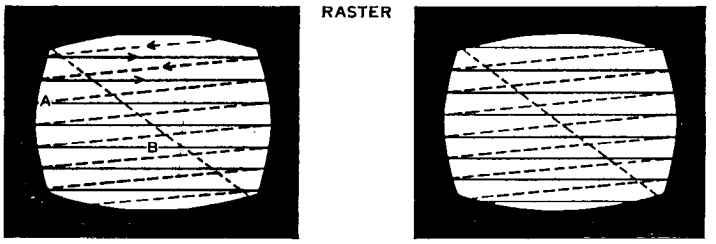
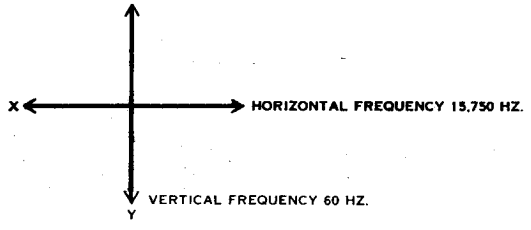
One dot only: the space/time mechanics of video

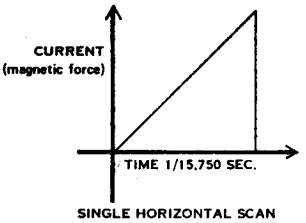
Since image *per se* is illusion, a functional formal description must deal with what *is* actually there from moment to moment – the dot – a phosphorescent trace left by an electron beam hitting the phosphor covered surface of the tube moving across the tube and back and scanning from top to bottom 60 times each second. On retrace from right to left the beam is blanked out, as it is on return from bottom right to beginning at top left (dotted lines). The distinction between the film image and the video could be likened to the relation of press printing to typewriting. In film, as in printing, all information is impressed simultaneously ; in video, as with the typewriter, each bit of information is laid down sequentially in a left to right and retrace scan.



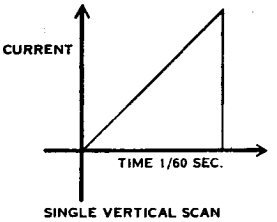
ODD FIELD EVEN FIELD

A video *frame* – one complete image – of 525 scan lines consists of two alternate *fields*, an odd and an even, of 262½ lines each. Consider then the motions necessary to create a raster of 525/2 lines, 60 times a second. Clearly the dot must move horizontally across the tube and back 525/2 x 60 times a second or 15,750 cycles per second (HZ). (Hence 1 line lasts 1/15,750 seconds and Point A is 25 x 1/15,750 seconds from Point B.) Equally obviously the dot which creates these horizontal lines must move from top to bottom of the tube and back 60 times a second (once for each field.) Thus we have two basic constants – 15,750 cycles per second, the horizontal frequency, and 60 cycles per second, the vertical frequency. These relationships may be visualized in a force vector diagram.





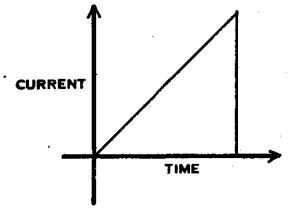
SINGLE HORIZONTAL SCAN

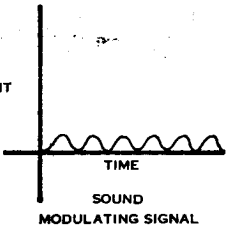


SINGLE VERTICAL SCAN

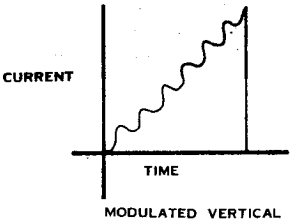
Thinking of the image in terms of force vectors becomes more useful as we consider the actual force used to deflect the beam on these two axes. The force, electromagnetic force, is created by passing electric current through a coil wrapped around the neck of the picture tube. Two coils are used ; one deflects horizontally, the other vertically. The amount of deflection is proportionate to the amount of current passing through the coils. (The *intensity* of the dot is proportional to the energy of the electron beam itself which is controlled by the *voltage* applied to the electron gun). Thus we can translate our vector diagrams into electrical terms.

The relation of such vector diagrams to the concept of analogy is simple. If I were to use another electrical force pattern derived from, say, analysis of sound to alter the shape of the vertical scan pattern, the vertical scan rate would vary *in analogy* to the sound.

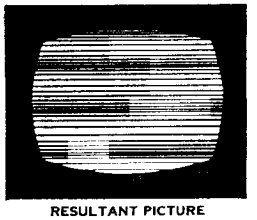




SOUND MODULATING SIGNAL

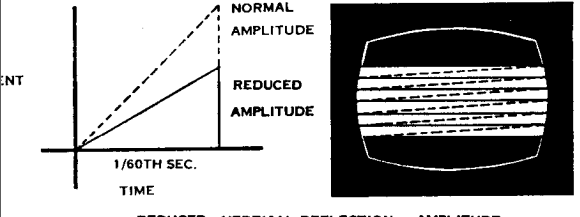


MODULATED VERTICAL DEFLECTION



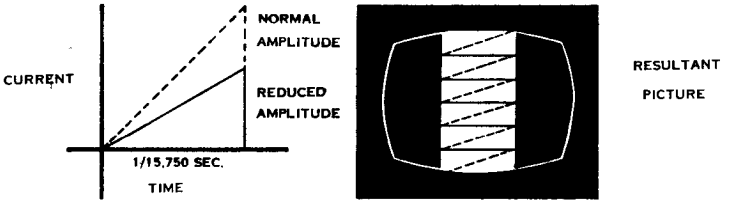
RESULTANT PICTURE

Analogue distortion may be introduced by altering the shape, frequency, or amplitude of the deflection force patterns. The simplest case (see above), *vertical spatial distortion*, is familiar to us in the works of Bridget Riley and other Op artists. The illusion of contour in a field of horizontal lines is generated by the spacing of the lines. In a video picture the spacing of the lines depends on the rate of rise of current versus time. The normal deflection pattern is linear to provide even line spacing and hence the illusion of flat space. If, however, we took the wave form of a sound and imposed it upon the deflection pattern, the line spacing, and hence the space, would ripple in analogy to sound.



REDUCED VERTICAL DEFLECTION AMPLITUDE

Reducing the total amplitude of the vertical deflection pattern will squash the whole picture on a vertical axis.



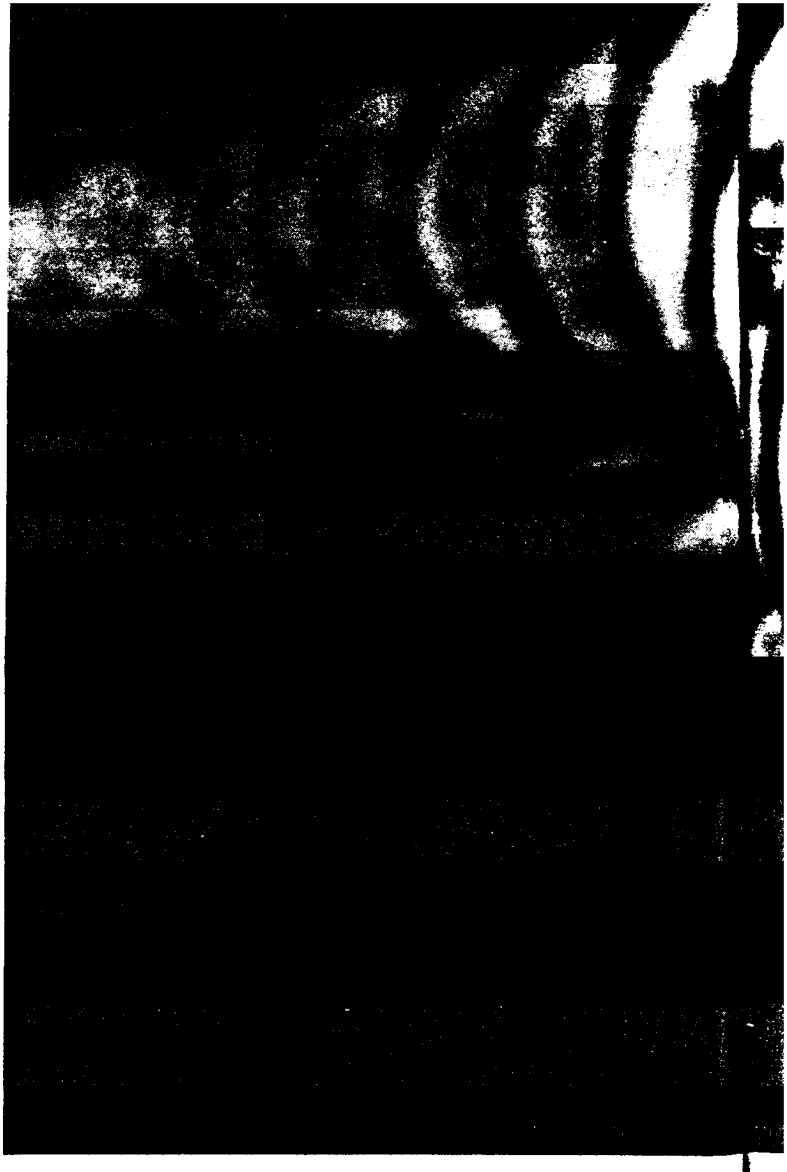
REDUCED HORIZONTAL DEFLECTION AMPLITUDE

And similar reduction of the horizontal deflection amplitude will squash the horizontal axis. Video synthesizers give simultaneous control over these and many other dimensional and tonal properties of the image.

By James S. Trefil

It's all relative when you travel faster than light

In the paradoxical world of tachyons, you could find yourself arriving before you left, and then deciding not to go after all



In the relativistic world near the speed of light, time itself appears to slow down. A tachyon,

How familiar the scene is. The handsome spaceship captain leans forward and snaps out a command:

"Ahead Warp 8, Mr. Chekov."

"Aye, aye, Kepten."

And the gallant starship *Enterprise* moves out at 512 times the speed of light.

Or how about that other favorite device of the writer—the hero who travels backward (or forward) in time to visit another age? Pure fiction, isn't it?

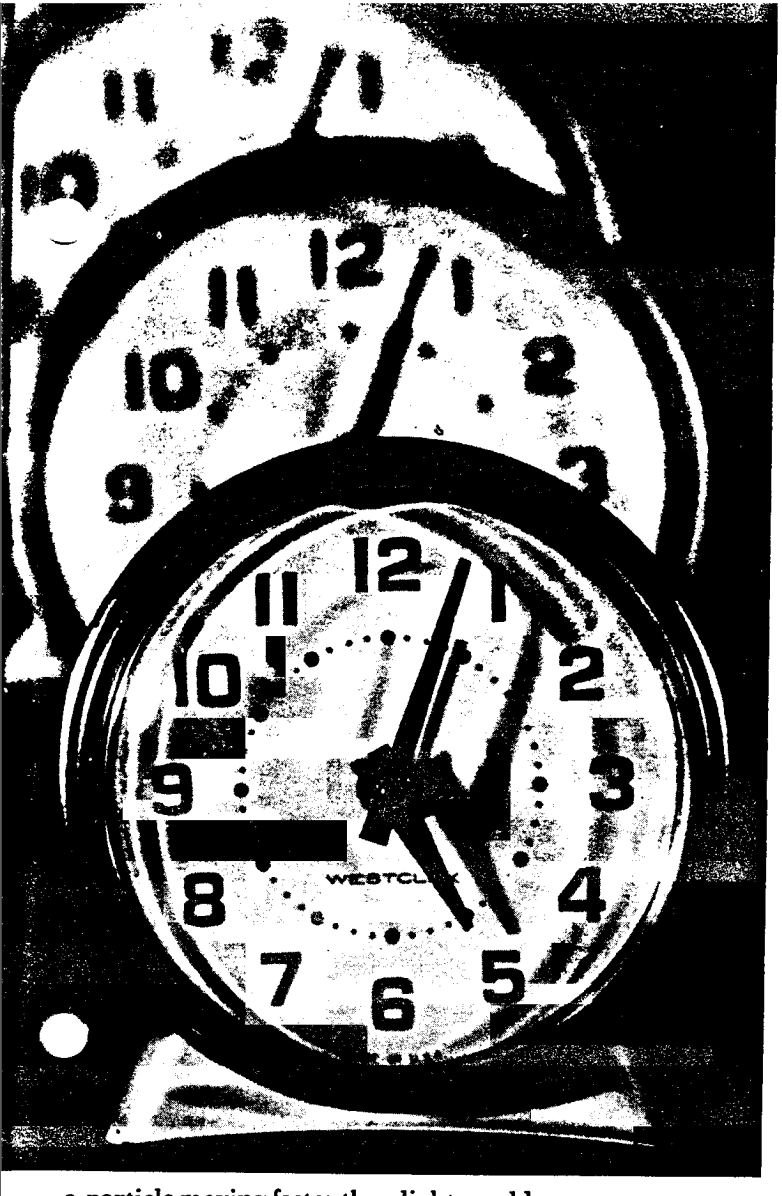
Or is it?

For the last several years, theoretical physicists have been speculating about the existence of objects which, should they ever be found, could conceivably make something like the *Enterprise* a reality someday, and might even have something to do with time travel. These hypothetical objects are called "tachyons"—"swiftly moving ones" (from the Greek root *tachys*, meaning swift). If they exist, they would have the property of moving faster than light. By contrast, all of the more mundane matter that we know about that moves at less than the speed of light would be lumped under the general heading of "tardyons," or "slowly moving ones."

Most of us have heard that it's impossible to move faster than the speed of light, and that this cosmic speed limit is somehow imposed by Einstein's theory of relativity. Does this mean that scientists now believe Einstein was wrong? Not at all. What the emergence of the tachyon idea means is that scientists have taken a closer look at the theory of relativity and have concluded that, under certain conditions, faster-than-light travel is not forbidden. But to understand how this conclusion has been reached, we'll have to understand exactly what it was that Einstein said in the first place.

People tend to accord the theory of relativity a kind of reverential awe. There is an impression that anything having to do with this particular theory must be so far out and complicated that only the most advanced scientists could possibly understand it. Perhaps the old chestnut about there being only a dozen men in the world capable of understanding it has contributed to this feeling. But the truth of the matter is that the basic ideas of relativity are not hard to grasp and, in fact, can be taught to today's undergraduates.

We've all had the experience of riding in a car or a train and dropping something, either intentionally or by accident. Strange as it may seem, just thinking about an everyday occurrence like this can lead us to



a particle moving faster than light, could even seem to travel back in time, with paradoxical results.

the principle of relativity. No matter how fast you are moving, 10 miles per hour in a car or 600 miles per hour in a jet, if you drop something it will fall right at your feet. The laws that govern the fall of the object don't seem to depend on how fast you're moving.

Let's look at this in a slightly different way. Suppose you are sitting on a moving motorcycle and a friend of yours is standing on the ground (p. 134). While you are watching the object falling straight down, what does he see? Well, during the time it takes for the object to fall to the ground, he will see the motorcycle move along the ground a certain distance. Consequently, he will see the object fall in an arc. You say it fell straight down, and he says it fell in an arc. This apparent contradiction is resolved by saying that each of you is watching the same event from a different point of view (the technical term is "frame of reference"), and therefore each saw something different.

What isn't so obvious, but is true nonetheless, is that if you and your friend were to make some measurements—you in the car and your friend on the ground—you would come to the conclusion that even though you see different things when you watch something fall, you agree on the basic laws that govern the fall. In other words, even though you see the object fall straight down and he sees it fall in an arc, you would both agree that the laws of nature which govern falling bodies (the ones first discovered by Galileo) were true. For example, in both cases the object takes the same amount of time to reach the ground.

And that is the Principle of Relativity! It states that no matter what frame of reference you are in, the laws of nature that hold for you are exactly the same laws of nature that hold in any other frame of reference. In other words, *every* point of view is correct, even though each point of view corresponds to a different description of what happened. This idea has profound philosophical consequences, and would have been anathema to a deeply religious man like Isaac Newton. But what does it have to do with the speed of light?

Up to now we've talked about only one law of nature, the law that governs falling bodies. There are many other laws, of course, and one set governs the behavior of electricity and magnetism. The speed of light (and of radio waves, microwaves, X rays and any other forms of electromagnetic radiation) is built into these laws. In this way, the speed of light is different from other speeds (like the speed of sound), and enjoys a special place in nature. It follows from this fact that if the laws that govern electricity are to be the same for every frame of reference, then the speed of light has to be the same for any two observers, even if they are moving with respect to each other. In other words, if you were on your motorcycle going 30 miles per hour and you flashed a beam of light at your friend on the ground, he would see the light moving at 186,000 miles per second and *not* at 186,000 miles per second plus 30 miles per hour.

Let's take the famous "clock paradox" as an example of the surprises that follow from relativity. Einstein is supposed to have come to the theory of relativity by imagining what would happen if you traveled away from a clock at the speed of light. If you think about it for a minute, you'll realize that if you did this, you'd always "see" the same position on the hands of the clock, so that as far as you were concerned, the clock would be stopped, even though someone standing next to the clock would see it moving as usual. This would happen because the light wave that carries the signal

The author, who has written on elementary particles for SMITHSONIAN, *is completing a book for laymen called* Physics Appreciation.

that says "it's 2 P.M." moves away from the clock as fast as you do, so when you looked, you'd always see 2 P.M.

Think about it a little more, and you'll realize that if you traveled a bit slower than light, it would appear that the clock had slowed down, and if you traveled a bit faster than light, it would appear that the clock was running backwards! In other words, what you see a clock doing depends on how fast you or it is moving, and two observers moving with different speeds will see the same clock running at different rates.

Is this result really so paradoxical? Actually, it's no more so than the fact that you saw something fall straight down while your friend saw it fall in an arc in our earlier example. What every observer has to agree upon is the fact that the laws of nature are the same, but individual events, like the ticking of a clock, needn't be perceived in the same way.

Let's go through the clock paradox in a slightly different way so that we can see how the speed of light comes into the problem. We could imagine making a clock in such a way that a "tick" of the clock would consist of a flash followed by the light traveling up to the mirror, bouncing off, and coming back to the receiver which, in turn, would trigger another flash (opposite). In principle, we could adjust this "clock" to tick once a second, or however often we wished. Now suppose you and your friend each have a clock like this, and you drove past him in your car. What would each of you see?

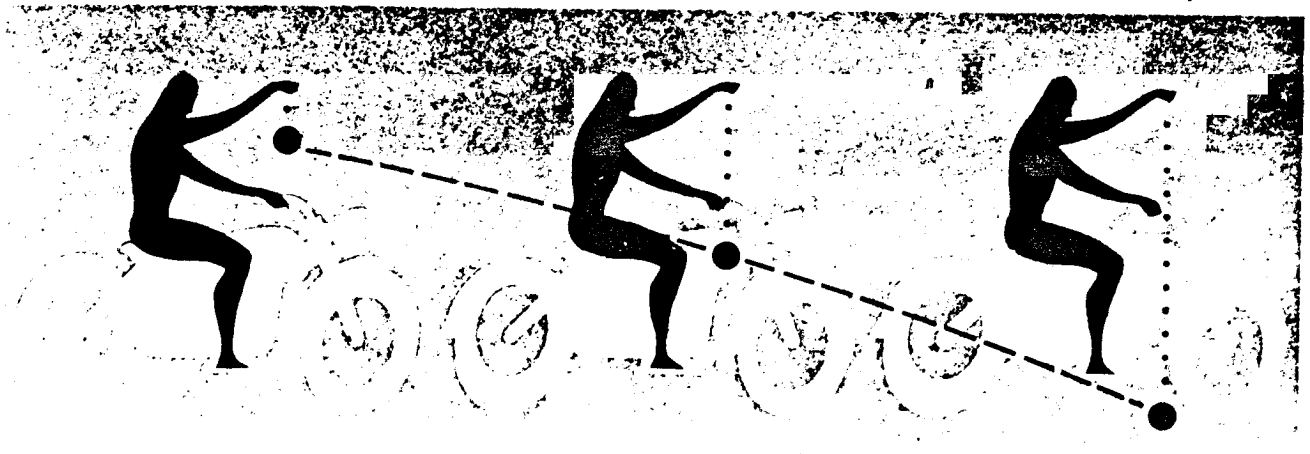
You'd see your clock working as usual, but your friend would see something different. Just as he saw an arc when you dropped something, he will see the light traveling as a sawtooth, because while the light from the flash is moving up to the mirror, the mirror will be moving with the car. Since light traveling on a sawtooth has to go farther than light traveling up and down, and since you both agree on the speed at which light travels, it follows that he has to see your clock slowing down compared to his. Again, no paradox, but a rather surprising conclusion following from relativity.

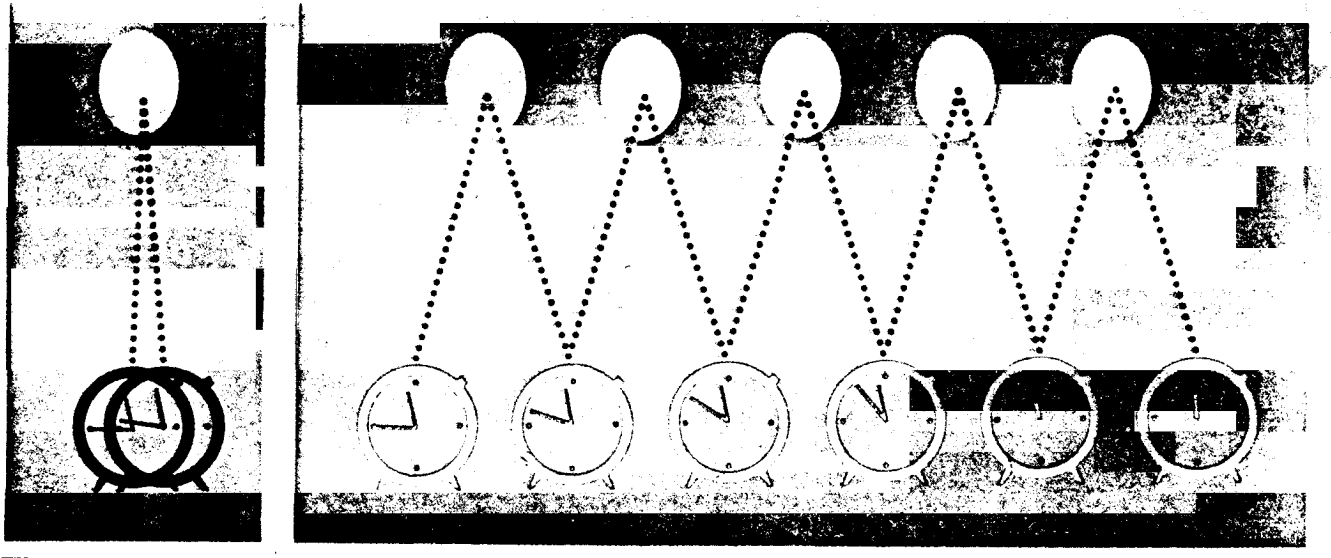
This result—that moving clocks appear to be running slower than stationary ones—is the idea behind the so called "twin paradox." If one of a set of identical twins goes flitting around in a rocket ship, and the other stays here, then when the traveling twin returns, he will be younger than the stationary one (p. 136)! It's hard to believe, but this difference has actually been measured by flying very sensitive clocks on airplanes.

There are other surprises in special relativity. It turns out that arguments based on the same principles as the ones we used in the clock paradox result in statements that virtually every property of an object changes when it moves. Its time slows down, its length contracts, its energy appears different and it gets heavier. This last property explains the conventional statement that faster-than-light travel is impossible, because if we try to accelerate an ordinary object to a high speed, we'll find it getting heavier as it goes faster. This means that we'll have to exert more force to get an equivalent increase in speed on a quickly moving object. As we approach the speed of light, we need more and more force, until we are just a hairsbreadth from it. To raise the speed that last fraction would require an infinite force. Since this isn't available in the universe, we have to say that if the theory of relativity is correct, no object now moving at less than the speed of light will ever be accelerated by conventional means to a speed greater than the speed of light. This argument is the basis for the usual statement that faster-than-light travel is impossible.

But it doesn't prove that at all, because the same argument could be used to "prove" that travel *at* the speed of light is impossible as well, and we know of at least one thing that travels at the speed of light—light itself. What the argument actually says is that things going at less than the speed of light (the things we've called tardyons) will always be tardyons, and that things now traveling at the speed of light will always

A dropping ball seems to be a perfectly simple event, but different people can see the same event in very different ways. Imagine the motorcycle is going 30 miles per hour. If we disregard wind resistance, the ball will appear to the man on the motorcycle to fall straight down. But to a man on the side of the road, the ball appears to move forward along the dashed arc. What you see depends on where you are.





These clocks emit a pulse of light that travels up to a mirror and then back to the clock, triggering another pulse. The clock at the left belongs to a stationary observer. The clock at right, originally synchronized with the one at left, is moving. The light has to travel farther, and so that clock appears to run slower than the stationary one. This relativistic effect actually happens to clocks carried on airplanes.

do so. There is nothing in the argument that says we can't go one step further, either. Suppose that somewhere in the universe there is something that actually travels faster than light—a real tachyon. From the theory of relativity we could say that such an object must always be a tachyon and must always have been a tachyon, but we can't say that such a thing is impossible. The fact that we can't turn a tardyon into a tachyon doesn't prove that tachyons don't exist, any more than our inability to accelerate a tardyon to the speed of light proves that light doesn't exist.

So even though there are lots of surprising ideas contained in the innocent-looking principle of relativity, there is nothing there that says that objects traveling faster than light can't exist. It just says that if they do, they always have to move at such speeds. A useful analogy might be two countries separated by a high mountain range. People live out their lives on one side of the mountains or the other, but no one ever crosses them. Philosophers on each side might even argue that no one lives on the other side, on the grounds that it is impossible to cross the mountains. But the main point, of course, is that it really isn't necessary to cross the mountains for people (though not necessarily people "like us") to exist on the other side. If they were there from the start, they're there now. The conjecture is that the world of tachyons and our normal tardyon world are like this—they are separated from each other by the speed-of-light barrier.

Modern physicists often quote something called the Gell-Mann dictum, named after Murray Gell-Mann, Nobel laureate in physics and a member of the Smithsonian's Board of Regents. It goes like this: "Whatever isn't forbidden is required." In other words, if there's no reason why something shouldn't exist, then it must exist. If we accept this idea, then we would have to conclude that there must be faster-than-light objects unless some reason can be found for denying them.

Actually, we've already hinted at what this reason might be when we talked about the clock paradox. You will recall that when we moved away from a clock face at more than the speed of light, the clock appeared to run backwards. This is a hint about one very important and puzzling property of tachyons and, indeed, the main reason that they were not accepted as a possibility until very recently: they seem to involve us in time travel.

Let's think about an experiment we might do if we could control tachyons. We could set up a tachyon transmitter at one point and a tachyon receiver somewhere else (p. 137, top). We could then send signals via tachyons, just as we now can send out signals with radio or light waves. The tachyon would leave the transmitter (which would use up some energy and give it to the tachyon) and, sometime later, would arrive at the receiver, which would then gain the energy that the transmitter has lost. The only way we'd know that we were dealing with a tachyon would be by noticing that the time it took to go from the transmitter to the receiver would be less than the time it would have taken light to travel the same distance. If the two were 186,000 miles apart, it would take one second for light to bridge the gap, while a tachyon might make it in half that time. But aside from this, there is nothing at all strange or paradoxical about the emission and reception experiment we've described.

The funny business begins when we ask how this experiment would look to other observers, say flying by in a spaceship and watching through the window. Remember, all points of view are supposed to be equally valid. Suppose there are two men in the rocket, each with a stopwatch. If the man in the front stops his

Illustrations by Clifton Line

watch when he sees the "receiver" activated, and the man in the rear stops his when he sees the transmitter activated, they can compare the times on their watches after the experiment. If the rocket ship is moving fast enough (but still less than the speed of light), they will find that the front stopwatch will have recorded an earlier time than the rear one.

In other words, the tachyon will be "received" before it is "transmitted." Furthermore, if they could measure the energy changes involved, they will see the receiver lose energy, instead of gain it, and they will see the transmitter gain energy instead of lose it. Surely there is no way of reconciling this sort of thing with any rational interpretation of relativity.

Actually, people thought until recently that this seeming inconsistency was a strong argument against the existence of tachyons. After all, one of the basic laws of nature is the principle of causality, which says that an effect must come after its cause. In this example, one observer sees events which follow this principle, and the other sees events which do not. Therefore, it was argued, the existence of tachyons is inconsistent with the laws of nature.

Well, not quite. Let's describe what the men in the rocket ship see in a little more neutral language. They see the apparatus which we called a "receiver" lose energy, and then, sometime later, they see the apparatus we called the "transmitter" gain energy. They wouldn't say that causality was violated at all, but that the man on the ground had got his labels mixed up. The thing which loses energy is what should be called a transmitter. Then their description of what they see is perfectly sensible: the transmitter sends something out, and that something is received at a later time. In short, they see the tachyon going the other way.

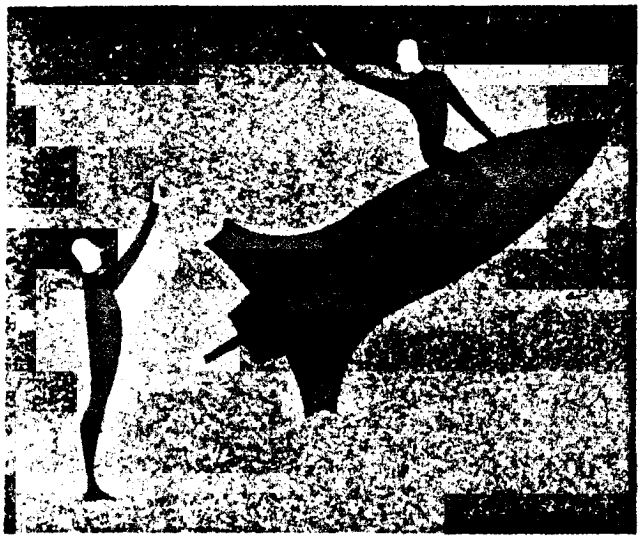
So each of the two sets of observers agrees that "effect" (the reception of the tachyon) follows "cause" (the emission of the tachyon). They both agree that the law of causality is valid as far as they are concerned. What they disagree on is which event is to be labeled "cause" and which "effect." Likewise, they disagree on what piece of apparatus is the transmitter and what is the receiver. This situation is analagous to the case of the object dropped from a moving motorcycle: the observers disagree on the description of events, but agree on the laws that governed those events.

Once we accept that, however strange the tachyon's behavior might appear, it does not violate any law of nature or of logic, the apparent backwards-in-time motion of a tachyon seen by some observers leads to another topic that science-fiction writers have elaborated on over the years: communication in time. Let's go back to our observers in the rocket to see how.

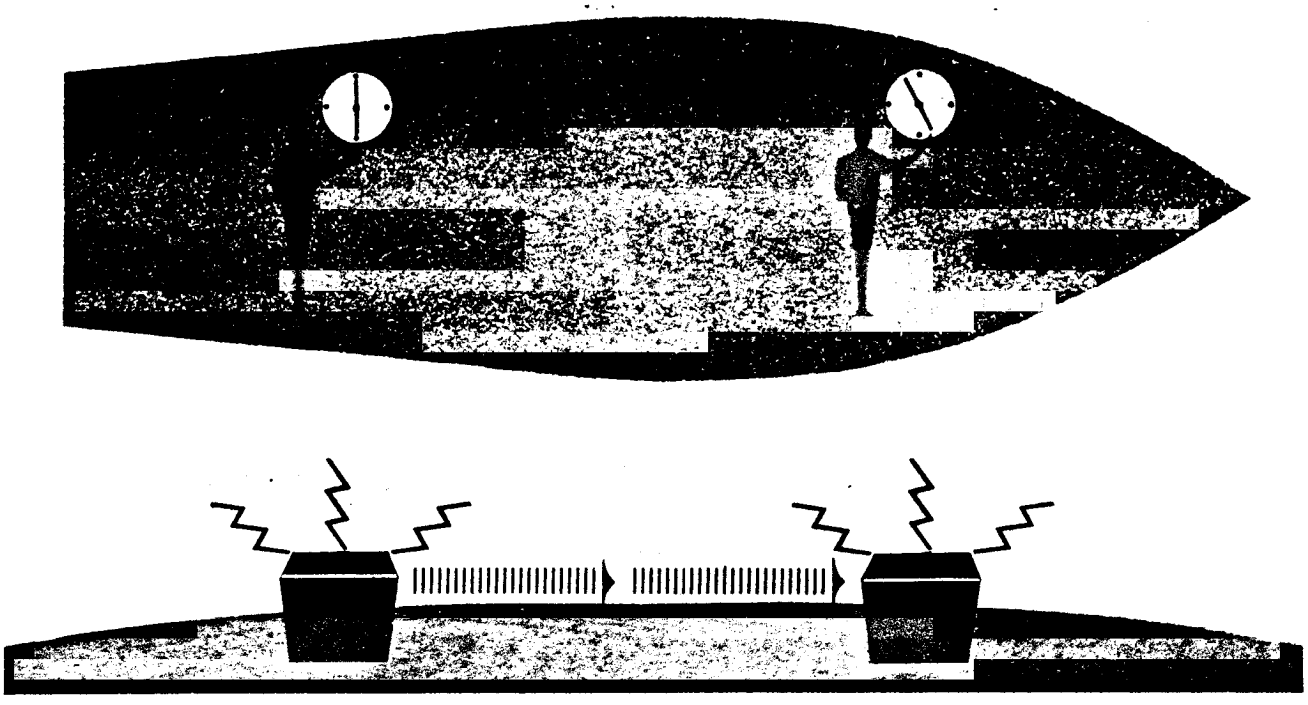
Suppose the man in the front of the rocket had a tachyon transmitter and the man in the rear a receiver just like the ones on the ground. Now suppose the man in front sends a tachyon to the man in back as soon as he sees the ground receiver interact with the first tachyon. To the man on the ground, it will appear that the tachyon in the rocket ship is sent by the man in back. If we choose the speed of the rocket properly, we can even have the tachyon in the rocket transmitted before the one on the ground.

The possibilities in a situation like this are mind-boggling. What if, after seeing the second tachyon "sent," the man on the ground refuses to send the first

In a famous paradox, a twin leaves his brother behind, left, to travel around the galaxy at relativistic speeds.

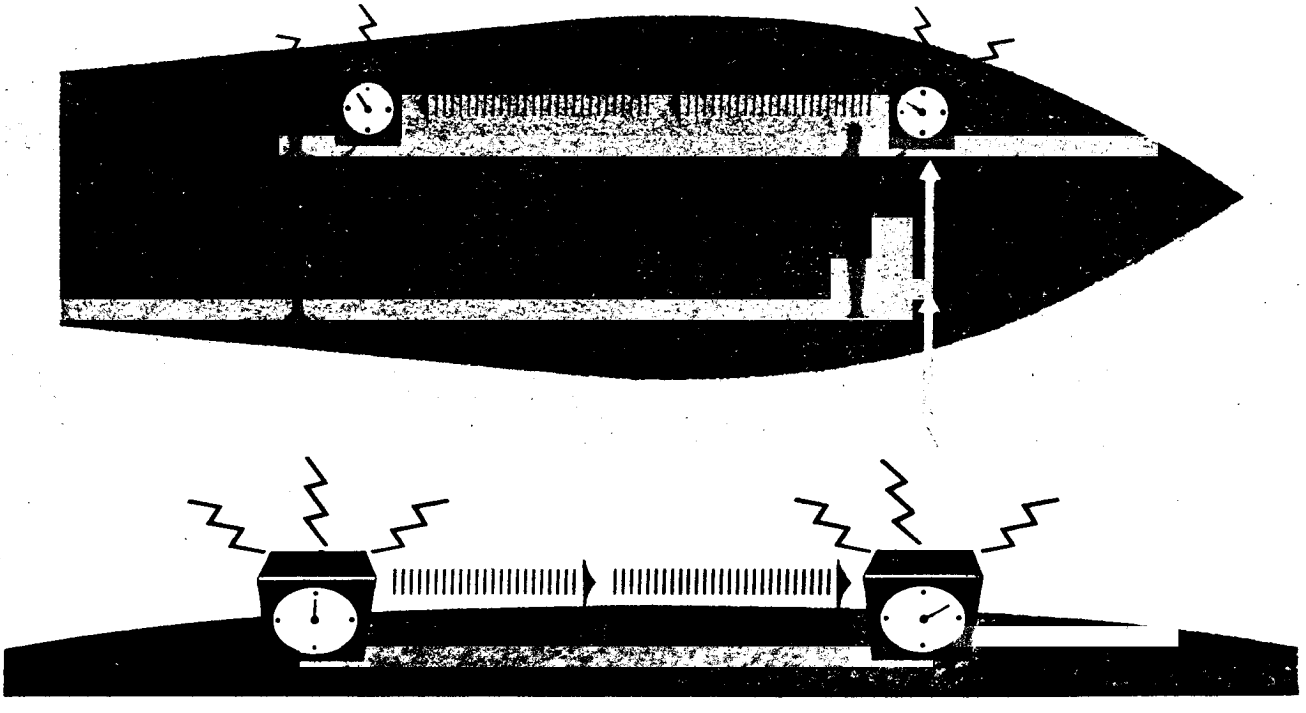


He returns years later, right, to find that his brother, now stooped and paunchy, has aged faster than he has.



To an observer on the ground, a tachyon sent from the box at left above to the one at right simply gets there faster than a light beam would have. But two observers in a passing rocket see something else. The crewmen at left stops his watch when the tachyon is transmitted. The crewman at right stops his when the tachyon is received. When they compare notes, they find that the man on the right stopped his watch first.

The tachyon was "received" before it was "sent," or, more simply, it went the other way. Below, the situation becomes even mind-boggling. This time when the man in the front of the rocket sees the transmitter-receiver below him activated, he sends another tachyon to the man in back. By comparing all the clocks, they discover that the second tachyon was received before the first one was even sent.



one and perhaps even destroys his transmitter? Then the second tachyon wouldn't have been sent. But it's already been received....

I can remember fantasizing about situations like this when reading science fiction as a boy. If something had been sent back 15 minutes in time, then that something would appear in the laboratory 15 minutes before the switch was pulled to send it back. For 15 minutes the object that you are going to send back in time would be sitting on the desk in front of you. Imagine what would be going through your mind during those 15 minutes. What if you didn't pull the switch? It would be like playing "chicken" with the universe.

Actually, physicists have thought quite a bit about this type of paradox involved with tachyons. I think it is fair to say that at the present time, all of the paradoxes can be resolved at the particle level, although the resolutions become stranger and stranger. For example, in the paradox described above, the man in the rocket ship actually sees the first tachyon "sent" from the ground "receiver." If the ground "transmitter" is destroyed, the men in the rocket will see that tachyon go right through the spot where the transmitter was and eventually be absorbed in a remote corner of the universe. He still sends the second tachyon, though, since the "receiver" was activated.

From the point of view of the man on the ground, the first tachyon will appear to move in the opposite direction—from a remote corner of the universe to the ground "receiver." So just after he has destroyed his "transmitter," he sees the tachyon he would have sent come zipping in from outer space, so that his receiver goes off no matter what. In terms of particles, there is no paradox: both tachyons always get sent. But what does a resolution like this do to our idea of causality and chance events?

Whether or not we find tachyons, it's fun to think about time travel. One of the great stories on the subject is "All You Zombies" by Robert Heinlein. The story concerns a girl, abandoned on the steps of an orphanage as a baby, who grows up, is seduced, has a daughter who is stolen from the hospital, and then undergoes a sex change operation. "He" makes a living writing confession stories, and one day comes into a bar and spills the whole thing to the friendly bartender. While the jukebox plays "I am my own Granpaw," the bartender recruits him into the Temporal Bureau, a sort of time-travel CIA. In the end, we realize that all the characters in the story—infant, mother, seducer, writer, and bartender—are all the same person on different stages of travels backward and forward in time. Think about *that* for a while.

So where do we stand now on the question of faster-than-light travel? We know that the existence of tachyons wouldn't violate any general principles of physics, and that an entire world of faster-than-light objects could exist side by side with our own. We have no experimental evidence that they do exist, although this isn't so surprising. Except for the fact that they travel faster than light, we have to guess what other properties they might have, which makes it difficult to think of experiments to find them.

They might not even interact with normal tardyon matter at all, or they might interact in a way that we haven't thought of yet. A good analogy to this sort of situation would be the existence of radioactive elements before the discovery of ways of detecting radioactivity. The elements were there, but no one knew it, and there was no way of detecting them. In any case, all of this is a long way from the starship *Enterprise*.

If at some time in the future someone does come up with a way to detect tachyons, and maybe even control them to the point of being able to emit signals, there would be some interesting consequences. For one thing, the question of whether or not advanced civilizations exist in the galaxy could be settled, because we could have practically instantaneous communication over interstellar distances.

At the same time, the existence of tachyons would pose some pretty sticky philosophical problems about the nature of causality. Physicists have argued that there would be other problems as well: they might not obey the same kinds of laws that govern other subatomic particles. When I think about problems like this, however, I always recall a motto of the Temporal Bureau in Heinlein's story:

A Paradox May Be Paradoctored.

Some day we may talk to the galaxy by flipping a dial (*e.g.*, the blue channel for blue transmitter, upper left).

Of Time and the Mind

KEITH FLOYD

Both present profound paradoxes, and their consideration leads to speculation about a holographic model for the structure of consciousness.

To think about thinking, to wonder about wondering, to feel strongly about feeling strongly: these are perhaps uniquely human forms of awareness. This capacity to reflect upon itself—i.e., reflection upon reflection—appears fundamental to the nature of human consciousness. This thinking about thinking about thinking . . ., Arthur Koestler has called "the paradox of the ego spiral."[1] It is at once our triumph and our tragedy, for in this very human process reside equal potentials for ecstasy and anguish. The moment one thinks a thought, the thinker (subject) and the thought (object) may be experienced as one in the unitary process of thinking. When this occurs, it is as if two mirrors have been opposed and each reflects the other into an infinite regression of reflective depth—past the speed of light, out of time altogether. It is an immediate, direct experience of the infinite within one's own consciousness. On the other hand (the right?), just as we possess the capacity for experiencing the ecstatic heights of union and wholeness in that reflective depth, so do we have an equal capacity for fragmentation and the schizoid splitting of ourselves into thinker and thought, body and mind, feeling and action. This split-up condition of the human psyche is what is commonly known as "normalcy." And as R. D. Laing has so poignantly put it, "What we most need is to be cured of our blasted normalcy."[2]

The mind is perhaps the deepest mystery, the most profound paradox, of all existence. It may truly be that "Darker than any Mystery," to use the words of Lao-Tzu.[3] There is, however, yet another paradox that must be confronted prior to our attempt to formulate a theoretical model of the mind. This preliminary problem concerns the nature of time.

Given our apparently linear, sequential experiencing of past, present and future, we quite naturally interpret time as a constant instead of in terms of a construct, despite Einstein's gentle proddings to the contrary.

Contrary to common conviction, we may all rest assured that nothing has ever happened in the past and that nothing will ever happen in the future. Everything that happens happens at the moment of being, right now, or not at all. We have memory traces that we conveniently refer to as "the past," and we have anticipations that we confidently regard as "the future," but *being* itself is of the present, and ever was, is and shall be. *Now* is none other than that inconceivably subtle (non-existent?) interface between "past" and "future." Paradoxically enough, our present is indeed a generous gift—of absolutely everything and nothing.

Perhaps we'd best pause at this point for a somewhat more concrete treatment of these confusing abstractions. Ready? Five seconds ago we think of as residing in the past, right? At approximately that time you were perhaps reading the word "Perhaps" at the beginning of this paragraph. But at the time you were first reading it, of course, it had to be happening in the present. Five seconds from now will be in the future, right? All right, beginning *now* please check your watch and together we'll find out what it's like to arrive in the future. One, two, three, four, five; here we are in the future, right? Well, hardly. To repeat this elementary consideration, nothing has ever happened in the past and nothing will ever happen in the future. All that happens happens in the present or not at all.

The paradox of the present

Now we must address ourselves to the problem of the present. If it is true that five seconds ago may be considered the past, and five seconds from now will be in the future, then it must be equally true that a thousandth of a second ago must also be viewed as the past, for it is no more. And a thousandth of a second on the other side of this exceedingly fine line we call the present must be thought of as the future, for it is not yet. Between the "no more" and the "not yet,"

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occupying infinitely less than a billionth of a second, lies that eternally present, yet absolutely absent, timeless time zone within which everything that has happened has happened. But it's beginning to seem as if there is no time left in which anything could possibly be happening. There would appear to be no time at the interface. As Paul Tillich expressed it in his brilliant and moving little book, *The Eternal Now*, "The riddle of the present is the deepest of all riddles of time."[4]

The profound paradox of the present is that it both is and is not, all at once, just as the infinite exists only because it doesn't, and it doesn't only because it does . . . (etc., *ad infinitum*, appropriately enough).

To extend the paradox one step further: if all awareness occurs within this infinitely fast moment of being known as the present, then, as Zeno long ago insisted, motion is impossible. A photograph of a racehorse in action snapped at a thousandth of a second yields an image of the horse frozen in a fixed position within that single still frame. Yet we may liken the instant of awareness in the present (for, remember, there is nowhere else for awareness to occur) to a camera that is set infinitely faster than a billionth of a second. If we pan the racehorse and snap the shutter at that speed, we shall have captured stillness indeed, a picture of perfect motionlessness.

Our whole notion of time grows out of what we sense and interpret as motion. Apart from the experience of what *appear* to be sequential, still frames of awareness, giving rise to the illusion of motion, there can be no concept of time.

This principle is readily apparent in regard to motion pictures, but is generally unapparent when it comes to our "ordinary" awareness. (What we think of here as ordinary being most extraordinary indeed!) Sitting in a darkened theater viewing a scene on the screen, we perceive continuous motion, just as is observed outside on the sidewalk. Yet in the case of the former, we are aware that what we experience is merely the illusion of motion created by a sequence of separate still pictures flashing on the screen at the rate of approximately 24 frames per second. At that rate—within the range of our own waking, beta brainwave rhythm, incidentally—we are unable to perceive the separate stills, as the brain insists on interpreting the unfolding scene in terms of smooth, flowing motion.

By way of setting up an analogy that will be useful in a moment, imagine if you will that the projectionist has slowed the projector so that the frames are passing between the light and lens at only half the normal rate. Obviously, the viewer would then observe the scene on the screen unfolding in slow motion, half as fast as before. At 16 frames per second, he begins to be aware of a flicker effect, and at 8 frames per second observes choppy, pixilation movement as in old-time movies. For future reference, please keep in mind that 8 frames per second would correspond roughly to the lower threshold of the alpha rhythm of the brain. Suppose the projector were then switched to a rate of 5 frames per second, corresponding to the middle range of our theta rhythm. The viewer could then begin to distinguish the separate still photographs out of which the illusion of motion is created. Further slowed to 2 frames per second, one's awareness of the paradoxical moving stillness would become even more pronounced. This would, of course, correspond to the delta rhythm which our brains ordinarily produce only during deep, dreamless sleep. Then if the film were to suddenly stop rolling, one would see a single still picture projected on the screen.

Needless to say, it would be quite a revelation for someone having no knowledge of the cinematographic process were he exposed to the above sequence of events. At somewhere around 4½ frames per second, we would probably hear him exclaim, "Ah ha, now I see how the tricky devils do it!" And the moment the sequence came to a stop on one still frame, the entire process would be revealed in perfect clarity.

Still, our friend most likely fails to understand that essentially the same process will continue to function in his own consciousness as he leaves the theater and strolls down the street. It will be no more apparent to him than was the other when he was viewing 24

frames per second, for his brain will be processing the "pictures" that comprise his awareness at a continuous rate approximating 24 frames per second, assuming he is in the normal, waking, beta state.

Let us suppose, however, that our friend approaches an intersection and stumbles onto a teacher of sorts who takes him aside and instructs him in one of the various disciplines that point one toward achievement of "the quiet mind," as they say. Let us further suppose that day in and day out he conscientiously devotes himself to the monumental task of simply sitting quietly and doing nothing. Having struggled to so sit through several years of seemingly self-defeating effort, suppose now our friend is sitting crosslegged in a dimly-lighted room, with his spine straight, his ears in line with his shoulders and his nose in line with his navel. With this picture clearly in mind, imagine that his eyes happen to fall inadvertently upon the illuminated face of a nearby clock.

Having just begun his meditation practice for the evening, he is probably firing beta (approximately 14-30 bursts of neural energy per second) as his predominant brainwave rhythm. In that state of normal awareness, he observes the clock's second hand sweeping around the dial at what appears to be its usual speed. As he continues quietly sitting, thoughts and words, concepts and images slowly begin dropping away from his consciousness. Evidently, his rate of brainwave flashing is gradually decreasing. After a few more moments of this disciplined letting-go, as it might be described, an electroencephalograph would reveal that he is consistently firing alpha (within the range of approximately 8-13 flashes per second). At a constant 10 flashes per second, he experiences not only a blissful, serene state of consciousness, but notices also that the second hand on the clock appears to have slowed to approximately half its former speed. "A very interesting subjective effect," he thinks, in a temporarily jarring burst of beta. And he notices without thinking that a barely perceptible on-off flickering of light has begun to punctuate his awareness, as if he is opening and closing his eyelids at a rapid clip.

Another three minutes of this sitting in tense relaxation brings him yet closer to the stillness within, and he drops down into theta rhythm (approximately 3-7 flashes per second). In this altered state of brain functioning, he experiences a number of highly interesting effects. First he is aware, without verbalizing it internally, that the blissful serenity of alpha has increased so markedly in intensity that it could only be called a state of ecstasy. He finds his mind flooded with creative insights, as if it has established direct contact with every mind that has ever been or ever will be. It could almost be described as a dimension of awareness beyond space and time. His consciousness is expanding and he feels himself at the threshold of what has been called Cosmic Consciousness. And the flickering light pulsations observed earlier have now become much more pronounced. It is as if a strobe light set at around 5 flashes per second, the basal rate at which his brainwaves are firing, is flashing in the darkened room. He notices the choppy, pixilation movement of the second hand on the clock and observes that it corresponds precisely to the stroboscopic rate of flashing. The flickering light he recognizes unmistakably as the flashing of his own brainwaves. It now seems to take the second hand from 15 to 20 seconds to cover a 5-second span on the face of the clock.

When times stands still

Next his brainwave activity drops down to the middle of the delta range, in the area of 1.5 flashes per second. The clock's second hand now "moves," if one could call it that, in imperceptibly shifting still frames, and the ecstasy of waking delta becomes virtually unbearable. Then the strobe-like flashing slows, slows, and stops, and in that timeless instant the second hand on the clock stops dead still. He is astonished to discover that with the stopping of his own brainwaves, all motion in what passes for the physical universe has stopped — dead. Prior to this "moment of the slack jaw," he had always thought of his perceptual apparatus as a sort

of sound-camera, a recorder of events, but now he has glimpsed for the first time that he is also the projector. He has seen that when one's brainwaves stop flashing, birds freeze in flight, people cannot move and the entire universe stands still. The "out there" of external reality has suddenly been seen in a whole new "inner" light. Distinctions such as "inner" and "outer" all vanished in a lightning flash, and he realizes what Lao-Tzu must have meant when he suggested, "It is due to making distinctions that its Suchness is lost sight of."[3] Even the perfectly nonsensical Hindu hint, *"Tat Twam Asi"* ("You Are That") has suddenly made sense beyond sense, and he knows he will never be the same again (he may even rightly wonder if he will ever be "sane" again). With the intrusion of that disquieting thought, the brainwaves again begin flashing, slowly at first, then picking up speed, and the observed "movement" of the second hand on the clock corresponds precisely to the rate of flashing.

Back to beta and the flicker-fusion of smoothly moving images once again, our friend reflects on the implications of the madness he has just experienced. He sees, first of all, that what we think of as time is merely a function of one's basal brainwave rate, a convenient and fascinating fabrication of the conscious mind. Looking even more deeply, he thinks he may see a clue to the nature of what we are pleased to call "death." Clinically considered, he knows that death occurs upon the cessation of brainwave activity, and that the cessation is usually preceded by a slowing-down process. Assuming his experience may be taken as a fleeting glimpse into the nature of things, he anticipates that his own "death" will be preceded by observations of activity perceived in increasingly slowing motion as the moment approaches—people moving about, voices, all sights and sounds inexorably slowing, slowing, and finally stopping—stopping "dead still" (an apropos expression if ever there was one). And he strongly suspects that in that inevitable moment one cannot but catch the biggest joke of all, the one Wei Wu Wei has so cleverly called "the joke that made Lazarus laugh."[5]

When brainwaves are still, time stands still, and when time stands still the illusion of motion becomes impossible, and with the impossibility of that illusion, the fundamental illusion of separate selfhood is in double jeopardy.

Having seen that time (and/or motion) goes slower the slower the brainwave rhythm, it would not be at all surprising to discover that those with superior skills —great athletes, for example—may merely be blessed with basal brainwave firing significantly slower than that of the general population. This may prove to be the critical difference between the "star" and the "superstar." The baseball player firing alpha, for instance, might perceive the ball at no more than half the speed perceived by his teammate firing beta. One firing theta could carefully observe the approach and spin of the ball, examine the stitches, read the label, and have up to four times as much "time" to regulate the swing of the bat and make his moves. The player with the slower brainwave rate could more nearly come close to observing the individual units of motion just short of pixilation. Stopping just short, he would be unaware that his perception differed radically from that of others on the field, but he would clearly have a definite advantage over his fellows. John Brodie of the San Francisco 49ers football team has described precisely this effect and indicated that he and others occasionally experience it during critical plays of crucial games.[6] It might well be that anyone who could produce delta waves at will could pick up a ping-pong paddle for the first time and promptly become the greatest ping-pong player in the world. With the ball perceived as moving at less than one-tenth its usual speed, one would have more than ten times as long to observe and plan and act. You are invited to fantasize freely, Walter Mitty style, and dream up additional applications of this intriguing principle.

While the hypothetical experiences of our friend may be written off by many as pure fantasy, increasing numbers of people know from personal experience that time is an entirely flexible function of their own minds. In various altered states of consciousness, time may be slowed down, speeded up, leap-frogged, or

even run backward. One who insists such things are impossible is presuming a great deal about the nature of reality. The limits of reason, we may reasonably surmise, hardly define the limits of reality. Nature is not bound by the limits we impose upon ourselves. Presumably, whatever obligations She cares to assume are assumed strictly for the sake of Her own amusement.

An experiment with time

To help solder the connections between time, motion, brainwaves and the material that follows, you will need to secure the equivalent of about a dozen 3" x 5" notecards. The only other equipment required for this demonstration are a floor, in lieu of the actual ground, and a willing spirit. Assuming you were conscientious enough to secure the cards, let us proceed.

Please imagine that each card represents what we shall hereafter refer to as an "on phase," a flash, of brainwave activity. This we might view as the level of operation of the conscious mind. Imagine also, if you will, that the floor, or ground (for those of you who are really serious about this), extends infinitely in every direction and represents the dark, deep unconscious, the "Ground" of the conscious mind, out of which come the spheroid bursts of light represented by the notecards. It is roughly the equivalent of Jung's "Collective Unconscious," or "Objective Consciousness," as he later came to prefer calling it.[7]

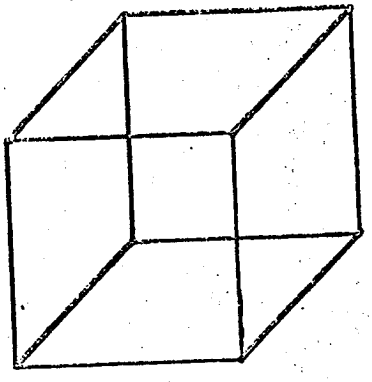
Now, with cards in one hand and this journal in the other, please line your cards up end-to-end across the floor. That done, you are asked to consider that, as with your abutting cards, the flashes of our conscious awareness ordinarily appear as a continuous stream of experiencing with no spaces between flashes and, thus, no perception of separate flashes. We are simply unaware of the dark gaps between flashes; that is to say, we are unconscious of the unconscious (but, after all, that is what makes it the unconscious). Just as an alternating current appears to produce a continuous stream of light in a turned-on bulb, so it is with our conscious awareness. But in both cases it is nothing more than an apparent sequence of stroboscopic on/off pulsations of electrical energy that are simply flashing too rapidly to permit the perception of separate flashes in our field of ordinary awareness. Cards separated by no more than a millimeter would correspond to our normal, waking, beta rhythm.

Reducing the rate of flashing, as in meditation, sensory isolation, psychedelic experience, and other forms of brainwave alteration, we begin to be subliminally conscious of separate flashes. This is preliminary to our conscious awareness of the spaces between flashes. In the language of the street, we are talking literally about getting "spaced out."

Returning once again to your continuous stream of cards laid out across the floor, it would be helpful if you would now separate each card from its neighbor by a distance of about one inch. What you are invited to see in this modified arrangement is suggestive of what one experiences while tuning in the alpha rhythm, as happens in the early stages of most forms of meditation. One begins to become aware of the dark gaps (off phases) between flashes (on phases). With this awareness, one cannot but feel a deep sense of peace and serenity, although one may be completely unaware of why it is happening. Let me suggest that it is because one is on the verge of seeing through the dark gaps into the infinite depths of the unconscious, the ground of one's being. And this inexpressible merging of the conscious mind and the unconscious has all the earmarks of union and communion with the "Ground of Being."

Spreading the cards further apart, say, 5 inches apart, you may now notice that one has equal amounts of "time" in which to be aware of the on phase and the off. This might be seen as corresponding to the upper threshold of one's theta rhythm. It is in this state, you'll recall, that creativity abounds, as one's consciousness is experienced as One with a limitless ocean of Consciousness. As a single process, the conscious mind plunges into the infinite depths of the unconscious and/or the unconscious breaks through from the depth to envelop the conscious mind.

Further slowing the rate of firing (as represented with cards perhaps 12 inches apart) one now has "all the time in the world," as they say, in which to be absorbed and assimilated into that fathomless depth. Then the flashing stops dead still (quickly, pick up your cards!). In that instant, all motion ceases, one is out of time, beyond the relative world altogether. Nothing stands between oneself and the Ground. The conscious mind and the deep unconscious are One, as was always so, but was simply unrealized. And up until the moment the flashing resumes, one is perfectly content, as Camus expressed his highest aim, "to remain lucid in ecstasy."



The Illusion of motion

We must now address ourselves to the problem raised by the necessity for qualifying "sequence" as nothing more than an "apparent sequence." As was suggested earlier, past and future are purely subjective operations and have no objective existence in reality. (The question remains, of course, whether anything exists "objectively" in reality.) Reality knows only the single still frame of the moment of being. Subjective memory and expectation make possible our interpretations of "before" and "after," and give rise to a sense of motion derived from the appearance of a sequence of still frames. It is this apparent sequence that makes possible the illusion of motion. If past and future do not, in fact, exist, there can be no motion. And if motion does not exist, there can be no time. And if time does not exist, space and matter become very tenuous propositions indeed.

To illustrate what appears to occur in the processes of perceived motion, let me begin by presenting below my favorite demonstrator of perceptual shift, the classic Necker cube.

If you will gaze at the above configuration of connected lines for a few seconds, you will suddenly observe that the figure-ground relationships have shifted and you are viewing what appears to be a quite different box. First it may have seemed to be resting on a flat plane, and then it was perhaps seen as hanging out in space. Something apparently changed, but what moved to make that change possible? Obviously, in this case, only your mind "moved."

As you continue gazing at the illustration, you might attempt to discern the point of shift, the interface, between distinctly interpreted perspectives. No doubt you have already noticed that there is apparently no perceptible movement to be seen anywhere in the process. Where there is change, we infer movement, but please keep in mind that it is no more than an inference. In this case, that much is clear; in other cases it may appear less clear, but it is no less the case.

The "motion" of the box shifting cannot be observed, and its "speed" cannot be measured, because what happened happened out of time—infinitely beyond the speed of light. The figure-ground shift occurred in the timeless interval between on phases (flashing) of your conscious mind. During one interpreted flash, which comprised the totality of your awareness in that instant, you observed a single, stable configuration of the cube. Then came an off phase (the dark gap between flashes), and the next on phase revealed the box in a new perspective. (Remember that the idea of an actual sequence of flashes is nothing more than a conceptual convenience and should not be taken literally.) The off phase is of the unconscious, that timeless, limitless dimension, while the on phase is a manifestation of the conscious mind, the surface-level at which we carry on our multifarious (if not nefarious) business of the relative world.

All that we perceive as motion (which is also all that we experience as time—and space, for that matter) is exclusively a function of consciousness shifting figure-ground relationship to create the "next" picture in the perceived "sequence." That "motion" is the no-motion at the point of shift (that infinitely subtle nuance), which only seems to be made up of one still frame after another. Our everyday perception of sequential motion is precisely analogous to the shift in perspective of the Necker cube. As we observe the shifted perspectives, we might be inclined to believe the shift simply happened too quickly to perceive, yet it is actually of a dimension beneath the level of conscious awareness. Neurologically speaking, we have an "on flash" of brainwave activity (conscious mind) in which we perceive one perspective, then comes the off phase in which the figure-ground pattern is shifted to appear as the next picture in the perceived sequence, etc., *ad infinitum*. With every perceived shift in figure-ground relationships we have a new ambiguous pattern presented for interpretation at the conscious level. So the conscious mind and the unconscious, again, shift like the Necker cube, the off phase being the phasing itself between distinctly interpreted perspectives which give every appearance of unfolding sequentially in time.

Another interesting property of this fascinating process is that any number of figure-ground shifts may be perceived in any given amount of "time," since time is not actually a factor. What we might think of as a billion shifts in the perceived motion-picture sequence may seem to happen in what we would call a billionth of a second, or one shift may take a billion years. This might help account for the experience of countless individuals near death who have reported seeing their whole lives in a flash, as if unrolled on a scroll. When the flashes of neural energy slow and stop, all the still frames are there to see simultaneously and instantaneously for there is no more time out of which the illusion of sequence can be fabricated. We are not looking at frames rolling by with the past being taken up on a reel to the right and the future unreeling from the left—we are viewing at a tangent to the linear plane, peering into the infinitely reflective depth of a single still frame. All frames are of the one frame.

In what we observe to be the on-off flashing of brainwave activity, apparently the flash itself is only the moment of awareness of a shifted perspective of the figure-ground relationships in an ambiguous pattern comprising the screen of conscious awareness. Both the point of shift and the flash (the dark and the light, the figure and the ground) evidently occur in no-time, but Consciousness conspires to create the appearance of separate, sequential flashes or frames of awareness. Since there is no time between flashes (the shift requiring none, as was seen with the Necker cube) there is nothing to separate flash from flash, or flash from no flash. The one flash of dark/light is merely the light/dark of Consciousness playing like the illusion of time/motion is for real and forgetting it is playing a trick on itself just for fun.

What before we perceived in terms of a dualistic on/off, light/dark sequence of brainwave activity, we may now wish to view instead as a unitary dark/light pattern of a single frame within which all awareness manifests itself, and out of which any form may be created. The shifting of figure-ground relationships alone

creates distinctions such as on and off in our field of consciousness. This should come as no great surprise as our Buddhist neighbors have for centuries been trying to tell us that Nirvana (the Infinite Unconscious) and Samsara (the day-to-day activity of the conscious mind) are one and the same. The unconscious is as readily apparent in every off phase as the conscious mind is in every phase of the cycle, but we fail to see the former because of our lock-step habit of paying attention only to the latter. When brainwaves are slowed to the range of perceptible flicker, we begin perceiving with equal c[illegible] the off phase and the on phase (Nirvana and Samsara) and we realize the essential oneness of the cycle, i.e., that there is no on without an off and no off without an on—each creates the other and is the other. Every wave has a crest and a trough; every brainwave has an on and an off.

To repeat once more, the unconscious is manifested in every off phase of the on-off cycle. It is as if one shoots down (or opens up) at a tangent through the dark gap between on phases, and that tangent extends infinitely in every direction into the deep unconsciousness. But it must be remembered that there is no time or space, and so, no directionality in the unconscious.

In our "ordinary" consciousness we fix our awareness only on the on phase of the cycle. In our "high" moments, we see through the surface screen and see that which cannot be seen. This is like God playing hide-and-seek with Himself, as in the Hindu Vedanta scheme of things. There can be no on phase without an off, but there can be an off without an on. Before the beginning (of "time") there was an off (Void) that wasn't even that, for it wasn't an off relative to an on or to anything at all. "And God said, 'Let there be light'" (an on flash), and the cycle was established. At "death" the on phase ceases along with the relative off, but not the Absolute Off, the Ground of All Being. Once one has awakened to even a partial realization the deeper Nature of his Being, (i.e., catches a glimpse into his Self-Nature, as they say in Zen), then the idea of death has forever lost its sting.

It is as if all that we see as comprising our separate selfhood is drawn on an infinite sheet of paper (infinite in every direction, unimaginably enough), and we learn to think of ourselves as contained within the outline of the drawing. We neglect to notice that the outline appearing to circumscribe our entire being is the same line as the inline of everything else. And that inline delineates and defines our apparent individuality as precisely as does the outline. They are, in fact, the same line; it's just a question of shifting perspective. We naturally fail to see that all that surrounds us and gives us our sense of selfhood is everything that is —and that includes ourself. At the moment of what we term "death," it is as if the line, the most superficial aspect of our case of mistaken identity, is merely erased. There is as much "self" as ever left within the former boundary line, but now we see the whole idea of a separate self was no more than the illusory feeling of separation itself. To illustrate it somewhat more poetically, we are rather like a plastic bag of seawater sinking into the fathomless depths of some infinite ocean. At the moment of "death" and/or "ego death," the plastic bag, by which we maintained all sense of our separate seawaterness, suddenly disintegrates and disappears leaving no trace. The water we had identified as our "self" may appear forever lost, or the whole of the warm and boundless Sea of Being may be seen as gained. Again, it's all a question of shifting perspective. Clinging to the unreal sense of separate selfhood past that ultimate point would quite literally be one hell of a fix, figuratively fraught with no little weeping, wailing and gnashing of teeth. Conversely, letting go to flow freely beyond that infinite point could be nothing less than a perpetual state of ecstasy.

This way of looking at our Self-Nature might go some distance toward explaining various forms of psi phenomena which otherwise may seem to defy both "natural law" and rational explanation. If the deep unconscious is continuous with everything that is (or is what everything is!), then what we think of as our consciousness is one with all the consciousness that is, has been or shall be, to put it in temporal terminology. From this perspective, it would be expected that ESP

is not limited by the speed of light, for Consciousness has nowhere to go—it's already there! It should not seem surprising when a mother dreams her son's plane crashes on the other side of the world at the precise instant of the actual event. After all, is it not the same Consciousness in which they live and move and have their Being? Being in the here and now knows no separation, no split, in time and/or space. Precognition and retrocognition would be seen as natural phenomena, and not at all astounding, once one recognizes the absence of even the concept of time in the deep unconscious. Distance and duration are exclusive properties of the relative space-time frame of reference. It is encouraging to note that the idea of the Oneness and Allness of one and all, once thought the drink of wild-eyed mystics, is fast becoming the meat of clear-eyed modern physicists.

A holographic model of consciousness

In Consciousness, the one frame is every frame, storing an infinitude of images in an infinitely creative pattern of pure and perfect ambiguity. As in the enormously exciting process of three-dimensional lensless photography known as holography, a vast amount of optical information—many pictures—may be stored within, and retrieved from, a single holographic plate, depending on shifts in angles in the exposure and reconstruction of images. To extend the parallel one step further, it is interesting to note that any single fragment of the hologram is seen to contain the entire image stored within the complete holographic plate. Each part is at once the whole, and the whole is every part. It does appear modern science and ancient mysticism are about to meet at the crossroads. Perhaps neither will be too surprised to discover each is but a mirror image of the other.

If we are to succeed at this point in developing a holographic model of the structure of consciousness, it will be necessary to assume for the time being the philosophical posture of commonsense realism. In other words, we must proceed as if we accept at face value the objective existence of external reality in general, and of the physical brain in particular. The built-in limitations of our dualistic language structure will also no doubt continue to bedevil us.

All that we experience as external reality is apparently nothing more than patterns of neuronal energy firing off inside our heads, yet these patterns have the capability of representing (or reflecting?) a broad spectrum of sensory, nonsensory and extrasensory experiences. A free (and freeing) translation from an ancient Sanscrit manuscript has provided the rules for the game: "Gracious one, play your head is an empty shell wherein your mind frolics infinitely."

Increasing numbers of neuropsychologists and neurophysiologists are coming to regard higher brain functions in terms of an optical system processing a form of bioluminescence (light in the midst of the darkness of the skull). To briefly summarize my own tangent in this general line of speculation, let me suggest that brain functions such as perception, memory, imaging, etc., are beginning to appear most clearly explainable on the basis of a holographic model[8,9]. The "screen" of awareness may turn out to be an organic form of a holographic plate which processes three-dimensional perceptions and reconstructed images with equal facility.

Although laboratory evidence is just beginning to accumulate, and introspection remains suspect, it may not be premature to hypothesize that the area of the midbrain immediately posterior to the optic chiasma will be found to be the locus of a neural holographic plate. The pituitary gland, hypothalamus, thalamus and pineal body in particular appear to be intimately associated in the theater of conscious awareness. The discovery that the pineal body, long thought by many a vestigial sensory organ, is partially composed of light-sensitive tissue similar to that found in the retina of the eye, seemed to lend support to the speculation that it might serve as the "grid" of patterned ambiguity on which perceptions are constructed and memories are reconstructed. This seemed too much to hope for, of course,

inasmuch as this pea-sized organ has for so long been regarded in the East as the "third eye," and considering that Descartes and others had so long ago designated it "the seat of the soul."

In attempting to work through the interrelationships of the organs of the midbrain, all that seemed clear at first was that the thalamus apparently radiates neural energy to the opposing cerebral hemispheres and possibly organizes incoming impulses into more coherent wave forms. In this process, it was also suspected that t[illegible]halamus may serve as the source of the alpha rhythm, as a regulator of brainwave frequency and intensity, and may play an important role in the scanning and retrieval mechanism(s) of the brain. It appeared, however, that if the pineal body did play a primary role in perception and memory, its excision would be seen to produce profound, if not total, disruption of these functions. Such, of course, has not been shown to be the case. The removal of the pineal body in rats disrupts the circadian rhythm, the biological clock of the organism, and similar effects have been observed in humans. Further reflections on the process suggested that the "screen," the holographic plate which I had so long been attempting to identify with an organ, may actually be a function of an area instead of an organ. It began to appear that the pineal body occupies the midpoint at the center of a neural energy field, at which point occurs the burst of light that is experienced as the screen of consciousness on which shifting figure-ground relationships represent external reality. This would be the same point at which the sense of time and/or motion manifests itself, and so it should not be surprising to discover that the removal of the pineal body strips the gears of the biological clock. This would simply mean that the monitoring mechanism of the sequential bursts of light goes when the pineal body goes. The flashes persist in the s[illegible] area, at the same point, even though the organ at which they had occurred has been removed.

It now seems highly plausible that the "seat of consciousness" will never be found by a neurosurgeon because it appears to involve not so much an organ, or organs, but the interaction of energy fields within the brain. These patterns of energy would be disrupted by surgical intervention, and have long since disappeared in cadavers. Neurophysiologists will not likely find what they are looking for outside their own consciousness, for that which they are looking for is that which is looking.

In terms of the model under consideration, this mysterious area of the midbrain would evidently function as a transducer in the processing, or impedance matching, of "external" (physical) and "internal" (neural) wave energy. Patterns of brainwaves would be activated in the contralateral cerebral hemispheres (each being a mirror image of the other) based on the holographic image perceived. Memory would involve enervation of the originally-fired neuronal circuits, a reactivation of the brainwave patterns that were interpreted as the original experience, a convergence of interference waves reflected from the contralateral hemispheres, and a reconstruction of the original hologram. What we term "memory" would be seen as the conscious-level interpretation of the otherwise ambiguous figure-ground pattern appearing on, or within, the holographic plate, the locus of conscious awareness. Coherent wave energy may also be found essential to the process, just as coherent light produced by the laser is necessary in holography. Perhaps the neural energy must be polarized and made coherent for the system to function efficiently. As is true of the holographic process, the more coherent the light, the clearer the reproduction of the holographic image. The degree of coherence of the wave forms might well determine the relative degrees of efficiency in both the storage and retrieval processes.

In all fairness, it should be remembered that the foregoing summary of personal speculations is based

on the perhaps groundless assumption of the brain in a general scheme of commonsense realism. Still, it will surely do us no harm to recognize and acknowledge our assumptions as assumptions. We might even go so far as to seriously consider that, contrary to what everyone knows is so, it may not be the brain that produces consciousness, but rather that it is Consciousness that creates the appearance of the brain, matter, space, time and everything else that we are pleased to interpret as the physical universe. All we can possibly know for sure is that something very interesting is going on. Exactly how, why or what it's all about, God only knows! And the biggest paradox of all may well turn out to be that there's not a paradigm's worth of difference, so to speak, between Him and you.

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