Impacts of Terrestrial and Astronautical Sociology on the Evolution of Spaceflight by Spacefaring Civilizations

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Abstract. It is suggested that flaws in terrestrial sociology (the negative social dynamics of individual and corporate human natures on Earth) is, to some degree, delaying achievement of the science and technology needed to revolutionize spaceflight and meet this planet's future energy and transportation. Here, scientific timidity, self interest and resistance to change is delaying the replacement of current propellant-consuming and carbon-emitting power and propulsion by nearly propellant-less, emission-free power and propulsion for terrestrial energy and transportation and cost-effective space exploration to the further reaches of the cosmos. Propellant-less and emission-less power and propulsion systems would generate energy and force by the actions of fields - not the combustion of matter. So, when favorable developments in terrestrial sociology and technology enable field power and propulsion, long, ambitious space expeditions can begin if "astrosociology"- stable, harmonious social dynamics between many cooperating people in space – can also be achieved.

Keywords: Astrosociology, Interstellar, Field Power, Field Propulsion, Quantum Vacuum, Zero-Point Field
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INTRODUCTION

Past and present spaceflight activity by the world's spacefaring nations have not involved long enough mission times or large enough numbers of individuals for extremely in-harmonious social interactions to develop – especially with the high character, intelligence, stability and temperament required for current astronaut and cosmonaut selection. And current NASA-defined human space missions for the next 10-15 years do not require significantly longer mission durations or numbers of people than current Space Shuttle and Space Station missions do. Thus, the social sciences and social graces already developed by terrestrial sociology have been successfully applied to past human space activities and they appear adequate for those envisioned in the near future. But future ambitious space missions - such as human expeditions to Mars with chemical rocket technology - require long flight durations and long stay times on Mars before expedition people are returned to Earth. Thus, astronautical sociology "astrosociology" issues may begin to develop for such missions. Examples are the current biological and medical unknowns associated with long term human exposure to Mars gravity (about 0.39 that of Earth) by its first settlers. This astrosociology issue requires learning the effects of long-durations of reduced gravity on Mars. For it is known that long term exposure to zero-g for one year by one Russian cosmonaut was very deleterious. Thus, astronauts could conceivably face significant rehabilitation time, effort and pain after long chemical rocket expeditions to Mars – unless: bone calcium removal is found much less at 0.39 g than at 0 g; or if calcium removal solutions are found. In summary, the paper explores advances in terrestrial technology and sociology that enable long and large space expeditions by space faring civilizations – expeditions where astrosociology will become vital for mission success.

IMPACT OF SPACE FLIGHT AND TERRESTRIAL SOCIOLOGY ON EACH OTHER

Air flight began with propeller propulsion and steadily advanced for over 50 years. But air flight was not revolutionized until propeller propulsion was superseded by air breathing jet propulsion that enabled much swifter,

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safer and more economical air flight by jet airliners such as the Douglas DC-10 in Figure 1. Thus jet propulsion and the advent of information technology (by more powerful digital computers) had enormous impact on terrestrial sociology. For, it gave rise to the stupendous current travel infrastructure of airlines, hotels, auto rental agencies, and food services that have provided careers and economic opportunity for millions of people on Earth. The air flight revolution also provided the new experience of flight for millions; and worldwide travel revenues of trillions of dollars per year.

FIGURE 1. DC-10 Jet Propelled Airliner that Helped Revolutionize Air Flight

Spaceflight began with the Soviet Sputnik and with rocket jet propulsion and, like air flight, spaceflight steadily advanced over 50 years as commercial satellite systems impacted planetary life with television, mobile phones and internet information. This caused significant change in the social behavior and dynamics of humans and societies - and billions of dollars per year in commercial space revenues have benefited the economic lives of many on Earth. But, despite rockets reaching the highest possible performance they can achieve with safe, chemical combustion of energetic non-toxic propellants, space flight has not yet been revolutionized like air flight. For, space transportation cost to deliver satellites to earth orbit (about $10,000 per kg) is about 100 times greater than air transportation costs. It is hoped that eventual development of air breathing reusable launch vehicles can reduce Earth-to-orbit costs by a factor of 5 to 10. But space transportation costs per kg of payload are expected to be 10 to 100 times more than current Earth-to-orbit costs for journeys to the moon and Mars. Unofficial NASA cost estimates of human Mars expeditions are in the hundreds of billions of dollars range. And such space transportation costs are at least 100 times more than those that would enable commercial space exploration and space settlement within the solar system.

Much of the high current cost of space transportation is caused by the enormous amounts of propellant that must be combusted and expelled in rocket ships. Thus, just as revolution of air flight required replacement of propeller propulsion by jet propulsion; so many believe the revolution of spaceflight will require replacement of jet propulsion by field propulsion – by developing thrust by the actions of fields (not consumption of matter). But actions of fields are much less understood than combustion of matter, and today's high cost of earth-to-orbit transportation is within what commercial satellite system corporations will pay. Thus, aerospace companies are content to continue making profits by what they know how to do (rocket propulsion for governments and telecommunications providers) and they are little motivated to develop a new mode of propulsion they understand far less. And government space R&D leaders are content to continue what seems safe and low risk (rockets for Earth orbit, Moon and Mars) despite the huge cost involved. Hence, corporate and government aerospace R&D expenditures on field propulsion science and technology are less than 1 percent of R&D spent on refining today's well-understood rocket science and technology.

GREEN POWER AND PROPULSION NEEDS FOR SPACEFLIGHT AND EARTH

Although there is no pressing need today for nearly propellant-less power and propulsion for human spaceflight to the further reaches of space, there is urgent need for drastic reduction of the global-warming CO_2 emissions from Earth's power and transportation systems. Here, global warming scientists call for more than a 50 percent reduction in CO_2 emissions by 2050 – when worldwide demand for energy and transportation is expected to be about twice what it is today. This would require about a 4-fold reduction in emitted CO_2 – compared to that emitted by terrestrial energy and transportation systems today. And, because other human activities (including clean fuel manufacturing) emit CO_2, it would probably be desirable that 4-fold reduction be increased to about 8. Drastic social change should surely accompany drastic CO_2 reduction, with increase in "clean": solar; wind; tide; and geothermal power hopefully replacing much of the power currently generated by fossil fuel burning. Such "green" social change should surely assist in demand for both spaceflight and terrestrial power and propulsion being green - embodying more actions of fields and less combustion of mass - until the almost propellant less power and propulsion of Figure 2 is approached.

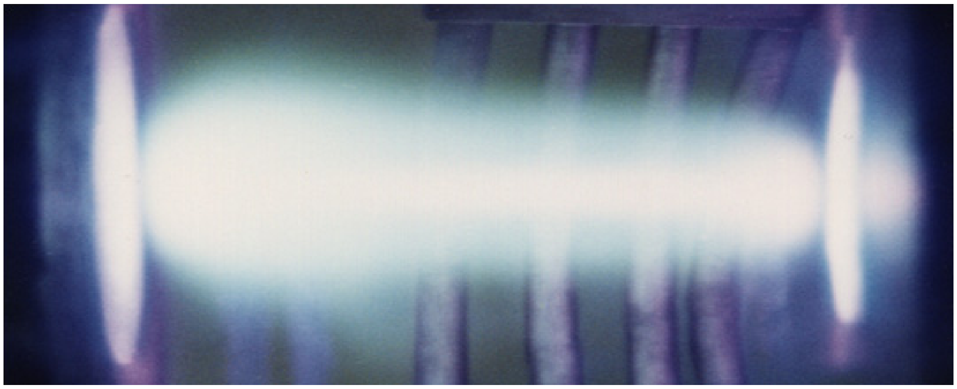

FIGURE 2. Development of Power and Propulsion by Actions of Fields – Not by Combustion of Mass

Many aerospace and propulsion leaders may intellectually accept the idea that spaceflight will never be really revolutionized and space will never be truly settled until matter-consuming rocket propulsion and power is superseded by that is almost propellant-less - like field propulsion and power. But will some of these leaders have the fortitude to actually make the hard decisions to bring this about in the current climate of human and corporate inertia and self interest – a negative mental climate that would prevent bold R&D re-direction from the *safe and familiar* to the *uncertain and unknown*? In this respect, the many field power and propulsion possibilities and their technical unknowns discourage one from even starting. But, the many field propulsion possibilities can be sorted into 3 general groups and 3 general assumptions as to origins and relations between gravity and electromagnetism.

One category of field propulsion possibility would involve the "Lorentz" force generated by electromagnetic (EM) interactions involving vector cross products of magnetic (B) and electric (E) fields that are created inside vehicles or that exist within the electromagnetic flux of the interplanetary or interstellar space. This category of field propulsion is attractive in that it embodies well-understood EM interactions and requires no special assumptions as to the underlying relationships between electromagnetism, gravity and inertia. Thrust from Lorenz force is small for interactions that involve the relatively weak E and B fields of outer space. But NASA studies such as Chase (1996) have explored its use in Earth's atmosphere by air breathing engines. Here, Lorentz force would strongly slow airflow: to improve engine efficiency; generate enormous electrical power; and significantly amplify thrust per fuel flow rate. This was done by wrapping ionization and magnetic sources (electron beams, electrodes and superconducting magnets) around engine flow paths. These components greatly increased dry mass of single stage-to-orbit space planes. But their takeoff mass was less and propellant consumption was reduced by almost 30 percent.

Another category of field propulsion possibility (Woodward, 2007) would use well-known EM interactions. But, it assumes - in accordance with "Mach's Hypothesis" - that fluctuation in a system's mass will be instantly responded to by the gravitational presence of all nearby and distant cosmic bodies. Field propulsion is achieved by inducing mass fluctuations within capacitor dielectric materials by subjecting them to electromagnetic (EM) energy pulsations of very high frequency and voltage. The EM pulsations are modulated to create Lorentz forces in the desired direction during the mass reducing phases of the fluctuations - to cause unidirectional force. Thrust of this system increases with: dielectric thickness and mass; magnetic field strength; capacitor dielectric constant; and applied voltage; and operating frequency. Positive experimental results have been obtained by Woodward and others over several decades with customized off-the shelf components. But operational systems would need much lower-loss dielectrics and about a 3-fold increase in their: operating frequency; and dielectric constant; and fatigue lifetime.

The third category of field propulsion systems is based on the possibility of an innate connection between gravity and inertia and electromagnetism that this might allow specially conditioned, higher-order EM fields to couple with the higher-order fields that may underlie gravity and inertia. In this respect, Barrett (2008) uses gauge and group and topology theory to derive higher-order, specially conditioned SU(2) EM fields that contain added *A* vector fields and added field interactions that involve couplings between *A* and *B* fields and *A* and *E* fields. He found one way of creating specially conditioned SU(2) EM fields is by phase and polarization modulation of a portion of ordinary input EM energy in wave guides and combining this modulated energy with the un-modulated input energy to emit laser or microwave radiation whose electric and magnetic field directions and amplitudes can undergo many cycles of change during very short travel distances in space. Also, Barrett, 1998 describes specially conditioned SU(2) EM fields generated by toroids with appropriate geometry, coil winding and frequency. At resonant radio frequency, the 2 ordinary U(1) *A* vector potential patterns that surround radiating toroids cancel themselves and a single SU(2) *A* vector field is created that greatly increases toroid signal strength at any range. Tests of SU(2) EM fields generated by Toroids (Froning and Hathaway, 2001) have yielded significant results, as have tests of SU(2) EM fields generated by polarization-modulation. But like Woodward's field propulsion work, much more work has to be done.

Unfortunately, most electrical, electronic and electromagnetic professionals assume there is nothing new beyond Maxwell's electromagnetism that was derived in the late 1890's. And most of mainstream science disbelieves in Mach's Principle and possible couplings between gravity and electromagnetism. So, science is much more focused on things such as search for the Higgs boson and reconciling General Relativity with Quantum Theory - not search for new modes of EM field generation, and their possible coupling with the fields that underlie gravity and inertia.

FIELD POWER FROM CLEAN NUCLEAR AND VACUUM ZERO-POINT ENERGY

Its assumed that by 2050, much terrestrial power from CO_2 emitting fossil fuels will be replaced by an enormous increase in power generation from solar, wind, tide, and geothermal sources. But, the much lower energy gathering densities of these sources require vast areas of land, shore and sea and disadvantages of more security and power distribution (over longer distance) expense. Thus, if twice today's terrestrial energy is required by 2050, new sources of energy in addition to solar-wind-tide-geothermal may be required. In this respect, nuclear fission is an energy system generally perceived as undesirable because of its radioactive waste. By contrast, nuclear fusion is less dangerous and generates less radioactive waste. But, energetic neutrons emitted from fusion reactions are difficult to shield and result in material erosion and residual radioactivity. However, "aneutronic" fusion reactions emit no neutrons and cause no radioactivity. For example, the aneutronic reaction in Figure 3 causes the high temperature fusion of boron 11 and hydrogen nuclei to create a total of 3 helium ions (electricity) and 5.68 MeV of energy per fusion. Critical research on challenging aneutronic fusion areas are described in (Froning and Miley, 2004).

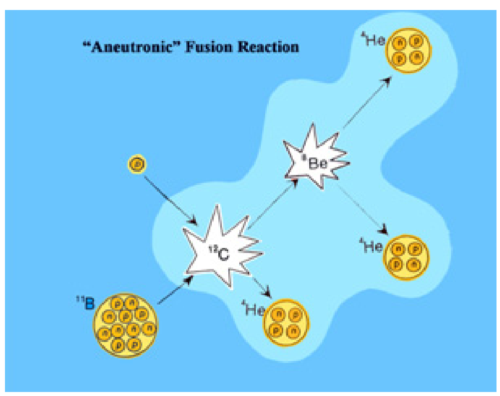

FIGURE 3. Neutron-Free and Radioactivity-Free Nuclear Fusion Reaction.

Although space seems inert and "empty" to the senses, quantum theory reveals it as possessing enormous vigor and vitality over sub-microscopic scales of distance and throughout the entire enormous vastness of cosmic space. Contributing to this vigor and vitality are zero-point fluctuations in the vacuum's electromagnetic state, which come from processes such as creation and annihilation of virtual charged particle pairs in small regions of space. Figure 4 shows such fluctuations at a given instant as numerous EM energy pulsations of various frequency and wavelength. .

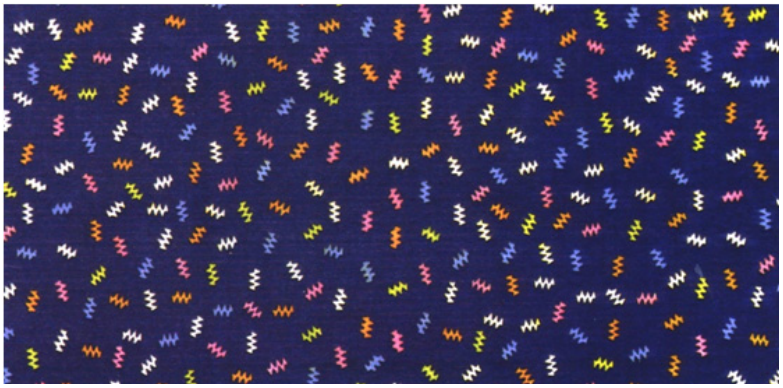

FIGURE 4. Zero-Point EM Energy Fluctuations in a Sub-Microscopic Region of Space

Over 10^{-3} cm scales of distance, which are comparable to a tiny spec of space, expectation value of the zero-point energy density of the vacuum is 10^{-8} J/cm^3 – a value that is indiscernible to the senses. But over 10^{-6} cm distances, expectation value of vacuum zero-point energy density is an enormous value of 10 kJ/cm^3. And investigators such as Wheeler (1968) speculate that destructive wave interference, in effect, diminishes the higher energies within individual fluctuations to small values that are smeared over the much larger scales of distance that human senses can resolve. And, despite skepticism by many scientists over the possibility of harvesting the very elusive zero-point quantum fluctuation energies of space, Casimir (1984) and Forward (1984) show the possibility of developing force and extracting energy from the zero-point vacuum. Thus, companies such as "Earthtech" have established precision calorimeter facilities to test their own and other zero-point energy devices – with no positive results announced yet.

FASTER-THAN-LIGHT TRAVEL AND ITS IMPACT ON ASTROSOCIOLOGY

Interstellar travel to distant stars does not appear to be of pressing concern today. However, it is well known that the crew of a relativistic spaceship, accelerating at modest 1.0 earth gravity to almost light speed during the first half of an interstellar journey and then decelerating at 1.0 earth gravity during the final half, could reach stars in galaxies beyond our Milky Way in less than 30 years of time and 30 years of physical aging by the ship and crew. But such slower-than-light (STL) flight would forever separate the crew from friends and homes on Earth. For millions of Earth years would elapse by the time they reached their destination. Thus astrosociology would be of critical importance to mission success because it would have to completely replace the terrestrial sociology that will be forever left. From an astrosociology standpoint, such relativistic STL interstellar travel could be somewhat similar to very slow STL solar system journeys that would keep humans away from Earth for so many years that they like Earths early frontier settlers and pioneers would have to create and maintain their own society and government.

Faster-than-light (FTL) travel that would results in very short journey durations in the solar system or interstellar space would, of course, have significant impact on astrosociology. For, short journey durations in both Earth and vehicle time would allow ships and humans to return to Earth soon after departing from it. Thus, astrosociology issues would less critical in terms of the expeditions need for in-situ resources, and long duration self-government.

Issues of causality consistent or paradox-free FTL travel are still being argued, despite encouraging "warpdrive" field propulsion concepts that enable rapid, stress-free vehicle acceleration to FTL speed by warping spacetime metric or perturbing the zero-point quantum vacuum with exotic fields. Unfortunately, stupendous energies appear to be required for the warping of space-time. But work such as Froning and Meholic (2008) show the possibility of rapid transitions between STL and FTL state with much less energy expenditure in a higher dimensional realm that includes and encompasses 4D spacetime itself. Progress has also been made in the modeling of field-propelled STL-FTL transitions by CFD methods that compute the zero-point radiation pressure gradients that form about an accelerating vehicle that is perturbing a fluid-like compressible negative-pressure quantum electromagnetic vacuum. Figure 5 shows such a vehicle being propelled from STL to FTL speed by vacuum zero-point radiation pressures.

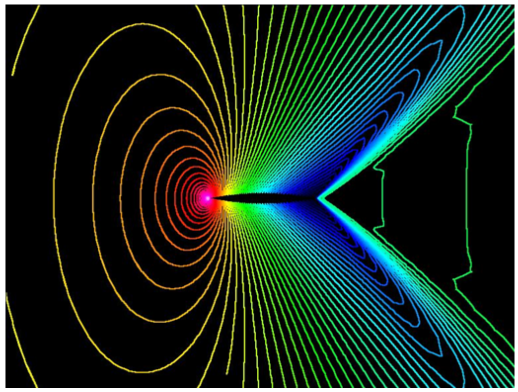

FIGURE 5. Zero-Point Radiation Pressures Surrounding an Accelerating Vehicle at 0.99 of Light Speed.

There is enormous science interest in higher dimensional theories that attempt to describe the observed 6 degree-of-freedom activity of physical things in 4-D spacetime by the higher-order, 20 degree-of-freedom activity of vibrating strands of energy (strings) in a higher dimensional 11-D realm. The 7 additional dimensions of the string realm are submicroscopic spatial ones - and these 7 extra dimensions and their 16 extra degrees-of-freedom describe the extremely high-order activity that gives rise to the lower-order physical activity that is perceived within the material word. But the extra dimensions and degrees of freedom also allow bizarre possibilities like faster-than-light travel and other inaccessible universes in addition to our own. Unfortunately for space flight, most string theorists have utmost faith in other unreachable universes and complete disbelief in possibility of FTL travel in our own. Moreover, an early way of reducing early proliferations of string theories was eliminating those that were "plagued" with the most tachyon FTL solutions. Thus, enormous amounts of sophisticated science are expended in speculations on natures of other unreachable universes and very little is expended on how humans might swiftly traverse their own.

"HYBRID" AND "PURE" FIELD POWER AND PROPULSION SYSTEMS

Transitions from jet to field power and propulsion may or may not be accomplished in one fell swoop. One example of a hybrid of jet and field propulsion is shown in Figure 6. It is a reusable single-stage-to-orbit aerospace plane that was studied for the U. S. Air Force for future development in the time period between 2025 and 2030. It combines chemical air-breathing engines and a fusion rocket engine for propulsion and power (Froning and Czysz, 2006). The air breathing engines embody magnets, electron beams and electrodes (as described previously) to create an airflow-slowing and current-creating Lorenz force that increases propulsion efficiency and generates electric power. The fusion rocket engine embodies a "dense plasma focus" device that enables clean aneutronic fusion of boron 11 and hydrogen nuclei (This is described in more detail in Froning and Czysz). The air-breathing and fusion rocket engines integrated well – with sharing of engine flow paths, superconducting magnets and electron beams. And gigawatt power from Lorentz force generation in the air breathing engines at Mach 12 speed was found ample for in-flight fusion system ignition at very high altitude.

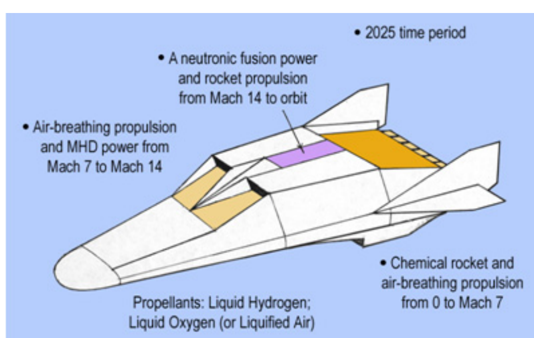

FIGURE 6. Single-stage-to-Orbit Aerospace Plane Propelled by Jet Power and Propulsion and the Actions of Fields.

Favorable EM field actions during air breathing and less fuel consumed during fusion rocket flight caused vehicle fuel consumption to be only 1/5 that of ordinary air breathing earth-to-orbit vehicles and less than 1/10 that of all-rocket ships. This results in a vehicle takeoff mass that is only 1/5 to 2/5 that of the air breathing and rocket ships.

Figure 7 is an example of an entirely field-propelled vehicle. It is a fully reusable lunar vehicle configured by March (2007). It embodies the previously described Woodward (2007) mass fluctuation field propulsion system to take 6 people to the moon (as do the mostly expendable Ares 1 + Ares 5 vehicles of NASA's "Constellation" system) with an Earth takeoff mass of only 26.5 t. If this vehicle were re-configured to take the same people and cargo as does Constellation, its takeoff mass would increase to about 200 t only about 1/25 the current takeoff mass of Ares 1 and Ares 5; and its propellant (H_2+O_2 fuel cells for power) would be only about 1/250 of that consumed by Ares 1 and 5.

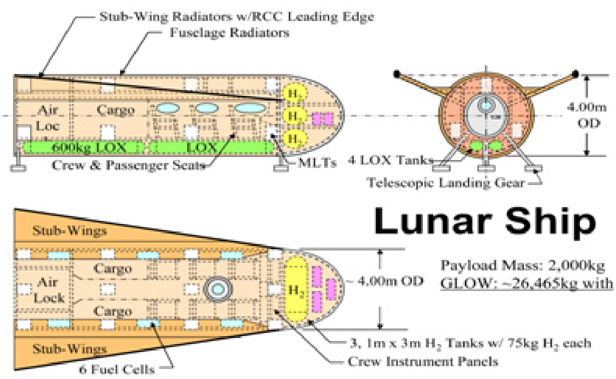

FIGURE 7. Reusable Earth-to-Moon Vehicle that Embodies Woodward Mass Fluctuation Field Propulsion Systems.

Field propulsion systems would, of course, be applicable for land transportation. Preliminary calculations indicate weights of mass fluctuation propulsion and power systems (with lithium ion batteries instead of fuel cells) would be less than 100 kg for a 1.3 ton auto. Such propulsion and power weight would be lighter than propulsion and power weight for all-electric cars like Elon Musk's 1.3 ton Tesla Roadster (http://www.teslamotors.com/) - whose lithium ion battery alone weighs 450 kg.

ETHICS FOR ASTRO-SCIOLOGY AND THE SETTLEMENT OF SPACE

Critics of space settlement always point to the early settlement of North and South America and Australia, when indigenous people were rather ruthlessly displaced by pioneering settlers from Spain, England, and the newly founded United States. And these critics declare that the very same displacements could be caused by space faring civilizations from Earth landing on other inhabited worlds. Thus, C.S. Lewis, the famous English writer and academic - whose works included several popular science fiction books - wrote an essay "The Danger of Rocketry" in which he declared the only barriers to export of human greed; dishonesty and sin to other worlds are the enormous gulfs of space that separate those worlds from us. Surprisingly, these same sentiments were repeated more recently by Actor Patrick Stewart - the second famous commander of the "Starship Enterprise"- during a BBC interview about 5 years ago. The same greed, dishonesty and sin that displaced native people long ago still seem to be alive on Earth. But one might hope that there is more sensitivity today to such issues and the dire consequences of greed and sin. And, if our World's people can develop the needed character to survive and solve its present tribulations – including its crises in energy and transportation, it will bode well for astrosociology. For such character development should endow future spacefarers with the needed integrity for stable, harmonious, social dynamics between many cooperating people in space and for the non-intrusive exploration and settlement of other worlds.

CONCLUSIONS

Many years of space transportation cost analyses has convinced the Author that: (1) no real space exploration and space settlement will occur until propellant, consuming jet propulsion is superseded by nearly propellant less field propulsion; and (2) the same advances in power and propulsion needed to take us to distant worlds will also be needed to meet the future energy and transportation needs of Earth. Some field power and propulsion technical and social challenges are shown to illustrate typical technical and social changes needed to achieve field power and propulsion. Then, terrestrial- sociology changes that enable ambitious, field-powered and field-propelled exploration and settlement of distant worlds will require astro-sociology – long, stable, harmonious social dynamics between vast numbers of space faring people.

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