Discussion Plan For Chapter 09 "The New Physics" (Norman DeWitt's "Epicurus And His Philosophy")

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Preamble: The Context For This Chapter - Why Are We Studying Physics? What Types of Questions Should We Be Looking to Answer? Examples are:

1. *Is there evidence that the Universe was created at a single point in time, from which data we might draw the conclusion that what existed before, or what brought about the creation of the universe, was supernatural?*
2. *Is the Universe finite in size so that there might be a center point, or a superior point from which a god or an omniscient being might have an absolute perspective from which it is appropriate to say "this is absolutely true" or "this is absolutely false?"*
3. *Is there evidence of Supernatural management of the universe?* If there is evidence of supernatural creation or management of the universe, then we will want to focus our attention on that god in order to determine how to live.
4. *Is the Universe structured in such a way that knowledge is possible?* Is there a "flux" and if so does that flux move and change so quickly that knowledge is impossible? This question was addressed by Diogenes of Oeneanda in Fragment 5: "*[Others do not] explicitly [stigmatise] natural science as unnecessary, being ashamed to acknowledge [this], but use another means of discarding it. For, when they assert that things are inapprehensible, what else are they saying than that there is no need for us to pursue natural science? After all, who will choose to seek what he can never find? Now Aristotle and those who hold the same Peripatetic views as Aristotle say that nothing is scientifically knowable, because things are continually in flux and, on account of the rapidity of the flux, evade our apprehension. We on the other hand acknowledge their flux, but not its being so rapid that the nature of each thing [is] at no time apprehensible by sense-perception. And indeed [in no way would the upholders of] the view under discussion have been able to say (and this is just what they do [maintain] that [at one time] this is [white] and this black, while [at another time] neither this is [white nor] that black, [if] they had not had [previous] knowledge of the nature of both white and black.*"
5. *Can a human be structured in such a way as to possess a soul which survive after death?*
6. *Can there be a realm of forms or ideas that exist eternally and provide for us an eternal definition of "virtue" and therefore absolute reference for our actions?*
7. *Is it possible for there to be in the universe a place of absolute rest where motion ceases and all things remain the same eternally?*

8. *Is the Universe finite in size so that there might be a center point, or a superior point from which a god or an omniscient being might have an absolute perspective from which it is appropriate to say "this is absolutely true" or "this is absolutely false?"*
9. *Is there evidence that the Universe was created at a single point in time, from which data we might draw the conclusion that what existed before, or what brought about the creation of the universe, was supernatural?*
10. *Are there other examples of core questions to be answered by physics which we should add to this list?*

CHAPTER IX - THE NEW PHYSICS

1. **Ethics is based on Physics - the Physics makes ethical law based on supernatural or eternal ideal principles impossible** : "IN THE Epicurean scheme of knowledge the Physics takes precedence over the Ethics because it furnishes the major premises from which the nature of the soul is deduced and the proper conduct of life is formulated. The Sensations, Anticipations, and Feelings, that is, the Canon, are not represented as furnishing the content of knowledge but as being instruments of precision by which the certainty of knowledge is tested at all times."
2. **The Twelve Elementary Principles** - "As a substitute for technical terms he resorted often to the use of synonyms and paraphrases as a means of attaining the desired clearness. To illustrate, in the foreword to the Little Epitome, as a preparation for the tabulation of the Twelve Principles he refers to them in seven different ways: the most comprehensive doctrines; the outline of the whole system; the panoramic view; the most commanding view over the universe of things; the most general outlines; truths condensed to elements and succinct statements; the condensed view of the integrated survey of the whole."
    1. Matter is uncreatable.
    2. Matter is indestructible.
    3. The universe consists of solid bodies and void.
    4. Solid bodies are either compounds or simple.
    5. The multitude of atoms is infinite.
    6. The void is infinite in extent.
    7. The atoms are always in motion.
    8. The speed of atomic motion is uniform.
    9. Motion is linear in space, vibratory in compounds.
    10. Atoms are capable of swerving slightly at any point in space or time.
    11. Atoms are characterized by three qualities, weight, shape and size.
    12. The number of the different shapes is not infinite, merely innumerable.
3. **The Twelve Elementary Principles are proved by Deduction, not induction**: "The first two principles deal with the indestructibility and uncreatability of matter. If the question be raised how the truth of these propositions is established, the answer is by deduction. It must be observed that Epicurus makes no show of his logical procedures

and, like the layman, employs the enthymeme or elliptical syllogism. Nevertheless, if his omissions be discerned and then supplied, the procedure is as follows. The purpose is to demonstrate the uncreatability of matter. Let it then be assumed for the purpose of the argument that the reverse is true: Matter is creatable. This assumption becomes the major premise and the method becomes deductive. The deductions would be that there would be no need of seeds of plants, no limits of size, no geographical distribution, no part for the seasons to play, and no necessity for fish to be born in the sea nor animals on the land.4 These inferences are all contrary to observed phenomena. Therefore, the assumption is false and the contrary must be true: Matter is uncreatable.

4. **What Constitutes The Universe -** "The problem of what constitutes the universe is dispatched by Epicurus with extreme brevity. The universe consists of solid bodies and void. That the former exist the evidence of sensation alone is sufficient proof; in the case of bodies too small to be perceived by the senses recourse must be had to reasoning by analogy from the visible to the invisible. As for space or void, if it did not exist, then solid bodies would have no place in which to rest nor room in which to move, as they manifestly do move. Epicurus does not think it worth while that beginners should be told of the Eleatic philosophers, who held different views."
5. **Attributes and Accidents** - "The account of attributes and accidents given by Epicurus is perspicuous. He states that a given object receives a predicate of designation by virtue of a combination of particular qualities reported by the senses. Some of these qualities are always present in the case of a given object; these are attributes. Others may or may not be present; these are accidents. In the Little Epitome space is saved by the omission of examples. In the Big Epitome, represented by Lucretius, weight is cited as an attribute of rocks, heat of fire, and fluidity of water. Lucretius also defines an attribute, coniunctum, as a quality inseparable from an object without its destruction; an accident, ***eventum***, is a quality of which the presence or absence is a matter of indifference." *Note:* The 1743 translation uses "events" to describe changeable attributes rather than "accidents" as used by more recent translators. Cassius argues that "event" is the better term because "accident" implies a degree of "fortuity" or "chance" which is not consistent with the main point - which is that the regularity we observe in the universe arises from the properties and qualities / events of the atoms which come together to comprise them, rather than from divine will or from chaos.
6. **Gradations In the Atom -** " Having assumed the existence of subsensible, immutable, and indivisible bodies as the ultimate existences the next step was to elucidate the description of them. At the outset it might be assumed that they were all alike or that differences existed. If they should be assumed to be all alike it would be impossible to account for the great variety of qualities exhibited by compound bodies. Therefore it must be concluded that differences exist. For example, they must differ in size. Again, once differences of size have been assumed, the question arises whether the differences in this regard are infinite or finite. If it should be assumed that the differences are infinite in number, then in the gradation downward from larger to smaller the ultimate limit would be zero, which is equivalent to annihilation. If, on the contrary, in the gradation upward from smaller to larger the differences should be assumed to be infinite, visible

magnitudes would be reached, which does not occur, and it is impossible to conceive of it occurring.18 Therefore the differences must be finite in number, falling well short of zero at the one end of the series and well short of visibility at the other. Even between these extremes it is possible that the differences, if not infinite, should at least be innumerable, and such is the doctrine enunciated."

7. **Micrometry Of The Atom -** "... reasoning by analogy from the seen to the unseen. ... In the world of sense we have visible and mensurable magnitudes. Descending one scale lower, we have magnitudes visible but not mensurable, such as grains of dust. Of these we can only say "bigger" of the bigger ones and "smaller" of the smaller ones. Descending another step lower in the scale, we have magnitudes neither visible nor mensurable; these are the atoms. In this last step we are merely extending a long way the meaning of the term small.23 The same reasoning holds, however, and we may still say that some are bigger and some smaller. The visible minima have furnished a standard of measurement for the invisible. Here the analogy ends because, though a heap of dust is possible, "a heap of atoms endowed with motion is an impossibility."
8. **Motion** - "Of the Twelve Principles four, Nos. 7 to 10, deal with the topic of motion. Epicurus distinguishes clearly between the motions of atoms through the void and the motions of solid bodies under terrestrial conditions. In the latter he points out the presence of acceleration and retardation while denying the same for atoms or visual images moving through the void.
    1. The motions of atoms themselves are of two kinds, being linear in the void and vibratory in compound bodies.
    2. He also deals specifically and sensibly with combinations of motions; for example, the atoms in a compound body maintain their vibratory motion at the same time that they share the linear motion of the body in which they are contained.
9. **Linear and Vibratory Motion -** "The primary and original motion of atoms is declared to be straight downward owing to weight. This motion is consequently rectilinear. While a slight deviation may occur, as will be mentioned presently, this deviation is assumed to be insufficient to require speaking of curvilinear motion. Moreover since Epicurus, like the rest of the ancients, lacked any precise concept of force as apart from motion, he could have no concept of fields of force and thus was bound to find other explanations for the curvilinear motions of the heavenly bodies. It is thus correct to think of the motions of his atoms as rectilinear. Oblique motions in all directions, including perpendicular motion upward, were thought to arise through successive collisions and to take place at the same velocity as the original motion downward owing to weight. Because of the solidity of the atoms the speed of the rebound was declared to be equal to the speed of impact. Thus all atomic motion, like the speed of light in modern physics, was at a uniform velocity, without acceleration or retardation."
10. **Swerve Of The Atom - "**In addition to the linear and vibratory motions of the atoms Epicurus postulated yet a third: it was assumed that at any point in time or space they were capable of veering ever so slightly from the straight line. This is known as the swerve, declinatio, Greek paregklisis. This was an addition to the teaching of Democritus and necessary for two reasons: first, because atoms would never have collided if the

motions of all had been downward in parallel lines and consequently no compound bodies would ever have been formed; second, if the atoms were assumed to be incapable of deviating to the slightest degree from a given course, their motions would all have been unalterably predetermined and all events would be part of an infinite chain of causation. This infinite causation, the Necessity of the physicists, was above all things abhorrent to Epicurus and was a prime reason for his defection from the school of Democritus. More must be said on this topic in the chapter on the New Freedom."

11. **Acceleration and Retardation -** "One of the more obscure passages in the Little Epitome has occasioned much tribulation among editors; it deals with acceleration and retardation and aims to make clear the difference between atomic motion in the void and the motion of projectiles under terrestrial conditions. The key to the difficulty lies in recollection of the Epicurean rule that any proposition inconsistent with the Twelve Principles is "inconceivable." Let us apply this to the particular instance. It is uncertain just what moving body Epicurus had in mind, but it suits the context to assume that it was a meteor. The flight of this is invisible for part of its course and visible for the remainder. "How then," the critical observer may be imagined to ask, "can we be sure that its speed was not equal to that of the atoms for the first part of its flight?" 41 "The suggestion is inconceivable," Epicurus replies in effect, "because the very fact that the flight of the object at a certain point became visible is proof that retardation was taking place. The velocity of the atoms, on the contrary, is uniform at all times."
12. **"Up" and "Down" In An Infinite Universe -** "In an Infinite Universe Epicurus in a single paragraph 4a essays to immunize the minds of his disciples against certain views propounded by Plato and by Aristotle in criticism of Democritus. The latter had postulated a primary motion downward to infinity, which signified a perpendicular universe. Plato flouted this theory on the ground that the universe was spherical, which implied that it was finite. This was equivalent to denying meaning to "up" and "down," because all points on the surface of the sphere would bear the same relationship to the center. Moreover, as he pointed out, if a man should be imagined to walk over the surface of the spherical universe, any given point would be "down" to him when standing over it and "up" to him when he arrived at the antipodal point. Aristotle, in his turn, had advanced the criticism that the downward motion postulated by Democritus would imply the existence of an absolute "up" and an absolute "down," which was meaningless in an infinite universe. In modern parlance he was denying the possibility in an infinite universe of setting up any frame of reference for motion. The paragraph of Epicurus on the topic is designed as much to immunize the minds of his readers against the views of Plato and Aristotle as to refute the same. As for the view of Aristotle that the world has a top and a bottom, he denies its validity for an infinite universe."
13. **A Perpendicular Universe -** "The principle of Epicurus that the primary motion of the atoms is straight downward owing to weight involves rather startling inferences so far as concerns the shape of his multitudinous worlds. So far as the atoms and their motions are concerned, the principle is indifferent, because, owing to the constant collisions and the consequent rebounds, the atoms are thought of as moving in every conceivable direction throughout the void. Moreover, there is no such position as upside down or downside up

to an atom. With the human being it is otherwise, for whom "up" and "down" have a constant significance. In other words, he must stand upright and he must have something flat to stand on. His major axis must normally be at right angles to a horizontal plane. It follows from these facts that, so far as man is concerned, the universe of Epicurus is a perpendicular one. By the same reasoning, it follows that of his multitudinous worlds only those with a flat top would be inhabitable by man. Furthermore, since motion is conceived of as downward, and not toward a center, the notion of antipodes would be inconceivable, and the proposal to emend the text to make room for this idea is untenable."

14. **The Problem Of Cause -** "The brevity of this account has not prevented it from being perspicuous, so far as it goes. The first cause is manifestly weight, which causes the downward motion of the atoms. It is equally manifest that the second cause is the blows arising from the clash of atoms, which are the cause of all opposite and oblique motions. The third cause is the swerve of the atoms from the perpendicular in their downward motion. This serves two ends: first, it makes possible the collisions of atoms, which otherwise would fall in parallel lines and never meet to form compound bodies; second, it emancipates man from an infinite chain of physical causation, the pet abomination of Epicurus, and makes possible the freedom of the will. While this brief account is perspicuous, it is also dogmatic and in keeping with the nature of an epitome. In the Epicurean scheme of education it was intended that the student should first acquire right opinions and only after an interval learn the reasons. The modern reader, lacking the larger works to which the original students had access, must expand the meager data of the Epitome as logically as he can. The swerve, for instance, being inherent in the atoms, cannot be confined to downward motion; it must be extended also to the oblique. Moreover — and this is more important and more subtle — it must be allowed to extend to the vibratory motions, which alone prevail in compound bodies, including the bodies of animate creatures. What then becomes of the finita potestas, "the fixed valence," which determines rigorously what can come into existence and what cannot be? Can variable motion produce invariable results? This question remains unanswered."