

## AN EPISTEMOLOGY<sup>1</sup>

*John D. Boon*

Our world lies midway between the stellar world above and the subatomic world below. It would be difficult to conceive of a more favorable position for a race that seeks to comprehend the material universe. This position makes it possible to look both upward and downward, and to use both telescopes and microscopes in obtaining empirical evidence upon which to build theoretical conclusions. A few years ago it might have been claimed that this midway position is more apparent than real; that by mere chance men had gone equal distance into things that were above and below their world; that the real extensions may be far from equal. In recent years there have appeared some reasons for thinking that this location of man is just as real as it is apparent.

The theory of relativity with its curved space sets an upper limit to the volume of space, and to the things that are contained therein, and this volume is not hopelessly beyond the power of telescopes that man may construct. Jeans<sup>2</sup> has said, "If we cannot yet see the whole of space, we can at least see a comparatively large part of it." The idea of limited space is fairly well fixed in the minds of the leading theoretical astronomers of today. On the other hand, the investigations into the subatomic world seem to

<sup>1</sup>This Epistemology is an outgrowth of an article, "The Limit of the Physical World", written by the author, that appeared in the *Southwest Review*, Vol. XV., No. 2. The Epistemology, with the exception of the last paragraph, was written, mimeographed, and sent out to a number of scientists in the United States in the spring of 1930. On the day that the proof for this issue of "Field and Laboratory" was being read, a copy of Hans Reichenbock's "Atoms and Cosmos" came to the hands of the author. It is of interest to note that on pages 27 and 28 of the introductory chapter some of the same ideas are expressed as are found in the first part of this Epistemology.

<sup>2</sup>Jeans, Sir James, *The Universe Around Us*, page 81. Macmillan.

be nearing the end of the subdivisions of matter for lack of units for further analysis. The fact that there remain few fundamental material units, indicates that subdivisions are coming to an end. Perhaps it is not going too far to say that the upper and the lower limits of matter may be dimly seen, and that the world into which we are born, and in which we normally spend our lives is in reality a middle world.

Our early mental evolution was the normal evolution of the middle world, our thoughts were middle-world thoughts, and our laws were middle-world laws; but for a number of years our mathematical formulations and some of our experimental observations have transcended these limitations, so that it is often true that we are trying to make the limited thoughts of one world fit the extended observations of another world. In one sense we are provincial, in the other cosmopolitan. This point is well illustrated by the early efforts that were made to explain the rapid recession of the spiral nebulae as being due to linear motion, a notion that soon led to impossible conclusions. Much of the confusion of modern physics has been due to this unconscious duplicity of world life. Perhaps Einstein may be thought of as the first cosmopolitan citizen of the material universe.

No distinct boundaries separate the three worlds here under consideration; they blend into one another without a line of demarcation; the laws of one are the laws of all; the distinction is one of degree, not one of kind. Our middle world, being a middle world, is free from extremes in mass, distance, and velocity, and in this environment we have evolved a system of laws that are first approximations to truth in our limited world. When observation and calculation began to be extended beyond these restrictions we naturally expected the laws to continue to be applicable, and it was here that disillusionment came. Some of the laws were found to be far from first approximations when tested in a larger way. Newton's first law of motion, which states "Every material body continues in its state of rest or uniform motion in a straight line, except in so far as it is

compelled to change by the application of external force," illustrates the point. Eddington<sup>3</sup> has facetiously remarked that the law should now be restated as follows: "Every body continues in its state of rest or uniform motion in a straight line, except in so far as it doesn't." If we, in our thinking and observation, had remained in the middle world it is likely that this error would never have been detected, but once beyond these limitations the error became apparent.

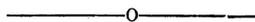
The experimental physicist soon learns the folly of conclusions that are drawn from limited observations, but for some strange reason we have not thought of the full range of the eye as being a limited observation. We are now learning that the true laws of nature are not revealed unless masses, distances, and velocities are observed in their full range of values, conditions that are fulfilled only when the view extends from the atoms to the galaxies. Thus is the universe tied together. Just how many of our fond creations of the middle world must be abandoned if we are to comprehend the three-fold world that lies about us, is difficult to say at the present time.

The habit of aiding the mind by means of two-dimensional drawings and tri-dimensional mechanical models is of doubtful value when it comes to understanding the extreme worlds. Books written on this subject are strangely free from drawings. It is possible that our conceptual development has not yet reached the point where we can grasp some of the fundamental facts of nature. We are still tied to a three-dimensional world, and will have to live in this larger realm a long time before it seems natural. It is probable that many people will never be able to cross the mathematical bridges that connect our world with those that lie above and below.

I have often wondered about these mathematical bridges. Is there no other way by which men may enter these worlds? Are they open alone to those who are highly gifted? I have not been able to get an answer to these

<sup>3</sup> Eddington, Sir Arthur, *The Nature of the Physical World*, page 124. Macmillan.

questions, but I remember that there was a time when few men were able to conceive of a round earth moving alone in space without a support beneath it; today this conception is readily grasped even by children. Both the infant child and the infant race begin to think in terms of material objects. As the mind grows, these material objects are gradually left in the background of thought, so that in time, to the gifted thinker, they are no longer essential; the mind goes on without them; their symbols only are retained, and these without thought of their material origin. Here is a strange thing, which, I think, has remarkable significance. When these thoughts which have wandered alone for great distances are brought back and checked with their material origin they are found to correspond in a remarkable way with the material world; thus, mathematical symbols that for a time have no numerical significance, may come after certain operations to stand for real numerical values. There is a principle of correspondence between the mind of man within and the world without so that the mind may play its own game according to its own rules of logic, and find in the end that it has likewise followed the rules of the material world. It is this, I think, that causes Eddington to select a certain theory because of its "good form," knowing that good form is an evidence of truth. There are deeper things here than we have dreamed. Perhaps this principle of correspondence may justify us in believing that in the long run of time there is nothing unknowable.



## A COMPARISON OF COMMERCIAL AND CRUDE SAMPLES OF SODIUM CHLORIDE

*Jean Horace Sullivan*

The object of the experiment was to compare the relative purity of several brands of table salt with crude sodium chloride as it comes from the mines. The comparison was