## **Zeno II** PHIL301

## Dichotomy resolution

- As we have seen, Zeno is mistaken in thinking that one must travel infinitely far to travel any finite distance. Even though there are infinitely many distinct distances to cross, between any two points, we know mathematically that the sum of these distances is finite.
- What about the supertask logic?
- The point of Benacerraf's genie illustration is this: if we confine our attention to the supertask, *nothing follows* about events or conditions external to that task.
  - In the case of the genie, this means that there is no logical difficulty in asserting both (a) that the genie exists at every point to the left of B, and (b) the genie does not exist at point B.
  - In the case of Thomson's lamp, this means that while (a) there is no final switching event, and hence (b) no possibility of saying whether the lamp is off or on at the completion of this supertask, nevertheless (c) we are not required to say anything about the state of the lamp outside of the supertask. In particular, we needn't say that the state of the lamp is "indeterminate" after the supertask is completed. Rather, what we may say is that the state of the lamp beyond the supertask is not determined by the supertask.
- Such lingering confusion or uncertainty as we may have, at this point, is perhaps more owing to our inability to represent distinctly to ourselves infinite sequences, much less those converging on a limit.
  - The same applies, *mutatis mutandis*, to the problem of beginning motion.

## The Arrow Paradox

- See fragment 10/A27.
- Zeno seems to reason as follows:
  - 1. At every moment of its flight, the arrow occupies a space equal to its own length.
  - 2. To occupy a space equal to a thing's extent along a particular dimension is to be at rest with respect to the axis of that dimension.
  - 3. Hence, at every moment of its flight, the arrow is at rest.
  - 4. If at every moment of its flight the arrow is at rest, then the arrow does not move during its flight.
  - 5. Consequently, an arrow does not move during its flight.
- Aristotle's solution seems to deny that motion is possible at an instant. But this notion runs contrary to our standard analysis of motion, which makes use of the concept of instantaneous velocity: the instantaneous velocity of an object at time *t* is the limit of the sequence of its average velocities as these converge on *t*.
- Note, however, that the concept of instantaneous velocity does not offer us a solution to Zeno's problem. As Russell pointed out, that concept depends on our

prior assumption that the object in question is in motion over some period, by reference to which we identify its velocity at an instant during that period. But the possibility of motion is the question at hand, so this solution would beg the question.

- Resolution is perhaps available if we distinguish the motion of the arrow from measurement of that motion. (The following after E.J. Lowe.)
  - An arrow at rest differs from an arrow in motion in that the latter will change location, whereas the former will not.
  - If we *define* motion as this change in location, however, then we lose the capacity *to explain why* the arrow changes location if moving.
  - So, not only does an arrow at rest differ from one in motion in that the latter but not the former changes location, but we should also say that the arrow at rest has no *tendency* to change location; an arrow in motion has, at any given instant, the tendency to change location.
- Bergson's solution: Henri Bergson maintains that the motion of the arrow from A to B is not equivalent to its being located at the various points along its route.
  - Bergson is a latter-day Heraclitean. He believes that reality involves various on-going processes of *becoming evolutionary* processes, such as a larva becoming an adult ant; *qualitative* becomings, such as red things becoming blue; and *extensive* processes involving bodily activity and other kinds of motion, such as eating or fighting.
  - Further, Bergson believes that the structure of our thought and language tends towards what he calls a "cinematographic" understanding of reality. This involves our thinking of these processes as consisting in discrete, instantaneous states or stages superimposed against an abstracted background of change. It is this way of thinking that enables Zeno to pose the problem for motion in the Arrow paradox.
  - Bergson's solution to the paradox is to claim that the flight of the arrow from A to B is not composed of its "being" at a series of intermediate points. Indeed, to think of the arrow "at" any one such point is to alter the scenario dramatically.
    - To be at (as opposed to moving through) a given point is to imply a process of existence. But no process is of only instantaneous duration. To think of the arrow as being at a given point, then, is actually to think of the arrow as existing there for a while, which is quite different from thinking of the arrow as passing through the point during its flight.
    - In other words, to think of the arrow at the midway point C of its flight from A to B is to think of not one flight but two: that from A to C and that from C to B.
  - Bergson goes on to distinguish the flight of the arrow from its trajectory. The former, he says, is single and non-composite. The latter may well be de-composed into points or positions, insofar as it is, after all, a mental abstraction, an ideal representation, a geometrical form – i.e., a curve. Curves are lines; lines consist in points. The flight of the arrow may be

conceived by us as marking out a curve. But we should not mistake the properties of a curve with the properties of the arrow's flight.

The Stadium Paradox

- See fragment 11/A28. This fragment is particularly obscure. One interpretation is the following (after Lowe):
  - 1. If space and time are discrete, then there is a smallest temporal unit *m* and a smallest spatial unit *l*.
  - 2. Suppose time  $t_1$  and  $t_2$  differ by *m*; and that the blocks measure *l* on a side.
  - 3. Then, if motion is possible, states  $S_1$  and  $S_2$  are possible, such that blocks  $B_1$ - $B_3$  move left *l* and blocks  $C_1$ - $C_3$  move right *l*.
  - 4. However, if the *B* and *C* blocks move in opposite directions, then it appears that blocks  $B_2$  and  $C_2$  pass each other without ever being next to each other.
  - 5. It is impossible for blocks  $B_2$  and  $C_2$  pass each other without every being next to each other.
  - 6. Hence, motion in discrete space and time is impossible.
  - Another version of the argument might assert the necessity of an intermediate state  $S_{1.5}$  in which  $B_2$  and  $C_2$  are next to each other, if they are to pass each other. But since there are no temporal and spatial units 1/2m and 1/2l, the relative *B*-*C* motion is impossible.
- However, a friend of atomism concerning space and time can respond effectively by simply "biting the bullet" and agreeing to (4) and denying (5).