You'll be able to see this easily using our radio telescope, since you can receive signals at up to three wavelengths simultaneously, and can compare the arrival times on the three graphic displays.

By measuring the times of arrival of pulses from the same pulsar at different frequencies you can determine the distance to the pulsar, as long as you know the speed of radio waves through the interstellar medium at different frequencies. We do in fact know how frequency affects the speed of electromagnetic radiation from the theory of electromagnetism developed over 100 years ago.

B. An Example from the Everyday World

In a simplified case unrelated to electromagnetism, we can look at how arrival time helps determine distance traveled by two athletes running a race. Suppose we have two runners (A and B) who are racing each other. Runner A runs a steady 5 kilometers an hour, and Runner B runs a steady 10 kilometers an hour.

We do not know ahead of time *HOW FAR* they are running, but we do know their speeds and we do know that they both start running at the same time. It's easy to see that the *difference* in the times they cross the finish line depends on the length of the race. (See FIGURE 4). Suppose the course is 10 kilometers long. Runner A finishes in two hours. Runner B finishes in 1 hour. So there is a 1 hour difference between them if the course is 10 kilometers long. If the course is 20 kilometers long, Runner A finishes in four hours, and Runner B finishes in 2 hours, or a 2 hour time difference between the two. You can, in principle, determine the length of the race from the difference in the finish times.

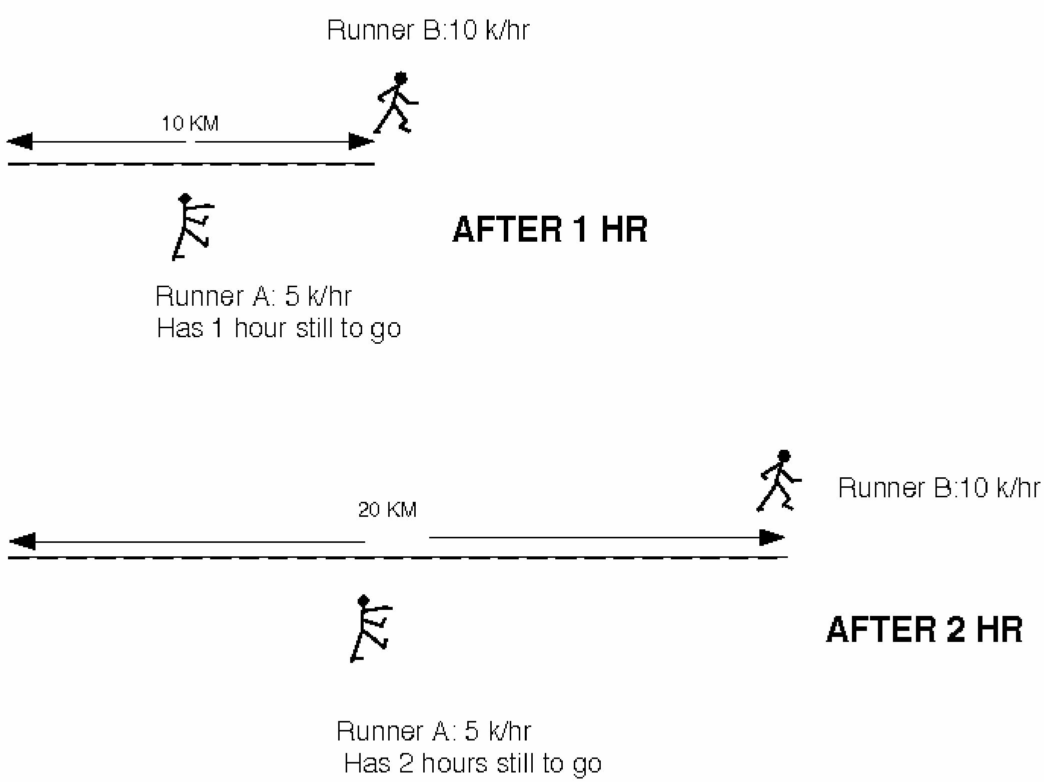

Figure 4: Illustration of the example

We can represent this mathematically by deriving a formula where the length of time it takes for runner A to finish the length of the course L is divided by her speed: