects of western thought. The philosophy of science indicates that Zen-like, intuitive leaps of consciousness, as well as ratiocination, are required for the creation of scientific theories. Both the teachings of Zen and the interpretation of quantum mechanics generate paradoxical statements, and modern studies in the field of formal logic support the thesis that, in both cases, the paradoxes result from using ordinary, objective language to describe a reality for which the classical concept of objectivity is inadequate. These similarities are neither accidental nor superficial but, rather, reflect the basic philosophical issues that lie at the heart of these disciplines. This paper presents a detailed study of the way in which these aspects of western philosophy parallel the teachings of Zen. The insight contained in the experience of Zen consciousness cannot, by its very nature, be reached by this kind of analysis. These analogies do, however, help to de-mystify the strange language and techniques which the master uses to transmit the experience of Zen to his disciple.

Thesis Adviser: Professor Huston Smith

Thesis Title: Paradox East and West: Some Parallels Between Zen Buddhism and Western Philosophy

Contents

<u>Chapter</u>	<u>Page</u>
<u>Abstract</u>	2
<u>Foreword</u>	4
I. Introduction.....	6
II. Zen and the Philosophy of Science.....	23
III. Zen and Quantum Physics	
<u>Part I: The Interpretation of Quantum Mechanics</u>	36
<u>Part II: Some Parallels with Zen Buddhism</u>	56
IV. Logic, Paradox and Godel's Theorem.....	76
V. Conclusions.....	90
<u>Bibliography</u>	96

Foreword

Although one usually thinks of the fields of Zen Buddhism and of western science and logic in terms of contrasts rather than similarities, the purpose of this paper is to investigate certain parallels between the teachings of Zen and these fields of western thought, with special emphasis upon the philosophy and interpretation of modern physics and upon the study of paradox from the point of view of formal logic. Here follows a brief outline describing the scope and organization of the paper.

The first chapter, which serves as an introduction, outlines very briefly the techniques and philosophical background of Zen Buddhism and introduces topics discussed in greater detail in later chapters. A brief mention is also

made of parallels between Zen Buddhism and Christian mysticism and existentialist philosophy in acknowledgment of their relevance to any discussion about Zen and the west.

The second and longest chapter of the paper is devoted to examining parallels between Zen and modern physics. Although Einstein's Theory of Relativity, with its advocacy of the relativity of space and time, has some relevance to Zen, the discussion in this chapter is restricted to the interpretation of quantum mechanics -- a branch of physics which, because of its paradoxical statements and its uncertainty relations, is rich in analogies with Zen Buddhism.

The next chapter, on formal logic and logical systems, investigates the western study of paradox for relevance to the paradoxes of Zen and includes a discussion of Godel's famous incompleteness theorem.

The final chapter presents some conclusions about Zen that can be drawn from the parallels discussed in the main body of the work.

At this point, I would like to express my thanks to my thesis adviser, Professor Huston Smith for his assistance in recommending articles to read and in suggesting some initial lines of research when I first began this paper. I would also like to **express my thanks** to Steve Girshick of the Palo Alto zendo for his encouragement and to Anya for her valuable conversations and invaluable moral support.

Chapter I
Introduction

Zen is a sect of Mahayana Buddhism which currently is strongest in Japan. Although the doctrines and practices of Mahayana Buddhism can be traced in the teachings of its rival sect, Hinayana Buddhism, the two sects differ in the emphasis that each places on various aspects of Buddhism. The Hinayana sect is the more austere, conservative, and most concerned with individual salvation. Both schools claim to trace their origins back to Gautama, the Buddha.

Bodhidharma, who is credited with bringing Buddhism from India to China during the early period of the development of the Mahayana sect, summarized his teachings in four propositions:

A special transmission outside the scriptures;

No dependence upon words and letters;
 Direct pointing to the soul of man;
 Seeing into one's nature.¹

These four propositions point out some of the important features of the Chinese interpretation of the Mahayana approach to Buddhism. First, the experience by which the Buddha became the Enlightened One is not an experience exclusively his own but rather one that could be (and had been) transmitted to others. Second, the experience itself contains the essence of Buddhism, and Buddhism is not restricted to the orthodox teachings contained in the sutras. Third, this experience which confers Buddha-hood involves seeing into one's own very nature.

The sixth Chinese patriarch, Hui Neng, founder of the "Sudden School" (which was opposed by a now extinct rival sect), continued the transformation of Buddhism into its Chinese form. Commenting upon his method of teaching, he said:

If I tell you that I have a system of law to transmit to others, I am cheating you. What I do to my disciples is to liberate them from their own bondage with such devices as the case may need....In expounding the Law, I do not deviate₂ from the authority of the Essence of Mind.

Thus, the unenlightened are held in bondage by their own illusory concepts of themselves and of the world. The essence of Buddhism, according to the Sixth Patriarch, is to break through this illusory perception, by whatever methods are required to achieve this purpose. Because the patriarch

himself has already escaped the bonds, there is no question of violating the teachings, since they are the "Essence" of his own mind. The master speaks and acts from the level of Zen consciousness and works upon the minds of his students in order that they might also attain this level of consciousness.

Soon after Hui Neng, Hyakujo founded the institution of the Meditation Hall, and by the tenth century, the koan system was in use by the Chinese Buddhists-- the sect initiated by Bhodidharma had developed into what is recognizable as Zen.

Koan ('kung,' public; 'an,' case record) are given to the Zen student as problems and act as aids to enlightenment. Koans are often examples of dialogues and stories involving a famous Zen master and a student. Given a problem such as the classic, "What is the sound of one hand clapping?", the student cannot solve it intellectually. Any intellectual solution must make use of the discriminating intellect which is one of the bonds that must be cast off in order for the Zen disciple to achieve satori, the enlightenment experience. Rather, the solution of one of these koans involves "seeing into one's nature," and achieving the goals set forth by Bhodidharma and Hui Neng in their teachings. As Isshu Miura puts it:

If, in coming upon expressions such as these, you feel as if you were meeting a close relative face to face at a busy crossroad and recognizing him beyond a shadow of a doubt, then you can be said to understand the Dharmakaya, But, if you use common sense to conjecture about

it, or run hither and thither trying to follow the words of ³others, you will never know the Dharmakaya.

Although there are standard compilations of koans and standard courses of study in which the Zen student must solve a number of successive koans, just about anything could serve the function of a koan if it is, as Hui Neng says, such a device as "the case may need." Various methods of Zen study will be discussed more fully below.

During the twelfth century, three monks brought Zen Buddhism into Japan: Eisai, founder of the Rinzai sect; Dogen, founder of the Soto sect; and Ingen, founder of the Obaku sect (now ^{largely} absorbed into the Rinzai). Both the Rinzai and the Soto sects make use of the unique Zen techniques of koan and zazen, or Zen meditation, and differ chiefly in the way in which these techniques are employed in relation to one another, and the emphasis placed upon each one.

Zazen, the form of meditation peculiar to Zen Buddhism, is an essential part of the practice of Zen. The name 'Zen' itself is a translation of the Sanskrit term, 'dhyana,' which means meditation (although the Indian form of meditation, dhyana, is not zazen). Zazen does not involve meditation upon any particular object or idea. However, it does involve concentration also that the mind "attains one-pointedness and no longer disperses its force in the uncontrolled proliferation of idle thoughts," but at the same time, "the mind is freed from bon-

10

dage to all thought-forms, visions, objects and imaginings."⁴
Zazen may involve simple exercises of concentration, such as counting breaths, or it may involve work upon a koan. The contemporary Zen master, Yasutani, describes three different results that flow from the practice of zazen: development of the power of concentration, satori-awakening, and actualization of the enlightened realization in everyday life.⁵

Yasutani distinguishes between the Rinzaï and Soto sects in terms of these goals: the Rinzaï emphasizing satori above all else, with little attention to continued practice and actualization in daily life, the Soto emphasizing development of powers of concentration to the neglect of realization through satori.⁶ Dogen, the founder of the Soto sect, discussed the relative merits of the two techniques:

In the pursuit of the Way, the prime essential is sitting /zazen/....By reflecting upon various public cases /koan/ and dialogues of the patriarchs, one may perhaps get the sense of them but it will only result in one's being led astray from the way of the Buddha.... There have been some who attained enlightenment through the test of the koan, but the true cause of their enlightenment was the merit and effectiveness of sitting.⁷ Truly the merit lies in the sitting.

Thus, one can see that the Soto sect, at least in its original form, did not neglect the importance of satori, although it did de-emphasize the role that koan-study plays in the development of satori. Perhaps the differences in the modern sects, commented upon by Yasutani, can be best described by contrasting the writings of Suzuki, an exponent of the Rin-

zai sect, who devotes nearly a third of his multi-volumed Es-
says to koan study but less than a chapter to the practice of
zazen with a writer such as Wienpahl (who presents, like Yasu-
tani, teachings that are drawn from both sects, but is more
strongly influenced by Soto Zen than Suzuki is) who speaks
of koans as "aids to zazen," and says, "We do not worry about
satori or getting it....We call these experiences by-products
of the process. But we do not aim for them. We do not aim for
them and you may progress without them." Thus, one can see
that both sects accept and make use of all the techniques and
goals of Zen, but differ from each other in the emphasis placed
upon the various aspects of Zen practice.

Zen Buddhism is the result of the interpretation of
Mahayana philosophy by the Chinese mind. This philosophy de-
veloped simultaneously with the rise of the Zen sect of Bud-
dhism. In order to present a coherent picture of Zen, a brief
sketch of some of the major ideas of Mahayana philosophy, as
interpreted by the Chinese mind, will be presented here. Ma-
hayana philosophy provides both the historical and psycholog-
ical background for the development of Zen.

The first of these is the doctrine of Enlightenment.
It has been mentioned above that Zen avows the transmission
of the original enlightenment experience of the Buddha --
handed down from master to pupil. What is it that is revealed
in the timeless instant of satori? Bhodidharma's proposition

states that it involves seeing into one's own true nature and that it points directly at the soul of man. But if it is the self that is revealed in satori, it is not the ordinary self of ego.

The Japanese master Hakuin wrote:

For such as, reflecting within themselves,
 Testify to the truth of Self-Nature,
 To the truth that Self-Nature is One-Nature,
 Have gone beyond the ken of sophistry.⁹

That is, when one sees into his true Self, the self no longer appears as an isolated, independent ego surrounded by other self-contained egos-- but rather appears as the One-Nature which includes both the Self and the rest of the universe. The conventional mode of thought is dualistic; i.e., the ordinary discriminating intellect conceives of the universe in terms of two opposing poles--the self and the not-self, the observer and the observed, black and white. But from the viewpoint of Zen consciousness, the universe appears as One-Nature, and the separate and independent existence of each pole of every pair of opposites is seen to be illusory. Individual objects lose their separateness in the apprehension of the One-Nature.

And yet, even this does not tell the story. For 'many' and 'one' themselves form a pair of opposites conceived by the discriminating intellect. That which is known by Zen consciousness is that which transcends even this form of dualism. This is the nature of the Absolute and it is indistinguishable from the true nature of the self -- the Buddha nature, the face be-

fore your mother was born.

The Mahayana Buddhists refer to this universe of non-discrimination as sunyata, "Emptiness," or "the Void." This ultimate reality is called Emptiness not in the spirit of nihilism, but rather as an assertion that the ultimate reality cannot be grasped by the discriminating intellect. Ultimate reality cannot be truly described in terms of a multiplicity of independent entities, nor can it be objectified and set apart from the self that describes it.

D.T. Suzuki describes the situation by contrasting two ways of knowing: intuition (prajna) and discursive reasoning or intellect (vijnana).¹⁰ Reason can comprehend only the dualistic relationships of the discriminating intellect and deals best with abstractions. But since the ultimate reality transcends all dualistic notions, it cannot be grasped by vijnana but must be apprehended directly through prajna-intuition. Since prajna is not involved with abstractions, which are the realm of the intellect, the Zen masters do not discourse upon metaphysical topics in order to convey their insight to their students, but rather deal in the concrete and the immediate, that which is grasped by prajna-intuition. For it is as the concrete and the immediately experienced that the ultimate reality appears -- not as the metaphysical concept of the Void.

A master once said: "When I began to study Zen, mountains were mountains; when I thought I understood Zen,

mountains were not mountains; but when I came to full knowledge¹¹ of Zen, mountains were again mountains."

That is, the enlightened man does not live in a strange, mystical world of Nothingness but rather in the concrete, everyday world of direct experience. But nonetheless there is a difference between what was experienced before satori and that which is experienced after satori. Although the Zen man encounters the same experiences as the unenlightened man, the Zen master is no longer a slave to the illusions created by the discriminating intellect. By transcending dualism and going beyond the process of discrimination he has escaped the process which begins the causal chain that leads to the suffering or dukkha which the Buddha saw in the everyday life of mankind.

This brief survey has introduced most of the topics relevant to this discussion of the parallels between Zen and western philosophy. However, since the paradoxical statements of the Zen masters play such a large part in this paper, it is necessary to take a closer look at the Zen technique of koan in which many of the paradoxical Zen statements are found.

Closely related to the Zen technique of koan is that of mondo (questions and answers) which take the form of dialogues between a master and his pupil in which the master tests the student's knowledge of Buddhism or brings him to satori. There are numerous examples of these mondo preserved in Zen stories.

Particularly sparkling examples of these mondo themselves become koans for later students to puzzle over. A classic example:

A monk asked Tozan, when he was weighing some flax: 'What is Buddha?'¹² Tozan said: 'This flax weighs three pounds.'

Now, satori is not necessarily a "once-and-for-all" experience in which one has a blinding flash of illumination and is transformed from that moment onward. There can be many levels of satori and one may experience many of these enlightening flashes throughout a lifetime.

Isshu Miura has outlined¹³ the course of koan study in Rinzai Zen, in which the student passes through a succession of different types of koans, first attaining satori and then deepening it through successive koan studies. First, the student passes through the hosshin koans by which he gains his first glimpse of the void; then the kikan koans, to learn to manipulate the interlocking differentiations of the phenomenal world; the gonsen koans, which involve the study and investigation of words; the nanto koans, most difficult to pass through; and finally, the five ranks, which force the disciple to renew and re-experience all that he has already accomplished. in order to solve them.

Thus a method appears in the midst of the apparently bizarre, paradoxical and non-sensical utterances of the Zen masters. There are different families of koans, each of which

attacks the illusions of dualistic thinking from a particular aspect. Yet at the same time each type of koan is directed from the same point of view -- ultimate reality from the viewpoint of Zen consciousness. Of course, this system of classification, like all forms of classification, occurs on the level of the discriminating intellect. These koans, as they were originally spoken by the masters who originated them, are the immediate and intuitive expressions of the direct and unmediated experience of Zen consciousness.

Suzuki has classified the utterances of Zen masters along slightly different lines.¹⁴ There are the paradoxical, wherein the master simultaneously asserts that the same thing both is and is not; the denial of opposites, a special case of the first type (most of the examples quoted in the body of this paper are of the first two types); contradiction, in which the master denies that which he himself has explicitly expressed; irrelevant affirmations, in which the answer bears no rational relationship to the question; repetition, where the answer is the same as the question; exclamations; and the direct method, whereby the master uses a handy physical object, makes gestures or even delivers blows in order to awaken the disciple.

The paradoxical utterances of the Zen masters, then, can be viewed as techniques for bringing the student's mind to enlightenment -- by confronting the disciple with paradoxes and problems that are self-contradictory, the pupil is

forced to abandon the intellectual approach to understanding Buddhism, an essential step in attaining Zen consciousness. On the other hand, these paradoxes are not "mere" technique, for the masters themselves are speaking from the point of view of this non-dualistic consciousness but are forced to use dualistic concepts in speaking about them through the medium of language. It is because language itself is dualistic and because the writings of the Zen masters are viewed from the point of view of the dualistic mind of the student, that the statements appear to be paradoxical. From the point of view of Zen consciousness, the paradox is seen to be no paradox at all.

Certainly, at first sight, Zen Buddhism appears to be something quite foreign to the philosophy of the west with its emphasis upon logic, rationality, and scientific explanation.

Perhaps the most obvious place to begin seeking parallels between Zen and the west is in the realm of religious experiences reported by Christian mystics. Although both speak of One-ness, is the Christian's experience of mystical union with God the same as the Zen Buddhist's experience of satori? One cannot help but feel that these experiences are closely related to each other, but there are differences in the way in which those who have experienced them speak about them. George Thomas has pointed out that for the theistic

mystic, however close the union between his soul and God in in the mystical experience may be, he remains a finite being distinct from the infinite God.¹⁵ Where the Zen master does not hesitate to identify any two distinct entities in the experience of the Void, the Christian mystic holds something back.

Certainly this difference is not unexpected, considering the vast differences of theology and philosophy that form the psychological backgrounds for the two experiences. The theist, no matter how deep his experience, sees blasphemy in the assertion that he is himself God. Yet, when Eckhart says, "Call it ... if thou wilt an ignorance, an unknowing, yet there is in it more than in all knowing and understanding without it, for this outward ignorance lures and attracts thee from all understood things and from thyself,"¹⁶ one can see in this unknowing something of the Zen way of knowing through prajna-intuition.

One can also see traces of Zen in the writings of the existential philosophers -- with their emphasis upon the creative role of the self in the construction of reality and their talk of the experience of gaining existential awareness (c.f. Camus, The Fall).

Kierkegaard, for example, whose "existential leap" is often cited as a western parallel to satori, places great stress upon the need to "become a subject" in order to reach a

truth that can never be apprehended by thinking "objectively."¹⁷
 In this one can see a suggestion of the Zen exhortation to seek the truth within one's own nature and of the Zen insistence that the truth can never be comprehended by the rational, "objective" intellect.

On this same point, Heidegger says of logic, "Exact thinking is never the strictest of thinking, if the essence of strictness is the strenuousness with which knowledge keeps in touch with the essential features of what-is."¹⁸ And in his discussion of Nothingness, he urges that we "equip ourselves and make ready for one thing only: to experience in Nothing the vastness of that which gives everything the warrant to be."¹⁹ In the first quotation, Heidegger suggests something of the Zen demand to go beyond conceptual thinking, and in the second, one can see echoes of the Mahayana doctrine of sunyata.

Most existentialist writings are taken from the viewpoint of phenomenology -- a philosophical method which begins from experience as it is actually experienced. Thus Sartre, for example,²⁰ criticizes philosophical theories based upon notions of "sense data" or other abstract concepts which are not part of experience as it is lived. In this there is a hint of the Zen method of teaching which relies upon concrete instances of immediate experience, rather than upon metaphysical speculations. Of course, there are important differences between the phenomenological meaning of "immediate" and the immediacy of

Zen experience. Phenomenology still involves logical analysis and metaphysical theorizing. (Kierkegaard, for one, did not believe that any truly immediate experience was possible). In spite of their use of metaphysical systems, these philosophers, with their emphasis upon a revelatory existential experience, the importance of subjectivity, and the need for a kind of knowledge that goes beyond logic, show some significant similarities to the Zen Buddhists.

But the parallels between the Zen Buddhists and western philosophy are not restricted to the mystics and the existentialists. Surprisingly, the fields of modern physics and mathematical logic have in the last few decades produced results reminiscent of the teachings of Zen. The bulk of this paper is concerned with investigating the parallels between these disciplines and Zen Buddhism.

Footnotes

1. Quoted in Humphrey, Christmas, Zen Buddhism (New York, n.d.), p. 32.
2. Mou-Lam, Wong, trans. The Sutra of Wei Lang (Hui Neng), ed. Humphreys (London, 1944), p. 32.
3. Sasaki, Ruth Fuller and Isshu Miura, The Zen Koan (New York, 1965), p. 49.
4. Kapleau, Phillip, ed. Three Pillars of Zen (Boston, 1967), p. 13.
5. Ibid., p. 48.
6. Ibid., p. 49.
7. de Bary, W.T., ed., The Buddhist Tradition (New York, 1969), p. 371.
8. Wienpahl, Paul, The Matter of Zen: A Brief Account of Zazen (New York, 1964), p. 40.
9. Humphreys, Zen Buddhism, p. 94.
10. Suzuki, D.T. Studies in Zen (New York, 1955), Chap. IV.
11. Ibid., p. 187.
12. Reps, Paul, ed., Zen Flesh, Zen Bones (New York, n.d.), p. 104ff.
13. Sasaki and Miura, Zen Koan, Part Two, "Koan Study in Rinzai Zen."
14. Suzuki, D.T. Essays in Zen Buddhism, First Series (New York, 1961), Essay VI, "Practical Methods of Zen Instruction."
15. Thomas, George. Religious Philosophy of the West (New York, 1965), p. 160f.
16. Quoted in Thomas, Op. Cit., p. 146f.
17. Kierkegaard, Soren, "Concluding Unscientific Postscript," A Kierkegaard Anthology, ed. Bretall (New York, 1959), p. 208.

18. Heidegger, Martin, Existence and Being (Chicago, 1940), p. 356.
19. Ibid., p. 353.
20. Sartre, Jean-Paul, Being and Nothingness , trans. Hazel Barnes (New York, 1966).

Chapter II

Zen and the Philosophy of Science

At first sight, no two categories of human endeavor would appear to be more distinctly separate than the practice of modern science and the practice of Zen Buddhism. One carries with it associations with the ritualistic trappings of the Buddhist temple -- ritual chanting and long hours of meditation. The other carries associations with the modern laboratory -- antiseptic environment, precise measurement and complex mathematical formulas. And yet there are certain aspects of modern science -- held up as the apex of western rationalism -- that carry with them echoes of the utterances of the Zen masters. These analogies appear in certain aspects of the philosophical attitude encompassed within science, in the creative act of generating scientific theories, as well as in the paradoxical results associated with the interpretation of modern

physics, particularly in quantum mechanics.

Philosophically, both Zen and Physics are rooted in the concrete ground of immediate experience. Although each involves a particular frame of reference which it imposes upon that which is experienced, one cannot understand either one of them except by reference to the world of experience.

An example which illustrates this point is the status of metaphysical statements in both disciplines. A.J. Ayer, addressing the question as a philosopher of science, introduces the criterion of verifiability. In order to determine whether or not a given question is meaningful, "We inquire in every case what observations would lead us to answer the question, one way or the other; and, if none can be discovered, we must conclude that the sentence under consideration does not, as far as we are concerned, express a genuine question." Thus, a "meaningful question" is one that can be answered by reference to experience. Ayer classifies all traditional metaphysical questions with the "meaningless," and suggests that they arise from the structure of language rather than from observations of the real world. The "concept of substance," for example, arises from confusing the grammatical necessity that every sentence have a subject with the ontological necessity that there be some "thing-in-itself" which corresponds to the grammatical entity.²

Of course, one could argue that the positivistic ap-

proach presented by Ayer is too extreme, and is not truly representative of scientific practice. Ayer rather sweepingly excludes all questions as metaphysical that are not, in principle, verifiable by his criterion; in so doing, he assumes that all of the conclusions that can be derived from a given statement are known and that the "principles" by which these conclusions may be verified are timeless and independent of the state of science at a given time.

But Ayer's position, in its extremity, has the advantage of clearly expressing the need for reference to the realm of experience in the making and testing of scientific statements. No theoretical explanation, no matter how logical, can count as scientific unless the theory is itself verifiable by experience in the physical world. A statement which truly has no consequences which refer to that which is experienced is thus excluded as metaphysical, as so much empty noise.

The practice of the Zen masters in rooting their teachings in the concrete ground of direct experience is well-documented. Traditionally, the Buddha passed on his teaching to Mahakasyapa by holding up a golden flower, and Zen masters often punctuate their teachings by waving (or sometimes smashing) ordinary objects, ringing bells, slapping faces and pointing out the most mundane things. Nor are they at all reticent about discouraging metaphysical speculations and driving their pupils' minds back to the concrete. For ex-

ample:

Murata-Shuko, one of the most eminent tea-masters of his day, visited Ikkyu and was asked what he thought of master Joshu's well-known reference to tea drinking. Shuko made no reply and at last, Ikkyu served him a cup of tea.

As Shuko lifted the cup to his lips, Ikkyu suddenly let out with a kwatz and smashed the cup with his iron nyoi.

Shuko made a deep bow.

'What are you like,' Ikkyu asked, 'when you've no intention of taking tea?'

Without answering, Shuko got up and moved toward the door.

'Stop,' Ikkyu called, 'What are you like when you've taken tea?'

'The willow is green,' Shuko said, 'the rose is red.'

Ikkyu, approving Shuko's grasp of Zen, smiled broadly.³

Or the following:

A monk asked Joshu, 'I read in the Sutra that all things return to the One, but where does the One return to?' Answered the master, 'When I was in the Province of Tsing, I had a robe made which weighed seven chin.'⁴

The first story quoted is an example of Zen dialogue which never once refers to any abstraction which might be called a principle of Buddhism but rather is carried on entirely in the concrete -- by both word and act. The second example shows the Zen master Joshu's response to the metaphysical question of his student -- his response is not in metaphysical terms but rather in the concrete -- driving the student's mind away from such pointless speculation.

Of course, it is a long leap from the logical positivism of Ayer to the Buddhism of Joshu and Ikkyu. Although both

shun the metaphysical, Ayer demands a straightforwardly logical connection between a meaningful utterance and that which can be seen or felt. For the Zen masters, on the other hand, it is not at all clear to the logical mind just what the connection is between smashed tea-cups, red roses and Buddhism. The truth transmitted by Zen is beyond logic and language, and one cannot expect to understand these statements by applying a criterion like Ayer's which is based upon logical analysis. But nonetheless, the Zen mind, is concerned with the experiences of the phenomenal world, with the happenings of everyday life. Ma-Tsu refers to the enlightened mind as the "everyday mind:" "The grasping of the truth is the function of everyday mindedness. Everyday mindedness is free from intentional action, free from concepts of right and wrong, taking and giving, the finite and the infinite." Thus, where Ayer demands that the concrete be amenable to description in a logical framework, the Zen masters speak from a state of mind that transcends the need for this kind of framework and sees the higher reality in everyday experiences.

But if it is a dogma of the scientific credo that the world of experience can be described in terms of a pattern that follows the laws of logic, these laws are not adequate to describe all of the activities that one associates with scientific investigation. Although Ayer is not wrong in saying that the phenomenon that are explained by science are explained by

virtue of the fact that these observables can be deductively derived from the principles of scientific theories, one might well ask whence come these deductive principles?

In general, it is not the case that scientific theories follow deductively from the observations which they purport to explain. In this sense, there is something in scientific activity which is itself beyond the laws of logic. DeMorgan has pointed out the difficulty of describing the act of generating scientific hypotheses in logical terms in the following story:

A hypothesis must have been started...not by rule but by that sagacity of which no description can be given, precisely because the very owners of it do not act under laws perceptible to themselves. The inventor of hypothesis, if pressed to explain his method, must answer as did Zerah Colburn /a Vermont calculating boy of the early nineteenth-hundreds/ when asked for his mode of instantaneous calculation. When the poor boy had been bothered for some time in this manner, he cried out in a huff, 'God put it into my head, and I can't put it into yours.'⁶

Not all writers, however, are content to relegate the problem of generating scientific hypotheses to the realm of intuition. Hanson, for example, writes, "It is not so often affected by intuition, insight, hunches or other imponderables as biographers or scientists suggest."⁷ Hanson insists that the dawning of a scientific hypothesis that will explain a number of previously unexplained observations is itself a reasonable process and that there is nothing mystical about

it.

The situation is describable in terms of the classical hypothetico-deductive model of scientific experimentation. To explain some set of phenomena, the scientist tentatively postulates some hypothesis, which, if it correctly explains these phenomena, will have these phenomena among its logical consequences. One then derives, by the usual rules of logic, the observed effects from the hypothesis. The most desirable hypotheses, of course, have additional logical consequences which are open to experimental test. Hanson insists that arriving at the correct hypothesis is not a matter of intuition but rather a particular form of reasoning which he calls retro-⁸duction. Now, about this process of retroduction he says little beyond naming it and affirming that it is an entirely different process from that of either inductive or deductive reasoning. Rather, he asserts, almost as an article of faith, that since it is possible to produce a hypothesis which will logically imply the desired results (without itself being implied by these results) that this process must itself be rational. Beyond this, he is only able to illustrate what he means by examples drawn from the history of science, and these examples serve mainly to show that there is a certain amount of trial-and-error involved in this process and along with it, a large amount of creative genius.

But if this process of retroduction is not logical in the sense of deductive logic, it certainly can be said to

go beyond the laws of logic and to involve a form of insight which transcends the limitations of the strictly logical approach. Since there is no rule which will generate the correct hypothesis, the scientist may study his data for months or years without ever hitting upon the key which will tie together the unexplained phenomena in a coherent pattern. And yet, since scientific hypotheses do sometimes explain the data that they are supposed to explain, it is also possible that the scientist will experience, in a flash of intuition, the pattern which he seeks.

But there is certainly something in the above description which is analagous to statements made about the practice of Zen. Just as the mind of the scientist must make the leap from what he observes to the scientific hypotheses which he seeks without following the rules of logic, so also must the student of Zen make the non-logical leap of satori from the everyday mind of normal consciousness to Ma-Tsu's "everyday-mind" of the enlightened man. Suzuki writes, "Satori is not a conclusion to be reached by reasoning,"⁹ and "Satori may be defined as an intuitive looking into the nature of things in contradistinction to the analytical or logical understanding of it....Our entire surroundings are viewed from quite an unexpected angle of perception."¹⁰

It is true that the scientist's mind does not leap into an understanding of the essence of Buddhism, but often,

even in genuine satori experiences, neither does the mind of the Zen disciple. As Ruth Fuller Sasaki points out, "There are greater and lesser satori's,¹¹ and this also parallels the intuitive leap involved in scientific discovery. One can see an analogy in Hanson's characterization of the formation of scientific hypotheses as a step-by-step process of trial and error in which one gradually approaches the correct hypothesis to Wienpahl's characterization of "Ladder Zen," wherein, "At each step the student sees logic in something in which he saw only contradiction before."¹² The difference between producing an "ordinary" hypothesis which corresponds to the currently accepted theoretical structure of science and producing a revolutionary hypothesis, such as Einstein's Theory of Relativity, is analogous to the difference between greater and lesser satori.

Thus, in spite of such attempts as Ayer's to characterize science as a purely formalized system describable by the laws of logic, science remains a human means for seeking truth, which, like Zen, is rooted in actual experience. The need for some non-rational or at any rate non-logical form of insight remains a key feature of science as well as of Zen Buddhism.

Margaret Masterman has suggested that this kind of scientific discovery can be, along with Christian revelation and Zen satori,¹³ can be described under the general heading of "revelation," and that all three of them are simply different examples of the same human experience. Masterman's view ex-

tends the analogy between Zen and the philosophy of science even further. She illustrates her thesis with the example of George Boole's discovery of Boolean Algebra and the formulation of its axioms.

For Masterman, Boole's discovery of Boolean Algebra can be described as a change in the level of his consciousness, and that it is from this higher level of consciousness that Boole was able to see logical relationships expressible in terms of a new form of mathematics. The axioms of his algebra ($x \cdot x = x$ and $x^n = x$) then become the koan which Boole presents in order to enable others to experience this new level of consciousness for themselves.

Masterman's argument for the koan-like nature of these axioms is precisely their unintelligibility in terms of ordinary algebra. If one views Boole's axioms in terms of ordinary algebra, one obtains results that are illogical and contradictory. But once one has made the leap into Boolean Algebra (and according to Masterman, into the state of consciousness which Boole himself must have experienced in order to create them) one can make sense out of these equations, and what once appeared to be contradictory now appears as simple and logical.

Zen writers have made similar statements concerning the progress in understanding that the Zen student makes as he pursues the study of koans. Wienpahl, for example, says:

As the student takes step after step he appreciates the fact that there is nothing illogical

in Zen. It is the student who is illogical, and he is so only because he cannot see the logic of the matter. On the other hand, he comes to see its logic not by ratiocination but by living through the paradoxical, by taking steps on his own.¹⁴

And Ruth Fuller Sasaki writes:

When the koan is resolved, it is realized to be a simple and clear statement made from the state of consciousness which it has helped to awaken.¹⁵

And D.T. Suzuki says:

What the koan proposes to do is to develop artificially or systematically in the consciousness of the Zen follower what the early masters produced in themselves spontaneously.¹⁶

From the above remarks, one can see the analogy that Masterman intended to present. However, just as in the case of the status of metaphysical statements, one feels that some caution must be exercised here. Although one must make a leap into a different consciousness in order to create (or assimilate) a new scientific theory, this new level of consciousness is still not the consciousness of post-enlightenment Zen. Although it may, perhaps be a step to another ring on the ladder, these scientific theories still maintain a dualistic point of view. The scientist remains an observer detached, at least philosophically, from the universe which his system attempts to describe. The task of understanding a scientific or mathematical theory remains by and large the intellectual task of dealing with complex abstractions -- the province of the vijnana-intellect rather than that of prajna-intuition. Although

there is an intuitive leap involved in apprehending Boolean Algebra, it nonetheless remains a logical system made up of abstract entities -- something that appears to be very far from the "everyday-mind" of the Zen master.

And yet, the parallels between scientific thought and Zen Buddhism are far from exhausted. It is not only in the criterion for formulating scientific theories that one finds analogies with the prajna-intuition of Zen, but also in the theories which result from these practices. In particular, many of the conclusions set forth in the interpretation of quantum mechanics make it possible to extend the analogy to a level that is deeper than that suggested in this chapter.

Footnotes

1. Ayer, A.J., Language, Truth and Logic (New York, 1952), p. 35.
2. Ibid., p. 42.
3. Stryk, Lucien and Takashi Ikemoto, trans., Zen: Poems, Prayers, Sermons, Anecdotes and Interviews (Garden City, 1965), p. 110.
4. Suzuki, D.T. Essays in Zen Buddhism, First Series (New York, 1961), p. 283.
5. Chung-Yuan, Chan, Original Teachings of Ch'an Buddhism (New York, 1971), p. 130.
6. Quoted in Cohen and Nagle, An Introduction to Logic and the Scientific Method (New York, 1934), p.221.
7. Hanson, N.R., Patterns of Discovery (Cambridge, 1965), p. 221.
8. Ibid., p. 88.
9. Suzuki, Essays in Zen Buddhism, Second Series (New York, 1971), p. 31.
10. Suzuki, Essays, First Series, p. 230.
11. Sasaki, R.F., "Zen: A Method for Religious Awakening," in The World of Zen, ed. Nancy Wilson Ross (New York, 1960), p. 26.
12. Wienpahl, Paul, The Matter of Zen: A Brief Account of Zazen (New York, 1964), p. 93.
13. Masterman, Margaret, "Theism as a Scientific Hypothesis," Theoria to Theory, Vol. I, Third Quarter, 1967, pp.235ff.
14. Wienpahl, Loc. Cit.
15. Sasaki, R.F. and Isshu Miura, The Zen Koan (New York, 1965), p. xi f.
16. Suzuki, Essays Second Series, p. 90.

Chapter III
Zen and Quantum Physics

Part I: The Interpretation of Quantum Mechanics

Although the concepts presented in the previous chapter revealed some parallels with the teachings of Zen Buddhism, they did not take us beyond the realm of logic into the kinds of paradoxical statements that one associates with the Zen masters. However, if one turns his attention to the realm of physical phenomena which occur on the scale of the very small -- the realm of quantum physics -- one begins to see some very paradoxical results.

A fairly simple example will serve to illustrate the kind of paradoxes involved and to introduce some of the relevant concepts of quantum physics. Consider the following two experiments designed to reveal certain aspects of the nature

of light.

The first of these experiments involves the photoelectric effect, the explanation of which by Einstein in 1905 was an important step in the development of the quantum mechanics. When ultra-violet light shone upon the surface of certain metals, electrons were emitted from the surface. One could attempt to describe this phenomenon using the wave theory of light, saying that the electro-magnetic radiation sets electrons near the surface of the metal into motion and that some of these move so rapidly that they escape. From the wave theory, one would expect that more intense light would cause the escaping electrons to have more energy and that the frequency of the light should be insignificant as long as the intensity is high enough. But in fact, what is observed is that the energy of the escaping electrons is independent of the intensity of the light (although a greater intensity causes more electrons to escape) and that higher-frequency radiation causes the electrons to fly off more energetically. Einstein showed that these effects could be explained by assuming that light consists not of a wave front but of a stream of photons -- massless particles that carry energy proportional to the "frequency" of the light. The intensity of the light is then simply proportional to the number of photons that make up the stream.

Now, contrast this result to the result of another experiment involving the well-known phenomenon of wave inter-

ference. If one shines a well-focused beam of light upon a flat surface containing two slits, one observes the classical interference pattern caused by the alternate reinforcement and cancellation of the two wave fronts that emerge from the opposite of the two slits. However, if one accepts the result of the photo-electric experiment and assumes that light can be treated as a stream of massless particles, how does one explain the appearance of this interference pattern? If light is simply a stream of particles, one would expect that the result of passing a light beam through two slits would simply be the sum that one would obtain by adding the intensity of the light at each point on the screen with one slit open to that observed with the other slit open and the first one closed. But this result is not observed. Rather, one sees projected upon the screen beyond the two slits the interference pattern that one would predict from the wave-picture of light.

How is one to explain this result? It appears that whether light consists of waves or particles depends upon the particular experiment that someone decides to perform upon it. Moreover, this peculiar dependence upon the method of observation for the result of a scientific experiment does not vanish in the quantum-mechanical description of the experiment. Rather, quantum physics makes this dependence even more problematic.

Since the mathematical complexities of quantum-mechan-

ical calculations are irrelevant for the purposes of this paper, only a brief sketch of the procedure, emphasizing the most relevant features, is presented here.² Basically, observable quantities are represented by mathematical operators which operate upon "state functions" in order to form the mathematical equation which gives a quantum mechanical statement of the experimental situation. The quantum description differs from a classical description in two important ways. First of all, certain observable quantities are seen to be "quantized," that is capable of taking on only certain discrete values as opposed to varying continuously as in classical physics. Second, by mathematical manipulations of the state functions, one is able to derive a number which corresponds to the probability of a particle being found within a unit volume at a particular point in space; one is not able to predict with certainty the particular point in space where the particle is located.

Now, according to the Copenhagen interpretation of quantum physics (developed by Bohrand Heisenberg (and generally accepted, with some exceptions, as the standard interpretation), this probability function can be connected with reality only if one essential condition is fulfilled: "if a new measurement is made to determine a certain property of a system."³ One cannot make, on the basis of quantum mechanics, statements about what happens to a given particle between observations.

Consider Heisenberg's view of the interference exper-

iment discussed above. From the state function for this experiment, one will be able to calculate a probability distribution for the photons on the screen which corresponds to the distribution of light intensity predicted by the wave picture. According to Heisenberg,⁴ the difficulties begin to arise when one tries to talk about the behavior of the photons during the time that they are not observed. That is, assume that every photon that passes through the apparatus and hits the screen has passed through either one slit or the other. If one considers only those photons that have passed through the first slit, their distribution on the screen should be given by a probability distribution that is independent of whether or not the second slit is open. Conversely, the distribution of only those photons that pass through the second slit should be given by a function that is independent of whether or not the first slit is open. The resulting pattern, with both slits open, then would logically be simply the result of adding the intensities that one observes by having each slit open with the other closed. Instead, the calculated distribution, which corresponds to the observed result, is the familiar interference pattern.

According to Heisenberg, the error in the above analysis comes from the assumption that each photon must have passed through one slit or the other. This is the statement that leads to contradictions and it is not allowed in the quantum mechanical description of the experiment, since it refers

to what happens between observations.

To clarify this, one can consider two possible states of the experimental system described above: State-1 with one slit open and State-2 with both slits open. For State-1 it is permissible to talk about the photons that have passed through that particular slit, since those are the photons that are observed and thus are described by quantum mechanics. In State-2 however, it is only permissible to talk about the observed photons -- those which hit the screen and whose distribution is accurately predicted by quantum mechanics. One can make no statements about the photons having passed through a particular slit, since no observation is made of the photons passing through the single slit.

This is certainly a paradoxical result; indeed, it flies in the face of logic. Any path through the apparatus to the screen must pass through one of the two slits; yet, it is meaningless to talk about a photon passing through either one slit or the other. Moreover, this result emphasizes the observer-dependence of quantum mechanical experiments. In Heisenberg's own words, "the reality varies, depending upon whether we observe it or not."⁵

Moreover, there is an important sense in which the quantum mechanical description does not escape the wave-particle problem described in the first presentation of the interference experiment. One of the early steps in the development of quan-

tum mechanics was DeBroglie's introduction of the concept of matter=waves.⁶ DeBroglie reasoned that very light particles, such as electrons and protons, should behave in a manner similar to massless photons. The success of DeBroglie's hypothesis is attested to by the observation of diffraction and interference phenomena involving particles such as the electron. The formal system of quantum mechanics which is used in actual calculations was developed by Schroedinger from the work done by DeBroglie. If one wishes to interpret quantum mechanics in terms of these matter-waves, one considers the amplitude of the "state functions" as the amplitude of these matter waves.

Now it makes no difference insofar as the mathematical calculations are concerned whether one wishes to interpret the "state function" as a probability function that deals with the location of particles in space or whether one considers it to be a wave-function that deals with the amplitude of a waveform. Problems arise, however, when one attempts to interpret quantum mechanical descriptions on a level that corresponds to the reality of a given observation. One cannot arbitrarily say, "Quantum events are wave phenomena," since one could not explain such observations as the photo-electric effect. Nor can one say, "Quantum events involve interactions between particles" without running into the difficulties which Heisenberg has pointed out, when one attempts to describe what "happens" to these particles in the interference experiment. What then

can one say in answer to such questions as "Is an electron a wave or a particle?" The two concepts are mutually exclusive and yet both are required if one is to provide a complete description of the interactions involving the electron or any other entity that is describable in terms of quantum mechanics.

It is important to keep in mind that such concepts as "particle" and "wave" come not from quantum physics but rather from the language of classical physics, which Heisenberg points out, "are just a refinement of the concepts of daily life and are an essential part of the language which forms the basis of all of natural science."⁷ That is, these classical concepts form the framework in which the experiments themselves are described, and one demands of an interpretation of quantum mechanics that it provide a means for describing the results of these experiments in the same language which one uses to describe the experiments themselves. Moreover, as an acceptable scientific theory, quantum mechanics fulfills the "boundary condition" that the classical concepts are special, limiting cases of the quantum mechanical phenomena. This boundary condition is essential, since otherwise, one would have two incompatible scientific theories being used to describe the same phenomenon.

For example, one of the most important features of quantum mechanics is that it allows certain observable quantities to take on only certain discrete values. For instance,

the energy of an electron in an atom cannot vary continuously over some range but rather must be an integral multiple of some value of energy. This integer, called a "quantum number" specifies the energy state of the system being described. Now, when one moves into the realm of macro-physics, this quantization is not observed. The explanation for this is not that there is a different set of physical laws which describe events in the macro-world, but rather that for macroscopic systems the quantum numbers are very large and the unit of quantization relatively small so that the range of possible energies is so close to continuous that the quantization is not observed. The macroscopic world is built up out of quantum mechanical systems. The need to describe quantum phenomena in the language of classical physics is a cornerstone of the Copenhagen interpretation.

Niels Bohr uses the word 'complementarity' to describe the "relation of mutual exclusion,"⁸ that holds between two classical concepts used to describe the same quantum phenomenon. Thus, "wave," and "particle," are complementary concepts, neither one of which is by itself sufficient to fully describe the behavior of very small entities. The concept of complementarity is not restricted to the wave/particle description, but rather is a theme which recurs often on many different levels of the description of quantum phenomena.

Complementarity, for example, appears in a somewhat different

form in relation to Heisenberg's uncertainty principle. As Heisenberg puts it, "The knowledge of the position of a particle is complementary to the knowledge of its momentum. If we know the one with high accuracy we cannot know the other with high accuracy."⁹ Heisenberg illustrates the uncertainty principle with a hypothetical experiment involving a gamma-ray microscope.¹⁰ The only way to determine the position of a small particle, such as an electron, is by the interaction of the electron with some other particle or with a wave-front. Now, a wave cannot specify the position any more closely than the actual wavelength of the radiation used. However, because of the laws of diffraction, there will be an uncertainty in the measurement of the scattered radiation inversely proportional to its wavelength. This uncertainty in momentum in turn corresponds with the uncertainty in the momentum of the observed electron. Thus, the more precisely one determines the position of a particle, the greater the uncertainty in the determination of that particle's momentum. A similar complementary relationship holds between the determination of a particle's energy and the determination of the time that the particle spends in that particular energy state. Thus, a particle can never be precisely located in space and time, since such a precise location would leave the particle's momentum and energy completely undetermined. Note that the uncertainty relations require that quantum-mechanical descriptions give probabilistic, or at

least uncertain, determinations of the energy and momentum states of a particle, since if they were to give precise descriptions of these states, they would leave the particle's location in space and time completely undetermined.

An important philosophical point about this indeterminacy in space and time is that it is an intrinsic feature of the quantum mechanical description of nature. These uncertainties are not simply limitations in the state of the art of measurement but limitations of the very concept of measurement. The scientist's uncertainty about the location of a particle is of a different nature than his uncertainty about, for example, the weight of a macroscopic object. On a macroscopic scale, the quantum mechanical uncertainties are so small as to be negligible and the limitations of determining the weight will be the limitations of the particular scales used for making the measurement. But the quantum mechanical uncertainties can never be removed (or reduced) by simply increasing the precision of the measurement technique.

One can apply Bohr's principle of complementarity in order to understand the uncertainty principle itself. That is, one could consider the particle whose position is to be determined to be a matter-wave. In this light, the uncertainty in position is simply due to the wave nature of the entity to be located -- one cannot specify the location of a wave to any degree of accuracy smaller than the actual wavelength. This

point of view helps to illustrate the point that these uncertainties refer to uncertainties in the very structure of nature.

But if the uncertainty relations are taken as intrinsic to the structure of the universe, this requires a revision of the concept of causality. In the view of classical physics, the universe is a causally determined mechanism, and complete knowledge of the state of the universe at a given instant in time is tantamount to knowledge of all states of the universe, past or future, as well as the present. But the uncertainty relationships state that there is no way to precisely specify a given state of the universe for a given time and, moreover, that the quantities of energy and momentum, which are essential to the specification of a physical state, are complementary to the determination of location in space and time. Moreover, since the only predictions that the physical theory makes about observable phenomena are described in terms of probability functions, the classical notion of a causally determined universe begins to collapse.

This is not to say, however, that there is no sense in quantum mechanics in which the notion of causality is retained. The state function itself can be written as a time-dependent mathematical expression whose value is determined at every point in time. But, as has been pointed out above, the state function itself cannot be connected with reality unless some observation is made. Niels Bohr has described

the situation:

Under such circumstances one may be able to apply the concept of causality but the concepts of space and time 'lose their immediate sense!' On the other hand, if conditions are arranged such that contact can be established between the system and some measuring instrument, then one may use the space-time concepts yet no longer ascribe a state to the system and 'there can be no question of causality in the ordinary sense of the word.'''

Thus the concept of space-time and the concept of causality appear as complementary concepts. This form of complementarity is also illustrated by the two slit interference experiment. One can choose to calculate the probability function either at the screen, where the interference pattern is observed, or at the slit where the light waves pass on their way to the screen. But one obtains a different value for the probability function depending upon where the observation is made; this difference is not metaphysical, since the differing predictions do appear as observed results. And yet, one cannot assign a causal connection between the two observations made at different points along the "path" of the photons, since the state-functions for the two observational cases are different. This example shows that the quantum mechanical attack on the concept of causality goes deeper than a mere weakening of causality by the introduction of statistical laws.

Again and again, the role of the observer intrudes upon the quantum mechanical description of a system. But,

the role of the observer is simply that of recording the physical effects that result from the inter-action of the system that is being studied with the apparatus, or measuring instruments, used to study the system. Can one eliminate the paradoxes of complementarity by generating a quantum mechanical description that includes both the experimental system to be observed and the measuring apparatus itself? If the paradoxes arise, as Heisenberg suggests, from the description of quantum phenomena in classical terms, this suggests that what is needed is a quantum description of the entire experiment, including the measuring apparatus, in order to eliminate the need for describing the experimental results in classical terms.

One can, to be sure, give a quantum mechanical description of the measuring apparatus, thus incorporating the apparatus itself into the quantum system that is being studied. To a certain extent, the boundary between the observed system and the observing apparatus is arbitrary and, therefore, movable. However, simply shifting this boundary does not eliminate all of the problems involved in complementarity. Bohr has shown that this procedure "will not influence the uncertainty in the description of the object."¹² That is, since the uncertainty relations remain intact, causality and space-time remain as complementary concepts. Moreover, at some point even this extended system must come into contact with the rest of the universe, which is described in classical terms, for otherwise, there

would be no way of obtaining information from it. Shifting the system/instrument boundary to include the measuring apparatus does not eliminate the boundary problem which requires the description of quantum phenomena in classical terms, which is the source of the paradoxical results, but rather simply shifts the location of the boundary.

But if the movability of the system/instrument boundary suggests that there is something arbitrary about the boundary itself, Bohr has pointed out that the placement of this boundary is not entirely arbitrary. The definition of the object is not made by an arbitrary whim of the experimenter but is rather made by the background of questions which has necessitated the experiment in the first place. A scientific experiment will, in general, be designed to test a specific hypothesis about a particular phenomenon or class of phenomena. It is the question of the acceptability of this hypothesis which defines the object of the experiment.

One can never entirely eliminate the element of subjectivity involved, since no experiment tests some phenomenon by itself, entirely isolated from the rest of nature. "What we observe is not nature in itself but nature exposed to our form of questioning."¹³

Bohr felt that the question about the arbitrariness of the system/instrument boundary in quantum mechanical descriptions illustrated important features of the more gen-

eral problem of the division of the world into subject and object which is necessary for any description of human knowledge. Bohr felt that the relation of complementarity was "the dominant feature in all fields where describing experience requires considering the conditions under which experience is gained," and that "instinct and reason, individual and society, compassion and justice" were all examples of complementary relations.¹⁴ And from the general applicability of complementarity, he drew far-reaching conclusions:

From these circumstances follows not only the relative meaning of every concept, or rather of every word, the meaning depending upon our arbitrary choice of viewpoint, but also that we must, in general, be prepared to accept the fact that the complete elucidation of one and the same object may require diverse points of view which defy a unique description.¹⁵

Complementarity thus appears not as a defect in the quantum mechanical description of nature but rather as a general feature of human knowledge. Complementarity results from the partitioning of the universe into subject/object categories, which is required not only by the Copengahen interpretation's demand for an interpretation of quantum mechanics in classical terms but also for any **System** which attempts to give an objective description of nature.

Although it may appear contradictory to call these quantum mechanical descriptions "objective" after taking so much space to point out the role of subjectivity in them, this

apparent contradiction can be resolved by considering more precisely what is meant by "subjectivity" in these descriptions. Quantum mechanics gives objective descriptions in the sense that it describes results that are independent of the particular observer who performs the experiment. They are subjective in the sense that some account must be given of the experimental conditions of the observation. However, in the process of making these observations objective, one must forsake the hope of providing a unique description of the particular object that is being studied. Rather, one must use complementary, i.e. mutually contradictory, descriptions of the same object under different experimental conditions. These descriptions are subjective in the sense that one set of observations will give results that are contradictory to those given by another set of observations -- even though both sets are made up of valid observations. The language of classical physics is objective in the sense that it describes systems without any reference to the observer or conditions of observation -- classical systems by their nature are not affected by the kinds of observations that one makes of them. The quantum mechanical descriptions do not display this kind of objectivity, and when one begins to use the classical, objective language to describe quantum phenomena, one finds it necessary to make use of complementary concepts in order to describe all the aspects of a given quantum phenomenon.

Another aspect of contemporary physics that is relevant to the present discussion is Dirac's "hole" theory of matter creation and annihilation.¹⁶ In 1928, Dirac formulated a quantum theory of the electron in conformance with Einstein's Theory of Relativity. The mathematically derived formula for possible energy values of the electron predicts negative energy values, which do not appear in the classical description. According to Dirac, these electrons with negative energy uniformly fill all of space, with infinite density, and are undetectable in their negative energy-state. If one of these electrons is raised to a positive energy level, a "hole" is left in this continuum of negative-energy electrons. The electron, now possessing positive energy, becomes observable and the "Hole" in the continuum appears as a positive particle, just as a bubble in the sea appears as an object to a fish, which ignores the presence of the sea itself."¹⁷ Thus, two particles appear where there were none before -- the electron and the "hole" in the substratum which appears as a positron or anti-electron. This process can be reversed when an electron collides with a positron and both disappear in a flash of "annihilation radiation." This reverse process is described by Dirac's theory as an electron falling into a "hole" in the substratum, and the "annihilation radiation" releases precisely the amount of energy that the electron must lose in order to fall from its positive energy state to the negative

energy-state of the substratum. So strange did this prediction of anti-particles appear that it was first considered a flaw in Dirac's theory until the positron was actually observed by Anderson in 1932.

Dirac's prediction of anti-matter certainly presents a novel view of material objects. Subsequent experimental discoveries revealed that the existence of an anti-particle is not unique to the electron but rather that each of the elementary particles has associated with it its own anti-particle.¹⁸ These elementary particles make up the "stuff" out of which physical objects are made. Dirac's theory suggests that all matter is created out of some imperceptible substratum and that the creation of matter leaves behind it a "hole" in this substratum which appears as anti-matter. Now, this substratum itself is not accurately described as material, since it uniformly fills all space and is undetectable by any observation. In a sense, it appears as nothingness -- immaterial, undetectable and omnipresent. But it is a peculiarly material form of nothingness, out of which all matter is created.

In summary, one can see that the present-day viewpoint of micro-physics contains many features which are alien to the classical and the common-sense views of the world. Although Einstein's earlier theory had already introduced the observer into the results of physics and undermined the absolute notions of space and time, the world of micro-physics, with its

paradoxical results, shows these features most clearly. Objects are seen to have mutually-contradictory properties, each of which appears under different experimental conditions. Causality and location in space and time appear as complementary concepts, and any description which includes one of them excludes the other. Relativistic quantum mechanics presents a theoretical picture in which every particle has associated with it its opposite particle, corresponding to a "hole" in the substratum out of which the particle has risen. The existence and non-existence of various properties appears to depend upon whether or not they are observed, and nothing possesses an exact location in space and time. Phenomena can no longer be adequately described by straightforward use of the objective language of classical physics.

Part II: Some Parallels with Zen Buddhism

The speech and actions of the Zen masters are all part of the technique which they use to "point the way." The Zen master wishes to instill into his students a new consciousness -- a new way of apprehending reality. At the moment of satori the student of Zen experiences **f**or himself the enlightened state which the Buddha himself experienced. This experience has, according to tradition, been handed down by an unbroken succession of Zen masters to the student himself who experiences the true nature of himself -- the Buddha nature.

Now, as has been pointed out already, this self is not the self of ego, the self which appears as the subject in all actions. Once one has achieved Zen consciousness, he sees that his true self is something quite different. The notion of the self in the subject/object opposition is but one aspect of the way in which ordinary consciousness separates reality into opposing pairs -- being and non-being, good and evil, black and white -- and sees each side of these opposites as a separate, independent entity rather than as what Alan Watts¹ calls "poles or aspects" of the same thing. From the point of view of Zen consciousness, these single-sided entities have no true reality.

Zen consciousness involves an immediate awareness that goes beyond the consciousness which divides the world up into

opposites and clings to these opposites as though they had a separate existence independent of the rest of the universe. The Zen master tries to show his students how to break through this tendency to cling to opposites and pass beyond it. The Chinese master Huang Po places great stress upon this aspect of Zen. The following passage is representative of Huang Po's teachings on this matter:

There are no Enlightened men or ignorant men, and there is no oblivion. Yet, though basically everything is without objective existence, you must not come to think in terms of anything non-existent; and though things are not non-existent, you must not form a concept of anything existing.²

Huang Po is trying to make his pupil realize that the very fact that he is seeking enlightenment is a stumbling block, since by objectifying "enlightenment" as something to be sought, the student is still clinging to the opposites of dualistic thinking. The opposition between Zen consciousness and ordinary consciousness is itself a distinction that is made from the point of view of ordinary consciousness. To the enlightened mind, this distinction is seen to be illusory.

Although one who has achieved Zen consciousness has gone beyond the stage of clinging to opposites, the language which he uses to communicate his insight remains rooted in this dualistic separation into opposites. If this form of discrimination must be discarded in order to apprehend one's own Buddha-nature, it still must be retained in order to talk about any-

thing. Since the Zen master is forced to use ordinary language in order to communicate with his students, his statements will contain these dualistic concepts. But since the master is speaking from the point of view of a consciousness that goes beyond dualism, it is not unusual to find statements which will apply a pair of mutually-negating concepts simultaneously to a single object. Examples of this kind of statement appear frequently in Zen writings. Thus, in the Mumonkon, one finds the following story:

Shuzan held out his short staff and said:
'If you call this a short staff, you oppose its reality. If you do not call it a short staff, you ignore the fact. Now what do you wish to call this?'

Mumon's comment: It cannot be expressed with words and it cannot be expressed without words. Now say quickly what it is.³

Examples of this kind of discourse are not difficult to find in Zen literature. Here are two more:

Goso said: 'When you meet a Zen master on the road you cannot talk to him, you cannot face him with **silence**. What are you going to do?' ⁴

Empty-handed, yet holding a hoe,
Walking yet riding a water buffalo.⁵

Many writers stress the role that these paradoxical utterances play in the technique used by the Zen masters in instructing their students,⁶ but it is important to emphasize that this is not "mere" technique which can be separated from Zen-consciousness itself. If Zen consciousness transcends the

the dualism of opposites, it must also transcend the distinction between the master's experience and the communication of that experience. The Zen master is not manipulating some abstract technique when he speaks to his disciples; rather, he is speaking directly from the state of consciousness which his teachings are supposed to transmit to the students. This strange form of communication or of technique is simply one aspect of Zen consciousness itself.

The paradoxes arise because ordinary language is formulated in terms of these mutually exclusive opposites, and there is no other language that the master can use in communicating with his students. Although the master may escape the trap of language by using the direct method of gestures or blows, when he puts his teachings into words, he must use dualistic language.

Here already one can see a definite parallel with the paradoxes that arise out of the interpretation of quantum mechanics. In quantum mechanics, the scientist is forced to employ the "objective" language of classical physics to describe phenomena that are beyond the range of this language. And the result of this method of description is no less paradoxical than the Zen statements quoted on the previous page. Bohr's concept of complementarity is essentially a formalized statement of this problem. Light is a wave-phenomenon, but it is also a particle-phenomenon, and the two descriptions are as mutually

exclusive as any pair of opposites.

The language of classical physics is "objective" in that it describes phenomena independently of any observer or apparatus for making observations. In order to be able to describe things in this manner, one necessarily assumes the dualistic distinction between that which is perceived and that which perceives. The observable phenomena are then attributed with an existence that is independent of the process of observation. In quantum mechanics, it is precisely this form of objectivity that disappears, thus requiring the introduction of Bohr's principle of complementarity. Not only do the Zen masters and the micro-physicists both find themselves asserting the paradox that something both is and is-not, but also they find themselves asserting this paradox for similar reasons. Just as the master must return to the objective, dualistic concepts of ordinary language in order to make himself understood, so also must the physicist return to the use of the objective and dualistic concepts of classical physics.

In both physics and Zen, the relationship between the subject and object becomes essential, and the object itself loses its separateness from the subject. The physicist cannot give an objective answer to the question, "Is an electron a wave or a particle?" since any answer that he gives must make reference to the conditions under which the electron is observed.

Toshihiko Izutsu uses the term "ontological field"

to encompass both the subject and the object as viewed in Zen consciousness:

All things /subject or object/ by themselves are simply nothing. Out of the depth of this Nothingness, however, both the Subject and the Object emerge to form between themselves an ontological field....And the field itself...is the absolute reality. ⁷

One could apply this concept of an ontological field in a similar way to the relationship between the observed phenomena and the experimental apparatus in physics. There is no sense in saying that light is really "waves or "really" photons but only in saying that light displays "wave-like" properties under particular observational conditions. The observed light and the experimental apparatus form an ontological field, and no description which fails to include both the subject and the object (i.e., the entire field) will be adequate.

The complementary relationship between space-time and causation also displays features relevant to Zen. As described in the previous section, this form of complementarity involves the following dilemma: The unobserved state of some system can be described in terms of causal laws but this state description does not refer to entities that exist in time and space. Through the introduction of an observation, the space-time framework is provided, but because of the inherent uncertainties involved in the location of something in space and time,

one can no longer use a causal description of the events observed.

The absence of a space-time framework in a quantum mechanical description can only be remedied by the introduction of the observer. In a sense, then, the act of observation itself involves the introduction of space-time. Space and time no longer exist as an immutable framework independent of the observer.

Moreover, since the uncertainty relationships are an inescapable feature of the quantum mechanical description of the universe, the downfall of classical causality is equally inescapable. Causality, or causal thinking, is clearly an example of the kind of dualistic reasoning that is transcended in Zen consciousness. To the enlightened mind, cause and effect form an inseparable unity-- neither the cause nor the effect can be separated from the ontological field and given an independent existence.

Of course it must be admitted that this parallel cannot be drawn too closely. Whereas both Zen and micro-physics negate the conventional concepts of time, space and causality, there are major differences in the way in which the two viewpoints reject these concepts. The physicist approaches this breakdown with puzzlement and holds on to the idea that there are rational natural laws which govern the behavior of physical objects, independent of any observations that the physicist

might make. He admits that these laws cannot be described in simple, objective, causal terms, as one might have expected -- but one would not expect a physicist to say, for example, that an electron begins to exist when someone begins observing it or that it ceases to exist when it is unobserved.

The Zen masters, on the other hand, are quite vocal about the intrinsically empty and illusory character of physical objects. For example, Hui Neng offers the following verse:

In all things there is nothing real,
And so we should free ourselves from the concept
of the reality of objects.
He who believes in the reality of objects
Is bound by this very concept which is entirely
elusive.

But even if physicists are not willing to go quite as far as the Zen masters in their claim that physical objects are illusory, the fact remains that the reality that is described by quantum mechanics is beyond the realm of conventional logic and that the application of dualistic language to this reality leads to paradox, just as it does in Zen Buddhism.

But if for the Zen Buddhists, objects have no reality, what does have reality? What is the ultimate reality which supports the ontological field in which the illusory reality of objects can take form? The Mahayana doctrine of sunyata, "the Void," has been mentioned in the introduction. It will

be useful, at this point in the discussion, to examine the Zen interpretation of this Mahayana doctrine in more detail. The Shingyo, a sutra commonly read by Zen students, has this to say about this doctrine:

O Sariputra, all things here are characterized with emptiness: they are not born, they are not annihilated; they are not tainted, they are not immaculate; they do not increase, they do not decrease. Therefore, O Sariputra, in emptiness there is no form, no sensation, no thought, no confection, no consciousness. ⁹

And Huang Po declares:

The Royal Treasury is the Nature of the Void. Though all the vast world systems of the universe are contained therein, none of them have existence outside your mind. ¹⁰

Of course, when the Buddhists speak about the Void or Nothingness, they do not simply mean non-existence. For, in the midst of this emptiness:

I raise the hand and lo! there is space, there is time, there is causation. Every logical law and every metaphysical principle rushes in to confirm the reality of my hand. ¹¹

Absolute reality cannot be a thing, since such a conception implies a dualistic picture -- a view of reality clouded by the discriminating intellect. It must be that which transcends all such distinctions -- that without which the apparent reality of objects and causes could not be.

You cannot describe it, you cannot picture it,
 You cannot admire it; you cannot sense it.
 It is your true self, it has nowhere to hide
 When the world is destroyed, it will not be
 destroyed. ¹²

The Absolute principle must be "Emptiness," since it must be free from all the distinctions of the discriminating intellect. It cannot be non-existence, however, because non-existence is simply one pole of the being/non-being duality, and the Absolute transcends all such distinctions.

The Zen masters stress the doctrine of sunyata in order to emphasize the need to cease clinging to opposites in order to experience that which lies beyond all the discriminations of the intellect -- they are not advocating a form of nihilism. That Buddhism is not nihilism is stressed in the earliest of Zen writings. Hui Neng, for example, instructs:

In the functioning of the Essence of Mind
...outwardly we should free ourselves from
attachment to objects,...and inwardly, with
regard to the teaching of the Void, we should
free ourselves from Nihilism. 13

Thus, one must use some care in interpreting Zen statements about the essential nothingness of objects. The Zen masters are not asserting that the world of everyday experience is non-existent. Kapleau stresses this point by making use of a modern-day analogy:

All forms in their essential nature are empty, that is, mutually dependent patterns of energy in flux, yet at the same time are possessed of a provisional or limited reality in time and space, in much the same way that the actions in a movie film have a reality in terms of the film but are otherwise substantial or unreal. 14

The point is to give up clinging to the illusory independent existence of objects, not to deny the reality of

experiencing them. To insist upon the nihilistic position that objects do not exist at all is to continue to cling to dualistic thinking.

That the Zen Buddhists do not wish to discard the reality of everyday experience is borne out by the masters' use of the concrete, immediate reality of common objects and physical blows in the transmission of their teachings. (Examples of the use of concrete, immediate reality in Zen teachings have already been quoted in previous sections of this paper, c.f. for example, Chapter II). Thus the Zen master imparts the principles of Buddhism by waving his staff, offering a cup of tea or calling attention to the sound of a running brook. That he who has achieved Zen consciousness is not experiencing a world of undifferentiated nothingness is reflected in the lines of a Zen poet:

How wondrously supernatural,
And how miraculous this is!
I draw water, and I carry fuel.¹⁵

Thus, when once one has passed through the "gateless gate" of satori, all opposites are transcended -- including the opposition between the Void and the phenomenal world. Thus, statements about nothingness are not intended to proclaim that true reality is only experienced by shutting out the experiences of everyday life. Rather, all these experiences are themselves experiences of the absolute reality of the Void -- once one has learned to see things in the Zen way.

It may appear that all of this discussion about the Void has led us away from the original line of discussion. For after all, physics is not really expected to give all the answers to questions about the ultimate reality of the objects which it studies. Quantum mechanics does not answer all the questions that could be asked about unobserved electrons, but the physicist could argue that there is no requirement that it should. As long as the scientist can correctly predict the behavior of observed electrons, there is no particular need, from the point of view of pure physics, to say anything about those that are unobserved. The physicist can justify his inability to answer this question on the grounds that it is a metaphysical question, and he can point to the concrete results of explained experiments to justify his use of the quantum theory. Of course, the Zen master also avoids metaphysical questions and may respond to a question about the nature of the Void by waving his staff in front of the eyes of the questioning pupil. (c.f. Chapter II)

However, physicists do not entirely avoid the question of the underlying reality of material particles, and there is in Dirac's "hole" theory a remarkable similarity to the Buddhist notion of the Void. Dirac's theory depends upon the conception of a substratum of particles in the negative energy state. This substratum fills all of space with infinite density, and has many of the characteristics of the Void.

It has no dimensions, no weight, no color and indeed no perceptible qualities whatsoever. And yet, at the same time, it is not nothing, for it is out of this substratum that all elementary particles are created, and it is out of these elementary particles that all mater is created. Although electron-positron pairs are created out of this substratum and drop back into it when they are annihilated, the substratum, like the void, is itself neither created nor annihilated in this process. And because this substratum of negative-energy particles fills all of space with infinite density, the particles of the substratum, like the Void, neither increase nor decrease. Like the Buddhist void, the substratum is at one and the same time nothing and the source of all things.

Moreover, in the process of creating a particle by raising it out of the substratum, there is necessarily created for each particle an anti-particle -- the "hole" that is left in the substratum. In a sense, no particle exists as an independent entity but only as one aspect of the ontological field which includes the particle, its anti-particle, and the substratum itself. In this sense, even physics acknowledges that the separate and independent existence of an object is illusory, and that the object only exists by virtue of its relationship with its opposite (i.e., the anti-particle).

16

Holmes Welch has noted the parallel between Dirac's "hole" theory and the picture of creation presented by Lao Tzu

in the Tao Te Ching.* Welch dismisses the similarity as a lucky "first guess" on the part of Lao Tzu. Although it is unlikely that Lao Tzu and Dirac were viewing the universe from the same point of view, the parallel between the two theories lies at a deeper level than that of mere guess or coincidence. Since both theories describe, in some sense, the process of creation of something out of nothing (which is itself paradoxical), one can see, in their common usage of pairs of opposite poles, an illustration of the basic, dualistic process involved in description in terms of language.

Dirac starts from the antithesis between the imperceptible substratum and the perceptible particle, and because of symmetry considerations involved in the mathematical construction of his theory, is then forced to describe matter creation in terms of pairs of "opposite" particles. The Buddhists on the other hand (along with Lao Tzu) start from the point of view of a consciousness which apprehends the Void and transcends the dualistic notions. From this enlightened point of view, the apparent reality of individual objects is seen to be the result of thinking in terms of only one of the poles of the ontological field.

This difference between the physicist's expression of the paradoxes of quantum mechanics and the paradoxes uttered by the Zen masters runs through all of the parallels that

*The influence of the Taoist point of view upon Indian Buddhism was historically and philosophically an important part of the Chinese development of Zen.

have been discussed above. The physicist is forced, by experimental results, to apply two opposing concepts to the same entity, and from this paradoxical result he tries to construct an interpretation. The Zen masters on the other hand start with an interpretation -- indeed, a special consciousness, a way of apprehending reality -- and express themselves paradoxically because of the limitations of language. The physicists have stumbled upon simple, physical examples which illustrate the limitations of this dualistic language and reveal some aspects of the common features of both systems which result in paradoxical statements.

It is tempting to describe quantum mechanics in the terms suggested by Masterman and discussed in the previous chapter. That is, the physicist experiences a revelatory insight through which he is able to formulate quantum mechanics, and the actual statements of the theory act as the koans by which this insight can be passed on to others. Looked at in this light, the parallels with Zen remain strong, since the "koans" of quantum physics contain paradoxical statements, introduce an ontological subject/object field necessary for interpreting quantum mechanical results, and expose the failure of such dualistic concepts as causality.

The only problem with the interpretation suggested above is that there is some doubt as to whether or not anyone, including the inventor's of quantum mechanics, have solved

these Zen-like "koans." One must distinguish between the mathematical formalism which makes up quantum mechanics and the interpretation of this formalism. Insofar as the mathematical formalism of quantum mechanics is concerned, the case is analogous to Boole's invention of Boolean Algebra (Masterman's example). However, the paradoxical results arise, when one attempts to interpret this formalism in terms of the objective language of classical physics. Although the Copenhagen interpretation, presented here, is the interpretation accepted by most physicists working in the field of quantum mechanics and is that advocated by Bohr and Heisenberg, pioneers in the field, even some of the originators of quantum mechanics (e.g. Schrodinger, Planck, Einstein) find it philosophically repugnant.

This is not to say, however, that Masterman's interpretation is entirely irrelevant. The fact remains that from the point of view of the mathematical formalism of quantum mechanics, the paradoxes do not appear. And this mathematical formalism, like Boolean Algebra, is understood by the inventors and practitioners of quantum physics. This does correspond to the situation in Zen, where the paradoxical koans are not paradoxes at all, if viewed from Zen consciousness. The analogy only fails in that the paradoxes of the Copenhagen interpretation, which echo the paradoxes of Zen Buddhism on many different levels, do not serve as the koans by which one learns to comprehend the quantum mechanical view of the

universe. This role is still played by the axioms of the mathematical formalism, which, although they are strangely different from the axioms of classical scientific theories, do not exhibit the Zen-like paradoxes in the striking manner of the statements of the Copenhagen interpretation.

Perhaps the paradoxical statements of the Copenhagen Interpretation are related to the kikan koans which deal with the interlocking differentiations of the phenomenal world (c.f. Chapter I). Certainly, the parallels with Zen Buddhism, which are so intimately connected with the subject/object partition, should not be shrugged off as accidental. Quantum mechanics has clearly exposed some of the limitations of some of the aspects of dualistic consciousness. The analogies between the two disciplines appear on a deep and philosophically significant level.

Footnotes

Part I: The Interpretation of Quantum Mechanics

1. Ford, Kenneth W., The World of Elementary Particles (New York, 1963), p. 125 gives a more detailed description of this experiment.
2. This description is condensed from the elementary presentation of the mathematical formalism given in Van Name, F.W., Modern Physics (Englewood Cliffs, N.J., 1952), pp. 120ff.
3. Heisenberg, W. Physics and Philosophy (New York, 1962), p.46.
4. Ibid., p. 52.
5. Ibid.
6. DeBroglie's theory as presented in Osgood et. al., Atoms, Radiation and Nuclei (New York, 1962), pp.156ff.
7. Heisenberg, p. 56.
8. Bohr, quoted in Petersen, Aage, Quantum Physics and the Philosophical Tradition (Cambridge, 1968), p.32.
9. Heisenberg, p. 49.
10. Described in Osgood, pp. 183f.
11. Petersen, p. 108. Material in single quotes is quoted from Bohr.
12. Bohr, quoted in Petersen, p. 113.
13. Heisenberg, p. 58.
14. Petersen, p. 29.
15. Bohr, quoted in Petersen, p. 181.
16. Dirac's theory is outlined in Van Name, pp.187ff. and Osgood, pp. 315ff.

17. Van Name, p. 188.
18. c.f. Ford, Elementary Particles, Table I.

Part II: Some Parallels with Zen Buddhism

1. Watts, Alan, The Book: On the Taboo Against Knowing Who You Are (New York, 1972), p. 30.
2. Blofeld, John, trans., The Zen Teaching of Huang Po (New York, 1958), p. 68.
3. Reys, Paul, ed., Zen Flesh, Zen Bones (New York, n.d.), p. 124.
4. Ibid., p. 118.
5. Miura and Sasaki, The Zen Koan (New York, 1965), p. 118.
6. c.f. Rosemont, Harry, "The Meaning is the Use: Koan and Mondo as Linguistic Tools of the Zen Masters," Philosophy East and West, Vol. XX, No. 2, April, 1970, pp. 109ff. and Suzuki, Essays in Zen Buddhism, First Series (New York, 1961), Essay VI.
7. Izutsu, Toshihiko, "The Philosophy of Zen," Contemporary Philosophy: A Survey (La Philosophie Contemporaine: Chroniques) ed. Klibansky (Firenze, 1971), p. 519.
8. Mou-Lam, Wong, trans., The Sutra of Wei Lang (Hui Neng) (London, 1944), p. 115.
9. Suzuki, D.T., Manual of Zen Buddhism (New York, 1960), p. 26.
10. Blofeld, p. 113.
11. Suzuki, D.T., Studies in Zen (New York, 1955), p.52.
12. Mou-Lam, p. 112.
13. Kapleau, P., Three Pillars of Zen (Boston, 1965), p.15.

14. Watts, Alan, The Spirit of Zen (New York, 1958), p. 52.
15. Welch, Holmes, Taoism: The Parting of the Way (Boston, 1965), p. 54n.

Chapter IV
Logic, Paradox, and Godel's Theorem

Throughout this paper there has been much discussion of paradox and its relationship to Zen consciousness. In the teachings of the Zen Buddhists paradoxes arise from the use of dualistic, discriminatory language to describe a reality which transcends the discriminating intellect. In the preceding chapter, it has been pointed out that these dualistic concepts are also inadequate to describe the reality depicted by quantum mechanics, and that similar paradoxes also arise. But the appearance of paradox in western philosophy is by no means restricted to the field of quantum physics. Studies in the field of formalized logic have in the twentieth century produced not only their own paradoxical results but also, in their attempts to resolve various paradoxes, have illuminated

certain aspects of the nature of paradox relevant to Zen Buddhism.

Paradox in western philosophy has a long history, dating back to the ancient Greeks. Zeno, for example formulated a series of well-known paradoxes, involving the race between Achilles and the tortoise, the flight of an arrow to its target, and the runner crossing the stadium. According to Zeno, Achilles can never catch the tortoise, since, no matter how slowly the tortoise runs, he will always have moved forward some distance by the time that Achilles arrives at the point whence the tortoise started running. And when Achilles reaches the new position of the tortoise, the tortoise will again have advanced some distance. Thus Zeno concludes that Achilles can never overtake the tortoise, provided only that the tortoise is given a head start. Similarly, Zeno demonstrates that the arrow can never reach its target, since in traveling to the target, it must first cross half the distance and, in travelling to the half-way point must traverse one quarter of the distance. Since the arrow must, therefore traverse an infinite number of finite distances, it can never reach its target in a finite amount of time. For the same reason, a runner, no matter how swift, can never traverse the distance from one side of the stadium to the other.

Zeno's paradoxes are not paradoxes in the sense of being self-contradictory, but they are paradoxical in the

sense that they produce absurd conclusions from apparently logical arguments. Zeno, interestingly enough, formulated his famous set of paradoxes in an attempt to show that the universe is one and that it is precisely the assumption that reality consists of separate individuals that led to the absurd results. Even Aristotle, in his attempt to refute Zeno's paradoxes of motion, admits that the infinite number of line segments that Zeno's arrow must traverse do not constitute the "real and essential character" of distance (Physica, 263B9). Plato's dialogue which describes the confrontation between Socrates and Zeno and his teacher, Parmenides, concludes with this Zen-like gem from Parmenides: "Whether the one is or is not, the one and the others in relation to themselves and to each other all in every way are and are not and appear and do not appear." ("Parmenides," 166C)

Before considering some paradoxes which do involve self-contradiction, it will be helpful to first examine some aspects of formal logic.

Formalized logic represents a very refined formulation of dualistic thinking. Conventional logic starts from a basically dualistic premise in its assignation of two-valued truth values to every statement. It is essentially a formalization of the dualistic reasoning process that is involved in all ordinary language and thought. The study of sets or classes in formalized systems has produced a number of paradoxes.

The language of sets clearly involves a specific application of the discriminating intellect. Cantor, one of the pioneers of set theory, defines a set as "any collection into a whole of definite and separate objects of our intuition or thought."¹ Not only is the discriminating process of the intellect implied by the notion of "separate objects," but the concept of "set" is itself essentially a formalized notion which corresponds with the discriminating process itself.

Cantor's work was chiefly in the field of "infinite sets," and his most well-known contribution is the concept of different orders of infinity, but the most interesting result in terms of paradox involves the concept of subsets. Cantor proved that the number of subsets of a given set always makes up a set with a larger number of members than the original set. That is, for any set, no matter how large, there is always a larger set -- namely the set of its subsets. This result becomes immediately paradoxical when one asks, "What about the set of everything in the universe?" By Cantor's results, this "Universal Set" cannot contain all of its subsets, and yet, by nature of being the "Universal Set," it must.

W.V. Quine has pointed out that this paradox is closely related to Russell's paradox concerning sets which are members of themselves.² Define as Ordinary Sets all sets which are not members of themselves. Thus the sets of all cats, tables, books or people are all Ordinary Sets. The set of all sets with more

than one member is an example of a non-Ordinary Set, since it has more than one member and thus must contain itself. Is the set of all Ordinary Sets itself an Ordinary Set? If it is, then it must contain itself as a member, which implies that it is non-ordinary. If, on the other hand, it is a non-Ordinary Set, then it does not contain itself and is therefore Ordinary. It is an Ordinary Set if and only if it is not.

Both of these examples show how paradoxical results flow directly from Cantor's unrestricted conception of sets. However, the concept of "set" is too useful to be scrapped, particularly in the light of the work of Frege and Russel to produce the logical structure of all mathematical reasoning, based upon set theory.

It has already been pointed out that the paradoxical utterances of the Zen masters often appear as part of their technique for opening up the minds of their students. Faced with a paradoxical koan which cannot be solved by the rational processes of the discriminating intellect, the mind of the student casts off the restricting dualistic framework of thought and experiences satori.

In a similar way, the appearance of paradoxes forces the logician and the mathematician to examine the intellectual framework in which the paradoxes arise in order to discover the limitations of that framework and hopefully to produce a new framework in which these paradoxes no longer appear.

Rapoport describes this process by which mathematical thinking grows and matures:

The method entails escaping from the conceptual framework in which a paradox or apparently unsolvable problem has appeared and putting the framework itself in a new perspective, so that the limitations of the old concept are revealed. Once the limitations are seen, a generalization of the concept suggests itself and a new framework can be constructed.³

In this sense, then, these paradoxes are koan-like insofar as they force the mind to give up restricting and contradictory concepts and to perceive things and their relationships to one another differently. Of course, the reformulations of set theory do not dispense totally with dualistic reasoning, but they do force the re-examination of some aspects of the dualistic point of view. Cantor's notion of a set appears no less natural than the notion of a separate object, and yet it is this natural (albeit, dualistic) concept which leads to the paradoxes.

Rapoport illustrates his point with the example of Zeno's arrow paradox. Zeno's apparently logical claim, blatantly contradicted by experience, led to the formulation of the concept of convergent series -- an infinite series of terms whose sum is finite.

But what of the attempt to reformulate set theory in order to eliminate the paradoxes discussed above. Quine⁴ suggests two different approaches to this problem. The first

of these attempts can best be understood by analogy with a similar solution suggested for another paradox which is closely related to the other two. This is the familiar liar paradox, usually attributed to Epimenides: "All Cretans are liars" (Epimenides himself was a Cretan). Its relationship to the paradoxes of Russell and Cantor can best be seen by restating the paradox in the terms suggested by Tarski:⁶ Let 'C' be the symbolic name of the following sentence: "'C' is not a true sentence." If one takes as a criterion of truth that a sentence is true if and only if the state of affairs described by the sentence is in fact a state of affairs that really exists, then one obtains: "'C' is a true sentence if and only if 'C' is not a true sentence." And, if one considers that all true sentences make up a set, 'T', then the liar paradox can be stated analogously to the statement of Russell's paradox:

"'C' is a member of T if and only if it is not."

The solution to this paradox suggested by Russell and Tarski is that the predicates 'true' and 'false' be expanded by the use of subscripts.⁷ Then one simply uses the rule that whenever the predicates 'true' or 'false' are applied to a sentence, the subscripts on the predicates so applied must be higher than any subscripts that appear within the sentence. Then, one can ask whether or not "'C' is not a true₁ sentence." is a true₂ sentence, but not whether or not it is a true₁ sentence. If one formulates the liar paradox according to this

rule, one obtains the following:

"'C' is a member of T_2 if and only if it is not a member of T_1 ."

The statement is no longer paradoxical, for the liar paradox now states that a sentence belongs to a given class if and only if it does not belong to some different class, and there is no contradiction involved.

Other methods of resolving the liar paradox involve restricting the use of the predicate true, so that it becomes meaningless when applied to the paradoxical cases. Robert Martin, for example, introduces the notion of the "range of applicability" of truth predicates and defines the concept of "range of applicability" in such a way that the liar paradox falls outside this range. The paradox is avoided because it is no longer meaningful to talk about the truth or falsity of "'C' is not a true sentence."

Although these results are less striking than those found in the previous chapter, one can see in both suggested solutions to the liar paradox an erosion of the dualistic concepts which originally led to the antimonies. In the Russell-Tarski solution, 'true' and 'false' are no longer mutually exclusive opposites. A given sentence can be both true and false at the same time, provided that it is true₁ and false₂. It is not clear how to interpret these subscripted predicates in terms of the intuitive notions of truth and falsity.

Martin's solution also attacks the fundamental dualistic nature of the true/false pair by suggesting that there are statements which are neither; i.e., a sentence that is not true is not necessarily false.

Russell, in his Theory of Types,⁹ suggests a solution to his paradox as well as Cantor's by employing subscripts along the lines of the first solution of the liar paradox. Here, '0' is assigned to individuals, and any set whose members are of type ' m ' must itself be of type ' $m+1$ '. The paradox is then resolved because no class of type ' $m+1$ ' can be a member of itself, since all of its members must be of type ' m ' or lower. One can also apply the Theory of Types to Cantor's paradox. The set of the subsets of a given set will be of a higher type than the type of the original set. This solution allows for indefinitely large sets, and since there can be no maximum type of set, there can be no "Universal Set."

Another solution of Cantor's paradox is proposed in Zermelo's formulation of set theory.¹⁰ In this solution, the axioms of set theory are so constructed as to restrict the method of defining sets so that there can be no "Universal Set," which includes everything in the universe ("everything" is not an adequate specification of a set in Zermelo's theory) and hence, no Cantorian paradox.

Again, one can see some parallel with Zen thought, but, as in the case of the solution to the liar paradox, the

analogy is rather weak. The process of classifying objects of the universe into sets is a clear-cut use of the discriminating intellect. Moreover, even simple notions of classifying individuals appear to be self-contradictory unless they are restricted in ways that are counter to one's expectations. If one can divided the universe into distinct classes of individuals at all, it is rather surprising that there is no consistent method of specifying the class of all things. The Zen masters warn against believing in individual objects, and mathematicians find paradoxical consequences in attempting to classify them into sets.

A result that is closely related to the paradoxes that have been discussed above is Godel's famous Incompleteness Theorem. Godel's theorem states that "in a formal system satisfying certain precise conditions, there is an undecidable proposition, that is a proposition such that neither the proposition *itself* nor its negation is provable in the system."¹¹

The precise conditions necessary for the demonstration of Godel's result are not conditions unique to the segment of arithmetic in which Godel constructs the formal proof of his theorem, but rather are properties of "all known axiom systems of mathematics."¹²

Godel's theorem is a theorem about the provability of statements within a given logical system, not a statement about the truth of these propositions. Thus Godel's theorem

is not itself paradoxical in the same sense that Russell's paradox is. It does assert, however, that there can be unanswerable questions even in a rigidly formalized structure such as pure mathematics.

Godel's theorem is essentially a statement of the limitations of axiomatic systems and logical reasoning. Godel's proof is valid even for systems which are allowed infinitely many axioms and demonstrates that no amount of logical manipulation can "decide" such propositions in the sense of establishing their truth by a logical proof.

In his original paper, Godel constructs such an undecidable proposition, namely the proposition that asserts of itself that it is not provable. This proposition is analogous (although not identical with) the liar paradox described above. The proposition is undecidable because it is provable if and only if it is false.

But the above-given informal argument demonstrates the undecidability of the proposition that asserts of itself that it is not provable without making use of the formal properties of a mathematical system. The conditions for such a proof are, in Godel's own words, that the formal system under consideration "has at its disposal sufficient means of expression to define these notions...(in particular the notion of 'provable formula') and in which, second, every provable formula is true in the interpretation considered."¹³ But these

criterion are certainly fulfilled by a large number of logically consistent systems less formalized than pure mathematics.

Smullyan, for example, has shown how such "Godel sentences" can be constructed in a very simple artificial language, whose major predicate is a "normal function" which enables a sentence to refer to itself.¹⁴

Godel's theorem functions in logic in a manner analogous to the way that the uncertainty principle functions in micro-physics. Just as Heisenberg's principle describes the limitations of the concept of location in space and time for physical objects, Godel's theorem shows the limitations of the concept of provability in reference to the truth or falsity of propositions. Moreover, the property of self-reference, which is an essential feature of any system in which Godel's theorem can be proved, itself has interesting implications.

Self-reference also appears as an essential feature of Russell's paradox, which is itself analogous to many "common-language" paradoxes, such as the liar paradox or the paradox of the barber who "shaves every man who does not shave himself." If one examines the grammatical structure of any self-referring sentence, he finds that necessarily the subject and the object of the sentence are the same. That modern logic demonstrates that paradoxes follow from such self-referring statements provides some additional understanding of the para-

doxical statements of Zen.

The Zen master is speaking from a state of consciousness in which subject and object are one. This ontological one-ness parallels the grammatical one-ness of subject and object in a self-referring expression. It is not surprising that the Zen expressions, which are made from this state of consciousness, appear as paradoxes in ordinary language. Of course, the Zen master is speaking from the reality of his immediate experience while the logician and the philosopher of language are speaking in terms of the relationship between grammatical concepts, which are intellectual abstractions. The Zen master, however, is forced to translate his experience into these grammatical entities in order to speak. Looked at in this light, the paradoxical statements of the Zen masters are not illogical at all; rather, they follow as logical consequences of the translation into language of the point of view which they express.

Footnotes

1. Cohen and Hersh, "Non-Cantorian Set Theory," Scientific American, Vol. 217, No. 6, December, 1967, p. 105.
2. Quine, W.V., "Paradox," Scientific American, Vol. 206, No. 4, April, 1962, p. 94.
3. Rapoport, Anatol, "Escape from Paradox," Scientific American, Vol. 217, No. 1, July, 1967, p. 56.
4. Ibid., p. 50.
5. Quine, "Paradox," p. 94.
6. Tarski, Alfred, "The Concept of Truth in Formalized Languages," Logic, Semantics and Metamathematics (Oxford, 1956), p. 158.
7. Quine, "Paradox," p. 87.
8. Martin, Robert L., The Paradox of the Liar (New Haven, 1970), esp. "A Category Solution to the Liar," pp. 91ff.
9. c.f. Ayer, A.J., Bertrand Russell (New York, 1972), pp. 44f. and Quine, Set Theory and Its Logic (Cambridge, 1969), Chap. II, esp. p. 263 and also, Quine, "Paradox," p. 94.
10. c.f. Quine, Set Theory, Chap. 12, esp. p. 278, also "Paradox," p. 94.
11. Godel, Kurt, "On Formally Undecidable Propositions," in Frege and Godel: Two Fundamental Texts in Mathematical Logic, ed. Jean van Hejnoort (Cambridge, 1970), p. 83.
12. Ibid., p. 84.
13. Ibid., p. 90.
14. Smullyan, Raymond M. "Languages in which Self-Reference is Possible," Journal of Symbolic Logic, Vol. 22, 1957, pp. 55-67.

Chapter V

Conclusions

Having uncovered some interesting parallels between such apparently divergent fields as Zen Buddhism, modern physics, and formal logic, the question remains, "What are the implications of these parallels for both Zen and western philosophy?"

With regard to the analogy between Zen Buddhism and the philosophy of science, the major point of similarity is the intuitive leap that must be made by the theoretical scientist in order to envision a new theory. What is required of the scientist in this situation is very similar to what is required of a Zen student. Both must throw off the confining intellectual structure of the old theory in order to perceive things from a different point of view, i.e., with a different

consciousness. Masterman's suggestion that the postulates of the new scientific theory act as koans which are used to transmit the consciousness that sees reality in terms of the new theory would be attractive to anyone who has struggled with problems in an unfamiliar branch of mathematics. If the student persists in his study, suddenly the unfamiliar concepts fall into place, and in an elating instant, the material is finally "learned." The chief difference in the two insights is that in science, one is simply exchanging one set of axioms for another while the method of reasoning remains the same -- the logical manipulation of abstract concepts with the discriminating intellect of vijnana. In Zen, on the other hand, one must learn to abandon the use of the discriminating intellect (at least temporarily) and experience the world directly through prajna-intuition in order to obtain the insight which brings him to Zen consciousness. But even in the case of learning new scientific theories, there is an element of intuition involved in the sudden leap of understanding that one experiences when the patterns fall into place.

If however, the new scientific system that is learned is quantum physics, one can carry the parallel with Zen even further. Not that quantum mechanics is an intuitive science, but rather that the results of the quantum mechanical point of view require the discarding of some of the most fundamental dualistic concepts. The uncertainty relations explicitly show

the limitations of the concepts of space and time and, moreover, require that the classical, mechanistic concept of causality be discarded. The analogy with Zen Buddhism goes much deeper than the weakening of these fundamental dualistic concepts. The interpretation of quantum mechanics is full of paradoxical statements, which may be subsumed under the general heading of Bohr's principle of complementarity. These paradoxes result from a fundamental feature of the quantum mechanical description of reality -- namely, the impossibility of separating the properties of some observable phenomenon from the conditions under which the phenomenon is observed. In the interpretation of quantum mechanics one can see the absolute nature of the subject/object partition begin to disappear and some aspects of the relative and arbitrary nature of this partition begin to appear. Nor is the analogy weakened by the fact that these paradoxical results emerge not from the mathematical formalism of the theory but rather from the interpretation of it. Paradoxes arise in the interpretation of quantum mechanics because this interpretation must be made using the language of classical physics. This language is an "objective language," in the sense that it tries to describe reality without any *reference* to the observer. But in quantum mechanics, this type of objectivity is impossible: the intrusion of the observer affects the result of the experiment all the way up to the level of the mathematical expression

from which the observable result is predicted. The paradoxes of the Copenhagen interpretation arise precisely because quantum events take place outside the framework of this "objective language" of classical physics and yet at the same time must be described in that language. In Zen Buddhism also, the masters are forced to use "objective" language in order to communicate to their disciples a consciousness which cannot be contained in the subject/object framework. Just as the paradoxical koans, when they are solved and the student of them has experienced satori, no longer appear paradoxical from the point of view of Zen consciousness, so also do the quantum mechanical descriptions appear non-paradoxical from the viewpoint of the mathematical formalism. For both Zen and Physics, it is when one attempts to talk about new point of view in ordinary language that the paradoxes appear. In Dirac's "hole" theory of matter creation and annihilation, quantum physics even has its own version of the Buddhist doctrine of sunyata or the Void.

Moreover, these similarities between Zen Buddhism and quantum mechanics are neither accidental nor coincidental. At the heart of both disciplines is the breakdown of the subject/object boundary. It is no longer possible, both from the point of view of Zen and from that of quantum physics, to refer to an object without at the same time referring to the subject, that is, the self in Zen Buddhism and the measuring apparatus

in quantum mechanics. Modern studies in logic have demonstrated that predicates of self-reference are intimately connected with some of the paradoxes of western philosophy. Both Zen and quantum mechanics, because of the nature of the reality which they disclose involve self-reference even in statements which appear, from the point of view of dualistic concepts, to be purely "objective" statements. Just as the appearance of the paradoxical-appearing Godel sentence requires self-reference in the system in which it appears, so also are many other paradoxes bound up in the property of self-reference in language. But if even the most objective-appearing statements, in either Zen or quantum mechanics, in reality involve self-reference, then there is nothing illogical at all in the appearance of paradoxical statements.

The above conclusions are not intended to suggest that Zen Buddhism can be reduced to logic or to philosophy. The attaining of Zen consciousness involves an insight that goes beyond the limits of logic and of discursive reasoning. But to say that Zen involves a kind of knowing that goes beyond reason is not the same as saying that Zen is irrational or anti-rational. The above conclusions, however, do serve to de-mystify Zen insofar as they help to make sense out of the bizarre and apparently non-sensical statements made by the Zen masters. Although the Zen masters are speaking from the point of view of a consciousness that has gone beyond the limi-

tations of language, when they speak the language that they use, as has been pointed out so many times in this paper, is simply language -- the dualistic language of the discursive intellect. And as such, the language of the Zen masters is amenable to the same kind of logical analysis that one may apply to the language of mathematics or any discursive language. Although this kind of analysis can never reveal the truth that lies at the heart of Zen, it does reveal certain aspects of the connection between this truth and the language used by the teachers of it.

Bibliography

- Ayer, A.J. Bertrand Russell. New York: The Viking Press, 1972.
- Ayer, A.J. Language, Truth and Logic. New York: Dover Publications, Inc., 1952.
- Blofeld, John, trans. The Zen Teaching of Huang Po. New York: Grove Press, Inc., 1958.
- Cohen, Paul J. and Reuben Hersh. "Non-Cantorian Set Theory." Scientific American, Vol. 217, No. 6, (December, 1967).
- Cohen, Morris R. and Ernest Nagel. An Introduction to Logic and the Scientific Method. New York: Harcourt, Brace and Company, 1934.
- Chung-Yuan, Chang. Original Teachings of Ch'an Buddhism. New York: Vintage Books, 1971.
- de Bary, W.T., ed. The Buddhist Tradition. New York: Modern Library, 1969.
- Ford, Kenneth. The World of Elementary Particles. New York: Blaisdell Publishing Co., 1963.
- Fowler, H.N., trans. Plato with an English Translation. Vol. VI. Cambridge: Harvard University Press, 1926.
- Godel, Kurt. "On Formally Undecidable Propositions." in Frege and Godel: Two Fundamental Texts in Mathematical Logic. ed. Jean van Heijnoort. Cambridge: Harvard University Press, 1970.
- Hanson, Norwood Russell. Patterns of Discovery. Cambridge: Cambridge University Press, 1965.
- Heidigger, Martin. Existence and Being. Chicago: Henry Regnery Company, 1940.
- Heisenberg, Werner. Physics and Philosophy. New York: Harper and Row, 1952.
- Humphreys, Christmas. Zen Buddhism. New York: The MacMillan Co., n.d.
- Izutsu, Toshihiko. "The Philosophy of Zen." Contemporary

- Philosophy: A Survey (La Philosophie Contemporaine: Chroniques). ed. Ray, ond Kiblansky. Firenze: La Nuova Italia Editrice, 1971.
- Kapleau, Phillip. Three Pillars of Zen. Boston: Beacon Press, 1967.
- Kierkegaard, Soren. "Concluding Unscientific Postscript." in A Kierkegaard Anthology. ed. Bretall. New York: Modern Library, 1959.
- Martin, Robert L. The Paradox of the Liar. New Haven: Yale University Press, 1970.
- Masterman, Margaret. "Theism as a Scientific Hypothesis." Theoria to Theory, Vol. 1, No. 1-4 (1966-67).
- Miura, Isshu and Ruth Fuller Sasaki. The Zen Koan. New York: Harcourt, Brace and World, Inc., 1965.
- Mou-Lam, Wong., trans. The Sutra of Wei Lang (Hui Neng). ed. Christmas Humphreys. London: Luzac and Company, 1944.
- Osgood, Thomas, A. Ruark, and E. Hutchison. Atoms, Radiation and Nuclei. New York: John Wiley and Sons, Inc., 1955.
- Petersen, Aage. Quantum Physics and the Philosophical Tradition. Cambridge: M.I.T. Press, 1968.
- Quine, W.V. O. Set Theory and Its Logic. Cambridge: Harvard University Press, 1969.
- Quine, W.V.O. "Paradox." Scientific American. Vol. 206, No. 4 (April, 1962).
- Rapoport, Anatol. "Escape from Paradox." Scientific American. Vol. 217, No. 1 (July, 1967).
- Reps, Paul, ed. Zen Flesh, Zen Bones. Garden City: Doubleday and Comoany, Inc., n.d.
- Rosemont, Harry. "The Meaning is the Use: Koan and Mondo as Linguistic Tools of the Zen Masters." Philosophy East and West. Vol. XX, No. 2 (April, 1970).
- Ross, W.D., ed. The Works of Aristotle, Vol. II Oxford: Clarendon Press, 1930.

- Sartre, Jean-Paul. Being and Nothingness. trans. Hazel Barnes. New York: Washington Square Press, 1966.
- Sasaki, Ruth Fuller. "Zen: A Method for Religious Awakening." in The World of Zen. ed. Namcy Wilson Ross. New York: Vinatge Books, 1960.
- Smullyan, Raymond M. "Languages in which Self-Reference is Possible." Journal of Symbolic Logic. Vol. 22 (1957).
- Stryk, Lucien and Takashi Ikemoto, trans. Zen: Poems, Prayers, Sermons, Anecdotes, Interviews. Garden City: Doubleday and Company, Inc., 1965.
- Suzuki, D.T. Essays in Zen Buddhism, First Series. New York: Grove Press, Inc., 1961.
- Suzuki, D.T. Essays in Zen Buddhism, Second Series. New York: Samuel Weiser Inc., 1971.
- Suzuki, D.T. Manual of Zen Buddhism. New York: Grove Press, Inc., 1960.
- Suzuki, D.T. Studies in Zen. New York: Delta Books, 1955.
- Tarski, Alfred. "The Concept of Truth in Formalized Languages." in Logic, Semantics and Metamathematics. Oxford: the Clarendon Press, 1956.
- Thomas, George. Religious Philosophy of the West. New York: Charles Scribner's Sons, 1965.
- Van Name, F.W. Modern Physics. Englewood Cliffs, N.J. : Prentice-Hall, Inc., 1952.
- Watts, Alan. The Book: On the Taboo Against Knowing Who You Are. New York: Vintage Books, 1972.
- Watts, Alan. The Spirit of Zen. New York: Grove Press, Inc., 1955.
- Welch, Holmes. Taoism: The Parting of the Way. Boston: The Beacon Press, 1965.
- Wienpahl, Paul. The Matter of Zen: A Brief Account of Zazen. New York: New York University Press, 1964.