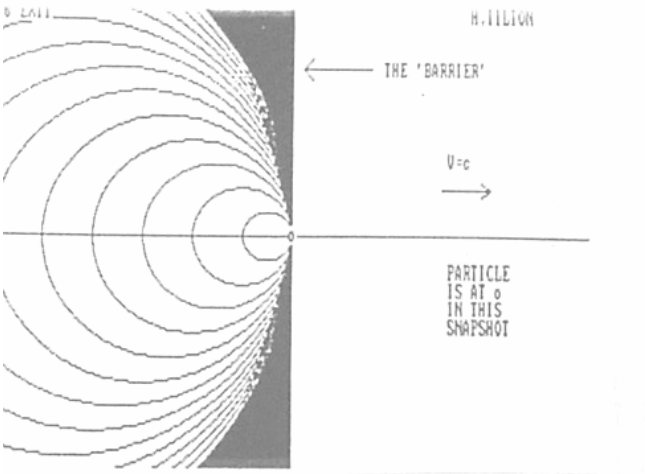
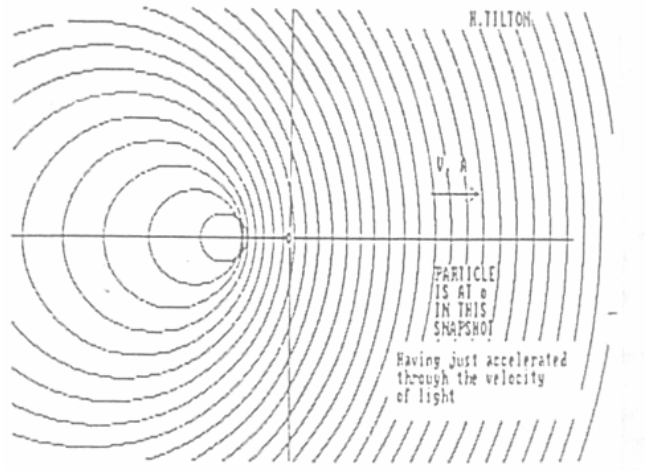
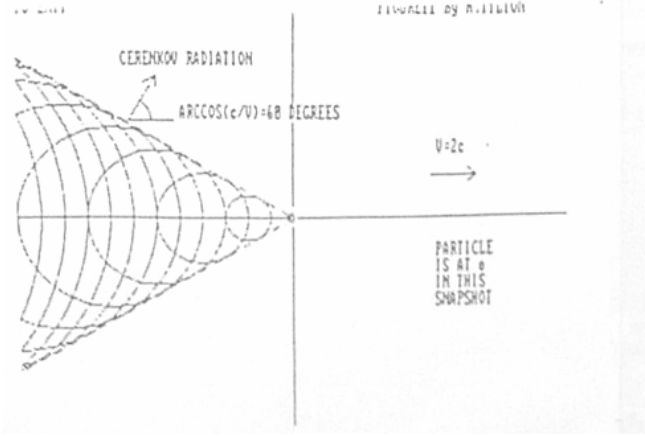
BEGIN the ADVENTURE
How to Break the Light Barrier by A.D. 2070

Homer B. Tilton
Florentin Smarandache







To the memory of Benjamin E. Tilton (1876-1955), a close contemporary of Albert Einstein (1879-1955)

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BEGIN THE ADVENTURE
How to Break the Light Barrier by A.D. 2070

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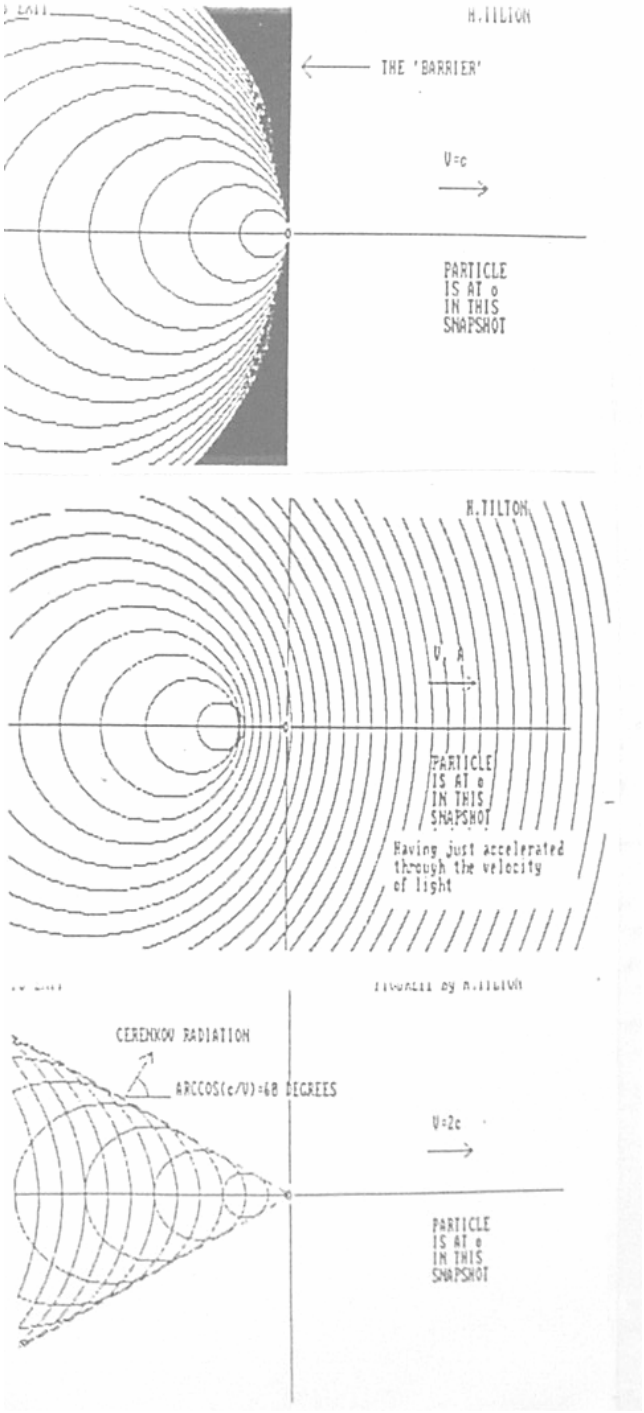
2004

About the Cover



The three illustrations on the cover are figures 9, 10 & 11 from the book LIGHT BEYOND BELIEF by Homer B. Tilton, Echo Electronic Press, 1995; ch.4, "The Dynamic Equipotential Model."

Top - The pattern of isochrons from a particle moving at the velocity of light; the barrier is evident;

Center - The pattern as a particle accelerates through the velocity of light; note that there is no longer a barrier in evidence;

Bottom - The pattern corresponding to a particle moving at twice the velocity of light; the Cerenkov shockwavefront is clearly shown.

Isochrons are the loci of gravitational or electrical quanta that are emitted from the particle at the same time. Successive isochrons correspond to discrete, successive times of emission. Isochrons are spherical bubbles of information expanding at the speed of light with center at the position the particle had at the time of emission in the observer system in accordance with the second postulate of special relativity.

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Preface

For most of the 20th century, both relativity and star travel fascinated this writer. The reasons Albert Einstein concluded there is an absolute barrier at the speed of light seemed at first clear, then later not so clear upon closer examination.

"The speed of light relative to what?" I often asked anyone who would listen. The common response was, "Light needs no specification of that kind; its speed is the same no matter who measures it."

"That's true." I would respond; "That's just the second postulate of special relativity which is not in doubt; but that postulate applies to light, and we're talking about rocketships here." However it seemed that no one understood what I was saying.

By referring to the universal constant c= 299.792 458 megameters per second as "the speed of light," we paint ourselves into a logical corner in which light is automatically taken as the subject of discussion even when it is not. The careful reader will know not to immediately think "light" when he hears or reads "the speed of light." But it is better to have a neutral name for that universal constant. It has been called the Lorentz speed; Ignazio Ciufolini & John Archibald Wheeler (1995) called it the characteristic speed of space, and they were then able to apply it to all "primordial forces" whether electromagnetic or gravitational or other (what other, C&W did not say).

A fundamental difficulty that even experts have is separating Einstein's conclusion of a light barrier from the postulates of relativity. His conclusion does not follow with certainty from those postulates. One can accept the postulates and still justifiably doubt the impenetrability of the barrier. If one ferrets out the reasons for the penetrability of the local light barrier in the moderating baths of nuclear reactors by high-energy electrons then one can begin to see what is involved.

To help us do that, an appendix to chapter 4 explores an analogy wherein a case is made for calling *c* the resonant speed of space. For the engineer and the radio amateur, the term "resonance" can lead to a whole new vista of mental images, a healthy vista in the present context. To radio amateurs and those other readers who are knowledgeable in such matters I say, go now; go where your instincts take you.

The premise of this book is that the effects of the special theory of relativity are a kinematical perspective rather than being real; but "reality" is a slippery concept, and it is expected that the reader will keep that in mind. Towards clarifying that concept insofar as it applies herein, a working definition will unfold as the reader progresses through the book. The test of reality to be ultimately applied is whether or not it is really impossible to make a round trip to Alpha Centauri in a reasonable time.

This book is not an attempt to repudiate relativity; rather it is a clarification of it. It outlines an experimental design to test that clarification. It suggests that perhaps the only thing wrong with relativity is its usual interpretation.

This book, BEGIN THE ADVENTURE, 2004, is the last in a trilogy starting with THE LIGHT BARRIER, 1990, and continuing with LIGHT BEYOND BELIEF, 1995. Contact me for copies of those prior books. Related analyses also appear in *Speculations in Science and Technology*, 1993 (ISSN 0155-7785); and in Elec*tron and Ion Beam Science and Technology* from The Electrochemical Society, 1968.

Homer B. Tilton

Pima Community College, EC
Tucson, Arizona
April 2004

2nd-Author Preface

An hypothesis is presented in Chapter 10 that there is no speed barrier in the universe and that one can construct arbitrary speeds. One then asks if it is possible to have an infinite speed. The basis for the hypothesis lies in the entanglement theory of quantum mechanics and deals with the transfer of information over large distances.

Dr. Florentin Smarandache

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The University of New Mexico at Gallup
February 2004

Guest Preface

The special theory of relativity (STR) is indeed a kinematical perspective. By that I mean to say that STR simply deals with velocities, which are kinematical quantities. That the speed of light is the same for all observers is seen from experiment. Being a theorist, I cannot undertake a real experiment; however, the grand experiment that Homer proposes is only a theoretical one and I support his right to consider it.

Insofar as "reality" is concerned I claim not to know it. I only accept that all is illusion, and that "reality" is whatever one chooses to accept. Hence, I cannot state that STR is "reality"; but then I cannot also state what exactly is "reality." I am, however confident that much of my research in thin films is performed under the rubric of STR, my ignorance of "reality" notwithstanding.

Dr. Akhlesh Lakhtakia

Distinguished Professor, Engineering Science and Mechanics
Distinguished Professor, Graduate Program in Materials
Pennsylvania State University
March 2004

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Dr. David Iadevaia, astronomer
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Jim Oliver, engineer

Chapter 1

Introduction

The line between fact and faith is often blurred. In this spirit we ask the reader to please set to one side any pre-knowledge concerning the light barrier while we explore it in these pages.

One's reach should exceed one's grasp. Thus we reach for Alpha Centauri with a round-trip manned and womanned mission as the proposed overarching goal under a clear plan of exploration - *a grand experiment* described in later chapters.

Whether or not we succeed in grasping the goal under this or under any plan is not as important as it is to set a definite plan and work towards its goal. The plan outlined here is in two phases: Phase one has a high probability of success, given the required propulsion system; the chances of phase two working will be indicated by results obtained from phase one.

A fundamental problem is the one of propulsion. It is important to the working of this plan, a highly optimistic one, that the engine be capable of a sustained acceleration of ¼ G in phase one and 1G in phase two. ($1G = 9.80665\ m/s^2$) Such an engine is within the reach of present ideas.

Aircraft propulsion started with propellers in the Wright Flyer, briefly flirted with rockets in the Bell X1, and finally settled on air-breathing jets. Taking a lesson from that progression, we propose to accelerate the development of something along the lines of the interstellar ramjet proposed by Robert Bussard in 1960. His engine would harvest, en route, the tenuous interstellar cloud material to use as the working fluid or fuel in a nuclear-powered jet engine having a huge, electromagnetically-augmented intake maw. Mallove and Matloff, page 109: [1]

Bussard...found that for a starship mass of 1000 tons ... *the craft could accelerate almost indefinitely at one g!*

Bussard put the velocity at which the ramjet "bites" (its minimum operational velocity) at a few tens of kilometers per second. (60 km/s is 0.02% c.) But our present concerns are with relativity, not starship propulsion; so we leave it there and bank our propulsion hopes on Bussard and others.

An eight-year manned mission is planned to place a spacebuoy ¼-way to Alpha Centauri at *San Salvador Station* and return to Earth as phase one of the experiment. While such a mission might be carried out with an unmanned probe, the overall purpose of the grand experiment is to transport Humans to another star and return them safely to Earth in a reasonable time.

The projected timetable under phase one of the grand experiment is this:

2020 - First Human sets boot on Mars;
2021 - Development begins of Bussard interstellar ramjet and SS Alpha
2037 - Final crew training for SS Alpha begins
2040 - SS Alpha commissioned
2041 - SS Alpha heads outward at a steady ¼ G acceleration;
2045 - Spacebuoy placed at San Salvador Station ¼ way to Alpha Centauri;
2046 - *Jupiter Station* established;
2049 - SS Alpha arrives back at Jupiter Station with all hands safely on-board.

One reason for sending Humans on SS Alpha is to test for psychological, physiological and physical effects of the relativistic distortions. Ever since the introduction of the automobile, speed in transportation has been a concern:

> *The human factor may prove to be the real limitation [to high speeds]. The human body is ill-adapted to the physical and psychological effects of supersonic flight.*

That, from a 1957 encyclopedia (Collier's).

Recent trends in thinking view the distortions of the special theory of relativity as only appearances, unable to affect Human physiology or the intrinsic dimensions of objects. While particles in a particle accelerator really are limited to the speed of light, it is easy to show that is because the motor - comprised of the accelerating coils and electrodes - is fixed to the laboratory. The same is true for proposed ships propelled by light pressure from the sun. The sun is the ship's motor and its speed reference. But what about Einstein's sweeping generalization: "From this...we conclude that... *[c]* can neither be reached nor exceeded"?

In the case of a rocket or jet where the motor travels with the ship, how and why such vessels should be limited to light-speed relative to an Earth-bound laboratory or to the sun or to *anything* remains a mystery. The first manned starship under phase one of the grand experiment - while itself not attempting to exceed lightspeed - would help to resolve that mystery.

The slowing of certain kinds of clocks under increased gravitation and acceleration fields, as predicted by the general theory of relativity, is no doubt real in the sense that the speed of light is slowed in such fields; but note that a pendulum-regulated clock would run *faster* under increased gravity; and the assumption that "time itself" would run slower there seems to be a too-sweeping generalization. Physics books tell us that time has physical meaning only in its measurement in the form of uniformly repeated or periodic motion.

In any event, if a 1G acceleration is maintained throughout the trip to Alpha Centauri under phase two of the grand experiment, then under general relativity all clocks on the ship would be expected to keep pace with those on Earth; and if the twins paradox - formulated under the special theory of relativity - is only an appearance, there would be no permanent "set" in time. Just as a stick removed from water "unbends," so too would the twin's age differential be expected to "unset itself" when 'he returns to Earth.

A Human trip to San Salvador Station under phase one of the grand experiment, would conclusively test those things. Newton, as popularly paraphrased: "The proof of the pudding is in the eating."

Beyond the relativistic distortions, the inability to exceed light speed by compounding velocities is often taken as proof of an absolute barrier at the speed of light. But the resemblance of that scenario to Zeno's puzzle "The Achilles" is inescapable; and the compounding of velocities is only one particular way that the speed of light cannot be exceeded.

In Zeno's puzzle, Achilles' attempt to overtake the tortoise consists of an infinite series of jumps, each cutting in half the remaining distance to the tortoise, with each jump consuming the same amount of time; but that is equivalent to Achilles first running, then walking, then slowing to a crawl as he approaches the tortoise. To a neutral onlooker it would appear as if Achilles' goal was simply to pace the tortoise. In a similar way, the speed of light cannot be exceeded by reducing the acceleration towards zero as the goal is approached as is the case with particle accelerators. Is it mankind's goal to simply pace *photons*? A neutral onlooker might think so.

Another reason some have given to conclude that *c* is an absolute speed limit (...Not sure what that means any more?) is that no energy from a light signal would be returned to us from a body receding faster than that. But in the end, it all comes down to a matter of whether or not the observed distortions reflect actual physical changes to the bodies being observed. Phase one of the grand experiment would help to settle that question.

Recent work with the entanglement theory under quantum mechanics also casts doubt on the impenetrability of the light barrier. Finally, super-fast electrons in the moderating baths of nuclear reactors which produce blue Cerenkov radiation clearly have broken the local light barrier, and it is hard to rationalize the existence of a second barrier there at the free-space speed of light. [2]

The placement of a spacebuoy would be an invaluable experiment in itself. If it indicated that the speed of light is a barrier even for a self-powered rocket, then that would end our aspirations of practical star travel for now. On the other hand if it were to indicate that the relativistic effects are only appearances and that lightspeed presents no physical barrier, then that would mean speeds in excess of 300 megameters per second away from Earth can probably be attained using a rocket or Bussard interstellar ramjet in a way pretty much as Isaac Newton might have envisioned. In such an event the projected timetable would continue under phase two of the grand experiment as follows:

2050 - Crew training for the Alpha Centauri mission begins;
2069 - Starship Suzue leaves Jupiter Station for Alpha Centauri at a steady 1G acceleration with eight crew and ambassadors on-board;
2070 - Humans break the light barrier;
2073 - Humans reach Alpha Centauri, place two orbiting embassies there in a made-for-TV ceremony;
2077 - Starship Suzue arrives back at Jupiter Station with all hands safely on-board.

Notes:

[1] Mallove and Matloff give a good overview of these propulsion methods in Ch.7 & 8 of their book, *The Starfligh Handbook*, 1989, ISBN 0-471-61912-4.

[2] The electrical "Q" and the resonance peak (the light barrier) of water are not infinitely high because water is a lossy medium; therefore impinging high-energy electrons are able to cross the barrier. The Cerenkov shockwave can be diagrammed as a series of eccentric circles to accurately show the orientation of the Cerenkov shockwavefront at an angle of Arccos(c/(nv)) to the particle path in a medium whose index of refraction is *n*. See cover illustration or a physics text.

Chapter 2

The Human Barrier

There is a Human barrier standing guard over the light barrier. It is a buffer that refuses to let rational Human beings question a statement by authority.

Once a barrier is erected, it is difficult to dismantle it. The Berlin Wall is one example; the Light Barrier is another. And when we speak of measuring the velocity of a ship as it approaches the velocity of light, a fact that is commonly overlooked is that when the ship tickles the speed of light, the observer loses sight of it anyway, and even relativistic mathematics is unable to penetrate beyond that point. The application of sublight relativistic mathematics beyond that speed is clearly idealistic and virtual. It is simply inappropriate and can be misleading. It is true that for a ship receeding at nearly the speed of light, photons from it continue to impinge upon the observer's position at the speed of light (ideally and virtually), but those photons have lost all sensible energy. They have without question become unreal. And a superluminary speed would not undo that loss of visibility. Some written reactions to our view which may be typical are given next. These and other concerns are addressed in this book.

Professor of physics NS at PCC: Light as a limit was not Einstein's opinion; it's as supported as gravity... Perhaps you should consult with a physicist... . (May 1996)

[We *had* previously consulted a physicist. His reaction is noted next. …HBT]

Professor of physics RP at UA: It is indeed known that the special theory does not necessarily prove the speed of light cannot be exceeded; [but] I'm comfortable considering the speed of light to be the maximum speed. As it happens that we have never been able to observe meaningful speed greater than that of light, and because light appears to have the same speed in all inertial frames, physicists take the "maximum speed" to be the speed of light. (Ca.1972)

[A view not often seen expressed, and one not in direct opposition to our own. Apparently RP saw no theoretical basis for ruling out faster-than-light speeds. It might be pointed out that we have never seen a supersonic bird either, and so the fact of non-observance does not seem to be quite adequate to rule out those speeds. ...HBT]

Professor of astronomy DI at PCC: If an experiment is performed such that "the motor travels with the ship" the KE [kinetic energy] for a given mass "ship" at a given velocity will increase if relativity is correct or [will not] if Tilton is correct... . The KE will be dependent only on the v^2 and not on the relativistic mass (m) for Tilton to be correct. (March 2004)

Professor of engineering JM at PCC: The assertion has been made that if a rocket simply accelerates long enough it will exceed the velocity of light. / To see if this is true one needs to solve for the equations of motion. / The fastest the rocket can go, as measured in the fixed frame, is one light year per year. / The limiting velocity of material objects is the speed of light. / The argument has been made that the mathematics are correct, but that the "apparent" velocities are just an illusion like the apparent bending of a straight stick extending into a pool of water. This is false. The predictions of relativity are real and have been experimentally verified. Verification of the composition-of-velocities formula near the speed of light is also provided by particle accelerators which accelerate particles near, but never beyond the velocity of light. Time dilation has been verified by measuring the lifetimes of unstable particles in cosmic ray debris and particle accelerator experiments. Experiment is the final arbiter in science, and experiment verifies that the velocity of light is the speed limit. (April 2004)

Einstein apparently thought of the distortions described by special relativity as reflecting actual physical changes in the bodies being observed; that view would make little difference if it had not led him and his disciples to conclude that there is an impenetrable barrier at the speed of light: "The velocity *c*...can neither be reached nor exceeded by any real body."

Nearly everyone picked up on that reality theme, and ever since it has been principally those outside the mainstream who openly question the impenetrability of the light barrier.

Einstein's conclusion is so firmly embedded in today's culture that books are written for the general reader which treat it as gospel; one recent book written by Zimmerman & Zimmerman comes to mind.[1] Actually, only the tenth chapter deals directly with the light barrier: "Can Anything Travel Faster than Light?" on pages 79-84. After asking the question twice more on pages 79 & 80, Z&Z give Einstein's answer at the top of page 81: "The answer is no." Then they present perhaps their strongest argument in support of that answer at the bottom of page 81: "At the speed of light, all the energy that one puts into an object is converted into mass." [2]

Z&Z continue: "A golf ball that is traveling at the speed of light cannot speed up any more." True in the sense that no accelerating force can reach it from the ground.

Z&Z end the chapter on page 84 with: "In media such as glass or water, yes [you can go faster than the local speed of light]" as Cerenkov hypothesized and proved, but they do not address the question of how much faster. It is true that no one knows for sure how much faster because that experiment has not yet been performed; and so Z&Z assume Einstein's sweeping generalization as is usually done: "The speed of light in a vacuum... is the fastest that anything in the universe can travel." A bald-faced declaration with no traceability to a conclusive proof or a definitive experiment.

The theme has a tenacious hold on the scientific community as well. Robert L. Forward: [3]

> *It is difficult to go to the stars. They are far away, and the speed of light limits us to a slow crawl along the starlanes. Decades and centuries will pass before the stay-at-homes learn what the explorers have found. ... If standard rockets are used to propel a space vehicle, the vehicle will be limited in its terminal velocity to a small fraction of light speed.*

Those few lines contain too many (six) downer words and phrases to list, so they have been underlined instead. It is essentially one entire downer passage; in addition, it may unfortunately suggest to some that rocket propulsion is no better at attaining high speeds than any other kind of propulsion - say, light sailing. Sorry to say, such a depressing outlook - and an erroneous one in our view - is all too common. It is directly traceable to Einstein's reality view of special relativity.

But an alternate view now gaining popularity is that the distortions of special relativity, in the words of two mid 20th-century Cornell University physicists, F. K. Richtmyer and E. H. Kennard, are only "a sort of kinematical perspective" like the optical illusion of a rod stuck in water that appears to be bent but is straight, or the stars that appear as mere points of light but are much more. The practical results of such a change in view are most profound in that we can no longer be certain that we are "limited... to a small fraction of light speed." Showing how we might exceed lightspeed while remaining within the bounds of relativity is what this book is all about. Relativity is taken as a given; the devil lies in its interpretive details.

Einstein died in 1955. Then around 1974, cognitive scientist Palmarini discovered a hitherto unrecognized human characteristic that he calls *cognitive illusions*.[4] Such illusions color one's thinking - even that of a genius. Thus there is now a scientific basis for questioning Einstein's reality view of the relativistic distortions which led to his conclusion of an impenetrable light barrier.

> *If an emissary from* Megalopolis *at the hub of Galactic civilization had arrived at Earth 100 years ago to clandestinely and deliberately disuade Humanity from attempting to reach the stars, the effect could hardly have been more devastating than what has actually transpired. We are truly captives of our own doubts & fears, superstitions & beliefs, which often masquerade as superior knowledge, and which hold us back even while our dreams and instincts work to carry us onward and outward.*

Notes:

[1] Barry E.Zimmerman & David J.Zimmerman, *Why Nothing Can Travel Faster that Light... and Other Explorations in Nature's Curiosity Shop*, Contemporary Books, 1993, ISBN 0-8092-3821-7.

[2] But it can be shown that such an interpretation of "mass" consists of two physical components: the *source strength* of the mass-object which equals the intrinsic (proper) mass, and the average density of the graviton field. The source strength is constant, the other component is not; and that is in accord with the usual interpretation of the constancy of electric charge. (In the case of electric charge, "the other component" is the kinematical construct we call "magnetic field.") This analysis appears in *Speculations in Science and Technolgy*,1993, Vol.16, No. 4, pp. 297-303, ISSN 0155-7785.

[3] Robert L.Forward, "The Stars Our Destination? The Feasibility of Interstellar Travel", *The Planetary Report*, Jan/Feb'03, pp. 6ff; The Planetary Report is the official publication of the Planetary Society whose membership includes many from JPL which has done much of the work connected with planetary exploration, including the building and operating of the two Mars rovers which are presently active on the surface of Mars as this is being written in early 2004. Thus Bob Forward has the ear of a significant part of the interested scientific community.

[4] Massimo Piattelli-Palmarini, *Inevitable Illusions: How Mistakes of Reason Rule Our Minds*, 1994, ISBN 0-471-58126-7.

Chapter 3

An Overview

Einstein's postulates of relativity as translated from his celebrated 1905 paper by W. G. V. Rosser:

1. The laws by which the states of physical systems undergo change are not affected, whether these changes of state be referred to the one or the other of two systems of coordinates in uniform translatory motion.

2. Any ray of light moves in the "stationary" system of coordinates with the determined velocity c, whether the ray be emitted by a stationary or by a moving body.

Albert Einstein: "The rigid [metre] rod is thus shorter when in motion than when at rest, and the more quickly it is moving, the shorter is the rod. ...From this we conclude that [the velocity of light is] a limiting velocity, which can neither be reached nor exceeded by any real body. "He did not teach that the rigid rod *appears* shorter but that it *is* shorter. That stance will be referred to as *Einstein's reality view*. Also note that his declaration of a light barrier was just a conclusion inferred from the distortions of special relativity and reinforced by the discovery of an actual barrier for accelerated particles. There is today this trend:

Scientists are coming more and more to the view that special relativity is a kind of kinematical perspective.

Henry Margenau: "If sense data alone were recruits for reality, its domain would be ill-defined." Thus while Einstein's light barrier may always appear, it does not follow that it is always physically effective.

Twentieth-century science writers have generally followed Einstein's reality view; however, Rosser wrote this provocative passage but then seemed to back away, giving examples only of ineffectual faster-than-light *phase velocities*: [1]

It must be stressed that the theory of special relativity does not say that one cannot have velocities exceeding the velocity of light in vacuo, but simply says that energy and momentum cannot be transmitted with a velocity exceeding the velocity of light in vacuo.

Under the kinematical perspective view and in light of the second postulate of special relativity, the last part of Rosser's statement might be modified and expanded, without contradiction, to read: *but simply says that electromagnetic energy and momentum is transmitted at the finite velocity of light resulting in observed distortions of space, time, and mass associated with fast-moving objects.*

While relativistic distortions are subject to being sensed by our instruments as well as by our eyes, it would be silly to think that our mere act of observing can affect changes to the body being observed.

There is also this: The up-to-now popular pastime of assigning a speed limit to a rocket is a non sequitur;[2] for when someone declares, "Lightspeed is a limiting velocity for your ship" our Rocket-Rider must respond with "Lightspeed relative to what?" He needs a reference. Colloquially, **there is no road in space** along which to post a sign for rocketships reading:

SPEED LIMIT 299 792 458 METERS PER SECOND
STRICTLY ENFORCED

On the one hand, a sailing ship which depends on light from the Sun to accelerate it remains in that way connected to the Sun; its reference is the Sun, and its speed is limited to less than the speed of light, *c*, relative to the Sun because propulsive energy cannot reach a ship traveling away from the Sun faster than that. *It is limited to lightspeed in the same way that a San Francisco cable car is limited to the speed of the cable.* So when the ship reaches that speed it coasts, and coasts, and coasts without being further accelerated. A speed limit - an actual speed limit - applies.

On the other hand, if the ship carried a back-up rocket it could now be lit to provide additional thrust and acceleration. A conventional rocket or interstellar ramjet flying free in space is self-propelled and disconnected from Earth, Sun, and all astronomical bodies.

> *Its speed might be referenced to some luminiferous ether; but there is no luminiferous ether. Or it might be referenced to the interstellar cloud, a situation considered later.*

And so it accelerates, and accelerates, and continues to accelerate for as long as the engine operates. To someone watching on Earth there might appear to be a limit but appearance does not define reality.

This book is about star travel but it is not science fiction; it is a **science story** describing a scenario centered around a fresh look at relativity in the light of current thinking. It is written at a level designed to appeal to the technically-savvy layman and amateur scientist. A wide, popular audience is sought to swamp the myriads who take the phrase "You cannot exceed the velocity of light" on faith alone or who generalize from a too-narrow base.

Three new analyses are presented, two of which show that a barrier at the velocity of light does indeed exist for a light-sailing ship and for subatomic particles which are electro-dynamically accelerated. Then in the third analysis, that of a conventional rocket or Bussard jetship, no light barrier is found to exist under the kinematical perspective view; and the reason light speed presents a barrier in the first two cases becomes clearer than ever.

There are these points which we embrace here:

(1) Maxwell showed the speed of light to be an electromagnetic property of space;

(2) the light year is only a measure of distance

And under the kinematical perspective view there are these additional points:

(3) time distortion described by special relativity is only an appearance without necessarily being "real" in the sense that Einstein taught;

(4) the general relativity environment can truly affect the running of clocks which depend on atomic processes for their timekeeping and in that sense the distortion is real; and while all atomic

processes would be expected to run slower under increased gravitation fields, biological processes, pendulum-regulated clocks and balance-wheel-regulated clocks would not be affected in the same way; and it seems needlessly abstruse to say that the rate of flow of "time itself" is affected by the presence of a gravitational field.

Time distortion under general relativity is reminiscent of the clock problems faced by early transoceanic navigators; those problems were finally solved by clocks designed and built in the particular tradition proven by John Harrison in the 18th century.

The following conversation is reported to have taken place in the summer of 1950 between famed physicists Enrico Fermi and Edward Teller:

Fermi: Edward, what do you think? How probable is it that within the next ten years we shall have clear evidence of a material object moving faster than light?
Teller: Ten to the minus sixth. [One chance in a million.]
Fermi: This is much too low. The probability is more like ten percent.

The significance of that conversation is that neither gentleman put the probability at zero.

Two directly opposing camps have developed: those who maintain that there is an absolute speed barrier at the speed of light, and those who maintain there is not. The powerful draw of the first camp is that Einstein placed himself there: "*c* plays the part of a limiting velocity which can neither be reached nor exceeded by any real body."

Which camp do you place yourself in? If you place yourself in the "absolute barrier" camp, after you have read this book through, please reexamine that self-placement.

Notes:

1] W. G. V. Rosser, M. Sc., Ph. D., Lecturer in Physics, Exeter University, 1964, p.183: An example of an ineffectual phase velocity (not one of Rosser's) is the speed of the trace on the screen of a high-speed oscilloscope which can easily exceed the speed of light. Another example is of a row of LEDs which are all switched on at the same time, simulating an infinite speed of propagation for a point generating a line.

[2] "Speed," the magnitude of the velocity vector, is sometimes used colloquially when the vector nature is not critical to understanding.

Chapter 4

Acceleration Due to Light Pressure

Newton's laws of motion according to S. Chandrasekhar, Newton's Principia for the Common Reader*:*

1. Every body continues in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed upon it.

2. The change of motion is proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.

3. To every action there is always opposed an equal reaction; or, the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.

A push is on by the *Planetary Society* to launch an interplanetary sailing vessel, a vehicle whose sails would be filled by light pressure from solar radiation to push it along. They call it *Cosmos I*. Such an experiment may indeed produce some useful results. Then later their journal, *The Planetary Report* for Jan-Feb'03, suggested that method of propulsion be used for a starship which we'll refer to as Cosmos II; page 5: "[Some] have concluded that light sailing is the only technology we know of today that can enable interstellar flight." We felt a comparative analysis was in order of the acceleration to be expected from such a plan.

Analysis:

In the theory of special relativity, it is chosen to define force as the time rate of change of momentum. Thus the Balance of Forces Equation is: [1]

$$F = ma + v\, dm/dt \qquad (1)$$

and $F = ma$, the low-speed form of Newton's second law of motion, follows when m is constant. Under relativity, even if the driving force is constant the acceleration (a) will not be if it appears to the motor, or to the Essential Observer (someone at rest relative to the motor) that the mass (m) of the ship varies. From special relativity the mass of the ship, as seen by an inertial observer picked at random from anywhere in the universe, is $m = m_o/\sqrt{(1-\beta^2)}$ where m_o is the ship's proper mass (its intrinsic mass) and β (= v/c) is the speed of the ship relative to the particular observer picked, normalized to the speed of light. [2] The Essential Observer is the only observer who counts in the Balance of Forces Equation, eq. (1).

With v dm/dt = m$a\beta^2/(1-\beta^2)$ it is found from eq. (1) that

$a = (F/m)(1-\beta^2)$, and

$$a = (F/m_o)(1-\beta^2)^{3/2} \qquad (2)$$

with the velocity of the ship (β) being specified relative to the Essential Observer.

For light sailing, the defining formula for the driving force is F = pA where p is proportional to the energy in the beam, with that energy being subject to the Doppler effect because of the Planck relationship E = hυ according to the factor $(1-\beta)/\sqrt{(1-\beta^2)}$. [3]

Putting it all together we find that the acceleration of Cosmos I I would be proportional to $(1-\beta)(1-\beta^2)$, applicable for $0 \leq \beta \leq 1$. Thus for β = ½ the acceleration drops to only 37.5% of its initial value and for β =1 it drops to zero,

and that is why there is a light barrier in this case.

The ship is a sop or gift - *a sacrificial lamb* - to the gods who would limit us. We actually brought the limit on ourselves by designing a ship in which the driving motor - the light source - stays at home, meaning the driving flux must chase the ship in order to push it.

As the ship nears the speed of light relative to the light source, the driving flux still impinges on the sail at the speed of light but it has run out of steam, by Doppler and by Planck, as just explained.

If $(1-\beta)(1-\beta^2)$ is graphed, it will be seen that the acceleration drops faster than linearly as vehicle speed increases. A further braking effect not taken into account by this analysis relates to the inverse-square law of radiation.

A sop to the gods.

Even the subatomic particles in a particle accelerator fare better than that even if the driving force *F* is constant (the Essential Observer is a laboratory worker) with acceleration being proportional to $(1-\beta^2)^{3/2}$ from eq. (2), dropping to 65% of its initial value at β = ½, large by comparison with the sailing vessel's acceleration at that speed, but again dropping to zero for β = 1; and we've offered up another light-barrier sop to the gods. In both this case and the previous case of the light-sailing ship, the barrier arises because the Essential Observer sees the mass of the body as increasing towards infinity as it is accelerated; so in this sense the increase in mass is real. *Note that in neither case does the motor travel with the accelerated body.*

The driving motor - the system of accelerator coils and electrodes in the case of the particle accelerator - is fixed to the laboratory, and the driving flux from that motor must chase the particle. When the driving flux energy cannot reach the particle it is no longer accelerated and we say the particle has encountered a speed barrier or limit. *But it is the driving flux energy which has encountered a speed limit, not the particle.* The particle is receptive to further "push" but none is forthcoming.

THERE IS A DRIVING FLUX SPEED LIMIT

The driving flux speed limit is both an upper and a lower limit; it may be helpful to view it as a *resonance phenomenon* or condition as explained in the appendix.

Notes:

[1] See for example W. G. V. Rosser, *An Introduction to The Theory of Relativity*, Butterworths, 1964; UDC#530.12, p. 181. Equation (1) also agrees with Newton's second law of motion as he stated it in the form "The change of motion is proportional to the motive force impressed, and is made in the direction of the right line in which that force is impressed." Read "change of motion" as *change of momentum*; and read "right line" as *straight line*. See S. Chandrasekhar, *Newton's Principia for the Common Reader*, Clarendon Press, Oxford, 1995, ISBN 0 19 81744 0, p. 23.

[2] Although the relativistic factor $1/\sqrt{(1-\beta^2)}$ is imaginary in the mathematical sense for $\beta^2>1$, its use in this context, historically, has only been shown to be valid for $\beta^2<1$; and it is easy to find a derivation which has that form for $\beta^2<1$ but not for $\beta^2>1$. Consider this integration:

$$\frac{1}{2\pi}\int_{-\pi}^{\pi}\frac{d\theta}{1-\beta\cos\theta}=\frac{1}{\sqrt{1-\beta^2}}$$ for $\beta^2<1$, but = 0 for $\beta^2>1$.

That integrand is the same for all β, both in the relativistic realm below lightspeed and in the superrelativistic realm above lightspeed. This analysis appears in *Speculations in Science and Technology*, Vol.16, No. 4, ISSN 0155-7785, 1993, pp. 297-303. While in a sense the "energy of motion [is] converted entirely into mass" (Zimmerman & Zimmerman), the increment is contained in the field, none being packed into the source particle itself. The strength of a source particle remains constant at its rest value, whether the particle is a mass or an electric charge. When in motion the added kinetic component is called the relativistic increase of mass with velocity in the case of a mass, or magnetic field in the case of an electric charge. Each kind of source particle continues ejecting quanta (gravitons or photons) at the same rate, according to its "strength," no matter how fast or slowly it moves. Bernstein, 1968 (p. viii): "In electrodynamics the photon plays a dual role. It is the medium by which charged particles exchange energy and it is also the `gauge field' that expresses the conservation of the electric current." A similar statement may apply to gravitons in their relation to mass.

[3] *A* is sail area, *p* is light pressure, *k = 2/c* with *c* being the speed of light, *U* is the energy in the light beam.

[4] Comparative graphs appear in MATH POWER for Nov'03, ISSN 1087-2035; www.ddj.com/Dr.Dobb's Math Power newsletter.

Appendix to Ch. 4

The Maxwell-Schelkunoff analog and the speed of light

The universal constant called "the speed of light" is seen as resulting from a resonance phenomenon analogous to the resonant frequency of a parallel inductor-capacitor tuned circuit in an analogy flowing directly from James C. Maxwell's work. We refer to the fact that $1/\sqrt{(LC)}$ is the free-space speed of light (or the resonant angular frequency of a hi-Q parallel tuned circuit), where L and C are the magnetic and electric constants characteristic of space (or of the tuned circuit). In the first instance, "L" and "C" are the universal constants permeability μ_0 and permittivity ε_0, respectively.* In the second instance they are network inductance and capacitance. Engineer Schelkunoff first broached this analogy in connection with antenna design.**

Ciufolini & Wheeler called *c* "the characteristic speed of space." Now we see it as the resonant speed of space. It sets the speed at which electromagnetic energy, and other "primordial forces" (C&W) (meaning primarily gravitation) normally and naturally propagate through empty space but it clearly does not set the speed at which rocketships and atoms move. (We may rarely or never see things moving faster than light, but we do see things moving far slower than that every day.) Although light normally moves at the resonant speed of space, atoms do not; this fundamental difference shows that photons and atoms are two different breeds of "particles." We cannot put them in the same camp. Even if photons are restricted to "the speed of light" that does not in itself justify the assumption that a rocketship cannot exceed that speed.

The second postulate of special relativity, the constancy of the velocity of light, follows from the Maxwell-Schelkunoff analog since the permeability and permittivity of free space do not depend on the speed of anything (a relevant experiment performed on a fast-moving rocketship would give the experimenter the same results as those obtained on Earth); and thus the second postulate is encompassed under the first postulate (the universality of physical laws). And, in material media where permeability, μ, and permittivity, ε, are increased over free-space values, the speed of light is understandably reduced according to $1/\sqrt{(\mu\varepsilon)}$ to give the index of refraction (as of glass) of $\sqrt{(\mu/\mu_0)}\sqrt{(\varepsilon/\varepsilon_0)}$.

Also now better understood, because of the dependence of the "speed of gravity" on the product $\mu\varepsilon$ as well, is the reduction in the speed of light inside gravitation and acceleration fields that is recognized in general relativity.

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* Since c is defined as exactly 299 792 458 meters/second and μ_0 is defined as exactly $4\pi \times 10^{-7}$ henries/meter, then ε_0 is also an exact number of farads/meter; neither μ_0 nor ε_0 is a rational number however.

** S. A. Schelkunoff, "The Impedance Concept and its Application to Problems of Reflection, Refraction, Shielding, and Power Absorption," *The Bell System Technical Journal*, Vol. XVII, No.1, January 1938, pp.17-48 - The "impedance" referred to in the title is the intrinsic impedance of space, about 377 ohms (exactly $4\pi \times 29.979\ 245\ 8$), the analog of the characteristic impedance of an LC circuit. The "Q" of truly empty free space, and its resonance peak, would be infinite; but even in free space, the barrier is momentarily lowered by accelerating through it, just as an FM signal effectively lowers the resonance peak of a tuned circuit. Impedance, and therefore Q and the "height" of the light barrier by analogy, are normally defined for a constant-frequency signal; therefore it is difficult to analyze the FM case, the analog of rocketship acceleration. For such an analysis in terms of Bessel functions see for example R. W. Landee et al, *Electronic Designers' Handbook*, McGraw-Hill, 1957, section 5, pp. 27-32. See also the author's 1968 analysis in terms of a

generalized impedance definition, "An Electronic Analog of Relativistic Space," in *Electron and Ion Beam Science and Technology*, Robert A. Bakish, editor, The Electrochemical Society press.

Second Appendix to Ch. 4

The role of speed and acceleration

To say that the speed of a material body needs no reference would be illogical. Even the hobby pilot knows that airspeed and groundspeed are not the same thing. The first is the speed of an aircraft through the air, the second is its speed across the ground. They are not the same unless there is no wind. We say that the air and ground, respectively, are speed references for the aircraft. The speed of the International Space Station (ISS) over the ground is thousands of miles per hour, and a shuttle in the process of docking has the same high speed; but if we specify the relative speed of the ISS and a docking shuttle, then that relative speed is near zero - exactly zero upon capture.

So of course a spacecraft needs a speed reference; the Galactic cloud or the Earth or the ISS for instance.

As for acceleration, that is given by the Balance of Forces equation. Only the speed of the craft relative to the Essential Observer is important in the Balance of Forces equation. The Essential Observer is someone at rest relative to the motor which propels (accelerates) the spacecraft. The Balance of Forces equation which governs the acceleration of the spacecraft is eq. (1): $F = m\mathit{a} + v\, dm/dt$, where $m = m_o/\sqrt{(1-\beta^2)}$ with β being the speed of the spacecraft relative to the Essential Observer, normalized to 300 Mm/s (exactly 299.792 458).

Chapter 5

Light Sailing Is Not All There Is

[Some] have concluded that light sailing is the only technology we know of today that can enable interstellar flight…
Louis D. Friedman, The Planetary Report*, Jan, Feb'03, p. 5.*

The Galaxy is permeated by a rarefied cloud or mist - a *tenuous atmosphere* - which rotates with it, and in 1960 Robert W. Bussard proposed tapping into that interstellar cloud. His engine, classed as an interstellar ramjet, in one version would collect the cloud material en route to use as a working fluid and would use a nuclear reactor as a source of energy to heat and expand it, and expel it in jets to propel a ship. [1]

Following up the analysis done in ch.4, it is well established that a relativistic increase in the mass of a ship will be seen by all who are not moving with the ship. But that increase is not absolute; its magnitude is observer-dependent, and only the Essential Observer counts in the Balance of Forces Equation as was already discussed.

Rocket dynamics -

A key point commonly overlooked with rocketships, also applying to the Bussard jetship, is that the Essential Observer is not someone on Earth, but our Rocket-Rider for whom $\beta = 0$; taking us right back to the low-speed form of Newton's second law, $F = m\mathit{a}$ with $m = m_o$, *now relativity qualified*, meaning that a constant jet force will most certainly produce a steady acceleration because the motor travels with the ship and the driving flux does not have to chase it. The increase in mass of the ship as seen back on earth is not seen by the Essential Observer on the ship, and so that increase is not real in the way it was with the sailing ship and the particle accelerator. [2]

Those on the ground will see the mass of the ship as increasing without limit; they will also see the jet thrust as getting larger as a steady acceleration of the ship is maintained. Those on the ground will see, too, at sublight ship speeds, a continually decreasing acceleration for the ship; but under the kinematical perspective view, that and the other two observations are only appearances. Mass and jet thrust do not "really" increase; acceleration does not "really" drop. ... No more than stars in the sky are really points of light.

The traditional relativist would say that the ship speed is really limited to *c* and that ship time really dilates in such a way as to make everything fit together. However, the new relativist's view can be just as valid: The view that ship speed really increases and ship time is really the same as Earth time for a constant 1G acceleration. Only an actual round trip can resolve the question of interpretation, for the final results under the two interpretations - principally astronaut aging – will be quite different.

While those on the ground may not be able to directly see a ship going at, say, 110% c relative to the Galactic cloud, they will receive evidence of it in the *Cerenkov radiation* produced by the ship's wake. (Cerenkov radiation is quite real, but was unknown until its discovery by Russian physicist Pavel A. Cerenkov in 1934-39, well after Einstein had formulated his theory of relativity.) If

the ship's motor is turned off at that time, forward energy will be lost through Cerenkov radiation until its speed drops to lightspeed relative to the galactic cloud at which point no more Cerenkov radiation will be produced. After that, simple, mundane resistance presented by the galactic cloud will continue to slow the ship but now at a lesser rate. Because of the tenuousness of the Galactic cloud, if the captain orders "**ALL STOP**," meaning to stop all engines, that will not result in the rocketship quickly coming to rest in its medium the way an ocean sailing vessel does, but for a superlightspeed ship, it will slow to lightspeed relatively quickly.

Project SETI expanded.

The speed of an ocean-sailing vessel can be referenced to the ocean waters; the speed of an aircraft to the air it passes thru; and the speed of a starship can be referenced to the Galactic cloud. But why should that cloud present a limit to spacecraft any more than a planetary atmosphere presents a limit to aircraft? Perhaps no one has said it does, precisely; but there is this generally overlooked clue:

> *Just the concept of a speed limit in space is a non sequitur simply because there is no all-pervasive luminiferous ether - no absolute frame to which the speed of any vessel can be referenced!*

The second postulate of special relativity affirms that. When someone says "you cannot exceed the velocity of light" that only means we will receive no direct visual evidence of a ship moving away from us faster than light. Relativity predicts that; and it would be true were it not for the Cerenkov radiation produced by a superlightspeed ship, unexpected even by Einstein.

> *Thus we might reasonably expect that a rocketship can exceed the speed of light relative to the Galactic cloud; and we can expect to see a "luminal flash" (compare sonic boom) as the Cerenkov shockwave from such a superluminary ship gives rise to broadband electromagnetic (and "gravimagnetic"?) radiation. Project SETI might be expanded to look for such deep-blue luminal flashes, or x-ray or gamma-ray bursts. Perhaps it already has.*

A few others have also concluded there is no light barrier but for other reasons. Smarandache: [3] "There is no speed barrier in the universe." His reasoning was based on an interpretation of the *entanglement phenomenon* of quantum physics. This point must be stressed: The concept and fact of *superluminary speeds* would violate only the popular interpretation of relativity; there would be no violation of relativity itself as interpreted under the kinematical perspective view.

The Homesick Centaurians.

Alpha Centauri is the nearest star, being 4.3 light years distant. The G4-sun component of that binary system is similar to our own G0 Sun so Alpha Centauri is a perfect focus for our first manned and womanned ('manned) interstellar adventure.

If we are ever to reach the stars we must first get our heads together, start thinking like homesick Centaurians, and get to work. Antimatter engines, wormholes-on-demand, and something resembling warp drive may come in time for intergalactic flight but we don't need them just to get "home." ... Such a short distance by comparison.

Early in the 20th century relativity developed a popular cult-like following due to the Alice-in-Wonderland spin it was given, and spin echoes remain to this day. Back then we were told that a moving meter stick would truly shrink and objects would truly get more massive without limit, and

that time itself would truly slow; but appearances do not always conform to facts, and isn't time just a parameter used to reckon change - at most an "abstract continuum" as David Landes called it?

H. G. Wells' time machine.

H. G. Wells' 1895 story, *The Time Machine*, is only engaging fantasy, yet it appears that some scientists take the idea of time travel as serious science. [But when the respected physicist John A.Wheeler was asked what he thought, he only recited a seemingly unrelated poem according to Nahin (p.362).] The presumption for such stories is, in itself, paradoxical because it requires two kinds of time to exist "simultaneously" at any given place: the time our perennial Wells sees on a clock external to the time machine and the time metered by the flow of his consciousness (presumably the same as the time he sees on his pocket watch) - both chronometers supposedly accurate timekeepers yet running quite independently and differently as the result of a "temporal field" generated by the Time Machine separating the two.

Norman: "Describe to me a new hypothetical property, any property at all that you may desire, and I will gladly `field' it for you! You want a temporal drive? Here. I give you a `temporal field' to explain it and a `temporal core' to implement it." Norman writes science fiction. P. A. M. Dirac understood. He conjured up a "creation operator" and an "annihilation operator" - serious mathematical tools for quantum mechanics. But, dear reader, mathematics is one thing and physics quite another. One must never forget that Margenau: "A theorem of mathematics can be true yet have no bearing upon reality."

When we attempt to "spacify" time - that is, treat it as just another (a 4th) dimension like the three of space - it seems that a new kind of time - a 5th dimension - pops up.[4]

And what if our hero is time traveling in a second time machine contained within the first? Then wouldn't a third kind of time, a 6th dimension, pop up? Who can accept such a proliferation of time dimensions as an actual possibility?

Would Occam of Occam's Razor fame have been comfortable with it? Could it be that time is not like space except in some of its mathematical properties? ... And that the characterization "spacetime continuum" is sadly misleading to many students of science - even some highly accomplished ones?

Einstein's time machine.

The prediction of *relativistic time dilation* begs for attention. One scenario called the *clock hypothesis*, *clock effect,* or *twins paradox*, deals with the aging of space travelers. [5] That tale was first told in the context of special relativity by Einstein in 1905 at age 26. [6] In the tale, a space traveler ages little by comparison with those who stay home.

But that scenario clearly must be treated under general relativity which he did not develop for another 7-10 years. And if a steady acceleration of 1G were maintained throughout the trip, there should be no effect from that quarter with special relativity giving no permanent "set" in time. It appears that Einstein never revisited the twins paradox after his development of the general theory.

Differing accounts have surfaced since his death. In a 1959 book (*Relativity for the Layman*, p. 71, Penguin Books), J. A. Coleman concluded: "Hence, there is no permanent effect and, of course, no paradox." W. Cochran (*Vistas in Astronomy*, Vol.3, p. 78, Pergamon Press, 1960): "It is amusing to find, in view of the controversy on the aging of space travelers, that in the simplest form of space travel, the traveler ages most!"

The Galilean-Newtonian-Einsteinian *principle of equivalence* equates gravitation and acceleration fields, and the speed of light in either kind of field is found to be less than c, its free-

space speed. [7] Since atomic processes are regulated by the speed of light, atomic clocks run slower under increased gravitation or acceleration; atomic processes slow; but to conclude that the rate of all processes would then slow--that time itself would slow--is unjustified. (It is noted that the opposite effect is depicted in science-fiction movies, where slower action on the part of the actors is used in gravity-free scenes!)

A pendulum clock runs faster under increased gravity; and the aging of space travelers depends on the effect of gravity on biological (not atomic) processes. An atomic clock built to track Greenwich Mean Time while on Earth would run fast on Mars because of the lesser gravity there; but a balance-wheel timepiece would operate the same in both places because such a timing mechanism is immune to changes in gravity and straight-line acceleration.

It seems likely that interstellar navigation simply calls for a certain kind of clock, just as transoceanic navigation did before the call was answered. [8] An ideal balance-wheel clock is needed; or possibly an atomic clock with its time display tempered by a g-sensor signal. Or we might simply maintain a steady 1G acceleration/deceleration during the entire trip.

What is the truth?

In the story of the twins paradox, why is it never said that the space traveler, when he returns home, is much shorter and more massive than his twin? ... Or thinner, depending on his orientation in the rocket. For surely that would follow if it truly follows that he is much younger. The two transformations are much the same. Perhaps that would be too crass to mention.

At this juncture in history there simply is insufficient reason to believe that a rocketship trip to Alpha Centauri and back must necessarily consume an inordinate amount of either "Earth time" or "ship time." A *Relativity Cadre* consisting of the best space-enthusiast relativists - to include radio hams because of their special knowledge of the electrical properties of space - needs to be assembled to find the best way to proceed.

Relativity may not need a mathematical retooling but it is due for some heavy-duty reinterpretation. At this point it looks as if we may not only be able to get "home," but get there in a reasonable time if we maintain 1G throughout the voyage - accelerating to the halfway point and decelerating the rest of the way; thus our clocks and our bodies will continue to "think" they are still on Earth throughout the entire voyage.

Summing up this chapter.

We have presented an uncommonly optimistic scenario, and there will remain those who say we are being naïve; but history's roads are paved with the dust of prestigious naysayers who were wrong, and there is no final proof that such a scenario could not play out pretty much as related here given a truly concerted effort. Indeed, without a Herculean effort we may never achieve star travel, leaving ourselves forever vulnerable to all in this vast universe who do. And, it seems fair to say, no one doubts that the universe is indeed vast and that vulnerability is a bad thing.

Guglielmo Marconi first announced, by radio, our presence to offworld SETI watchers in 1898 and our cover as a dead world was blown. If there is a star-capable civilization within 105 light years, a probe may already be on its way to us; and if from ε Ursae Majoris, Capella, Castor, Arcturus, Pollux, or Vega, we might feel its first effects tomorrow. But it will be 33 millennia before our signals reach the center of the galaxy assuming they survive the trip at all. Might we be able to outrun those signals and get there first?

Notes:

[1] An account is contained in M&M: Eugene Mallove & Gregory Matloff, *The Starflight Handbook: A Pioneer's Guide to Interstellar Travel*, John Wiley & Sons, 1989, ISBN 0-471-61912-4.

[2] The relativistic increase of mass with velocity is real in the same sense that the magnetic field of a moving charge is real. To one riding on the charge it has no magnetic field.

[3] Florentin Smarandache, *There is no Speed Barrier in the Universe*, Bulletin of Pure and Applied Sciences, Vol.17D (Physics), No. 1, p. 61, Jan-Jun, 1998.

[4] Read all about time travel in Paul J. Nahin's 600+page book, *Time Machines*, 2nd ed., Springer-Verlag, 1999, ISBN 0-387-98571-9. An impressive chronicle. Don't look for answers there, but the epilog (pp.355ff) presents an interesting give-and-take on the subject by some leading scientists.

[5] W. G. V. Rosser, *An Introduction to The Theory of Relativity*, Butterworths, 1964; UDC#530.12. See sec. 3.1 and 11.2.

[6] A.Einstein, "*Zur Elektrodynamik bewegter Körper*," Annalen der Physik, Leipzig, 1905, pp. 891-921.

[7] We speak of the index of refraction, n, of glass, the ratio of c to the speed of light inside the glass which, is $< c$ because of the strong electric and magnetic fields there in accordance with the Maxwell-Schelkunoff analog. Gravitation and acceleration fields, too, have a similar effect. Rosser, p.452: "The numerical value of the speed of light depends on the strength of the gravitational field."

[8] See the TV movie LONGITUDE (A&E network) dealing with the impact of clock design on navigation. ... Or the related book *REVOLUTION IN TIME* by David S. Landes from Harvard U.P., 1983, republished by Barnes and Noble, Inc., 1998, ISBN 0-7607-1074-0.

Chapter 6

Einstein's light barrier

Ode to the Common Man

And if we had not known better
We might have come to say
That a meter stick stuck in water
Is truly broken - for it looks that way -
At the surface of the flow
If someone whom we thought should know
Told us it was really so.

Einstein (1916): [1] "The rigid rod is thus shorter when in motion than when at rest, and the more quickly it is moving, the shorter is the rod. ... From this we conclude that in the theory of relativity the velocity *c* plays the part of a limiting velocity, which can neither be reached nor exceeded by any real body." Then: "As a consequence of its motion the clock goes more slowly than when at rest. Here also the velocity *c* plays the part of an unattainable limiting velocity." Those passages bring home the shear starkness and inevitability of Einstein's reality view of special relativity. Einstein was declared a genius not to be questioned or doubted; nearly everyone picked up on his reality theme, taking it as gospel. [2] And when it was found that the velocity of particles in particle accelerators was truly limited to *c*, that was the icing on the cake - the proof of the pudding, it seemed to many. But can relativistic contraction and a stroke of the pen really limit us that way? ..."We conclude [that *c* is] an unattainable limiting velocity." Are we to believe there is some *Venerable Force* at work behind it all which acts to turn appearance into reality? Einstein: "Try and penetrate with our limited means the secrets of nature and you will find that...there remains something subtle, intangible and inexplicable. Veneration for this force beyond anything that we can comprehend is my religion." [3] And are we to believe that our logical analyses are trumped by the Venerable Force, and further that Einstein's conclusion is in consonance with the Venerable Force?

Venerable Force or Cognitive Illusion?

Perhaps a mark of genius is to be able to speculate and convince all others; to express a bullet-proof combination of fact and faith. Einstein's work with the photoelectric effect has been variously described as "a remarkable assumption"; and by Millikan: "a bold, not to say reckless hypothesis." Planck expressed his awe somewhat differently: "That he [Einstein] may sometimes have missed *the target of his speculations*, as for example in his hypothesis of light quanta, cannot really be held against him."

According to work performed in just the past quarter century by Massimo Piattelli-Palmarini and others, each of us - including geniuses - is subject to *cognitive illusions*. Those are "mental eyeshades"; "biases, tunnels, or blind spots." [4] In the matter of special relativity, there is a choice between "real" and "apparent"; and, according to the gathering storm of the kinematical perspective view, Einstein led us down the garden path; when we look for a truly rational proof of an inevitable light barrier in relativity, we do not find one under the kinematical perspective view. Further, there is now a scientific basis for seeing the "inevitable light barrier" as only an *inevitable cognitive illusion*.

Indeed, we may already have witnessed faster-than-light phenomena without recognizing them; one case involves π-mesons as described in a later chapter. And there is the notable fact that Cerenkov particles in the moderating baths of nuclear reactors are clearly going faster than the local speed of light; and while that observation is often minimized by saying the particles (electrons) are still going slower than the free-space speed of light, *they have successfully broken the local light barrier*. And by what rationale might it be presumed there is a second light barrier in the bath at the free-space speed of light? μ and ε do not have their free-space values there.

Compounding velocities.

It is an elementary calculation of special relativity to show that velocities cannot be compounded to exceed lightspeed. [5] But it is important to note that in those calculations, where the first body is projected away from home base and the second body is projected away from the first, that there always remains an unbroken *umbilical connection* to home base; there are multiple Essential Observers involved with each seeing nonzero β. Such calculations do not recognize that there is but one Essential Observer for a rocket *for whom β is zero*.

Compounding of velocities is a scenario of special relativity, and special relativity deals with inertial systems not with accelerated systems, that's why it is *special*; but the accelerating rocket is not an inertial system. To contrive to analyze the motion of an accelerating rocket using special relativity is to fool oneself; it depends on an illegal "alternative rationality" (Massimo Piattelli-Palmarini). General relativity is <u>not</u> equivalent to unlimited, repeated application of special relativity; general relativity is a thing apart. And rocket propulsion is <u>not</u> equivalent to an infinite compounding of velocity increments.

One of Zeno's paradoxes argues that we cannot get from point A to point B, or go beyond, by first going halfway, then halfway, then halfway again and again; and citing the compounding of velocities as absolutely limiting us to *c* is reminiscent of that argument. How long does it take to overcome that kind of mindset? In the case of Zeno's paradoxes it took nearly two thousand years.

Risky business.

At the risk of incurring the wrath of hard-core believers in an absolute, impenetrable light barrier, we propose that each situation be cool-headedly analyzed on its own merits. Much of the dissent encountered to this approach appears to be on a high emotional, near religious level. Well thought-out dissent is invited; the other kind is not.

Because the motor travels with the ship, a cool-headed analysis strongly indicates that

lightspeed is no barrier for a rocketship or a jetship.

Also, reasonable doubt exists that time presents a barrier; under special relativity its variations are only appearances in the kinematical perspective view, and under general relativity they depend on the makeup of the clock. Electromagnetic energy propagates at the resonant speed of space there is no doubt; but it is not certain that material bodies are so restricted. Some have said that if we do manage to go faster than light we would also travel in time; but isn't that just a twist on the twins paradox? And the classical treatment of the twins paradox may now be seen as being another illegal alternative rationality because it applies the methods of special relativity to a problem of general relativity.

Venerable Force or kinematical perspective?

If the length of a meter stick moving in the direction of its length appears to be $L = \sqrt{(1- \beta^2)}$ as seems likely, then it might be seen to shrink to nothing for $\beta = 1$; and for $\beta > 1$ we have *Re*(L)=0, meaning only that the stick would remain unseen. The implication is that we are doing our sensing via light waves, in which case only if the speed of light were infinite would we expect there to be no distortion at any speed. Visual/optical distortion does not equate to a real change.

> *Similarly, when we sense via sound waves, there are distortions related to the speed of sound. A distant rifle which fires a bullet would be sensed to hit a target next to us before we hear the blast from the gun. Only if the speed of sound were much greater than the speed of the bullet would there be no distortion. Auditory reversal of cause-effect does not equate to a real change.*

To take such appearances/observations as proof of a physical barrier would mean bowing to the Venerable Force; quite a leap especially in view of the observer dependency of the contraction. Jules Henri Poincaré, in 1904 included the principle of relativity in his list of important physical principles.

> *The principle of relativity states that the laws of physics should be the same in all inertial frames of reference. An inertial frame is one which is not being subject to acceleration.*

Poincaré was less interested in the real-versus-illusion question of special relativity than he was in contriving ways to fool the senses. One such contrivance was a disk-shaped universe which has a radial temperature gradient; very hot at the center, absolute zero around the rim. Poincaré speculated on what an inhabitant of that universe, subject only to the expansion/contraction property of heated objects, would sense upon walking from the center towards the rim. The inhabitant would shrink towards zero, Poincaré, speculated, as he approached the outer rim thereby making him unable to reach the rim, like Achilles inability to reach the tortoise in Zeno's famous puzzle, "The Achilles."

Hendrik Antoon Lorentz (1927): "But I never thought that this [time transformation] had anything to do with real time." He may have recognized the analogy between relativistic distortions of space & time in the Minkowski diagram and geometric *rotation* (a transformation of visual perception) of a spacetime coordinate system, in which *length does not shrink, it simply rotates out of our full view as time rotates more into it*.

Max Born wrote: "A [metre] rod in Einstein's theory has various lengths according to the point of view of the observer. One of these lengths, the statical or proper length, is the greatest, but this does not make it more real than the others. The application of the distinction between 'apparent' and 'real' in this naïve sense is no more reasonable than asking what is the real x-coordinate of a point x, y when it is not known which xy - coordinate system is meant." Thus, Born managed to downgrade the importance of the concept of reality as it pertains to relativity.

Max Born compared the slicing of a pickle [cucumber] along a diagonal instead of squarely; a pickle is a pickle, says he, no matter how you slice it. Born (1962, p. 254): "Thus the contraction is only a consequence of our way of regarding things and is not a change of a physical reality." A few pages later he considered a trip to α-Centauri, giving the traditional depressing analysis, concluding with "these space experiments cannot at present be performed," showing he too felt the need for an actual star trip.

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*Compare with prepublication (white covers) edition

After being distracted by Einstein's strict reality view for several generations, more and more scientists are coming back to the view that special relativity describes appearance and a kinematical perspective which most often does not reflect real physical changes. Richtmyer & Kennard (1947): "Perhaps [relativistic contraction] is a sort of kinematical perspective."
Further relativistic experimentation of the kind outlined in later chapters is called for. The *thought experiment* without actual back-up experimentation has outlived its usefulness.

The dreams of the young die hard.

Some youngsters dream of star travel becoming routine; Einstein set a different course and dreamed of riding on a light beam it is said. That coupled with his use of *Elektrodynamik* in the title of his 1905 landmark paper - a clear association with light but used there in connection with a moving body *(bewegterKörper)* - might lead one to surmise that he based his conclusion of a light barrier partly on an unwritten hypothesis that riding on a light beam would be like riding on a rocket if only the rocket were subject to the same upper velocity limit as light. And he may have seen fulfillment of his dream when he wrote, "we conclude that ... *c* [is] a limiting velocity." But Einstein's photon is limited in *both upper and lower* velocities while rockets clearly are not.

Einstein resurrected the photon as a particle of light, an idea which many thought had been put to final rest by J.C. Maxwell, [6] to explain the photoelectric effect; and he may have felt free to think of a rocket in flight as a kind of *macrophoton*. But things do not scale up and down that way as quantum mechanics came to show, perhaps explaining Einstein's strong initial objection to that new science. Denis Brian reports that a friend said to him: "Einstein, I am ashamed of you; you are arguing about the new quantum theory just as your opponents argue about relativity theory." Later in life, it is said, he supported it.

Very late in life Einstein made an astounding admission: "Every physicist thinks he knows what a photon is ... *I spent my life to find out... and I still do not know*." After that admission if he had ever thought of a flying rocket as a macrophoton, it seems safe to say that in his final years he did not.

Notes:

[1] Albert Einstein, *Relativity*, 1916; Translation by Robert W. Larson, 1920; (c) 1931 Peter Smith, Crown Publ., pp. 43-4.

[2] Arthur March & Ira M. Freeman, *The New World of Physics*, Random House, 1962, LoC#62-20332, p. 89: *According to the theory of relativity [i.e., Einstein], nature is so constituted that its operations are limited by the value of a given constant c, the speed of light in empty space. In its most general form, this limitation states that there exists a principle of nature that makes it impossible to transmit an action from one point in space to another with a speed exceeding that of light, whether this be done by means of material bodies or by fields of force. This proposition, which Einstein deduced from his principle of relativity [is] a general regulating law that outranks any special law of nature* and on p.76:
The systems to which the physicist must refer natural phenomena...owe their effectiveness to... the objects present in the universe. This... is the essence of the principle of relativity.

[3] Denis Brian, *Einstein: A life*, John Wiley & Sons, Inc., 1996, ISBN 0-471-11459-6, p. 161-4.

[4] Massimo Piattelli-Palmarini, *Inevitable Illusions: How Mistakes of Reason Rule Our Minds*, John Wiley and Sons, 1994, ISBN 0-471-58126-7, pp. 139-41.

[5] Richtmyer & Kennard 1947, p. 125:

The equations just given for the transformation of velocities as measured in different frames should not be confused with the ordinary rules for the composition of two velocities measured in the same frame. The latter rules are, or course, still valid. To take a numerical example, let two electrons, ejected from a filament stationary in S, move off with equal speeds of magnitude 0.9c, one going toward -x and the other toward +x. Then their speed relative to each other still measured in S, is 1.8c, by the usual rule. This exceeds c. But, if we make u = -0.9c, so that frame S' keeps up with the electron going toward -x, the velocity of the second electron relative to the first, measured now in S' is (1.8/1.81)c which is a little less than c and on pp. 119, 123:

One might think of hurling a ball from one location to the other with indefinitely great speed, so that no correction for its time of flight would be necessary. This would, in fact, do the trick. But if all masses increase with velocity as the mass of the electron is known to do, a ball could not possibly be projected with a speed exceeding that of light. From the standpoint of existing knowledge, it is entirely possible, and it is a consequence of Einstein's new theory of relativity, that no signal can be transmitted faster than a light signal.

But only four pages later they present their "*kinematical perspective*" argument, perhaps not thinking it might also apply to mass.

[6] A distinction must be made between the photon as a flying particle of light under the ancient *corpuscular theory*, and a quantum of energy as espoused by Max Planck. The latter is readily embraced under the wave theory of light, the former is not. In a grand compromise of views it is today said that light is composed of *wavicles* (Eddington); neither particles nor waves.

Chapter 7

The Phase One Experiment: The First Starship

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Any species, in order to assure its long-term survival, must continually strive to go beyond where it now is.

Introduction.

During the 20th century stories of travel to the stars proliferated, being set in the 21st century and beyond. But still, today, such so-called science-fiction stories are more fantasy than science. *Starship Enterprise* designs from Gene Roddenberry are highly esthetic but also highly impractical in terms of present propulsion systems and other technology, and they do not well fit the needs of the space environment - being too much influenced by aircraft aerodynamic considerations. One can tell how close we are to reaching a goal from the reality/fantasy ratio of relevant writings. On that basis, we may be 1% of the way to star travel today, in 2004. If we are to reach the stars we must speed up while we are still able. However, judging from actual spacecraft designs of today we may be much farther along than that; perhaps 5% of the way there. It seems that science fiction is lagging behind science fact in the design of spacecraft.

We have just entered the 21st century and it is up to our generation to take the bull by the horns. While a core of enthusiasts have a general idea of what to do, details are still in flux. Even the imposing question of propulsion remains unsettled. The *Planetary Society* has been touting propulsion by light pressure, but the Bussard-DeLauer interstellar ramjet is not that much more expensive and can attain much greater acceleration and final speed, and do it independently of home base. Mallove & Matloff's 1989 book, *The Starflight Handbook*, is recommended reading especially chapters 7 and 8 (John Wiley & Sons, Inc., ISBN 0-471-61912-4).

In this chronicle we proceed to get real with SS Alpha, the first starship. Mostly 20th-century technology goes into it. SS Alpha is to be built in space and is to stay there. She is not further named in these pages, that privilege belonging to her first crew.

A plan for the design and operation of a starship will unfold in these pages. Her appearance, unpretentious. She is propelled by a nuclear reactor (as are military ships and submarines of today) which superheats a working fluid or *propellant* to produce a high velocity jet in the manner engineered by Bussard and DeLauer - their *interstellar ramjet*. The propellant for the main part of the journey is to be interstellar hydrogen and other ions, collected en route. Thus the range of SS Alpha is determined ultimately by the operating lifetime of the reactor.

The mission

The mission of SS Alpha is to place a navigational buoy at a permanent location one lightyear out, along a line to Alpha Centauri, thus staking the first Human claim to a definite parcel of Galactic space outside our own solar system. The ship will then return to Jupiter orbit, subsequently to Moon orbit, the crew finally being transported to the surface of the Earth. By the staking of that claim,

notice would be served to All that Humanity lays claim not only to that parcel but to the entirety of our solar system as well.

We do not yet know what the top speed of SS Alpha will be but do not rule out superlight, its F/m_0 acceleration not being relativity limited. If the average speed is only ¼ light relative to home base, then the trip would take but four years out and four years back under the developments so far.

Nearly all of the ship's operations are given over to computers, and SS Alpha requires a crew of but 12. The smaller the crew, the less life support capacity is needed, and the greater the acceleration because of the reduced mass. Passengers, pets? No. Artificial gravity? Definitely; a small price is paid for this true essential. Two genders aboard? Not this time; the social complexities still have not been worked out in submarines, a similar environment.

The main body of the ship is the habitat or Life Ring. It consists of five shipping-container-size *modules* arranged in the form of a regular pentagon, the ends of each module being joined to their neighbors by an angular *node*. The nodes carry airlocks and docking ports and provide stowage for spacesuits, tools, and other gear. Two modules (M3 & M4) form the *biosphere* (ecosystems/ environmental/hydroponics). Module M1 is given over to the ship's Bridge and Flight Deck containing flight/propulsion control, navigation & engineering; module M5 to life needs. Quarters for the four officers are located in the modules containing or near their duty stations; the medics in M4 and M5 for example. Quarters for the 8-member bridge crew are in the remaining module (M2) in four staterooms.

Crew members lived in M2-type Earth-bound quarters during ground training and later aboard the *Academy Life Ring* operating as a separate space station in low Earth orbit. The station normally rotates like a wheel three times a minute to provide a continual ¼G artificial gravity.

Permission to come aboard, sir.

You've just finished ground training, a shared responsibility of the Air Force, Navy, NASA and the prime contractor, and you are looking forward to the next phase: in-orbit training aboard *Space Academy LR1*, the life ring given over to preparing you for a flight nearly one-quarter of the way to Alpha Centauri and back.

On your flight-to-orbit with your crewmates, you try to contain your excitement but can't wait to start exploring "Laurie One" as she's affectionately called. Upon arrival, everyone proceeds through the docking locks. You swim under zero-G in a shirt-sleeve environment with the group to M2. A corridor runs the full length of M2. Corridors, present in M1 and M2, are placed along the aft wall to provide added radiation shielding for the living and operating quarters when mated to SS Alpha's Nuclear Propulsion Unit as she will be during the entire mission. After everyone and everything is aboard and the shuttle has undocked, LR1 begins rotating to provide artificial gravity. "That's better," you comment to no one in particular.

M2, the crew's living quarters module, contains four staterooms. Shift assignments are such as to assure single occupancy. Each room is nominally 2½ x 5 by 2 meters high. There's a lavatory with shower/minilaundry. The *head*, a dual john, is next door in eco module M3. You examine your assigned room. Your bunk is a hammock hung longitudinally along the module axis; an orientation and design chosen to best accommodate ship's acceleration during the actual mission. There's a 175-cm-long couch, a desk, wardrobe and bureau, and a large viewport overlooking Earth. "Wow!" you utter as you look out, not caring who hears you. The seats have retractable velcro in lieu of seatbelts. At the desk there is a large-screen video, CD-ROM/DVD video player/computer with internet and e-mail capability, and electrical convenience outlets for small personal appliances like your electric

shaver. Your severed whiskers are about all that is not recycled. Electrical energy use is strictly rationed with your personal energy card that works like a smart credit card.

The ship carries an extensive library-on-disk that rivals any library on Earth. You'll use it to study for your Masters ticket during the trip. It also contains an abundance of classic movies and videos.

You'd bunked in a similar room at the ground academy, but you notice differences now - especially with gravity and floors that seem to slope. You feel lightheaded. You don't yet have your space legs. Your roomee enters and you greet him with "Yo Mac!" and begin stowing your gear. "Name's Harley," he offers. "Mine's Norm," you respond. Then, speaking in chorus, "I knew that!" Laughter.

Each of the four rooms has a large mural on the wall behind the couch expressing a different topical theme. Your room is the *Jupiter Suite* with a painting by Chesley Bonestell.

An academy in space.

Aboard Laurie One is heard "Chow-down in M5 commencing at 1700 hours, followed by briefings at 1830 and 1930 in M1." Two identical briefings are to be given so the Life Ring does not become unbalanced by everyone being assembled in M1 at the same time. You are part of the first group. You look at your watch. Time to freshen up, change, and catch early chow. The mess, a self-serve cafeteria, is in M5. That module also contains the medical facilities, labs, and workout equipment.

The full crew complement is on board for final training, along with two instructors who won't be going along on the mission. Since this is "the first of the first" course of its kind, the instructors will be "running like crazy" just to keep ahead of the students!

Captain Rogers and the Pilot give each briefing - really a 'welcome aboard' pep talk - followed by a reminder to review your class schedule before morning.

Your first full day tomorrow aboard Laurie One will be mainly a tour to commence at 0600 hours. Breakfast at 0500. You'll be introduced to your primary duty station. Instructor Gladys says it will become "part of you" for these six weeks of training and the eight years of the mission that are to follow.

The first biweek is spent in theory and hands-on instruction. Most of your classes are in M1 because that's where your duty station is. The Bridge-Crew positions at the four forward consoles are, port to starboard (CCW going around the axis of the ship, looking forward):

Hulk	**Console**	-	S&P Engineer; spaceframe, propulsion, controls;
Hacker	**Console**	-	Computer engineer
Flash	**Console**	-	Mission Astro-Specialist
Sparks	**Console**	-	Communications, displays

You are one of the *Fabulous 8* bridge crew. Your primary duty station is *Flash*, but you must also be capable-to-proficient in the other three specialties. Hacker and Flash chairs are like saddles so they can be easily mounted and dismounted from behind.

The Flight Deck is also in M1, elevated behind the four forward consoles. There are two chairs with the primary flight/navigation consoles: the left chair is the Captain's. During flight simulations all four forward consoles are to be manned, and at least one of the two flight-deck officers (FDOs) will be on the Flight Deck of the remaining two officers, one is the Chief Medic stationed in M4/M5 and one an eco-specialist (2nd Medic) stationed in M3/M4. They are heavily cross-trained.

The large forward viewport in M1 doubles as a display viewscreen. It is basically a large CRT (cathode-ray tube) with multiple electron guns external to it in space. A rear-facing camera can present a view aft on that variable-transparency viewscreen.

After familiarization training, the remaining time is given over entirely to mission simulations. There are tough simulated emergencies programmed by the instructors at unannounced times, one of which requires a simulated service call to the large nuclear reactor in the tail.

Module arrangement of SS Alpha.

All modules, M1 through M5, are connected end-to-end in numerical order to form a regular pentagon which is the life ring. The floor of each module is at the outer side of the life ring. Since the ship has rotational symmetry there is no left ship side or right ship side - no global up and down. The "port-to-starboard" direction refers to moving counterclockwise around the life ring, facing forward. N1 through N5 are angular nodes connecting the five modules. Node N1 connects module M1 to module M2 and so on.

During the early design phase, some on the design team wanted the main viewscreen to face rearward to minimize erosion on its outer surface. Another few pushed for three eco modules. The quantity two was decided on to meet the allotted budget and to decrease ship mass. Computer modeling showed two eco modules to be adequate for a full crew of 12. They would be capable of supplying a closed ecology for as long as there was energy to power the modules. The Life Ring balances with six in M1, four in M2, and one each in M4 & M5.

The mission begins.

Your training complete, you depart to the surface for R&R and final briefings while the drydock crew maneuvers the nuclear propulsion unit into place. The large solar-cell array which had been providing electrical power to the life ring will be of little use in interstellar space, and is removed.

The dry-dock crew mates the larger open forward end of the NPU funnel to the aft open face of the life ring; its smaller remote aft end carries the nuclear reactor terminating in the main jet engine. Previously, maneuvering rockets, tanks, and payload were attached around the outside of the funnel. Spacesuits and other gear are now stowed in the intermodule nodes of the life ring.

Mating is now complete. The NPU funnel systems are checked, the reactor brought on-line, and the main engine is given a simulated run by the drydock crew. Auxiliary fuel, propellant, and oxygen tanks are filled. Water and other supplies are replenished. SS Alpha is now fully assembled, provisioned and fueled, its biosphere primed and operating to maintain the required closed ecosystem. All flight crew are brought aboard and the ship is ready to head out.

Three space tugs move into position, attach lines, and prepare to ease the big ship free of Earth orbit and slingshot it into solar orbit. The tugs accelerate, pulling the ship after them. After release, artificial gravity is re-established.

SS Alpha's new path inserts her into an elongated atmosphere-grazing Jupiter orbit for several evolutions, allowing the propellant tanks to be topped off with the methane and ammonia gases that are there, and giving the funnel a concentrated gulp of propellant. The trip to Jupiter was power-on and so took only a few months. The ship accelerates free of Jupiter orbit and eases into galactic orbit, setting sail for its designated spot in interstellar space. You expect to be back at Jupiter in eight years.

Initially, propellant is drawn from the tanks; but as the ship continues to gain speed the main engine becomes more-and-more self-sufficient, collecting larger-and-larger amounts of hydrogen and other ions from the tenuous atmosphere of space until the ramjet finally "bites." The main engine is

now self-sustaining at which time some of the collected propellant begins flowing into the tanks, soon refilling them. A steady acceleration of ¼G is maintained from this point.

SS Alpha's tanks are filled to capacity, and remain full during the outbound leg of the voyage. That stored propellant will be needed to start you headed homeward from the turn-around point, four years down the road - or sooner if the mission must be aborted.

The long voyage outward.

You're now well on your way to *Alpha Centauri Waypoint 1*, nicknamed *San Salvador*. You've settled down to the daily routine and ease back to enjoy the view. Through a rear viewport you watch the Sun recede. Watching long enough and often enough you imagine you can actually see it in the process of shrinking. You wonder: would Einstein say it is really shrinking? It certainly appears to be. Of course you're being silly; but in your musings you wonder about the reality of the relativistic foreshortening. You know that Einstein - gone 80-some years now - based his famous conclusion of an impenetrable light barrier on the supposed reality of that foreshortening. But what if it's only an appearance like the shrinking Sun you now see?

In any case there'll be no attempt to exceed lightspeed this time out. The prevailing view remains that it cannot be done, and until convincing evidence to the contrary is found, it is probable that no attempt will be made to do it. You remember reading that in the ship's bulletin last evening. Maybe you'll gather evidence and the next mission can attempt it. Anyway you're already accelerating as hard as the laws of physics allow this particular ship to do, and any attempt to exceed lightspeed this time out would simply extend the journey, already programmed at eight years round trip.

You punch up the daily newscast from home. Of course it's delayed but you have adjusted to that with no difficulty. Anyway, it seems to be the same, day after day, with continuing reports of escalation of bitter ethnic wars and rampant worldwide terrorism interspersed with reports of earthquakes, floods, and fires. And now on top of it all, there are growing demands for official recognition of interspecies marriages.

Harley, who is watching with you, quips, "Now when you kick your dog you could be arrested for spousal abuse!" You both laugh uncomfortably.

You add, "But only if Fido decides to press charges!" Uproarous, uncontrollable laughter.

You offer, "I knew a farmer once who..." trailing off when interrupted by an alarm sounding.

There seems to be a headlong rush back home to end civilization. Harley says it's because there are too many people too close together. You pray that efforts to find and reach new shores for Human settlement pay off in time. You wonder why people can't just get along as Rodney King asked, and get with the space program. This quotation from President Biden comes to mind: *Any species, in order to assure its long-term survival, must continually strive to go beyond where it now is*. ...A powerful call for cooperation and collaboration.

Was it Poul Anderson who, in a cynical pun, referred to the *planet of Terra* as "The Planet of Terror"?

Before turning in, you go to the rec room to enjoy an episode of Irwin Allen's "Lost in Space" with other off-duty souls. "What a blast!" you think. Especially Dr.Smith and the way he weasel-words himself into and then out of some tight situation or other. "Marvelous!" you verbalize and the others respond with "Shhh." Tomorrow night the program calls for George Pal's 1950s adventure, "Destination Moon." A real classic and a must-see.

You look forward to these Fridays when you can get with your small circle of friends informally.

Later lying in your bunk, you resolve to start hitting the books with an eye to taking your Masters exam before the trip is over. Thinking those thoughts, along with writing letters home, helps you keep your sanity. Even though the answers to your letters are delayed, it doesn't matter and you feel that each was written only the day before.

You give thanks for the duty periods as they keep your body and mind occupied. But during off-duty hours, melancholy sometimes sets in. Looking out the viewport doesn't help anymore, and indeed makes it worse, for it gives the distinct feeling that the ship is stuck in some infinite vat of star-studded black molasses. Except for the monotonous *quotidian rotation* of the sky due to the ship's slow rotation as if you were boring through the molasses, you sense no motion; you see no change in the star patterns. When you've had enough of that feeling, you call up the ship's realtime spectrographic star display for confirmation that you are, indeed, still moving.

Are we there yet?

You're nearly halfway there. Old Sol is now just a point of light - a star among stars. The ship has been accelerating steadily away from the Sun since departing Jupiter, but soon that will turn into a steady deceleration. The ship will not physically turn around until it is time to head back home because the funnel must continue facing forward along the flight path to harvest hydrogen. The impending retroburn phase thus means reversal of thrust and reversal also of the resulting on-board gravitational bias. You look forward to this new event, a period of readjustment, to break the monotony.

Your steady acceleration during the trip has been ¼G, and to return the gravity vector closer to normal, the ship rotation was increased to provide a total gravity of about ½G. When you walk down the corridor you now list an average of 12 metric degrees to one side; soon you'll have to adjust to an opposite list. [12 metric degrees equals 21.6 Babylonian degrees - Ed.]

San Salvador ho!

As you approach San Salvador, the chosen point in space as confirmed by the global star patterns, the impulse engines finally grind the ship to a halt - the condition where all star spectrographic sensors indicate that there is no average motion among the stars. It is at this point - ¼ of the way to Alpha Centauri - that ISAA, Interstellar Spacebuoy Alpha-Alpha, is to be deployed. For the deployment, three crew must engage in a space walk. You are among them. Your duties include video documentation of this historic event for immediate relay to Earth.

After deployment, ISAA's on-board sensors and vernier jets act to maintain it in a station-keeping Galactic orbit for scores of years, maybe longer. Its pulsating radio and laser beacons announce to the universe, "I am here." The casual astronomer on an uncharted world may, if he takes note of it at all, catalog it as just another pulsating stellar object. But if he looks long and hard, he may see it as an artifact of an intelligent species and a clear sign that someone has staked claim to a point in interstellar space; someone to be reckoned with; someone calling themselves *Humans*. Just the thought makes you look around to see if somebody else's spacebuoy is nearby!

While reboarding you muse: If we are *Humans* then shouldn't our solar system be called *Huma*? (Think "Vega" and "Vegans.") Organic earth is presently called humus. Then our Sun can also be *Huma* and the Earth can be *Huma 3A* with the Moon being Huma 3B. That way the words "sun", "earth", "moon", & "solar system" can be used generically; also such terms as "sunshine, moonlight, earthquake." And "moonshine" will always mean bootleg booze (except to our favorite channel-9 weatherman who would end a weathercast with "And expect plenty of moonshine

tonight!") ISAA is now deployed, in position, and operating normally. Humans have left their mark. The Milky Way Galaxy has a new star and the time has come to leave this place.

Heading homeward.

The vernier jets turn the ship towards home. The initial acceleration phase will be critical, as there can be no harvestation of interstellar hydrogen until the threshold ramjet speed is reached. To arrive at that happy state of affairs depends on the modest initial acceleration provided by the limited amount of tanked propellant and the maneuvering rockets. It requires nearly a week to accelerate to a velocity adequate to initiate a self-sustaining ramjet condition.

But finally the ramjet bites again, and SS Alpha is back in her natural environment - sailing along at a constant ¼G acceleration through interstellar space which soon moves you at a respectable fraction of the speed of light relative to *Huma*. In two years the deceleration halfway point is reached once again, and from that point another two years brings you to an orbiting stop at Jupiter. There is now a blossoming star base abuilding there, and you are home by interstellar standards. SS Beta is there, preparing to leave on its own pioneering interstellar journey, and cadets are all over you and your crewmates with questions when you arrive.

But the first starship will not end her journey here at Jupiter; the plan is to park it in permanent orbit around *Huma 3B*, in an extension of the Smithsonian Institution in a place of honor with the Wright brothers' *Flyer*, Lindberg's *Spirit of St. Louis*, and the *Apollo* moonship.

Welcome home starman!

The Sun looms large. You'd forgotten how large. The artificial gravity is gradually increased during these final weeks until you are at 90 percent of Earth gravity; thus you will have little trouble regaining your land legs when you finally step out onto terra firma.

You recall the story of the "Twins Paradox" and wonder: "Will all my friends have aged more than me?" Maybe some have even been dead for years. But no; you've kept up with the obituaries so you know that hasn't happened. And you've been informed of the current Earth date and time.

The newscasts from Earth which you had been following almost daily during the trip are now up to date. Yes, you come home fully informed and educated on all that has happened since you left, eight-plus years ago. You know that a respectable space infrastructure has grown up on and around the Moon and around Earth while you were gone, and that - in addition to the now-building *Jupiter Base* - the first permanent Mars base, *Utopia*, is nearing completion. You suppose that this impressive progress can be partly attributed to the inspiration provided by SS Alpha's success reported daily in the local news, and to the Priestley oxygen generators that have sprouted-up all across Mars. And the technology developed from all these efforts dealing with life-support needs has led to significant improvements in the quality of life on Earth too. Life is good.

The ship inserts into lunar parking orbit.

Home and family.

You are next transported to *Moon Base Armstrong* with the entire crew for debriefing and you see and talk with mom and dad by high definition video link. You hear "our boy," bringing you down a notch. After that you are transported directly to *Earth Station Goddard* and taken from there to the surface by a new generation of high-apogee shuttle.

You are now only 30-ish, having left when you were 22. On the way you muse: If someone asks me, "Would you do it again?" I'd answer, "Give me two weeks!" You may change your mind after you spot Julie. "But we really need three bio-modules so everybody can eat better."

It was surprising to learn that Earth clocks are almost half an hour behind the ship's. The reason, you are now told, is that while you were in space experiencing an average gravitational force of ½G, those who stayed behind were immersed in a full 1G field. Thus for eight years, atomic clocks on the ship ran faster than clocks on Earth in accordance with the general theory of relativity. It turned out that the opposite effect, which some had predicted from special relativity, did not materialize. You wonder if this new information will be enough to justify an attempt to break the light barrier next time out. You remember the television movie, *Longitude*, and think:
"John Harrison, where are you when we need you? We need a new space clock."

You're anticipating being home with your family once again. You're about to find that the toughest part of the journey lies ahead for you and your eleven crewmates, with ticker-tape parades followed by weeks of guest spots and interviews. The excitement is electric; the world has been following your epic journey all the way and it is now time for you to acknowledge the world.

Chapter 8

The Phase Two Experiment: Alpha Centauri or Bust

With the Essential Observer being anyone on the ship, the Balance of Forces Equation, eq. (1), for the rocketship/jetship reduces to $F = m_o a$ ringing us right back to a pre- Einsteinian treatment of the problem. Additionally, under the kinematical perspective view, time dilation resulting from the special theory of relativity is only an ppearance not producing a permanent "set" in time. And the general relativity component of time dilation is nulled out by maintaining a continual 1G acceleration. Thus when our travelers return home, age will not be a problem under the kinematical perspective view.

BULLETIN

Volunteers are Being Recruited:

As one of the first four ambassadors to Alpha Centauri, you will ride along and place two *Embassy Class surveyor satellites* in orbit around sun *G4*, then return to Earth. Married couples are encouraged to apply. You will go into the history books as one of the *first Humans ever* to live in two different solar systems. Apply at www.αCentauri.com

Got 50 gigabucks to invest and eight years for an exciting, fun-filled vacation away from home? The remaining start-up costs are to be picked up mostly by assorted sponsors and a far-seeing media mogul - Steven or Stephen something-or-other. NASA wanted to oversee, but Congress insisted on placing too many restrictions. Then when top-notch NASA engineers began defecting to *TheConsortium*, Congress relented some and NASA was welcomed as an active participant.

> *As part of the on-going development, the sponsors and media would find ways to use marketing and gee-whiz docudramas to make this effort continue to more than pay for itself even before it got started.*

An extreme ride.

Following Project Apollo, the dream of star travel was kept alive through marvelous stories, but those stories were mostly fantasy and it seemed that little was being done to make it happen. The International Space Station was never fully completed, efforts being siphoned off to establish a staging base on the Moon--a jumping-off place to Mars and beyond. Mars was being probed left and right.

Hard on the heels of the establishment of *Mars Base* in 2020, development of the first 'manned starship to test new hardware and software was begun. Thanks to an intensive effort, a Bussard interstellar jetship was fashioned; and in 2041 *Starship Alpha* was launched with a 12-man crew to place marker buoy *San Salvador* at a place partway to Alpha Centauri.

Midway through that eight-year trip, star travel began looking increasingly realistic to people around the world. The development of a deep-space infrastructure accelerated with *Jupiter Station* as the centerpiece. It became more and more apparent that it *could* happen, and that this is the way it *would* happen. The Japanese, Chinese, Indians, Europeans and Americans all wanted to be first to reach another star; and a healthy, fierce competition developed. The continuing effort coalesced into two major competing camps: *Eastern* and *Western*.

As optimism and excitement grew, the time-to-launch of the *Suzue* was compressed from early projections so that in a gigantic orgasmic eruption we now find ourselves on the first 'manned voyage to another star; the second 'manned star trip ever. This is not another voyage like Columbus'; it is more akin to the emergence of life from the primordial swamp onto dry land; it signals the beginning of a *cosmic migration*.

Born again.

German physicist Max Born wrote a book called *Einstein's Theory of Relativity* in 1920 which was translated into English in 1924, and he wrote a revision of that translation in 1962. A quotation is given here from the 1962 edition (Dover, pp.258-60):

> *Imagine a journey to α-Centauri. ... These space experiments cannot at present be performed. But there are phenomena due to small cosmic particles [π-mesons] which can be observed and used for a perfectly convincing confirmation of the time dilation and the effect described in the clock paradox. ... If the velocity of the cosmic mesons [with lifetime 10^{-8}s] were as large as that of light, the distance traveled by them would be only $cTo = 310^{10}10^{-8} = 300$ cm. But π -mesons of very high energy are observed on sea level. How is it possible that they penetrate the atmosphere, traveling a distance of about h = 30 km during their lifetime? This paradox is resolved by taking into account the dilation of time.*

Note the passage "if the velocity...were as large as that of light." Imposing such a limit as a precondition guarantees that there will be a paradox and further guarantees the conclusion reached there in a self-fulfilling prophecy.

That scenario may square with Einstein's view of relativity (i.e., that *c* is a barrier to physical motion) but, as explained throughout this account, it is not the only way to look at things while staying within the bounds of relativity. Under the kinematical perspective view we might instead consider that the velocity of the cosmic mesons is really larger than that of light. Enrico Fermi's 1950 call for "clear" evidence of a material object moving faster than light may already be at hand with the π -meson; but the in-crowd clouds things, giving explanations in terms of time dilation. Perhaps the only way we will ever receive "clear evidence" is to perform a Human experiment like the one described here. No, Max; no more *gedanken experiments*; we need to make the round trip to Alpha Centauri ourselves to see what the situation really is.

Onward and upward!

Our fictitious hero, David, born in 2026, will be 24 when he begins training in 2050 for his trip as captain of the first ship to Alpha Centauri, 43 when he leaves, and 51 when he returns to Earth. ... He, along with an engineer/navigator and two medical-life support types. All crew are heavily cross trained.

Two centuries of flight are chronicled now:

1903 Wilbur & Orville Wright achieve powered flight
1947 Chuck Yager breaks the sound barrier in the Bell X1, while some were still saying that the sound barrier could not be broken
1960 Robert Bussard conceives of the interstellar ramjet
1969 Neil Armstrong sets boot on Earth's moon (Huma 3B) at *Tranquility Base* in project Apollo
1972 First soft-landing of a probe on Mars
2004 President redirects space program towards Moon & Mars
2004 *Spirit* roves around Mars at *Columbia Memorial Station*
2004 *Opportunity* roves around Mars on t'other side
2005 Cosmos I sailing ship launched toward Mars
2019 Cosmos II sailing ship launched toward α-Centauri
2020 First Human sets boot on Mars at *Utopia Base*
2030 "Century City" stories setting (ABC-TV, 2004)
2041 Starship Alpha launched
2045 Spacebuoy *San Salvador* placed ¼-way to α-Centauri
2046 Jupiter Station established
2049 Starship Alpha arrives back at Jupiter Station with all 12 hands safely on-board
2049 President redirects space program towards α-Centauri
2050 Crew training for α-Centauri trip begins
2069 Starship Suzue leaves Jupiter Station for α-Centauri
2070 Humans break the light barrier
2073 Humans reach α-Centauri, place two embassies in orbit; Humanity now owns those two parts of Centaurian territory, without objection from any dominant indigenous intelligent society
2077 Starship Suzue arrives back at Jupiter Station with all eight hands safely on-board - four crew and four ambassadors

2077 President announces Megalopolis initiative

A science experiment.

Stonehenge; crop circles; Area 51; Cerenkov *x*-, gamma- and cosmic-ray bursts; SETI taken seriously; discovery of more and more extrasolar planets: If we were feeling like penned-up geldings in a galaxy of free-roaming stallions, that feeling began subsiding under the kinematical perspective view of special relativity.

"Ladies and gentlemen this is your Captain speaking. Happy New Year twenty sixty-nine and welcome aboard the Suzue, a Lockheed Martin New Constellation powered by General Electric SJ-32 interstellar jet engines. Through a forward viewport you might be able to see a sailing vessel, Cosmos II, by the reflection of starlight from its gigantic sail. It's that faint, out-of-place star, there, in the constellation Scorpius. It was launched 50 years ago by The Planetary Society with the same destination as ours. We will be back on Earth before Cosmos II reaches San Salvador, the quarter-way point.

"Our voyage to Alpha Centauri will take 49 months and we are projected to reach a top speed more than twice normal lightspeed. In any event, we will turn around and head back home before we have been out 50 months. And if everything works out as planned your twin sibling who stayed behind will still be your age."

Captain David Gallegher continues, "Sit back and enjoy your flight. After we are fully spaceborne, you will be free to go about your business in a shirtsleeve environment under normal Earth gravity. E-mail links will remain open and usable for another few months. We will also be testing a new superlightspeed comm link. I, along with the crew, look forward to meeting with each of you later in the cafeteria. Have a nice flight."

The *Suzue* is like a mini earth-sun system; self-contained, self-powered and self-regenerating; free to go as fast as its 1.1G acceleration capability will take it, virtually anywhere there is interstellar dust to swim through, for as long as its nuclear power plant is operational and its integrity can be maintained.

Ambassador Fergie turns to you and says, "My grandmother used to tell of crossing the Atlantic Ocean around the turn of the century from London to New York and back in the same day on the Concorde. ... And, on the westbound leg, she'd tell how the sun would actually appear to be moving from west to east--as if time were running backwards. She would tell us kids how exciting it was just to know you were really traveling `twice as fast as the speed of sound' as she put it.

"Well, here I am [voice quavering, pausing]. In a few months we'll really be traveling twice as fast as the speed of light. How awesome is that! ... And what bizarre sights must await us! Will the stars all vanish? ... Maybe new ones will appear!!"

Communication.

Ship-to-shore communication has to do with sending and receiving information; and as Norbert Weiner said, "Information is not matter or energy. Information is information." Backing that up is a 1996 finding of Roll Landauer of the IBM Thomas J.Watson Research Center in Yorktown Heights, New York, in which he concluded that there is no minimum energy requirement for sending information. Landauer's original announcement appears in the June 28, 1996, issue of *Science*. He suggested methods that might be used to send information without dissipating energy. A method of sending information at more than twice the speed of light was suggested by this writer in the *Journal of The British Interplanetary Society*, "Superresonance and Interplanetary Communications," Vol. 50, pp. 159-160, 1997.

The point is, the speed of transmission of information is not, in principal, subject to considerations of the speed of light because information is neither matter nor energy. Therefore there certainly is hope of communicating at super- or even hyper-light-speeds with no requirement to violate relativity.

Chapter 9

Voyage to the Center of the Galaxy

The grand experiment successfully completed,
we now consider a trip to a place we'll call
Megalopolis near the center of the Galaxy.

A highly instrumented unmanned probe of the *Suzue II class* is sent towards *Megalopolis*. *Suzue II* is a two-shape interstellar ramjet. Shape 1 takes her to 10 lt (10 X the speed of light). Shape 2 takes her to 100 lt and beyond.

The diameter of the Milky Way Galaxy is given as 100k lt · yr and our position as 2/3 of the way outward from the center. An impossibly long way to go? Not at all; not since we've found how to break the light barrier. At 2G acceleration it will take only about 500 years to cover the 33k lt · yr distance and return to Jupiter. Or with an acceleration of a little more than 50G, the round trip would take only 100 years. At those large accelerations atomic processes on the probe will slow, and we might say that ship time slows; the figures given here are Earth time. Ship time will never stop or run backwards however; for it is the acceleration field that causes the ship's atomic clock to slow under general relativity; and for it to stop entirely would require an infinite acceleration. [1]

Our path is set to lie along the northern edge of the Galaxy because the internal Galactic cloud is too dense to permit such speeds through it safely. Our path, straight thru space on a beeline to the center of the galaxy, will be shown to spiral naturally in accordance with the galactic Coriolis effect when mapped onto the galactic disk.

The nuclear component of the Bussard interstellar ramjet must be certified to operate for the duration of the round trip, whether 500 years or only 100. (Less than that by the ship's atomic clock.) It seems ironic now, recalling that late in the 20th century few could see how an adequate fuel supply could be assured for any kind of star trip to give a steady acceleration even while the long-term problem of the Yucca Mountain nuclear-waste burial site was clearly seen. The nuclear-power solution was the elephant in the living room that it seemed no one could see!

Note:

[1] The resonant speed of space inside a medium such as glass or water is decreased over its free-space value because of the increase in the product $\mu\varepsilon$ there. Since lightwaves and gravitational waves are connected by virtue of their having the same speed in free space, a similar thing would be expected to happen inside a large gravitation field. And, as the field strengths increase without limit, the product $\mu\varepsilon$ would also, and the local resonant speed of light would then drop to zero so that an atomic clock imbedded in an infinitely strong field would be expected to stop completely. Finally by the principle of equivalence, the same thing would be expected to happen in an infinite acceleration field. For the mathematical solution see, for example, Ciufolini & Wheeler, *Gravitation and Inertia*, Princeton U.P., 1995, ISBN 0-691-03323-4, section 3.2.2.

Appendix to Ch. 9

Megalopolis Explained

megalopolis*: a thickly populated region centering in a metropolis or embracing several metropolises.* … Merriam-Webster's Collegiate

We know that the stars are more densely packed together at the center of the galaxy in a region we call *Megalopolis*. If intelligent species have arisen in every n^{th} system throughout the galaxy at about the same time, factors would act to make it likely that the Megalopolitans' star capability is more advanced than ours, and there may already be a buzzing interstellar society in that region. Some of those factors:

(1) The larger number of intelligent species arising in the region because of the increased density of stars;

(2) The relative closeness of the neighboring stars there, providing dwellers with a stronger urge to reach out; and

(3) The possibility that one of those intelligent species lives on a world having gravity less than 1G, making it easier to get into space.

If star travel is as achievable as here indicated, there is some urgency in acting. We do have an advantage in that we know where they are - the Megalopolitans - whereas we are like a needle in a haystack to them.

Chapter 10

An Hypothesis: There Is no Speed Barrier in the Universe

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In this chapter one promotes the hypothesis that: *There is no speed barrier in the universe and one can construct arbitrary speeds*, and one asks if it's possible to have an infinite speed (instantaneous movement).

Introduction.

What's new in science (physics)?

According to researchers from the University of Innsbruck in Austria (December 1997): photon is a bit of light, the quantum of electromagnetic radiation (quantum is the smallest amount of energy that a system can gain or lose); polarization refers to the direction and characteristics of the light wave vibration; - if one uses the entanglement phenomenon, in order to transfer the polarization between two photons, then: whatever happens to one is the opposite of what happens to the other; hence, their polarizations are opposite of each other; in quantum mechanics, objects such as subatomic particles do not have specific, fixed characteristics at any given instant in time until they are measured; suppose a certain physical process produces a pair of entangled particles A and B (having opposite or complementary characteristics), which fly off into space in the opposite direction and, when they are billions of miles apart, one measures particle A; because B is the opposite, the act of measuring A instantaneously tells B what to be; therefore those instructions would somehow have to travel between A and B faster than the speed of light; hence, one can extend the Einstein-Podolsky-Rosen paradox and Bell's inequality and assert that the light speed is not a speed barrier in the universe.

Scientific Hypothesis.

We even promote the hypothesis that: there is no speed barrier in the universe, which would theoretically be proved by increasing, in the previous example, the distance between particles A and B as much as the universe allows it, and then measuring particle A.

An Open Question now:

If the space is infinite, is the maximum speed infinite?

Controversies.

This hypothesis is controversially interpreted by scientists. Some say that it violates the theory of relativity and the principle of causality, others support the ideas that this hypothesis works for particles with no mass or imaginary mass, in non-locality, through tunneling effect, or in other (extra-)dimension(s); the last ones assert that the principle of causality is not violated, i.e. the effect happens second, but because the cause is witnessed via the medium of light it appears to be after the effect – therefore our measurement is relative, not the simultaneity. [Kamla John]

Scott Owens' answer to Hans Gunter in an e-mail from January 22, 2001: It appears that the only things the Smarandache hypothesis can be applied to are entities that do not have real mass or energy or information. The best example I can come up with is the difference between the wavefront velocity of a photon and the phase velocity. It is common for the phase velocity to exceed the wavefront velocity, c, but that does not mean that any real energy is traveling faster than *c*. So, while it is possible to construct arbitrary speeds from zero in infinite, the superluminal speeds can only apply to purely imaginary entities or components.

Would it be possible to accelerate a photon (or another particle traveling at, say, 0.99c and thus to get speed greater than c (where c is the speed of light)?

Future possible research.
It would be interesting to study the composition of two velocities v and w in the cases when:

$v < c$ and $w = c$.
$v = c$ and $w = c$.
$v > c$ and $w = c$.
$v > c$ and $w > c$.
$v < c$ and $w = \infty$.
$v = c$ and $w = \infty$.
$v > c$ and $w = \infty$.
$v = \infty$ and $w = \infty$.

What happens with the laws of physics in each of these cases?

Notes:

[1] An early version of this paper, based on a 1972 paper, was presented at the Universidad de Blumenau, Brazil, May-June 1993, in a Tour Conference on "Paradoxism in Literature and Science"; and at the University of Kishinev, in a Scientific Conference chaired by Professors Gheorghe Ciocan, Ion Goian, and Vasile Marin, in December 1994.

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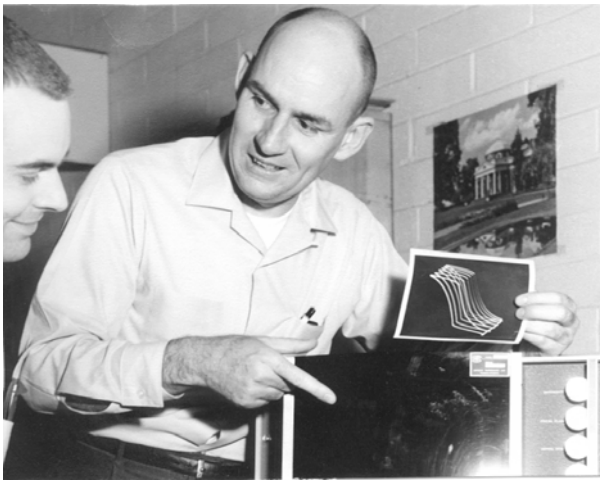
About the Authors

Homer Benjamin Tilton, born in Montana, served on active duty in the U.S. Air Force during the Korean Conflict 1950-55. After retiring in 1989 from 34 years as an electronics engineer in the aerospace industry, he joined the faculty at Pima Community College where he presently teaches mathematics.



Homer B.Tilton at age 40

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Author of: Textbooks in math (WAVEFORMS, Prentice-Hall, 1986) and electronics (THE 3D OSCILLOSCOPE, Prentice-Hall, 1987); and chapters in books from New York University Press, Princeton University Press and World Scientific Publishing.

Florentin Smarandache as a student at the University of Craiova in his early 20's

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Florentin Smarandache, born in Romania, escaped to the West in 1988. He received his Ph.D. in Mathematics from the State University of Kishinev in 1997. A prolific writer, he is the author, co-author and editor of 70 books and 90 papers in mathematics, physics, literature, philosophy. In November 2004 he was invited to lecture at NASA Langley Research Center. He teaches mathematics at the University of New Mexico, U.S.A.

Begin the Adventure

How to Break the Light Barrier by A.D.2070

Homer B. Tilton
Florentin Smarandache

A book of hard science culminating in three separate chapters of fiction (7, 8, and 9), this book, written for the technically-savvy layman and amateur scientist, is comprised of selected articles by the authors which previously appeared in various journals along with new material that ties it all together. The book critically examines Einstein's conclusion that nothing can go faster than light. A wide, popular audience is sought to swamp the myriads who take the phrase "You cannot exceed the velocity of light" on faith alone or who generalize from a too narrow base.

The book is about star travel but it is not science fiction; it is a science story describing a scenario centered around a fresh look at relativity in the light of current thinking.

In 1905, Einstein published his landmark special theory of relativity from which he concluded that nothing can go faster than light. However the current trend among scientists is that the relativistic changes are a sort of kinematical perspective and are no more real than the apparent bending of a stick which is partly immersed in water.

A barrier is manifested in particle accelerators and with light sailing spaceships and the reason for the barrier is clearly explained; but under that reason, the barrier does not extend to rocketships.

After development of arguments in the first six chapters, chapters 7, 8, and 9 are fictionalized accounts of voyages and journeys to the stars based on those arguments. Chapter 10 presents an hypothesis relating to the light barrier.

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