IV. THE TWIN PARADOX

The Twin Paradox, or Clock Paradox as it is sometimes called, is usually stated in terms of two twins, say Arlo and Bob. Each has a watch, which they synchronize as they stand beside each other on Earth. They are, let us say, 20 years old. Arlo then climbs into a rocket ship and zips off into outer space at high velocity, while Bob stays behind on Earth. The years go by until one day Arlo returns to reunite with his twin brother.

Now from Bob's point of view, it is Arlo's watch that has been moving, and therefore running slowly. Bob is now a man of 50, with grey hair beginning to show at the temples, and having learned a smattering of SRT as a student, he expects to see his twin brother to have aged very little, still with dark hair and lots of vim and energy, alighting from his rocket ship and rushing over to greet him with open arms, joyfully exulting at finally returning home.

Arlo, on the other hand, who also recalls delving into a description of SRT as a student, views the scene from his rocket ship and reasons that from his point of view it is his brother Bob who zipped away and returned. Arlo also knows about time dilation, and reasons that his brother's watch will have run more slowly than his. Arlo thus expects, upon reuniting with Bob, to find a vigorous young man much younger than himself, now perhaps just beginning his career and looking forward to a long and productive life.

Hence the paradox: Arlo's line of reasoning leads to the conclusion that Arlo is older than Bob, while Bob's line of reasoning leads to the opposite conclusion that Bob is older than Arlo. Which is correct? It is natural to wish to compromise, and by invoking common sense deduce that somehow neither one will have aged more than the other. After all, aren't they still twins?

By now, we should have no trouble answering this question and hence resolving the paradox. To gain clarity of thought, we may find it helpful to consider an analogous situation, relating to paths taken in Euclidean space: Suppose that Arlo flies on an airplane from San Francisco to Los Angeles by way of Hawaii, while Bob, who is of more modest means, takes the direct flight to Los Angeles. The question is: Who travels the longer distance?

We may suppose, for the benefit of this example, that each takes the same amount of time to fly from San Francisco to Los Angeles so that as they leave (simultaneously) from San Francisco, each can keep the other's plane in view. Now Bob will look out his window at Arlo, and since he sees Arlo's plane at first going away and then coming back, he will conclude that Arlo has traveled the longer distance. Arlo, on the other hand, looking out his window at Bob, will see Bob's plane first going away and then coming back, and so naturally will conclude that Bob has traveled the longer distance. Hence here too there is an apparent paradox. Of course, if each one carries a device to record the number of air

miles traveled, they can compare their findings when they meet again in Los Angeles and of course (of course?) the result will be that Arlo will have recorded the longer distance. Think: What qualitative criterion allows you (or Arlo or Bob) to determine immediately which path is longer?

It is a curious thing that the twin paradox has received far more attention than any other aspect of SRT. Well over 50 papers have been published on the subject, all in reputable journals, and countless chapters have appeared in books on relativity. To cite one example: Out of the American Institute of Physics collection of 16 reprints of journal articles on SRT (mentioned in the introduction), 10 are devoted specifically to the twin paradox, leaving only 6 for everything else. No doubt the notion that we might fly away in a spaceship and return to find ourselves younger than our children is a conclusion most of us find pretty hard to accept, a true space child's fantasy.