PART III OF EINSTEIN'S BOOK "RELATIVITY, THE SPECIAL AND THE GENERAL THEORY"

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Abstract

In Part III of Einstein's book he first deals with questions about the structure of the universe from the standpoint of Newton's theory of gravitation and then from the standpoint of his own conclusion that the universe must be finite and yet unbounded at the same time. He then spends most of the rest of the book rationalizing this self-contradiction with arguments involving pure logic alone.

Part III of this Einstein book is entitled "Considerations On The Universe As A Whole" It first deals with the universe as infinite, then with it as infinite yet bounded, and finally with its structure according to his General Theory. Einstein wrote that surely the first answer one would get to a question about the universe's structure would be that it is infinite. No matter where one traveled through it, he would find the numbers and the density of stars to be the same. But then, he continued, this would clash with the theory of Newton which requires the universe to have a center where the density of stars would be maximum so that if one traveled away from it, the density would diminish until it was succeeded by a region of emptiness. "The stellar universe would be a finite island in an infinite ocean of space." Finally he turned to the possibility that the entire universe could be finite yet unbounded at the same time. Here is how he tries to rationalize this self-contradiction.

First, he writes, imagine an existence in two-dimensional space. Flat beings with flat measuring rods move freely about in a plane which like our three-dimensional space extends infinitely in all directions. The constructions of plane Euclidean geometry can be carried out on this surface with their flat measuring rods. There is room for an infinite number of squares made up of these rods. Now consider a second two-dimensional existence but this time on a spherical surface instead of a plane. The beings with their measuring rods and other belongings fit exactly on this surface and are unable to leave it. Their entire observable universe extends exclusively over the surface of the sphere.

Here in this paragraph on page 109 Einstein's narrative begins to become confused. The observable universe does not extend over the surface of the sphere. A being in this world could not observe any object outside the point of his location on the sphere because the object would always be below his horizon. Then Einstein writes, when you

measure lines and areas on this surface, you get finite results in both length of line and extent of area. However, he immediately follows up on this by saying that this universe would be finite yet have no limits.. "Have no limits"? Where did this come from? He has just finished writing that both length of line and extent of area in this two-dimensional, spherical existence would be "finite"! They had limits.

Despite this confusion he goes ahead and on page 111 tries to extend this two-dimensioned spherical universe over into our real-world three-dimensioned one, writing that to the two-dimensional spherical universe there is a three-dimensional analogy. Then on page 112 he continues with "it is finite and has no bounds" which, of course, is the very same self-contradiction he got into with his two-dimensional consideration above. He now closes this chapter (Section XXXI) of his book by stubbornly repeating his message once again: "It follows from what has been said that closed spaces without limits are conceivable." But the facts are that this five-page chapter is nearly completely occupied by Einstein's explanations of how two and three-dimensioned universes are finite concepts only. And then occasionally he interrupts these explanations with brief statements giving a different story. The universe is not only finite, it is infinite at the same time. This self-contradiction is an example of why physicists have so much trouble putting their theories into words. In this case Einstein probably felt that the reason that the universe could be finite yet infinite at the same time was so obvious, he wasn't going to bother with it. To wit, the Big Bang theory said that the Universe was created out of nothing. So it is finite on that end of its existence. Then on this end there is no indication that it is going to vanish either. So it is not finite on this end. It is infinite.

On page 113 Einstein now leaves these considerations of the structure of our universe and jumps to a review of

earlier theoretical matters like the Lorentz equations and Minkowski's four-dimensional space. He finishes up with these by page 134, and then from there to the end of the book on page 157 devotes himself completely to arguments involving abstract things like points and lines and one typically far-out Einsteinian argument which finally leads to the following conclusion: there are an infinite number of different spaces in the universe all in motion with respect to each other. In other words, by using pure logic he once again showed that room in the universe extends infinitely in all directions, but now with an infinite numbers of spaces all in motion with each other. This new argument runs as follows.

Suppose a box has been constructed. Now objects can be arranged inside of it so that it becomes full. This possibility is a property of the box and the space enclosed by the box. This possibility is something that comes with the box and is different for different boxes. It is independent of whether or not there are any objects in the box. When there are none, the box appears to be empty. The storage possibilities that make up the box space are independent of the thickness of the box walls. The thickness of the walls can be reduced to zero without box space being lost. So the concept of space within the box would remain. But still it is undeniable that there is something unsatisfactory about space thought of as an independent real thing. For if the concept of space is formed in the above manner, then it must be something that is unbounded because a larger box can always be introduced to enclose a smaller one. When a smaller box s is put at rest inside a larger box S, then the s space is part of the S space, and the space which contains both of them belongs to each of the boxes. If s is moving with respect to S, then s always encloses the same space but only a variable part of the space of S. So each box has its own unbounded space, and each space is moving with respect to the other. Thus "space appears as an unbounded medium or container in which material objects swim

around." So there must be an infinite number of spaces all in motion with respect to each other. This idea is logically unavoidable.

Thus has Einstein somewhat laboriously used a stream of purely logical arguments to arrive at the conclusion that our universe is basically a limitless space in which a limitless number of cosmic bodies are moving around? Most of the remaining pages of this part of the book deal with similar treatments of pure logic on such subjects as time and inertia. But Einstein finally closes his book by going back to its first two parts to give brief reviews of the two relativity theories he presented there.