Interstellar Space War
By
Michael McCollum

The Imperial Battle Cruiser Constellation *entered the star cluster warily. There had been reports of Rebel smugglers, and even a few small convoys. With a hundred planets of the Empire in full revolt, it was Captain Vol Stendal's job to see that the rebel supply lines through this distant section of space were severed and remained that way. Despite the best efforts by the ship's environmental control system to keep the bridge at a constant 22 degrees C, Stendal was sweating. The Hamel Cluster was largely uncharted, with hundreds of stars where the rebels might hide a supply base – or even an entire fleet repair yard.* Constellation *was far from home and beyond Imperial support. If they had to fight, it would be Stendal's ship alone against whatever opposition they encountered.*

As he watched the stars march perceptibly toward him, slowly separate, and then pass on either side, Stendal couldn't help wondering just how many enemy craft those stars harbored; and more importantly, around which stars the enemy bases had been established. It was a question he had been asking himself for more than a week now. The tension of probing the unknown had built aboard his ship to the point where he would welcome the release of battle, should it come.

Stendal was roused from his reverie by a sudden series of alarms and the appearance of a bogey indicator on the main viewscreen.

"What is it, Ramirez?" he asked sharply, glad for something to occupy his attention at last.

"Starship hyperwake, Captain. Unidentified as of yet."

"Moving in which direction?"

"It was on roughly converging course, but seems to be moving to intercept now, sir."

"He knows we're here?"

"Yes, sir. He just finished his turn and is headed right for us. I don't think he's a tramp freighter."

"Neither do I," Stendal agreed. The long-range detectors on tramp freighters were seldom sensitive out beyond a few tenths of a light-year, and this bogey had detected Constellation *at the same moment the cruiser had spotted him. That bespoke a military detection capability.*

"How strong is the hyperwake?"

"The computer is making up its mind now, sir…" There was a pause, followed by a low whistle. "The computer says that it's the strongest hyperwake that we've ever recorded. Must be a large ship."

"Sound General Quarters, Mr. Ramirez. Let's get Connie *ready to do battle!*

"Aye aye, sir."

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The sound of the operator's words had barely died away before the raucous clang of the alarm filled the ship. It was less than ten seconds later that Stendal noted the sound of boots on the steel deck behind him. Over the next dozen seconds, all of the bridge crew entered and took their places in front of the data consoles.

Imperial Starship Constellation *was about to do battle with the unknown.*

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We have been reviewing what it is like to fight a battle in space. Surprisingly, this has not been a discussion centered on darting missiles and slashing laser beams, although we have engaged in some of that. Mostly we have spoken of rocket engines and their limitations. The tactics and strategies utilized in any war are largely constrained by the two sides' ability to maneuver about the field of battle, and the human race's ability to maneuver in space can charitably be described as pitiable. Today we might manage to shoot down a few low-flying satellites, but that is about the extent of our offensive capability at the beginning of the Third Millennium. Nor is our war-making ability in vacuum liable to expand dramatically for the next generation or so, not unless someone makes a breakthrough in propulsion technology.

However, the human race will eventually achieve the freedom of space. That is inevitable. If not our children, then our grandchildren will expand out into the Solar System and their children or grandchildren will claim it for their own. They will establish colonies on Mercury and Mars, they will mine the moons of Jupiter and Saturn, and they will tunnel into the mini-worlds of the Asteroid Belt. Someday, they will reach the outer planets, Uranus and Neptune, and eventually, even frigid Pluto.

Come the era of easy space travel, when our descendents travel to far-off Pluto with no more difficulty than an Eighteenth Century sailing ship faced crossing the Atlantic, on that day humanity will finally be ready to face its ultimate challenge. For beyond Pluto lies nothing but a vast gulf of vacuum, a sea of infinite blackness relieved only by the inviting lights of the stars. Whether humanity will ever cross that great gulf depends largely on the perseverance of the human species and the discovery of scientific principles hitherto unknown, if not unsuspected.

This is not an impediment to science fiction writers, however. What we lack in social grace, we more than make up in imagination. For that reason, we, the writers of escapist fiction, never let a little thing like interstellar distances daunt us. As the opening scene in this article illustrates, just because we lack the technology to reach the stars doesn't mean that we can't imagine what it will be like to do so. And since fiction is writing about conflict, it is inevitable that we transplant our little intramural squabbles onto this vastly larger stage. The result: Wars raging across the cosmos.

But wait a minute! Just because we have had 50,000 wars in a like number of years doesn't mean that we won't eventually outgrow our species' favorite antisocial sport. Maybe we will eventually mature to the point where we can settle our differences without attempting to kill one another. Perhaps, but I wouldn't be willing to bet a great deal of money on it. The instinct to go to war is too deeply buried in our culture and psyche to be easily rooted out. Many generations of tame lions will have to be bred before we willingly lie down with the lambs.

[Author's Note: The above words were originally written in the late 1990's, when it seemed that we might be making progress on our age-old dream of doing away with

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conflict. Those of us who lived through 9/11 ought to have no illusions as to whether the human race will ever outgrow wars and warfare.]

But maybe we don't need to grow out of our current infantile stage of development to rid ourselves of war. Perhaps interstellar distances are sufficiently large that they will make it impossible for one star system to fight another. If so, that is a compelling reason for humanity to expand into space as quickly as our technology allows. Being cooped up on this one little planet is inherently dangerous. It would not take much of a misadventure — either natural or manmade — to send humanity to the same place the dinosaurs have gone. A toehold on even one additional world would increase the species' chances for survival many times over.

It's a comforting thought that the human race's tendency to "eat its own" would make no sense over interstellar distances. Comforting or no, as the proverb says, "Wishing won't make it so."

That then is the first subject we will tackle this month. Is the distance between the stars so great that war between star systems is a physical and economic impossibility? And, as with most things, the answer is a firm, "It depends!"

War and the Scale of the Universe

One of the most daunting tasks for a science fiction writer is to portray to the reader just how truly vast interstellar space is. The reason for this is simple. The smallest number associated with star travel is the light-year, the distance light travels in 365.25 days while moving at a speed of 300,000 kilometers per second (186,000 miles per second). For the record, one light-year is 10 *trillion* kilometers (6 trillion miles), and the distance to the nearest star is some 43 trillion kilometers (25 trillion miles). A spaceship traveling at the speed of a modern airliner requires *5 million years* to reach Alpha Centauri, and having done so, really hasn't gone very far at all. Many of the most interesting stars are hundreds or thousands of light-years more distant. Other galaxies are literally millions of times farther away than the nearest star.

The problem with describing interstellar distances is illustrated by the preceding paragraph. We have distances measured in the trillions of kilometers, and the millions of trillions of kilometers. We who live on this little ball of rock called Earth, where the longest journey possible is only 40,000 kilometers (25,000 miles), find that such numbers boggle the mind. It is as though an overload circuit breaker buried deeply in our brains suddenly pops open when confronted with words like "billion" or "trillion." How many people even know what a trillion is? (For the record, in the United States, a trillion is 1000 billion or 10^{12}. In the United Kingdom, it's something else.)

Personally, I find it easier to explain interstellar distances using the following analogy: Assume that Los Angeles is the center of the Milky Way galaxy, and New York is on the outermost periphery. On this scale the distance between Sol (our sun) and the nearest star is approximately the same as the distance between two adjacent hairs on your arm. Note: While the above example gives the average person a better idea of the distances involved, it is actually conservative. If the hairs on your arm grew close enough together to make the analogy accurate, you would look like Chewbacca, the Wookie, in *Star Wars*.

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The huge distances between the stars will make war difficult indeed. That is because war is mostly a matter of logistics, the ability of each side to keep its troops supplied with fuel, ammunition, and food. This point is probably best illustrated by an historical example.

Japan attacked the United States on Sunday, December 7, 1941, plunging what had been a somewhat isolationist U.S. into World War II. Every American school child learns that at an early age — if not in his or her history books, then from watching television. What is less well known is that Adolph Hitler's Germany declared war on the United States a few days later, on December 11th. Historians generally agree that this was one of the half dozen or so major mistakes Hitler made during the war. Coupled with his failure to destroy the British professional army at Dunkirk and his attack on Russia, his declaration of war on the U.S. sealed Germany's fate.

Why? Because Germany's declaration of war greatly simplified one of Franklin Roosevelt's thorniest problems, namely how to give overwhelming priority to the European Theatre rather than the Pacific War. This made sense strategically because Hitler was a far greater menace than was Japan. Yet, had Hitler restrained himself, history might have been different. My father, who enlisted in the Army Air Corps on December 8, 1941, told me stories of what it was like that fateful Sunday when he heard the news about Pearl Harbor. News of the attack set off a shock wave of revulsion against Japan and all things Japanese. Had Germany not piled on, Roosevelt might have had difficulty in convincing a hopping-mad congress to include the Nazis in our own declaration of war.

Germany, a country that at the time had more than sufficient enemies to keep it busy, rather cavalierly declared war on the nation that had invented the assembly line. During World War II, the United States built more weapons in four years than all the other combatants (allied and axis) built in six. We equipped our own army, then went on to largely equip the British, French, and Russian armies as well. Germany had no hope of prevailing against this flood of men and materiel. They were simply overwhelmed.

So in this respect, war is not merely a contest between soldiers and generals. It is ultimately a contest between the industrial bases of the two antagonists. Of course, it isn't enough to merely build the weapons of war. They also have to be delivered to the scene of the fighting. And it is this factor that may well limit or prevent interstellar warfare from breaking out once we have colonized the stars. After all, what good would it do to raise an army of 50 million if you couldn't get them to the surface of your enemy's home world?

However, wars come in many varieties. Not all are the massive, fully involved contests-of-attrition like World War II. Wars can be small, relatively tidy affairs; and in fact, most wars were just that way prior to the industrial age. The combatants took to the field, shot off all their arrows or ammunition, and then retired. Unfortunately for our starfaring descendents, it is all too easy to imagine one of these "small" conflicts breaking out between star systems.

Limited War in Space

One of my favorite authors (other than myself, of course) is C. S. Forester, who wrote the *Horatio Hornblower* series. Hornblower is a British sea captain at the time of

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the Napoleonic Wars, and if Forester's books are to be believed, the most wildly successful sea captain of the era.

The series begins with *Beat to Quarters*. Hornblower, in command of the frigate *Lydia*, has just spent 7 months out of sight of land as he sails around the Cape of Good Hope and into the Pacific Ocean with a load of guns and cannon to foment a revolution in Spanish South America. If you happened to see *Captain Horatio Hornblower*, the 1950's movie with Gregory Peck in the title role, you will be familiar with what I am talking about.

Hornblower's voyage in the *Lydia* is fictional, of course, but the situation was fairly common from the 16th through the 18th centuries. Sir Francis Drake took *The Golden Hind* into the Pacific where he raided Spanish commerce and landed briefly at San Francisco. On these occasions when British warships were loose in the Pacific, typically the Spanish had only a few ships of their own to defend their cities, leaving them vulnerable to attack by a single ship or a small squadron. In the Caribbean during the time of pirates and the Spanish Main, a pirate ship would occasionally attack a city. Once defeated, the city was sacked by the pirates, its treasures carted off, its men put to the sword and its women carried away. (One book I read claimed that the pirates were fairly puritanical about such things. They tended to marry the women they carried off.)

The reason a single ship could attack and defeat a city was simple. Cannon were expensive and a small warship usually carried more guns than did the defending land fortress. Furthermore, even if the fortress had big coastal defense batteries, these were limited in range (how do you think the three-mile limit got to be the three-mile limit in the first place?) and fixed in position. Sailors and marines would land up the coast and march overland. These land troops would coordinate their assault on the town with that of their ship. With surprise on their side, they would often prevail.

In addition to pirates, privateers employed by one nation would often use the same tactic against an enemy nation's colonies. Such raids for the purposes of commerce disruption and just plain profit did not require huge logistics trains to support the attack. Basically, the ship was loaded to the gunwales with supplies in its home port, sailed for months to reach its area of operations, and then attacked the undefended enemy coast at times and places where it had the advantage over the defenders. If the attack succeeded, the ship would load with additional supplies and booty and would sail for home, arriving anywhere from one to three years after leaving port. The net investment of the raider's home nation or base while it was gone: zero!

One can easily see where a similar scenario would apply to an interstellar war. The distances are so large and the stars so spread out, that it would be virtually impossible to defend even a small interstellar federation or empire against raids by enemy starships. The defending navy would be faced with the task of guarding millions of cubic light-years of space while single aggressor starships could slip close to a planet and wreak havoc before anyone knew that they were there.

To defend against such raids, each side would have to invest heavily in planetary defenses — ground based heavy lasers and large orbiting battle stations, as well as mobile home fleets kept ready to sortie against an attacker at a moment's notice. Unfortunately, no matter how large the defending force, it is likely that they would be unsuccessful a significant percentage of the time.

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The reason for this is that a starship, especially one that accelerates anywhere near the speed of light, would be the most fearsome weapon ever invented.

The Tactics of Hypervelocity

I first began thinking seriously about the uses of starships in warfare while writing *Procyon's Promise*. In this sequel to *Life Probe*, the descendents of colonists who went to Procyon to secure the secret of faster-than-light travel return to Earth three hundred years later. They find the terrestrials' ardor to keep up their end of the bargain humanity made with the life probe has cooled. This leads to a confrontation in the middle of the book in which the probe's sentient-computer descendent, PROM, must decide whether human beings can be trusted with the secret to faster-than-light travel.

There are many imaginary technologies for traveling faster than light. The problem comes with those technologies where an *ftl* ship pops out of hyperspace, or whatever we call the condition of faster-than-light travel, and is moving in normal space at just under the speed of light. Writers are fond of describing what the universe looks like in a ship traveling at 90% of *c*. The stars ahead are blue-shifted by Doppler effect until they burn bright azure-white, while those behind are red-shifted to a collection of simmering coals. Nor do the stars fill the sky around the ship. On all sides is a stygian blackness. All the stars are crowded into a shrinking circle of space directly in front of the ship. As it accelerates, these distorted blue stars continue to shrink until, just at the speed of light, they disappear into a pinpoint.

But what writers frequently forget to consider is the converse view, namely what a ship traveling nearly at the speed of light looks like to observers outside the ship. Let us say, for instance, that a raiding starship sneaks to the very outskirts of the Solar System, then pops sublight just long enough to launch an old-fashioned cannonball (just like they used on the Spanish Main) directly at the Earth. At the time a spacer shoves the museum piece out the airlock (it masses 10 kilograms), the ship is moving at 99% of *c*.

Surely a society that can fly between stars isn't afraid of one little cannonball! Or are they? A little math would seem to be in order. Basically, 99% of light speed is 2.97×10^8 meters per second and we can calculate the kinetic energy of the cannonball by the formula $KE=MV^2/2$, where M is the 10 Kg mass and V is the velocity of the cannonball, 0.99*c*. You may be surprised to discover that the energy wrapped up in that little iron sphere is 4.41×10^{17} joules. For those of us who were raised under the tyranny of the English system of measurements and who do not think well in joules, that equates to 10 megatons of TNT. In other words, our little 10 kg paperweight will release the same energy as 10 one-megaton hydrogen bombs when it splats down on our fair Earth!

But wait! We've forgotten something.

Recently my boss and I were on a trip together and we began discussing why it is that nothing can travel faster than light. I explained that the problem exists because as one reaches the speed of light, mass increases to infinity, and since no amount of energy will accelerate an infinite mass, nothing can ever exceed light speed. I also mentioned, in an offhand way, that time slows down to nothing as one approaches *c*. He greeted this comment with exclamations of incredulity, so I had to explain time dilation effect.

If you react similarly to the discovery that both mass and time are a function of velocity, then you may want to read "Einstein's Barrier" earlier in this series. Otherwise,

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you will have to trust me. The formula for computing how much mass increases with velocity is as follows:

$$M = \frac{M_0}{\sqrt{(1 - \frac{V^2}{C^2})}}$$

Where: M = the mass at velocity V
M_0 = the mass at rest
V = the velocity
C = the speed of light

If you plug 0.99*c* into the above equation and do the math, you will see that our little 10-kg cannonball actually masses 70 kg, and the 10-megaton explosion when it hits will actually be a 70-megaton explosion! Back in the early 1960s, the Russians exploded a 100-megaton bomb just to show off. No one has come close to the 70-megaton power range since.

Obviously, then, the defenders need to act to stop the little projectile from reaching the home planet. But we have another problem with our hypothetical attack. Let us assume the enemy starship managed to sneak in as close as Pluto (5.9-billion kilometers from the sun) before letting fly with its projectile. Since an object traveling at nearly light speed tends to emit energetic particles such as x-rays, the defenders should have no trouble detecting its presence once the starship drops sublight. The problem is *when* they will detect it. Pluto is 5.5 light-hours away (it takes light five-and-a-half hours to travel from the sun to Pluto). Since the cannonball is only 1% slower than light itself, it will arrive at Earth some 5 hours and 33 minutes after it was released. Nor is it necessary for the ship to be anywhere near Pluto when it launches, merely at the same distance from the sun. The enemy captain has the entire circumambient sphere of space from which to choose an attack vector. Since the defenses are likely heaviest in the plane of Earth's orbit, the ecliptic, it would behoove him to approach from either galactic north or south.

Still, if the defenses are sufficiently distributed and alert, perhaps they can intercept the cannonball and destroy it before it wipes out a terrestrial city. After all, any ship capable of *ftl* flight can go a long way in five hours. The only problem is that the defenders don't have five hours. They don't even have five minutes! With only a 1-% advantage in speed, the high-energy photons that alert the defenders to the presence of an enemy ship will arrive at Earth only three minutes before the cannonball does. If this seems counterintuitive, things tend to get that way as one approaches light speed.

Five and a half hours after the event, Earth's defenders detect a ship dropping sublight on the outskirts of the Solar System, they note that it has launched a projectile in their direction, yet before they have time to spread the alarm, the projectile is on them.

Of course, marauding starships won't use ancient cannonballs to attack their targets, if for no other reason than they will be far more valuable as museum pieces. No, starships will likely use guided missiles to deliver their punch. When attacking other ships, these missiles will be nuclear tipped. When making hypervelocity attacks on fixed targets like cities, there is no need to go to the extra expense. A solid lump of lead or uranium carries as much punch as a nuclear weapon, and is a great deal cheaper.

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Starship Tactics

Of course, nothing says that a faster-than-light technology must involve having the ship climb all the way to light speed before it breaks the Einstein barrier. For one thing, accelerating even a small ship to light speed requires the expenditure of tremendous amounts of energy — more energy than the human race has yet produced! Remember the increase in mass of the cannonball. If it is seven times more massive at 0.99*c* than at rest, so too is the ship that launched it. That means the ship must expend seven times as much energy to slow itself than Newtonian physics would suggest. Of course, as the ship's velocity falls farther below light speed, it becomes progressively easier to slow its headlong rush through the universe.

But what if a science fiction writer postulates other technologies for going faster than light? With each new technology comes a new combat tactic. In fact, that is one of the reasons we SF writers have developed so many different superluminal drives over the years. Each has different characteristics and different plot possibilities.

Let us look at a short list of *ftl* technologies and how they affect the waging of interstellar war:

Relativistic Battles in Normal Space

When an object is moving at a significant percentage of the speed of light (90% plus), it is said to be moving at relativistic speed. That is, the time dilation effect and increase in mass associated with very high velocities begin to make themselves felt. Battles fought at relativistic speed have an interesting side effect, one that was thoroughly explored in Joe Haldeman's *The Forever War*, a novel that showcases Haldeman's attitude regarding his experiences in Vietnam. Haldeman's patrol was ambushed, he was seriously wounded, and the rest of the patrol killed (if I remember the story correctly). The incident left him with an understandable dislike for things military.

The Forever War is a novel in which humankind is engaged in a war with an alien enemy. Both sides use wormhole-style jump gates to move from star to star. While in transit between gates, the ships reach nearly the speed of light. Because they travel at relativistic velocity, the starship crews age much more slowly than do the people they leave behind. They may only live a few months aboard ship while decades pass at home. The faster they go the slower shipboard time passes.

Because time dilation is inherently confusing, physicists have established a convention to keep things straight. The slower passage of time aboard ship is called "subjective time," while the normal passage of time at home is called "objective time."

Obviously, aging only a few months while those at home age decades leads to a lonely existence. It doesn't take too many battles before anyone you left behind is dead of old age. Nor is this the only problem with time dilation effect. It also presents the ship's crew with an interesting tactical problem.

Because getting into battle is a matter of decades (as measured by the outside universe), whenever a human star cruiser met an alien one in *The Forever War*, they had no way of knowing whether their enemy was effectively from their past or their future. If this seems confusing, it is. However, time dilation effect produces counterintuitive results, so let me explain.

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Because the passage of time is a function of the velocity each ship attains in getting to the scene of the battle, there is no way of knowing how long it has been since your enemy launched. Perhaps they have been en route for 40 years; in which case a human ship in transit for the past 20 years would have the advantage. On the other hand, perhaps they launched recently; in which case a human ship would be at a disadvantage at the end of a 20-year voyage.

This assumes, of course, that two civilizations that are stalemated in war likely have similar levels of technology — otherwise, one of them would win decisively. Moreover, that technology doesn't stand still. It improves from year to year, which is why you would rather be in a newer ship than your opponent. The formula is simple: Younger ships have better weapons and fighting power!

What relativistic velocities do is de-couple each combatant from its home time. If you have spent 40 years getting to the scene of the battle, but are only one year older due to time dilation effect, then the technological level of your ship is significantly less than for an enemy who has taken only a single year to arrive at the scene of battle.

Imagine a situation where a World War II destroyer sets sail from Boston and in mid-Atlantic, encounters a 1990's era German destroyer. Who do you think would win that combat (assuming the German shot back after being attacked without warning)? Then again, the WW-II American ship might just as easily have encountered a World War I German craft (assuming both were subject to time dilation effect en route). It is this sort of paradox that makes combat at relativistic speed interesting — for the reader, anyway. Like all combat, it is likely to be terrifying for the participants.

All of the above is completely orthodox physics. Unless you want to tackle the inherent paradoxes of time dilation effect in your story, you may wish to limit the normal space speed of your ships to less than 0.9 *c*. Otherwise, you can get a headache keeping track of things.

Star Trek uses a system of warping space to make their ships fly faster than light. Warping space is a long time tradition in SF, and the ensuing battles bear a striking resemblance to the battles between seagoing warships. This is no accident. Many space battles are written as though they were sea battles because the readers are familiar with the form, and besides, it's less work for the writers. In fact, in the original *Star Trek* series, the episode that introduced the Romulans was written exactly like a duel between a destroyer and a submarine (the cloaked Romulan ship being the submarine). I know that because I recognized the movie from which they were cribbing their plot. It was *The Enemy Below*, with Robert Mitchum as the American destroyer captain and Curt Jurgens as the German U-boat captain.

In science fiction, ships in warp are usually always hunting for their quarries in order to engage them. They detect them due to the "vibrations" they leave in "subspace" and then attack with weapons that shouldn't work at speeds greater than light, but somehow do. If you want an exciting battle scene without having to think too much about it, use the *Star Trek* propulsion system, suitably disguised, of course! It isn't that they own the technology, only that people will laugh at you if you steal too blatantly from Captains Kirk, Picard, and Janeway!

Micro-jumping Your Way across the Universe

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The major practitioner of the micro-jump *ftl* drive is Poul Anderson. Using a micro-jump drive, the ship is able to jump instantaneously from one point to another a few million kilometers farther on. Since a million kilometers isn't a big distance on the scale of the universe, Anderson makes his ships faster than light by causing them to make the jumps in very rapid succession, say a few thousand each second. In effect, Anderson's ships hop-skip-and-jump their way across the universe, appearing and disappearing like a school of porpoises keeping pace with an ocean liner.

Obviously, if an enemy is able to jump from point to widely separated point without touching any of the points in between, it's difficult to catch him in the real universe long enough to attack him. If your heroes are going to stick a missile between his ribs, they will have to synchronize their own micro-jumps with those of the villain in order to get a shot off. Poul Anderson has written many evocative scenes where the fleeing heroes of the Polesotechnic League are being pursued by alien battleships. Throughout the battle, the enemy craft are forever fading into and out of visibility as they strive to match their generators to those of the fleeing ship. The effect is of two ships dueling in the dark, with only strobe lights to illuminate the action.

The long passage in which the heroes do everything in their power to avoid letting the enemy get in phase with their jump pattern can build tension as efficiently as any technique I now. And, of course, the larger ships always seem to find the right pattern to match the heroes' craft, at which point the heroes temporarily surrender until they can work their way out of the mess.

Foldlines, Worm Holes, Tramlines

Occasionally you run into a situation where you want your ships to travel to the stars, but for reasons of plot, you must restrict the path they use to get there. In such a case, you use a wormhole technology. Like so much of science fiction, wormholes are an actual theory the physicists have thought up, but the existence of which is not yet proven. A wormhole is a tunnel through the universe. You enter one end and suddenly pop out the other end halfway across the universe. If you have watched *Star Trek, Deep Space Nine,* or *Star Trek Voyager*, you have probably seen a wormhole in action.

Why would an author want to limit his ships' access to interstellar travel? In *The Mote in God's Eye*, Larry Niven and Jerry Pournelle limited the Moties' access via "tramlines" in order to establish the blockade of the Motie system that is the climax of the book. In my own *Antares Trilogy (Antares Dawn, Antares Passage, Antares Victory)*, I use "foldlines" and "foldpoints" to limit the number of ways the characters can travel between stars. My use of these limited-access technologies is a way to give the protagonists a history and to set up the dynamics of the Ryall-human war.

Obviously, then, if you are in a universe where star travel via wormhole is a viable technology, the strategy in warfare is much different than in a universe where you just point your starship and go. With unlimited access to the stars, the best strategy is one of offense. Let the other guy do the defending while your ships roam the universe wreaking havoc on your enemies. However, if all access to a particular star system is via a single point in space, namely the exit of the wormhole, then your strategy changes to the defense. You surround the wormhole terminus with heavy fortresses and large ships

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equipped with sufficient firepower to vaporize the enemy as quickly as they exit the wormhole.

All Out War Among the Stars

As noted earlier in this article, it is easy to envision a single ship or a small fleet of ships attacking planets across the gulf of interstellar space. For reasons of logistics, however, a major military campaign mounted over interstellar distances has a lot of problems. No doubt you could do it, but would the investment be worth the gain? After all the inhabitants of even a moderately well-populated world would vastly outnumber the invading enemy.

Still, telling the readers that interstellar war is impossible is not a good way to keep readers. So, we humor them and write about vast fleets putting out to space to avenge the destruction of our peace loving, God-fearing colony around Centauri-Prime, or some other thing.

If you would like to see how a big war story is handled, you might want to rent *Starship Troopers* at your local video store. I know I am going to get some flack over that suggestion, so let me defend myself in advance. I am a very great fan of Robert Heinlein and have read the book *Starship Troopers* literally dozens of times. I enjoyed the book (even though it was the first in which Heinlein let his didactic streak take over the plot). I was very disappointed in the movie, however, both because it portrayed Heinlein's military-centered society as a bunch of Nazis, and because the Mobile Infantry looked pretty stupid emptying hundreds of rounds into each bug they killed. The technology the bugs used to destroy Buenos Aires was also laughable, as was the explanation (or lack thereof) as to how they managed to get those big asteroids halfway across the galaxy.

Still, the one thing the movie has going for it is the look of the starships as they bear down on Klendathu for the abortive attack known as "Operation Bughouse," or the later attack on Planet P when *Roger Young* is hit by enemy ground fire. They spent a lot of money on those special effects, and in that respect; at least, they managed to capture the feel of the original novel. If there ever is an interstellar D-Day, then it will likely look something like those beautiful ship scenes from the movie.

So if you find yourself facing the part of your book where you must mount a massive interstellar invasion to save the heroine from a fate-worse-than-death, and if you aren't too squeamish at the sight of blood, you can view *Starship Troopers* to get in the mood. Who knows? Afterward you may write a rollicking good "shoot 'em up." And if that doesn't work, at least you'll be able to watch *The Surgery Channel* without flinching.

Conclusion

As in everything else having to do with science fiction writing, the technology you use to transit the vastness of interstellar space depends on the plot of your story. You can make star travel easy or difficult, or anywhere in between. You can build huge mobile fortresses (like *Star Wars*' Death Star), or single ships that fight lonely duels amid the deep black. Whatever your choices, there are a few things you need to remember.

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The first is the mind-boggling distance between stars. Don't do like one of Sci Fi – Arizona's regular readers did several months ago. After setting his story in the deep black of the interstellar void, he hatched a garden-variety detective/murder mystery plot to go with it. Needless to say, the size of the plot did not do justice to the scale of the backdrop. It was as though, having scraped the western face of the Sierra Nevada mountains clean for use as a canvas, he then attempted to paint *The Lord's Supper* on the head of a pin.

When writing about space, it is easy to write a story that is mismatched for the backdrop. Remember that the universe is a very large place indeed! Try not to despoil it with small story ideas!

The End

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NOVELS

1. Life Probe - ^{US}$5.00

The Makers searched for the secret to faster-than-light travel for 100,000 years. Their chosen instruments were the Life Probes, which they launched in every direction to seek out advanced civilizations among the stars. One such machine searching for intelligent life encounters 21st century Earth. It isn't sure that it has found any...

2. Procyon's Promise - ^{US}$5.00

Three hundred years after humanity made its deal with the Life Probe to search out the secret of faster-than-light travel, the descendants of the original expedition return to Earth in a starship. They find a world that has forgotten the ancient contract. No matter. The colonists have overcome far greater obstacles in their single-minded drive to redeem a promise made before any of them were born...

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3. Antares Dawn - US$5.00

When the super giant star Antares exploded in 2512, the human colony on Alta found their pathway to the stars gone, isolating them from the rest of human space for more than a century. Then one day, a powerful warship materialized in the system without warning. Alarmed by the sudden appearance of such a behemoth, the commanders of the Altan Space Navy dispatched one of their most powerful ships to investigate. What ASNS Discovery finds when they finally catch the intruder is a battered hulk manned by a dead crew.

That is disturbing news for the Altans. For the dead battleship could easily have defeated the whole of the Altan navy. If it could find Alta, then so could whomever it was that beat it. Something must be done…

4. Antares Passage - US$5.00

After more than a century of isolation, the paths between stars are again open and the people of Alta in contact with their sister colony on Sandar. The opening of the foldlines has not been the unmixed blessing the Altans had supposed, however.

For the reestablishment of interstellar travel has brought with it news of the Ryall, an alien race whose goal is the extermination of humanity. If they are to avoid defeat at the hands of the aliens, Alta must seek out the military might of Earth. However, to reach Earth requires them to dive into the heart of a supernova.

5. Antares Victory – First Time in Print – US$7.00

After a century of warfare, humanity finally discovered the Achilles heel of the Ryall, their xenophobic reptilian foe. Spica – Alpha Virginis – is the key star system in enemy space. It is the hub through which all Ryall starships must pass, and if humanity can only capture and hold it, they will strangle the Ryall war machine and end their threat to humankind forever.

It all seemed so simple in the computer simulations: Advance by stealth, attack without warning, strike swiftly with overwhelming power. Unfortunately, conquering the Ryall proves the easy part. With the key to victory in hand, Richard and Bethany Drake discover that they must also conquer human nature if they are to bring down the alien foe …

6. Thunderstrike! - US$6.00

The new comet found near Jupiter was an incredible treasure trove of water ice and rock. Immediately, the water-starved Luna Republic and the Sierra Corporation, a leader in asteroid mining, were squabbling over rights to the new resource. However, all thoughts of profit and fame were abandoned when a scientific expedition discovered that the comet's trajectory placed it on a collision course with Earth!

As scientists struggled to find a way to alter the comet's course, world leaders tried desperately to restrain mass panic, and two lovers quarreled over the direction the comet was to take, all Earth waited to see if humanity had any future at all…

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7. The Clouds of Saturn - US$5.00

When the sun flared out of control and boiled Earth's oceans, humanity took refuge in a place that few would have predicted. In the greatest migration in history, the entire human race took up residence among the towering clouds and deep clear-air canyons of Saturn's upper atmosphere. Having survived the traitor star, they returned to the all-too-human tradition of internecine strife. The new city-states of Saturn began to resemble those of ancient Greece, with one group of cities taking on the role of militaristic Sparta...

8. The Sails of Tau Ceti – US$5.00

Starhopper was humanity's first interstellar probe. It was designed to search for intelligent life beyond the solar system. Before it could be launched, however, intelligent life found Earth. The discovery of an alien light sail inbound at the edge of the solar system generated considerable excitement in scientific circles. With the interstellar probe nearing completion, it gave scientists the opportunity to launch an expedition to meet the aliens while they were still in space. The second surprise came when *Starhopper's* crew boarded the alien craft. They found beings that, despite their alien physiques, were surprisingly compatible with humans. That two species so similar could have evolved a mere twelve light years from one another seemed too coincidental to be true.

One human being soon discovered that coincidence had nothing to do with it...

9. Gibraltar Earth – First Time in Print — $6.00

It is the 24th Century and humanity is just gaining a toehold out among the stars. Stellar Survey Starship *Magellan* is exploring the New Eden system when they encounter two alien spacecraft. When the encounter is over, the score is one human scout ship and one alien aggressor destroyed. In exploring the wreck of the second alien ship, spacers discover a survivor with a fantastic story.

The alien comes from a million-star Galactic Empire ruled over by a mysterious race known as the Broa. These overlords are the masters of this region of the galaxy and they allow no competitors. This news presents Earth's rulers with a problem. As yet, the Broa are ignorant of humanity's existence. Does the human race retreat to its one small world, quaking in fear that the Broa will eventually discover Earth? Or do they take a more aggressive approach?

Whatever they do, they must do it quickly! Time is running out for the human race…

10. Gibraltar Sun – First Time in Print — $7.00

The expedition to the Crab Nebula has returned to Earth and the news is not good. Out among the stars, a million systems have fallen under Broan domination, the fate awaiting Earth should the Broa ever learn of its existence. The problem would seem to allow but three responses: submit meekly to slavery, fight and risk extermination, or hide and pray the Broa remain ignorant of humankind for at least a few more generations. Are the hairless apes of Sol III finally faced with a problem for which there is no acceptable solution?

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While politicians argue, Mark Rykand and Lisa Arden risk everything to spy on the all-powerful enemy that is beginning to wonder at the appearance of mysterious bipeds in their midst…

11. Gridlock and Other Stories - US$5.00

Where would you visit if you invented a time machine, but could not steer it? What if you went out for a six-pack of beer and never came back? If you think nuclear power is dangerous, you should try black holes as an energy source — or even scarier, solar energy! Visit the many worlds of Michael McCollum. I guarantee that you will be surprised!

Non-Fiction Books

12. The Art of Writing, Volume I - US$10.00

Have you missed any of the articles in the Art of Writing Series? No problem. The first sixteen articles (October, 1996-December, 1997) have been collected into a book-length work of more than 72,000 words. Now you can learn about character, conflict, plot, pacing, dialogue, and the business of writing, all in one document.

13. The Art of Writing, Volume II - US$10.00

This collection covers the Art of Writing articles published during 1998. The book is 62,000 words in length and builds on the foundation of knowledge provided by Volume I of this popular series.

14. The Art of Science Fiction, Volume I - US$10.00

Have you missed any of the articles in the Art of Science Fiction Series? No problem. The first sixteen articles (October, 1996-December, 1997) have been collected into a book-length work of more than 70,000 words. Learn about science fiction techniques and technologies, including starships, time machines, and rocket propulsion. Tour the Solar System and learn astronomy from the science fiction writer's viewpoint. We don't care where the stars appear in the terrestrial sky. We want to know their true positions in space. If you are planning to write an interstellar romance, brushing up on your astronomy may be just what you need.

15. The Art of Science Fiction, Volume II - US$10.00

This collection covers the *Art of Science Fiction* articles published during 1998. The book is 67,000 words in length and builds on the foundation of knowledge provided by Volume I of this popular series.

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16. The Astrogator's Handbook – Expanded Edition and Deluxe Editions

The Astrogator's Handbook has been very popular on Sci Fi – Arizona. The handbook has star maps that show science fiction writers where the stars are located in space rather than where they are located in Earth's sky. Because of the popularity, we are expanding the handbook to show nine times as much space and more than ten times as many stars. The expanded handbook includes the positions of 3500 stars as viewed from Polaris on 63 maps. This handbook is a useful resource for every science fiction writer and will appeal to anyone with an interest in astronomy.

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