Chapter 7
Bohm on Mathematics

In considering Bohm's views on mathematics, we are still mainly in the realm of philosophy, but this time epistemology. The question of how knowledge develops has a particular significance for Marxists, since they seek to root knowledge in a material world. It is not possible to expand on Marxist epistemology in any depth here, but a good introduction is given by Allen Wood.[1] We have seen that Bohm is especially opposed to positivism, which states that theories merely correlate sensory perceptions, or experimental results. How, then, do concepts and theories develop? Bohm expounds his ideas on this in *Causality and Chance*, linking the issue to his theory of infinite levels, in Chap. 5, especially in Chaps. 9 and 11.[2] In the letters, there is a brief mention of how to oppose positivism in the letter to Melba, which we mentioned in the last chapter, where Bohm explains his causal interpretation in response to Phil Morrison.[3] Thus, according to Bohm, every element in a hypothesis need not correspond to something observable. This was once the case with the atomic hypothesis, and as is now the case with the causal interpretation. Not admitting such hypotheses "is to cripple the imagination, when the time comes to investigate new fields, and to confine ourselves to the existing domain of concepts". In order to prevent the multiplication of hypotheses, the latter should also be required to "unite facts or domains of facts which had hitherto been arbitrary."

However, apart from this brief aside on hypotheses, Bohm's considerations on epistemology in the letters are mainly concerned with mathematics and the relation

[1] Wood (2004), Chap. 12.

[2] See also the early 1952 letter to Hanna (15, **20**, p. 124).

[3] (17, **37**, p. 153).

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of mathematics to physical theory. Following Engels,[4] Bohm considers all concepts and scientific laws to be "abstract". In the Marxist tradition, to say that something is abstract means that it is taken out of context, in other words, that it has been abstracted.[5] Concepts and laws are abstract because they can only give an approximation to the truth, as there are always processes and levels in reality that are not taken into account. Bohm wants to employ abstractions in order to give a theory that is sufficiently close to reality and likely to represent what is essential in the problem under consideration.

The problem with mathematicians, in Bohm's opinion, is that they tend to utilise abstractions that are too far removed from physical reality. This is because their propensity will always be to choose that mathematics which offers a tractable solution. Thus, in a letter to Miriam on mathematics he writes: "Of course, there are certain advantages in abstracting the problem in the way you mathematicians do, but in this case [statistical mechanics] I have hopes that the treatment of something approaching a real physical problem may suggest new ideas that will even be useful in the more abstract problems thus far treated in mathematics."[6]

Bohm expects the inter-connections in the world to be rationally understandable, but clearly also recognizes that this can lead to difficult problems. Skill is always involved in choosing between moving closer to reality, in order to bring out the more complex interconnections in the world, and taking a more abstract approach that is simpler to deal with.[7] Too much abstraction, however, can obscure the real problem. Mathematicians tend to have lost this skill and to be lazy, opting for those abstractions that can be given a simple solution, rather than "breaking their heads on real problems that might lead to new concepts and new modes of inter-connection of these concepts".[8]

The point about choosing the abstractions in order to give solutions is further expanded upon in Bohm's critique of von Neumann's work in relation to quantum mechanics. It is quite dangerous to use a number of abstract postulates in physics, and then to deduce "a great many things in an impressively ironclad way, including for example, that no causal interpretation of quantum theory can possibly lead to all of the results given by the usual probability interpretation".[9] It is not possible to check that the postulates are correct, and, even worse, nobody is clear (even von Neumann himself) "just what is being assumed." Bohm is clearly angry at the way mathematical virtuosity, towards which he admits feeling some jealousy, has held back conceptual clarification of the subject matter, perhaps by as much as 20 years. Hard, clear mathematical thinking is needed, but the postulates must be "clearly defined and well established". In relation to physics, it is possible that "with the aid

[4] Part I of Anti Dühring, Marx and Engels (1988).

[5] See Bohm (1957), p. 2.

[6] (21, **64**, p. 223).

[7] In Chap. 9, we will see Bohm attempting to follow this approach in developing a model for "chaos".

[8] (21, **64**, p. 223).

[9] (22, **67**, pp. 237–239).

of carefully reasoned analysis plus imagination, new solutions can be found, often having unsuspected properties, and thus a genuinely creative element is introduced." At the same time, finding precise mathematical solutions is a great service, as "it facilitates comparison with experiment."

Bohm explains that he is not opposed to mathematical thinking,[10] and he doesn't think it just has to be aimed at physics, but has a creative role in itself. However, with no objective basis to it, "it degenerates into the spinning of would-be-closed systems of thought, aimed mainly at raising the position of the individual in the pecking order."

Bohm is willing to admit that he finds mathematical notation difficult. In studying statistical mechanics and working with Miriam through Khinchin's, book he complains that "I have struggled for 20 years to learn what notation I now know, and I dont like to have to double my fund of notation just to learn about one subject."[11] His way of thinking is "not step by step, but rather through the inter-connection of various aspects of the whole."[12] He may then find a result by "intuition", and see other results that follow. But this qualitative approach, although "almost always correct", would not convince others, and was certainly not accepted in publications. Bohm felt he needed people who could detect logical "weaknesses in my arguments without attacking the basis", even if it sometimes infuriated the students correcting his manuscripts.

Clearly, Bohm does not think, initially, that he has adequately thought through the question of "intuition" versus logical deduction (or "instinct" versus "rigor", as he later puts it).[13] He devotes two pages to it,[14] followed by a long discussion, which then extends to other mathematical questions.[15]

Bohm agrees with the "intuitionist" that new ideas cannot be said to just come from "geniuses." But neither should intuition be seen as something mysterious, external to the thinking process. It includes observation and practice, but also, considerably more. In his case (and one could say, in general) it required "a lot of work to do it, thinking day by day, and "living" with a long series of scientific problems". It is also guided by a certain philosophy—in his case, the materialism that led him to look for causal laws—but we have noted that Bohm argues that all development of new concepts requires some kind of philosophy.[16] However, Bohm does not dismiss the role of abstract logical rigour in thinking, and with new hypotheses, "logic often plays a genuinely creative role in leading to unexpected conclusions", as it did in his work on the causal interpretation. It would seem, therefore, that the correct way

[10](23, **74**, pp. 285–259).

[11](21, **64**, pp. 223–224).

[12](21, **65**, p. 229).

[13]See the comment in (26, **92**, pp. 306–307) where Bohm recalls he had thought out these ideas while on vacation.

[14](25, **89**, pp. 295–296).

[15](25, **90**, pp. 297–302).

[16](18, **45**, pp. 167–169).

of looking at the thought process is a dialectical one, in which ""intuition" + logic were bound into an inseparable unit."

There are some four pages[17] discussing Bohm's ideas of dialectics in relation to mathematics and logic, and also referring to Hegel on "being and not being, which are resolved in the concept of becoming."[18] But we will not consider any further here the ideas Bohm sketches out, as that would take us into the specialized area of the foundations of mathematics.

Bohm concludes this comment on mathematics[19] with a broadside against "formalism", by which he aims to convey that the dominant trend in theoretical physics was to concentrate on lengthy mathematical calculations and equations (which are supposed to "fit" the numerical results from experiments). Bohm thinks that this move away from the conceptual approach he is trying to develop in his work has turned theoretical physics into "a grim dull business", spreading the idea that the world is an irrational place. Science has been turned into an "instrument of obscurantism", undermining confidence in the possibility of solving social problems, and spreading cynicism. In philosophical terms, the formalist approach is idealist, concerned only with abstract standards of elegance, rather than with ability to understand the real world. In sociological terms, the formalist approach informs a critique that tends to assess scientists (and lesser mortals!) with respect to how they meet the formal mathematical standards of a small elite group.

References

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[17] (25, **90**, pp. 299–301).

[18] This, along with the discussion on "a stone is a stone" in (21, **65**, p. 228), would seem to support the idea that Bohm had been studying Hegel's philosophy from quite early in his Brazil period.

[19] (25, **90**, pp. 301–302).