PASSAGE IV

NATURAL SCIENCE: From Mark Davidson, "Is Time Travel Possible?" Copyright 1990 by the Society for the Advancement of Education.

Contrary to the old warning that time waits for no one, time slows down when you are on the move. It also slows down more as you move faster, which means astronauts someday may survive so long in space that they would return to an Earth of the distant future. If you could move at the speed of light, 186,282 miles a second, your time would stand still. If you could move faster than light, outpacing your shadow, your time would move backward.

Although no form of matter yet discovered moves as fast or faster than light, scientific experiments have confirmed that accelerated motion causes a voyager's time to be stretched. Einstein predicted this in 1905, when he introduced the concept of relative time as part of his Special Theory of Relativity. A search is now under way to confirm the suspected existence of particles of matter that move faster than light and therefore possibly might serve as our passports to the past.

Einstein employed a definition of time, for experimental purposes, as that which is measured by a clock. He regarded a clock as anything that measured a uniformly repeating physical process. In accordance with his definition, time and time's relativity are measurable by any sundial, hourglass, metronome, alarm clock, or an atomic clock that can measure a billionth of a second because its "tick" is based on the uniformly repeating wobble of the spinning-top motion of electrons.

With atomic-clock application of Einstein's definition of time, scientists have demonstrated that an ordinary airplane flight is like a brief visit to the Fountain of Youth. In 1972, for example, scientists who took four atomic clocks on an airplane trip around the world discovered that the moving clocks moved slightly slower than atomic clocks which had remained on the ground. If you fly around the world, preferably going eastward to gain the advantage of the added motion of the Earth's rotation, the atomic clocks show that you'll return younger than you would have been if you had stayed home. Frankly, you'll be younger by only 40 billionths of a second. Such an infinitesimal saving of time hardly makes up for all the hours you age while waiting at airports, but *any* saving of time proves that time can be stretched. Moreover, atomic clocks have demonstrated that the stretching of time, or "time dilation," increases with speed.

Here is an example of what you can expect if tomorrow's space-flight technology—employing the energy of thermonuclear fusion, matter-antimatter annihilation, or whatever—enables you to move at ultra-high speeds. Imagine you're an astronaut with a twin who stays home. If you travel back and forth to the nearest star at about half the speed of light, you'll be gone for eighteen Earth years. When you return, your twin will be eighteen years older, but you'll have aged only sixteen years. Your body will be two years younger than your twin's because time aboard the flying spaceship will have moved slower than time on Earth. You will have aged normally, but you will have been in a slower time zone. If your spaceship moves at about 90 percent of light-speed, you'll age only 50 percent as much as your twin. If you whiz along at 99.86 percent of light-speed, you'll age only 5 percent as much. These examples of time-stretching, of course, cannot be tested with any existing spacecraft. Yet, they are based on mathematical projections of relativity science, as confirmed by the atomic-clock experiments.

Speed is not the only factor that slows time; so does gravity. Einstein determined in his General Theory of Relativity (the 1915 sequel to his 1905 Special Theory of Relativity) that the force of an object's gravity "curves" the space in the object's gravitational field. When gravity curves space, Einstein reasoned, gravity also must curve time, because space and time are linked in a space-time continuum. The concept of the space-time continuum, developed by one of Einstein's former professors, simply means that time and space must be considered together because time is a fourth dimension of space.

Numerous atomic-clock experiments have confirmed Einstein's calculation that the closer you are to the Earth's center of gravity, which is the Earth's core, the slower you will age. In one of these experiments, an atomic clock was taken from the National Bureau of Standards in Washington, D.C., near sea level, and moved to mile-high Denver. The results demonstrated that people in Denver age more rapidly by a tiny amount than people in Washington.

If you would like gravity's space-time warp to extend your life, get a home at the beach and a job as a deep-sea diver. Avoid living in the mountains or working in a skyscraper. If you're taking airplane trips to slow your aging, make sure you fly fast enough to cancel out the gravity-reduction effect of being high above the Earth's surface. That advice, like the advice about flying around the world, will enable you to slow your aging by only a few billionths of a second.

GO ON TO THE NEXT PAGE.