"The trick in hard SF is to minimize cheating, not just disguise it with fancy footwork" - The Transporter in Star Trek: Can it Work?

Victor Grech

Papers:

The transporter in *Star Trek* is a fictional device, originally contrived to cope with a limited shooting budget, but which rapidly became a standard prop and even the object around which entire episodes revolve.

Introduction

A "transporter" is a fictional device that is utilised in the *Star Trek* universe to move objects from one point to another. A concept of teleportation is first mentioned in the Bible where

> both Philip and the eunuch went down into the water and Philip baptized him.When they came up out of the water, the Spirit of the Lord suddenly took Philip away, and the eunuch did not see him again, but went on his way rejoicing. Philip, however, appeared at Azotus and travelled about, preaching the gospel in all the towns until he reached Caesarea (Acts 8:36–40).

The first SF story to deal with teleportation was David Page Mitchell's "The Man Without A Body" (1877) which depicted the successful transportation of a cat over a telegraph cable. When the inventor attempted to transport himself, the battery supplying power for the procedure failed, having only transported his head.

Undoubtedly, in the *Star Trek* universe, "no other piece of technology [...] so colors every mission of every starship of the Federation" (Krauss), reflecting a universal desire for a superior form of travel as even governments have seriously researched the possibility of physical teleportation, in any form (Davis).

"The Making of Star Trek" explains how the series' creator, Gene Roddenberry, originally planned to land spaceships on alien planets, but this proved impossible due to low budgets and episode running times. A transporter was conceived as an equally effective and suitably futuristic device that would transport persons or material from ships to other ships or planets, and vice-versa. Prior to computer generated imagery, the effect was achieved by a process of fade-in and fade-out, and by turning a slow-motion camera upside down and filming shiny

grains of backlit aluminium powder that were dropped between the camera and a black backdrop. In this way, the transporter appears to function as an almost instantaneous teleporter (Whitfield and Roddenberry).

This paper will introduce the *Star Trek* universe transporter, and will then expand on transporter malfunctions that have been witnessed during the series' history. The discussion will review issues of scientific feasibility, and more urgently, of personal continuity, concerns that are inevitably raised by such radical technology. An interdisciplinary flavour will be present as the author is a medical doctor.

Star Trek, like most SF, appears to be bound by John W. Campbell's insistence on stories based on plausible and reasonable science. His "ideal reader was an engineer, who would bat around ideas in stories with other engineers [...] in their search for real solutions" (James 23). Campbell

> changed the direction of science fiction writing. He refused [...] the tired old BEM space operas [...] he wanted hard, logical science, presented in the context of real, believable characters. He encouraged [...] social and political themes; he urged [writers] to dream clearly [...] to examine the world that was and to extrapolate what it might be (Latham vii).

In this way, portrayed scientific novums became plausible and could be logically and reasonably extrapolated from contemporary scientific advances (Asimov 73). Thus, paradoxically, SF, while continually refabricating reality, is also simultaneously forced to undergo its own "reality test" since stories are forced to be convincingly credible. This approach is not new, and was prefigured by Aristotle who stated that "we ought to postulate any ideal conditions, but nothing impossible." The transporter, as will be shown in this paper, attempts to adhere to this dictum.

In the *Star Trek* future, the device is invented early in the 22nd century by Dr. Emory Erickson, who is also the first human to be successfully transported (Straiton, "Daedalus"). Transporters allegedly convert a person or an object into an energy pattern (a process known as dematerialisation), and then "beam" it to a target location, where it is reassembled into matter (rematerialisation). In effect, it "analyzes the energy state of each particle in the body and then produce a Dirac jump to an equivalent state somewhere else" (Blish).

Canonical sources state that the procedure involves a scan of the target and a 'coordinate lock', verifying range, relative motion and confirming suitably safe environmental conditions for personnel transport. Overhead imaging scanners then obtain a real-time atomic or subatomic-level resolution image pattern and simultaneously, the "phase transition coils" convert the subject into a matter stream composed of subatomic particles by partially decoupling the binding energy between said particles. The entire process lasts two to two and a half seconds (Sternbach and Okuda 102-9), and when prolonged, may produce

unusual effects. For example, in "Vanishing Point," a crewperson experiences speed-up hallucination when trapped in a pattern buffer for 8.3 seconds during a difficult transfer, which includes the mention of an apocryphal but nonexistent personage called "Cyrus Ramsey," the first "test subject for the first long range transport: just 100 meters. Something went wrong with the pattern buffer – he never re-materialized" (Straiton, "Vanishing Point"). Similarly, a prolonged transport episode that is caused by the linking of two transporter machines on two different starships causes an engineer to witness and be attacked by two worm-like creatures during transport. These eventually turn out to be missing crewmen who had been trapped in a transporter beam when their ship exploded and this discovery leads to their safe rematerialisation (Bole "Realm of Fear").

Doppler compensation for movement is carried out in a "pattern buffer" which also allows a certain leeway and a degree of backup in the transportation process. This method also creates a memory file that can be used to reverse the process in individuals who have been adversely affected by a transporter malfunction. The matter stream is then restricted within an "annular confinement beam" which is created by "primary energising coils," and is then launched to its destination from an emitter. The "annular confinement beam" serves to keep patterns of different objects and individuals separate during simultaneous transport, to the extent that a person may even carry another person during transport (Nimoy). The emitters also incorporate long-range imaging scanners that are used during the beam-up process (Sternbach and Okuda 102-9).

The system components also include a transporter chamber within which the actual materialisation/dematerialisation cycle occurs on a raised platform. This semi-automated procedure is overseen from an operator's console. Transported cargo is only resolved down to the molecular level as higher levels of resolution are unnecessary and require more energy and memory storage capacity (Sternbach and Okuda 102-9). Replicators, which are used for the creating and the recycling of inanimate objects, such as food, also only resolve down to the molecular level (Sternbach and Okuda 90-91).

In emergency situations, the pattern buffer is capable of holding the entire matter stream in suspension for periods approaching 420 seconds before degradation in pattern image occurs (Sternbach and Okuda 102-9). Failsafes are incorporated in tranporters, and, for example, harmful micro-organisms are detected and removed by an active "biofilter" from within individuals who are infected or carrying such microbes (Bowman). The potentially deadly effects of such infections was highlighted in "Bounty" when a Vulcan crewmember was infected with a virus that triggered a potentially fatal mating urge (Dawson). Active weapons are also detected and disabled (Bond). However, the transporter can also help to deliver weapons, such as bombs (Bole "Dark Frontier").

The transporter is not entirely trusted initially but by the 23rd century, it is completely accepted to the extent that in the 24th century, this is deemed as "the safest way to travel" (Bole "Realm of Fear"). However, many individuals

continue to express disquiet with transporter travel, and interestingly, two of the most vociferous protestors are *Trek* doctors Leonard McCoy (Allen), and Katherine Pulaski (Lynch). This may be because doctors are sometimes viewed as artificially surviving inside a "bell jar" (Westfahl and Slusser 36), requiring an anachronistic shield that strives to maintain the status quo, thereby representing these individuals as a homely, conservative and conventional, and therefore familiar. A jittery and skittish engineer also fears the device (Bole "Realm of Fear").

The transporter has a finite range of up to 40,000 km (Straiton, "Daedalus"), a range that may be limited by interference in the line of sight between the transporter and the target. For example, dense metals (Scanlan "Contagion"), thick layers of rock (Scheerer), radiation (Livingston "Power Play") and solar flares can all severely curtail transporter range (Phelps). Interestingly, transportation has also been shown to be curtailed by telekinesis (Scanlan "Skin of Evil"), and by sheer brute force (Bole "The Hunted"). Transporters may also be actively and deliberately inhibited by technology. For example, transport inhibitors prevent a transporter from locking onto targets (Frakes), and transporter scramblers distort patterns in transit, destroying objects and killing living beings (Vejar). Transport is said to be impossible at warp (supraluminal) velocities (Landau "The Schizoid Man"), unless the sending and receiving sites are moving at the same velocity (Carson "Emissary").

While the transporter is a safe mode of travel, it is misused at one's peril. For example, a form of "subspace" transporter is said to be capable of transportion across interstellar distances but this is also said to be experimental and dangerous (Landau "Bloodlines"). Similarly, a modification of a transporter system so as to allow "dimensional shift" and untraceable transport by terrorists also causes irreversible damage to the users' DNA (Beaumont).

The utilisation of a transporter naturally requires energy, and individuals, such as Starfleet cadets, may be allotted "transporter rations" which can be used for relatively mundane purposes, for example, to move furniture into a dwelling (Livingston "Homefront").

In the original series which was set in the 23rd century, the beaming process could only occur to and from the transporter chamber. This was because transporter technology could not safely perform a "site-to-site" transport due to the risk of transported objects beaming into other objects at or near the target site for rematerialisation (Chomsky "Day of the Dove"). By the 24th century, while the transporter room is routinely used, the transporter can also be activated from virtually any other part of the ship and "site-to-site" transport is commonplace. However, the process involves the matter stream being sent first to the transporter chamber and then onto to the required destination, consuming extra time and energy (Sternbach and Okuda 102-9).

Transporters may also be remotely activated, for example, with "emergency transporter armbands" that perform this function (Braga). Personnel may also

be tracked by a subcutaneously implanted transponders. Portable transporters are also seen briefly in an alternate timeline (Livingston "Non Sequitur") and a prototype stand-alone "emergency transport unit" is also used to extricate Captain Pickard from an exploding enemy ship (Baird).

Despite all fail-safes, transporter malfunctions and accidents abound, and are often used as the novum on which a story hinges. However, the transporter has also been used as a life-saving device, and both aspects will now be outlined.

The transporter in *Star Trek*

The early transporters of the 22nd century are described as having no fail-safes against external incursions during transport, and blowing debris such as leaves are seen incorporated in a crewmember who is transported off a planet during a storm (Livingston "Strange New World").

Transporter psychosis was also a risk in the early days, due to a breakdown of neurochemicals during transport, disrupting motor, autonomic and higher reasoning functions. This incurable condition led to paranoid delusions, multi-infarct dementia, hallucinations, hysteria, insomnia, tachycardia, deterioration of eyesight and painful spasms in the extremities. The condition was eliminated by the invention of the "multiplex pattern buffer" that somehow prevented this nervous system disruption (Bole "Realm of Fear").

The transporter has been shown to split individuals into two halves. In "The Enemy Within" (Penn) a magnetic ore contaminates the tranporter and causes a dog-like alien beast to be split two separate animals: a docile and placid creature and a rabid and vicious brute. Humans are not immune, and Captain Kirk found himself split into two individuals: a physical manifestation of his selfish and evil qualities and a second, weak individual who has lost all abilities to make decisions. The repaired transporter is eventually used to recombine Kirk into the original whole.

The very first *Trek* novel "Spock Must Die!" was written by the noted science fiction author James Blish, who was also responsible for the *Star Trek* original series novelisations (Heaphy). In this story, the transporter is modified to send a tachyonic matter stream since tachyons (which are still theoretical particles) can only travel at supraluminal velocities (Bilaniuk and Sudarshan). This also increases the transporter's effective range. However, when a duplicate Spock is created and transported in this way, the signal bounces off a thought-reflecting field and the new Spock turns out to be the exact opposite of the original Spock, both psychologically and even biochemically, and he is killed.

Not all transporter splits result in opposed personalities, and in "Second Chances" (Burton), an "enhanced beam" that attempts to transport Lt. Riker through an "unstable" atmosphere is both reflected and refracted, as if through a prism, such that two identical Rikers are created, one who arrives on target and is unknowingly stranded on the planet, and one who remains on the starship *Enterprise*, believing that the transport had been unsuccessful. The stranded

Riker is discovered after eight years, and is then seen to go one with his career in Starfleet.

Conversely, transportation may accidentally amalgamate animate objects, and two plants are somehow amalgamated, and this also happens to two sentient alien *Voyager* crew, Tuvok, a Vulcan, and Neelix, a Thalaxian. This new individual names himself "Tuvix" and is depicted as a physical and psychological amalgam of the two, combining not only their physical characteristics, but also the best of their abilities, including Vulcan intelligence and Thalaxian sociability. The transporter is reused to split Tuvix back into two separate individuals at the end of the episode (Bole "Tuvix").

These last four narratives all appear to refute transporter mechanics as the original is doubled with a doubling of mass, or halved, in the case of fusion, with a halving of mass, seemingly also refuting the first law of thermodynamics which states that matter or energy can neither be created nor destroyed.

Deranged rematerialisation may lead to instant deformity and a swift death, as experienced by two crewpersons who are said to be "fortunate they didn't live long" (Wise). The transporter is also used to beam Captain Picard out into space as a disembodied entity composed of free energy after he is taken over by a mysterious being that appears to be composed of electrical energy, but the transporter is also eventually used to retrieve his corporeal body back from space (Bole "Lonely Among Us") A transporter interaction with a novel Romulan cloaking device puts two crewmen out of phase with normal matter, and since they become ghost-like, invisible and unable to communicate with the crew, they are presumed dead until their predicament is discovered and they are phased back to normal space-time (Carson).

Biofilters sometimes occasionally fail, allowing perilous substances, pathogens (Bole "Lonely Among Us") and dangerous psychic energy (Livingston "Power Play") to arrive onboard ship along with transported individuals. The filters also occasionally fail to detect and disable dangerous weapons (Bond).

While the transporter has safeguards that prevent individuals from being beamed into deadly milieus, these can be overrode, and two security guards are once inadvertently beamed into open space when the systems are sabotaged (Chomsky "And the Children Shall Lead").

The crew of *Voyager* use the pattern buffers to hide refugees from ship inspectors, and this process of "transporter suspension" extends the 420 second period of grace prior to pattern degradation by the use of "pattern enhancers," which are normally used to aid difficult transport, such as through thick layers of rock. Despite this precaution, cellular degradation still ensues and requires medical treatment (Landau "Counterpoint"). The longest recorded period of transporter suspension of 75 years was attained by Captain Montgomery Scott who extensively modified his transporter after being stranded in a crash. The transport was "fed power from the auxiliary systems [...] the rematerialisation subroutine [...] disabled [...] [t]he phase inducers [...] connected to the

emitter array. The override [...] gone and the pattern buffer [...] locked into a continuous diagnostic cycle." This resulted in a "less than point zero zero three percent signal degradation" (Singer).

By 2375, a micro-transporter was developed and was used to transport a fired bullet anywhere within the transporter's range, whereupon the bullet would continue along its original vector, providing an elegant and almost untraceable assassination method (Dow).

The transporter is also used to travel not only through space but also through time, both accidentally (Badiyi) and deliberately (McIntyre). By the 29th century, temporal transporter technology is developed and this allows travel through time (Eastman).

A transporter accident also introduces the *Mirror Universe*, an equally fictional parallel universe where a brutal Terran Empire replaces the benevolent United Federation of Planets. "Mirror, Mirror" (Daniels). The transporter is thereafter deliberately manipulated by characters in the *Mirror Universe*, a century after the events of "Mirror, Mirror," in order to cross over to our own universe, in the episode "Crossover" (Livingston) and others in *Star Trek: Deep Space Nine*.

Discussion

Umberto Eco states that series in general, respond "to the infantile need of always hearing the same story, of being consoled by the return of the identical, superficially disguised" a maxim that undoubtedly applies to the forty-six year old *Star Trek gesamtkunstwerk* (Eco 70).

Joanna Russ also commented on scientific accuracy or inaccuracy in SF, a theme prefigured by Campbell, editor of *Astounding Science Fiction*. SF must perforce, frequently make assumptions with regard to new scientific and technological advancements. While there can be no verifiability, there must be credibility, and assumptions must not be excesses that lead to inaccuracies that go beyond the boundaries of sensible and reasonable poetic license, as reasoned by Russ, "error-free science fiction is an ideal [...] impossible of achievement [...] not that [...] the author can be excused for not trying; unreachability is, after all, what ideals are for" (Russ 113).

This is evinced by the technobabble that surrounds transporter technology, including pattern buffers, memory files and annular confinement beams, all of which attempt to sway the reader to consider the possibility that science may one day invent such a device. However, there are certain physical limitations that make transporter technology (at least as depicted in *Star Trek*) impossible.

The initial phase of transportation activates imaging scanners that obtain resolutions at least at the atomic level. At maximum transporter range (40,000 kilometers, approximately three Earth diameters), assuming a scanning wavelength of less than a billionth of a centimetre, the diameter of the telescope has been calculated at circa 50,000 kilometers (Krauss 83). A

recalculation assuming that the property known as the Rayleigh diffraction limit for resolution is used, the equation is:

$$sin\ \theta = 1.220\frac{\lambda}{D}$$

Where:
Theta: Angular Resolution
Lambda: Wavelength
D: Aperture Diameter

Assuming at least atomic level resolution at the level of the covalent radius of hydrogen (25×10^{-12}m), then

$$sin\ \theta = \frac{25 \times 10^{-12}m}{40 \times 10^{6}m}$$

This works out to D = 1.95×10^{6}m, that is, a telescope aperture of almost 2 kilometres. Alternatively, if a resolution of just 1nanometre sufficed, that is a resolution just about adequate to resolve a cell membrane, then D= 48,800m. This could theoretically be achieved by probes or satellites that are spread over this distance if such receivers were sufficiently well synchronised as it must be noted that several synchronised receivers function just as well as one large sensor device, a technique that is utilised on Earth by large Radio Telescope Arrays.

The transporter is also seemingly in violation of Heisenberg's Uncertainty Principle which states that the position and momentum of a particle cannot be simultaneously measured with high precision, a limitation inherent in the nature of things which is unrelated to the skill and accuracy of scientific personnel and instrumentation. Both values must be precisely known in order to re-create a facsimile (Heisenberg). In the *Star Trek* universe, the Uncertainty Principle is circumvented by the transporter's 'Heisenberg compensators' that somehow remove uncertainty from subatomic measurements, hence making transporter travel feasible as the complete state of each component particle of the object to be transported is known precisely (Krauss 81).

The equation that governs the principle is:

$$\Delta x \Delta p \geq \frac{\hbar}{2}$$

Where:
Delta x: Positional Uncertainty.
Delta p: Momentum Uncertainty
h : Reduced Planck's Constant (1.05×10^{-34}J:s)

Because of the small numerical value of h this only really becomes relevant at atomic or subatomic levels. There is no convincing evidence that these effects are relevant at even at the cell organelle level of scale of things. If a 1nm scale

sufficed, then the uncertainty limit is not a practical limiting factor. However, Penrose has argued that quantum processes are

> involved in human cognition and consciousness, in which case, the uncertainty principle will certainly be an obstacle for scanning down to the subatomic level (Penrose). Moreover, it is believed that quantum effects play important roles in the stability of the DNA molecule, and hence, transporters would perforce need to take this level of scale into account (Rieper).

In addition, the physical reality is simply many orders of magnitude beyond any conceivable possibility of energy transfer. For example, the raw energy contained in a typical 90 kg adult male, converted using the familiar $e=mc^2$, is over 8×10^{18} J, equivalent to the energy release of 130,000 times the power of the atomic bomb dropped on Hiroshima in 1945. Further energy must be added to the process whereby the object is somehow scanned to the subatomic level, and then disassembled, moved, and finally reassembled at the target site after being re-encoded to match the original form. The physics community understate such inconceivable amounts of energy by calling them "nontrivial." Indeed, it is difficult to visualise how this amount of energy could possibly be handled, but then, a technology that somehow travels at supraluminal velocities and has the capacity of antimatter conversion may not view these as unscalable problems.

Furthermore, the energy created would need to be transmitted as photons of radiation. The equation that governs this is $E=h\,\lambda/c$ where E is the photon's energy, h is Planck's constant and λ is the wavelength of the radiation that the photon represents and c is the speed of light. This works out to the transporter having to utilise a wavelength of 2.4×10^{-44} meters, an impossible feat as the most energetic radiation know to exist in nature is gamma radiation which is 32 orders of magnitudes weaker than the purported transporter beam.

These problems might be circumvented if a matter stream is somehow sent instead of a radiation beam, but huge amounts of energy would be need to accelerate matter to anywhere near luminal velocities.

Yet another constraint is that of information density. It has been calculated that the average adult male is comprised of approximately 2.0×10^{45} bits of data (circa 2.5×10^{19} megabytes) assuming data collection down to the quantum level (Bekenstein). In theory, this information could be contained in a sphere with a radius of 0.88 metres. In practice, a simple calculation shows that it would require 2.27×10^{32} one terabyte hard disks to encompass this amount of information.

Even weightier philosophical issues are broached in the very first *Trek* novel "Spock Must Die!" which commences with the following dialog: "What worries me," McCoy said, "is whether I'm myself any more. I have a horrible suspicion that I'm a ghost. And that I've been one for maybe as long as twenty years."

McCoy's concern is that during transportation, the original body is destroyed and a new body, complete with memories, is recreated, but is that really the equivalent or the same as the original?

Most Star Trek viewers blindly accept that the reassembled person is physically mentally and psychologically identical to the person who initially stepped into the transporter, a facile assumption, and McCoy's concerns were prefigured by Thomas Reid, who asked, in a letter to Lord Kames in 1775:

> I would be glad to know your Lordship's opinion whether when my brain has lost its original structure, and when some hundred years after the same materials are fabricated so curiously as to become an intelligent being, whether, I say that being will be me; or, if, two or three such beings should be formed out of my brain; whether they will all be me, and consequently one and the same intelligent being.

One of the first points that needs to be raised is that the body is not the self, the individual's identity, albeit constituting an important component of what is tantamount to self. Lakoff and Johnson very clearly expressed this when stating that "[w]e all have constant phenomenological experience that reinforces the illusion of a disembodied Subject. Yet, cognitive science shows that our minds are not, and cannot be, disembodied" (563),

> and are therefore an inextricable part of the brain, with the self being supervenient to the body.

A Continuity Criterion is proposed which states that since there can only be one original, a duplicate cannot possibly be the original as: 1. It cannot be in the original physical location and 2. It cannot possess the continuity-of-being of the original. Thus a being who is destroyed and reassembled by transporter cannot be identical to the original, not matter how he or she might feel and/or remember, because of the discontinuity inherent in transport.

There are several arguments that refute this reasoning, and arguably, the most pragmatic argument against the Continuity Criterion is that long-term memory, the sum of which constitutes the basis for the individual, survives sleep and even true unconsciousness, such as deep anaesthesia and even cold hypothermic bypass surgery for the repair or palliation of complex congenital heart disease. In addition, some have argued that there exists a more immanent

> level of consciousness that is not contingent upon the human organism. It is autonomous from the human brain. This is where Buddhism just differs from modern neuroscience's view that all mental processes are functions of the brain. In Buddhism, anger, joy, fear, and so forth are said to emerge not from the brain but from more and more subtle levels of consciousness (Begley 155).

This is coterminous with the mind-body dualism that is a fundamental

component of most religions, a belief that the body will disintegrate after death but that an immortal individual will somehow continue beyond death. Krauss intriguingly asks: "What then happens to the soul during the transport process?" (69) Transportation might provide experimental "evidence that a human being is no more than the sum of his or her parts, and the demonstration would directly confront a wealth of spiritual beliefs" (69) if after transportation, the individual "remained intact and observably unchanged" (69). The transporter, however, somehow also transports the soul as clearly seen in the Star Trek movies, "The Wrath of Khan" and "The Search for Spock," and more recently, in the *Star Trek: Voyager* episode "Cathexis" wherein individuals who have transported many times still manifestly evidence a soul, variously referred to as a "Katra" in the former two films and "bioneural energy" in the latter episode (Krauss 69).

The Continuity Criterion can also be refuted as in the discipline of psychology, identity relates to self-image, that is, the individual's mental model of self and the capacity for self-reflection (Leary 3). This was prefigured by John Locke who famously stated that a person is "a thinking intelligent being, that has reason and reflection, and can consider itself as itself, the same thinking thing, in different times and places," in this way formulating one of the first modern conceptualisations of consciousness as the repeated self-identification of oneself, where self is founded on consciousness and memory. Through this self-identification, moral responsibility can be attributed to the subject for any action/s.

However, with true Vulcan pragmatism, in "Spock Must Die!" Spock quells McCoy's original concern by quoting Korzibski: "A difference which makes no difference is no difference" (Blish). More crucially, recently, the transporter-continuity argument was made moot as continuity within the transporter has been established within the *Star Trek* canon, when it was clearly stated that "for a split second you can actually feel yourself in both places at once" (Burton, "Fortunate Son"). This clearly establishes a continuity and a connection, for and by the individual being transported in two space-time loci: the source and the destination, and can even accept Parfit's theory of the individual which ultimately states that the self persists through a process of mental, psychological continuity and connectedness. Moreover, this also sidesteps epiphenomenal arguments which contend that mental states and processes are incidental effects of physiological events in the brain and nervous system. Parfit's concept also embraces the possibility of a transporter accident resulting in the fusion of two individuals, stating that "[t]he one person who results from a fusion can, similarly, [...] remember living the lives of the two original people" (405).

Interestingly, quantum theory provides quantum entanglement, a possibility that hints at information transfer at subatomic level across great distances, an effect that Einstein jokingly called "*spukhafte Fernwirkung*" (spooky action at a distance) (Einstein, "The Born-Einstein Letters" 158). Quantum entanglement occurs when two particles without mass (such as photons that comprise light

and other forms of radiation) or particles with mass (such as electrons) interact physically once, and then become separated from each other while carrying the same quantum mechanical state, that is, a description of important properties of the two particles such as position, momentum, spin, polarization etc. Irrespective of the distance between the two particles, any measurement that inevitably changes one particle's properties (as explained via the Heisenberg Uncertainty Principle above), instantaneously effects the other particle. This information transfer is immediate and therefore far faster than light-speed, and intimates the possibility of information transfer at great distances. However, this is a far cry from the *Star Trek* transporter.

Somewhat optimistically, a United States Patent Application was filed in 2006 purportedly claiming the ability to create "a pulsed gravitational wave wormhole generator system that teleports a human being through hyperspace from one location to another" (St. Clair).

In conclusion, this paper demonstrates that even through the limited reading of transporter usage and mishaps in *Star Trek*, the SF genre

> [i]s fundamentally a drastically different form of literary art [...] like medieval painting, addresses itself to the mind, not the eye. We are not presented with a representation of what we know to be true through direct experience; rather we are given what we know to be true through other means—or in the case of science fiction, what we know to be at least possible (Russ 112).

We have also seen that "[t]he trick in hard SF is to minimize cheating, not just disguise it with fancy footwork," such that technology has to somehow be as plausible as possible (Samuelson 193).

This paper also demonstrates yet another common trope of science-fiction it that not only "holds promise for a future society graced by the fortitude of scientific knowledge" (Caldwell), but also cautions us with regard to errant paths and mishaps that such radical technologies and inventions might beckon us toward.

ACKNOWLEDGMENTS

I would like to thank and acknowledge Dr. David Gatt, Consultant Anaesthetist at Mater Dei Hospital, Malta for help in checking out the physics calculations included in this manuscript.

REFERENCES

Allen Corey. Dir. "Encounter at Farpoint." *Star Trek: The Next Generation*. Paramount. September 1987.

Aristotle, *Politics* Books I and II, 32 [1265al7 18].

Asimov Isaac, *I Asimov: A Memoir.* New York: Doubleday, 1994.

Badiyi Reza. Dir. "Past Tense." *Star Trek: Deep Space Nine*. Paramount. January 1995

Beaumont Gabrielle. Dir. "The High Ground." *Star Trek: The Next Generation*. Paramount. January 1990.

Bekenstein J. D. "Black Holes and the Second Law." Lettere al Nuovo Cimento, 4 (1972):737-740.

Bilaniuk Olexa-Myron and E. C. George Sudarshan, "Particles beyond the Light Barrier." *Physics Today* 22 (1969):43–51.

Blish James. *Spock Must Die!* New York: Bantam, 1970.

Bole Cliff. "Tuvix." *Star Trek: Voyager*. Paramount. May 1996

Bole Cliff. Dir. "Dark Frontier." *Star Trek: Voyager*. Paramount. February 1999.

Bole Cliff. Dir. "Lonely Among Us." *Star Trek: The Next Generation*. Paramount. November 1987

Bole Cliff. Dir. "Realm of Fear." Star *Trek: The Next Generation*. Paramount. October 1992.

Bole Cliff. Dir. "The Hunted." *Star Trek: The Next Generation*. Paramount. January 1990.

Bond Tim. Dir. "The Most Toys." *Star Trek: The Next Generation*. Paramount. May 1990.

Bowman Robert, Dir. "Shades of Gray." *Star Trek: The Next Generation*. Paramount. July 1989.

Braga Brannon. Dir. "Timescape." *Star Trek: The Next Generation*. Paramount. June 1993.

Burton LeVar. "Fortunate Son." *Star Trek: Enterprise*. Paramount. November 2001.

Burton LeVar. "Second Chances." *Star Trek: The Next Generation*. Paramount. May 1993.

Caldwell Tom. "Science Fiction or Science Fact: The Transporter." *Trek New* May 28, 2011 <http://www.treknews.net/2011/05/28/science-fiction-or-science-fact-the-transporter>

Carson David. Dir. "Emissary." *Star Trek: Deep Space Nine*. Paramount. January 1993.

Carson David. Dir. "The Next Phase." *Star Trek: The Next Generation*. Paramount. May 1992.

Chomsky Marvin. Dir. "And the Children Shall Lead." *Star Trek: The Original Series*. Paramount. October 1968.

Chomsky Marvin. Dir. "Day of the Dove." *Star Trek: The Original Series*. Paramount. November 1968.

Daniels Marc. Dir. "Mirror, Mirror." *Star Trek: The Original Series*. Paramount. October 1967.

Davis Eric W. *Teleportation Physics Study*. Antelope Valley: Edwards Air Force Base, 2004.

Dawson Roxann. Dir. "Bounty." *Star Trek: Enterprise*. Paramount. May 2003.

Dow Tony. Dir. "Field of Fire." *Star Trek: Deep Space Nine*. Paramount. February 1999.

Eastman Allan. Dir. "Relativity." *Star Trek: Voyager*. Paramount. May 1999.

Eco Umberto. *The Limits of Interpretation*. Bloomington and Indianapolis: Indiana University Press, 1990.

Edward James, "Before the Novum: The Prehistory of Science Fiction Criticism." *Learning From Other Worlds*. Ed. Patrick Parrinder. Liverpool: Liverpool University Press, 2000. 19-36.

Einstein Albert and others, "Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?" *Physics Review* 47 (1935):777–780.

Einstein Albert. *The Born-Einstein Letters; Correspondence between Albert Einstein and Max and Hedwig Born from 1916 to 1955*. New York: Walker, 1971.

Friedman Kim. Dir. "Cathexis." *Star Trek: Voyager*. Paramount. May 1995.

Heisenberg W. (1930) Die Physikalischen Prinzipien der Quantenmechanik (Leipzig: Hirzel). English translation The Physical Principles of Quantum Theory (Chicago: University of Chicago Press, 1930).

Krauss Lawrence M. "Beam Me Up an Einstein, Scotty." *Wired* 3.11. Nov 1995.

Lakoff George and Mark Johnson. *Philososphy in the Flesh*. New York: Basic Books, 1999.

Landau Les. Dir. "Bloodlines.", *Star Trek: The Next Generation*. Paramount. May 1994.

Landau Les. Dir. "Counterpoint." *Star Trek: Voyager*. Paramount. December 1998.

Landau Les. Dir. "The Schizoid Man." *Star Trek: The Next Generation*. Paramount. January 1989.

Latham R. Scott. "Foreword." *A Treasury of Science Fiction*. Ed. Groff Conklin. New York: Bonanza Books, 1980.

Lawrence Maxwell Krauss. *The Physics of Star Trek*. New York: Basic Books, 1995

Leary Mark R. *The Curse of the Self: Self-Awareness, Egotism, and the Quality of Human Life*. New York: Oxford University Press, 2004.

Livingston David. Dir. "Crossover." *Star Trek: Deep Space Nine*. Paramount. May 1994.

Livingston David. Dir. "Homefront." *Star Trek: Deep Space Nine*. Paramount. January 1996

Livingston David. Dir. "Non Sequitur." *Star Trek: Voyager*. Paramount. September 1995.

Livingston David. Dir. "Power Play." *Star Trek: The Next Generation*. Paramount. February 1992.

Livingston David. Dir. "Strange New World." *Star Trek: Enterprise*. Paramount. October 2001.

Locke John, Chapter XXVII "On Identity and Diversity" *An Essay Concerning Human Understanding* (1689).

Lynch Paul. Dir. "Unnatural Selection." *Star Trek: The Next Generation*. Paramount. January 1989.

McIntyre Vonda N. *The Entropy Effect*. New York: Pocket Books, 1981.

Page Mitchell Edward. "The Man Without A Body" *The New York Sun* March 25, 1877.

Parfit Derek. *Reasons and Persons*. Oxford: Clarendon Press, 1984.

Penn Leo. Dir. "The Enemy Within." *Star Trek: The Original Series*. Paramount. October 1966.

Penrose Roger. "The Emperor's New Mind." xx

Phelps Win. Dir. "Symbiosis." *Star Trek: The Next Generation*. Paramount. April 1988.

Reid Thomas letter to Lord Kames. *Philosophical Works* Vol 1 (1775).

Rieper Elisabeth and others. "The Relevance Of Continuous Variable Entanglement In DNA." arXiv:1006.4053 (2011) < http://arxiv.org/abs/1006.4053>

Russ Joanna. "Towards an Aesthetic of Science Fiction." *Science Fiction Studies*. 2 (1975), 112-9.

Samuelson David N. "Modes of Extrapolation: The Formulas of Hard SF." *Science Fiction Studies* 20 (1993): 191-232.

Scanlan Joseph L. Dir. "Contagion." *Star Trek: The Next Generation*. Paramount. March 1989.

Scanlan Joseph L. Dir. "Skin of Evil." *Star Trek: The Next Generation*. Paramount. April 1988.

Scheerer Robert. Dir. "Legacy." *Star Trek: The Next Generation*. Paramount. October 1990.

Sharpn Begley. *Train Your Mind, Change Your Brain*. New York: Ballantine, 2007.

Singer Alexander. "Relics." *Star Trek: The Next Generation*. Paramount. October 1992

St. Clair John Quincy. "Full body teleportation system." United States Patent Application 20060071122. 6 April 2006.

Star Trek II: The Wrath of Khan. Dir. Meyer Nicholas. Paramount Pictures. June 1982.

Star Trek III: The Search for Spock. Dir. Nimoy Leonard. Paramount Pictures. June 1984.

Star Trek IV: The Voyage Home. Dir. Nimoy Leonard. Paramount Pictures. November 1986.

Star Trek Nemesis. Dir. Baird Stuart. Paramount. December 2002.

Star Trek: Insurrection. Dir. Frakes Jonathan. Paramount. December 1998.

Star Trek: The Motion Picture. Dir. Robert Wise. Paramount. December 1979.

Stephen E. Whitfield, Gene Roddenberry. *The Making of Star Trek*. New York: Ballantine, 1968.

Sternbach Rick and Michael Okuda, "Transporter Systems" *Star Trek The Next Generation Technical Manual*. New York: Pocket Books, 1991. 102-9.

Straiton David. Dir. "Daedalus." *Star Trek: Enterprise*. Paramount. January 2005.

Straiton David. Dir. "Vanishing Point." *Star Trek: Enterprise*. Paramount. November 2002.

Vejar Mike. "The Darkness and the Light." *Star Trek: Deep Space Nine*. Paramount. January 1997.

Westfahl Gary and George Slusser. Eds. *No Cure for the Future: Disease and Medicine in Science Fiction and Fantasy*. Westport: Greenwood Press, 2002.