DOWNLOAD PDF INTERSTELLAR TRAVEL

Chapter 1 : The Dismal Future of Interstellar Travel | HuffPost

Interstellar travel is the term used for crewed or uncrewed travel between stars or planetary www.nxgvision.comtellar travel will be much more difficult than interplanetary spaceflight; the distances between the planets in the Solar System are less than 30 astronomical units (AU)â€”whereas the distances between stars are typically hundreds of thousands of AU, and usually expressed in light-years.

Share Interstellar Travel is a term used to describe all methods used to move between star systems within a time frame that permits interstellar interaction. All require what are called "Advanced Physics" as standard Physical laws would nominally prevent the breaking of the speed of light. Burkhard Heim, uses gravito-magnetic field manipulations to permit a vessel to travel at faster than light speeds without actually exceeding the speed of light in real terms. These drives have a solid feasible speed cap of 53c - 53 times the speed of light - and while they were vital for early space exploration and colonization, the slowness of the drive means any workable interstellar state would be small in size. In the modern era Heim drives are most often found on vessels that are limited to intra-system travel or specialized drives to assist in crossing shoal regions. Hyperdrive Edit Inevitably a race that has discovered the use of Heim Drives tends to come across the necessary mechanics to effect a ship shifting into hyperspace. The utilization of gravito-magnetic fields of higher intensity than those employed in a Heim Drive allows such a bending of space-time that an object, even a transmission, can be projected into hyperspace. Hyperspace exists as a "foundation membrane" of space-time, according to hyperspace physicists, and within the confines of hyperspace a vessel traveling at an ordinary speed will, in interaction with real-space, be traveling at faster-than-light velocities. Hyperspace is not uniform, however. As a result, regions in which stars are few or rare or regions in which gravitational fields are of particular form create "Shoal" space, areas where Hyperspace becomes energized and stretched. Vessels have a harder time moving through hyperspace in Shoals; a worn down drive can even fail to successfully transition between hyperspace and realspace, while the energy resistance inside hyperspace creates wear on the spaceframe of a vessel. Though there are lanes through the Shoals, most scientists believe them to be the result of an ancient star-faring race that refined hyperspace dredging to the point that they could place limited lanes through Shoals. Along the other side of the spectrum, particular gravitational fields of local stars can create "lanes" in hyperspace, cylinders of light-year-scale space where hyperspace is quiet and far easier to traverse. These lanes increase the speed of standard hyperdrives by several factors, enabling trips that would ordinarily take a week to happen in the space of a couple days. In some places, these gravitational effects can lead to a great many lanes clumping in the vicinity of a single star system, creating a "Hyperspace Junction" and also usually signifying that many neighboring star systems are within the confines of a lane, thus meaning interstellar travel within the sector is vastly easier. Any section of hyperspace that is not considered "Shoal" hyperspace but is not in a lane is considered "off-network". This hyperspace is energetic and resistant to travel, but nowhere near as dangerous as shoal space. Experiments since the 31st Century have since shown that it is possible to "dredge" hyperspace through the generation of intense Heim fields within it; the result is a process that over many years can permit a state to "dredge" lanes within a sector that is primarily off-network, permitting easier colonization of local systems and planets. Most interstellar states now rely on standard hyperdrive, but the mysterious Collectors of the Wild Space shoal region are an exception that proves the rule. Expanding in a region that is entirely Shoals, the Collectors developed hyperdrive technology that accesses a higher plane of hyperspace, requiring more energy but being less effected by wide-scale gravitational fields. As a result Collector hyperdrives are not held back by Shoal space, but by the same token they gain no benefit from being outside Shoals or in a hyperspace lane. A Hyperdrive works by generating a gravito-magnetic "submersion" field that "slips" a vessel into hyperspace. Departing hyperspace is the result of this field being de-energized, permitting a ship to "slow" in relation with real-space until it reaches "transition velocity" and can shift back into real-space. For emergencies, there are also systems that force a ship to actively shift itself back into real-space through a sudden, powerful stop and an active field shift instead of a field shut-down; these are highly dangerous maneuvers and can cause the destruction of not only the vessel attempting the maneuver but of any vessels nearby, in both hyperspace or real-space, as a result of the violent energy shift. Hyperspace "interdiction" is possible in two ways. Secondly, a method used by most star nations is an "interdiction field" at points where hyperlanes intersect solar systems, forcing the ship to drop out of hyperspace if it does not want to risk being forced out and potentially crippled or destroyed in the process. The downside to the interdiction field is that the generating station is somewhat fragile, hard to protect, and easily destroyed by a combat fleet conducting an invasion. They ignore the issues of standard hyperspace entirely by creating a pocket of "warp space" that directly connects two points across vast interstellar distances, in the fashion of a wormhole. Though they require vast amounts of energy, a Warp Gate permits near-instantaneous travel between two points, the Sending Point and Receiving Point, ignoring Shoals along the route. The more mass you attempt to transit through a Warp Gate, the more energy it requires. Over relatively short distances - 2 standard sectors - the energy demand of shifting even the largest warships is sustainable by modern technology. But beyond this "fleet transit distance", as it is called, the power demand goes up logarithmically, such to the point that to go from one side of the known galaxy to another - from, say, Chamarra in the Chamarran Hierarchy to Guangdong in Tianguo - requires every available joule from the best modern power source for a Gate to transit just one vessel of Light size and tonnage, when the same amount of energy can transfer roughly 20 times that amount of mass in vessels within the fleet transit distance. Just as much, moving the equivalent of a Heavy hull just one extra sector by itself beyond the fleet transit distance requires more energy than any modern power source can provide as in there are no means for any power source currently available to transfer the necessary energy to the Warp Gate. Due to these limitations and the expense of construction and maintenance, most states only maintain one Warp Gate for their home system. The UN, at five divided among thirteen sectors, has the most of any state in the cosmos. Warp Gates are primarily used for rapid transit of government officials and VIPs for interstellar diplomatic summits and negotiations, as well as for high-cost luxury liner passage between major systems and for the transfer of high-value, short-life items that cannot be shipped to their purchaser in time if done via normal hyperspace route. Only in cases where a state has two or more Warp Gates, within two sectors of each other, are they capable of use for more, such as larger-scale ships and for military fleet deployments that move faster than standard lane-utilizing hyperspace.

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Chapter 2 : BBC - Future - The myths and reality about interstellar travel

Even the fastest humans and spacecraft launched thus far would take many thousands of years to reach the closest stars. Speeds about 75 times faster than this would be required if we hope to make.

Astronomer, NASA Heliophysics Education Consortium The Dismal Future of Interstellar Travel I have been an avid science fiction reader all my life, but as an astronomer for over half my life, the essential paradox of my fantasy world can no longer be maintained. Basically, science tells us that traveling fast enough to make interstellar travel possible requires more money than society will ever be able to invest in the attempt. His more comprehensive theory of general relativity also works exceptionally well and offers no workable opportunity to "warp" space in a way that can be technologically applied to space travel without killing the traveler or incinerating the universe. Interstellar travel will be constrained by the reality of special relativity and general relativity, and there is no monkeying with Mother Nature to make science fiction a reality. The Daedalus starship Credit: There are many workable ideas, such as ion drives, fusion drives and solar sails. In fact, the all-around best ready-to-go idea is the ion engine, which is an off-the-shelf technology that has been used on many satellites and several spacecraft so far. With a small but constant thrust applied over months, years and decades, scaled-up versions of these systems could boost small payloads to over 10 percent of the speed of light in a few years, allowing travel times to Alpha Centauri and other nearby stars of as little as a century or less. The Fly in the Ointment! It consists of 50, tons of fuel and tons of scientific equipment. There can be essentially no moving parts, because friction would create wear and tear over decades and centuries of use. It is entirely plausible to think about kilogram-sized payloads that can be boosted to near-relativistic speeds very economically, but this is impractical because at the distance of the nearest stars, you need a powerful and massive transmitter that can relay data back to Earth, or what is the point of the journey? Even a Voyager-class spacecraft with, say, a "souped-up" megawatt radio transmitter could not be detected at Alpha Centauri by the largest Earth-based telescopes, even at data rates of 1 bit per year! A laser-based system would be highly directional and could possibly do the trick, but it would weigh tons, not kilograms. One option could be a sophisticated nanotechnology system with a mass of a few dozen kilograms that would arrive at its destination, find an asteroid to mine, and then build from scratch a much more massive system capable of carrying out the scientific investigation and relaying the data back to Earth. But the concept of sending humans to the stars makes no sense technologically, or at an economic scale that would interest humanity as it is currently constituted. Even if we were at the brink of extinction, do you really think that 7 or 10 billion humans would want to foot the bill and the decades-long effort to send a few lucky humans on a one-way trip to a distant planet -- that may not even be habitable? So What Do We Do? Our solar system is vast, and a big-enough playground for human exploration to last us for centuries. It is technologically accessible to us even today, as the numerous unmanned spacecraft and robotic systems clearly show. There are many scenarios that can be planned over decadal or century timescales that would have human outposts and colonies on just about every interesting body in the solar system, from planetary surfaces and the surfaces of their moons to asteroids and comets. But is manned exploration the only way to go for now? When you subtract manned exploration, which is hugely expensive, and replace it with robotic rovers that relay high-definition images back to Earth, all of humanity can participate in their own personal and virtual exploration of space, not just a few astronauts or colonists. The Apollo program gave us 12 astronauts walking on the lunar surface, a huge milestone for humanity, but today we can do the Apollo program all over again and augment it with a virtual, shared experience involving billions of people! This is the wave of the future for space exploration, because it is technologically doable today and scalable at ridiculously low cost per human involved. More sophisticated versions will eventually explore the subsurface ocean of Europa and the river systems on the "Earth-like" world of Titan -- perhaps by the end of this century! Robotic exploration of the solar system is now in full-swing! As an avid science fiction reader, I too am pissed that we live in a universe where star travel seems permanently beyond reach in any kind of human future that makes scientific or economic sense. But this is the deck of cards that we are dealt. We can pine away for a mythical future of interstellar colonization, but that will be a reality for a future humanity that looks nothing like our civilization, perhaps driven by extinction to help focus the resources toward that goal.

Chapter 3 : The Physics of Interstellar Travel : Official Website of Dr. Michio Kaku

The brainchild of Russian-born tech entrepreneur billionaire Yuri Milner, Breakthrough Starshot was announced in April at a press conference joined by renowned physicists including Stephen Hawking and Freeman Dyson.

Interstellar probe Slow interstellar missions based on current and near-future propulsion technologies are associated with trip times starting from about one hundred years to thousands of years. These missions consist of sending a robotic probe to a nearby star for exploration, similar to interplanetary probes such as used in the Voyager program. Researchers at the University of Michigan are developing thrusters that use nanoparticles as propellant. Their technology is called "nanoparticle field extraction thruster", or nanoFET. These devices act like small particle accelerators shooting conductive nanoparticles out into space. Kaku also notes that a large number of nanoprobes would need to be sent due to the vulnerability of very small probes to be easily deflected by magnetic fields, micrometeorites and other dangers to ensure the chances that at least one nanoprobe will survive the journey and reach the destination. With onboard solar cells, they could continually accelerate using solar power. One can envision a day when a fleet of millions or even billions of these particles swarm to distant stars at nearly the speed of light and relay signals back to Earth through a vast interstellar communication network. As a near-term solution, small, laser-propelled interstellar probes, based on current CubeSat technology were proposed in the context of Project Dragonfly. Generation ship A generation ship or world ship is a type of interstellar ark in which the crew that arrives at the destination is descended from those who started the journey. Generation ships are not currently feasible because of the difficulty of constructing a ship of the enormous required scale and the great biological and sociological problems that life aboard such a ship raises. Sleeper ship Scientists and writers have postulated various techniques for suspended animation. These include human hibernation and cryonic preservation. Although neither is currently practical, they offer the possibility of sleeper ships in which the passengers lie inert for the long duration of the voyage. Embryo colonization A robotic interstellar mission carrying some number of frozen early stage human embryos is another theoretical possibility. This method of space colonization requires, among other things, the development of an artificial uterus , the prior detection of a habitable terrestrial planet , and advances in the field of fully autonomous mobile robots and educational robots that would replace human parents. There may be ways to take advantage of these resources for a good part of an interstellar trip, slowly hopping from body to body or setting up waystations along the way. Time dilation Assuming faster-than-light travel is impossible, one might conclude that a human can never make a round-trip farther from Earth than 20 light years if the traveler is active between the ages of 20 and A traveler would never be able to reach more than the very few star systems that exist within the limit of 20 light years from Earth. This, however, fails to take into account relativistic time dilation. For example, a spaceship could travel to a star 32 light-years away, initially accelerating at a constant 1. After a short visit, the astronaut could return to Earth the same way. After the full round-trip, the clocks on board the ship show that 40 years have passed, but according to those on Earth, the ship comes back 76 years after launch. From the viewpoint of the astronaut, onboard clocks seem to be running normally. The star ahead seems to be approaching at a speed of 0. The universe would appear contracted along the direction of travel to half the size it had when the ship was at rest; the distance between that star and the Sun would seem to be 16 light years as measured by the astronaut. At higher speeds, the time on board will run even slower, so the astronaut could travel to the center of the Milky Way 30, light years from Earth and back in 40 years ship-time. But the speed according to Earth clocks will always be less than 1 light year per Earth year, so, when back home, the astronaut will find that more than 60 thousand years will have passed on Earth. Regardless of how it is achieved, a propulsion system that could produce acceleration continuously from departure to arrival would be the fastest method of travel. A constant acceleration journey is one where the propulsion system accelerates the ship at a constant rate for the first half of the journey, and then decelerates for the second half, so that it arrives at the destination stationary relative to where it began. Supplying the energy required, however, would be prohibitively expensive with current technology. It will undergo hyperbolic motion. When the ship reaches its destination, if it were to exchange a message with its origin planet, it would find that less time had elapsed on board than had elapsed for the planetary observer, due to time dilation and length contraction. The result is an impressively fast journey for the crew. Rocket concepts[edit] All rocket concepts are limited by the rocket equation , which sets the characteristic velocity available as a function of exhaust velocity and mass ratio, the ratio of initial M0, including fuel to final M1, fuel depleted mass. Very high specific power , the ratio of thrust to total vehicle mass, is required to reach interstellar targets within sub-century time-frames. Thus, for interstellar rocket concepts of all technologies, a key engineering problem seldom explicitly discussed is limiting the heat transfer from the exhaust stream back into the vehicle. In an ion engine, electric power is used to create charged particles of the propellant, usually the gas xenon, and accelerate them to extremely high velocities. By contrast, ion engines have low force, but the top speed in principle is limited only by the electrical power available on the spacecraft and on the gas ions being accelerated. Such vehicles probably have the potential to power solar system exploration with reasonable trip times within the current century. Because of their low-thrust propulsion, they would be limited to off-planet, deep-space operation. With fission, the energy output is approximately 0. For maximum velocity, the reaction mass should optimally consist of fission products, the "ash" of the primary energy source, so no extra reaction mass need be bookkept in the mass ratio. Based on work in the late s to the early s, it has been technically possible to build spaceships with nuclear pulse propulsion engines, i. In each case saving fuel for slowing down halves the maximum speed. The concept of using a magnetic sail to decelerate the spacecraft as it approaches its destination has been discussed as an alternative to using propellant, this would allow the ship to travel near the maximum theoretical velocity. The principle of external nuclear pulse propulsion to maximize survivable power has remained common among serious concepts for interstellar flight without external power beaming and for very high-performance interplanetary flight. In the s the Nuclear Pulse Propulsion concept further was refined by Project Daedalus by use of externally triggered inertial confinement fusion , in this case producing fusion explosions via compressing fusion fuel pellets with high-powered electron beams. Since then, lasers , ion beams , neutral particle beams and hyper-kinetic projectiles have been suggested to produce nuclear pulses for propulsion purposes. This treaty would, therefore, need to be renegotiated, although a project on the scale of an interstellar mission using currently foreseeable technology would probably require international cooperation on at least the scale of the International Space Station. Another issue to be considered, would be the g-forces imparted to a rapidly accelerated spacecraft, cargo, and passengers inside see Inertia negation. In theory, a large number of stages could push a vehicle arbitrarily close to the speed of light. Because fusion yields about 0. However, the most easily achievable fusion reactions release a large fraction of their energy as high-energy neutrons, which are a significant source of energy loss. Thus, although these concepts seem to offer the best nearest-term prospects for travel to the nearest stars within a long human lifetime, they still involve massive technological and engineering difficulties, which may turn out to be intractable for decades or centuries. Although these are still far short of the requirements for interstellar travel on human timescales, the study seems to represent a reasonable benchmark towards what may be approachable within several decades, which is not impossibly beyond the current state-of-the-art.

Chapter 4 : Interstellar travel - Simple English Wikipedia, the free encyclopedia

The power to travel across interstellar distances. The user can travel across interstellar distances through various means, either through technology or their own power.

If a ship decelerates slightly while in the Void, it will emerge into the "real" universe at some point far distant from where it left normal space. Although this process of jumping through the Void allows ships to cover immense distances in very short times, jumping still takes several days. Most of this time is spent accelerating to jump speed and then decelerating at the other end. Jump Limits Edit Theoretically, a ship can jump any distance across the Void. The limiting factor is the precision needed in the pre-jump calculations. If the astrogator is risk-jumping, this probability is subtracted from his chance to guide the ship safely. After completing the jump, the ship turns over in an maneuver known as an "end-over" and decelerates at a steady 1g, again generating artificial gravity throughout the ship. At 1g, it will take little under 9. This in addition to the time needed to plot the course. Chemical Drives Edit Chemical-propulsion engines simply do not have the fuel capacity to reach void velocity on their own. If equipped with an astrogation program and properly programmed, a chemical-drive-equipped spaceship could be ferried to near-void velocity by a ship equipped with atomic or ion drives and released in order to enter the void on its own, but deceleration at the destination system would be problematic. For this reason, Chemical-drive ships are never used to cross the Void. Ion Drives Edit Ion drives are, by far, the most common and practical method of reaching Void velocity, crossing the Void and decelerating at the destination system. Each engine uses up one 10cm diameter pellet of atomic fuel per jump; half on acceleration to Void velocity and the other half in deceleration. Each pellet costs 10, Cr. This would make it seem that it is more economical to run an atomic drive starship, however, atomic engines require overhauls that consume man-hours of labor as much as 60 man-hours per engine per jump , which has costs in both time and manpower money. The inability to use alternative fuels also works against the practicality of atomic engines, as rules of supply and demand may affect the local supply of atomic fuel pellets. Sublight Interstellar Travel Edit While theoretically possible, slower-than-light or "sublight" interstellar travel is terribly impractical; taking a minimum of one hundred standard years to cross a single light year. Because of this, and the ease upon which any ship can enter the Void, only ancient pre-Frontier generational ships of the type launched prior to the discovery of the Void attempt sublight interstellar crossings. This is called the "jump window". These additional calculations require one hour of plotting for every hour the calculation has expired round down. If 5 hours after the calculations are completed, the ship has not used its launch window, it is considered to be risk-jumping with nine hours of plotting per LY since the total rounds down and would require an hour of calculations per light year to return to standard. Each hex is 10, kilometers across.

Chapter 5 : Interstellar Travel | Star Frontiers Wiki | FANDOM powered by Wikia

To one day, reach the stars. When discussing the possibility of interstellar travel, there is something called "the giggle factor." Some scientists tend to scoff at the idea of interstellar travel because of the enormous distances that separate the stars. According to Special Relativity (

The discovery is a major advancement in finding a habitable planet and in finding a planet that could support life. Existing and near-term astronomical technology is capable of finding planetary systems around these objects, increasing their potential for exploration. Proposed methods Main article: Interstellar probe Slow interstellar missions based on current and near-future propulsion technologies are associated with trip times starting from about one hundred years to thousands of years. These missions consist of sending a robotic probe to a nearby star for exploration, similar to interplanetary probes such as used in the Voyager program. Fast, uncrewed probes Main article: Interstellar probe Nanoprobes Near-lightspeed nanospacecraft might be possible within the near future built on existing microchip technology with a newly developed nanoscale thruster. Researchers at the University of Michigan are developing thrusters that use nanoparticles as propellant. 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This method of space colonization requires, among other things, the development of an artificial uterus , the prior detection of a habitable terrestrial planet , and advances in the field of fully autonomous mobile robots and educational robots that would replace human parents. There may be ways to take advantage of these resources for a good part of an interstellar trip, slowly hopping from body to body or setting up waystations along the way. Several propulsion concepts have been proposed [29] that might be eventually developed to accomplish this see also the section below on propulsion methods , but none of them are ready for near-term few decades development at acceptable cost. Time dilation Main article: Time dilation Assuming faster-than-light travel is impossible, one might conclude that a human can never make a round-trip farther from Earth than 20 light years if the traveler is active between the ages of 20 and A traveler would never be able to reach more than the very few star systems that exist within the limit of 20 light years from Earth. This, however, fails to take into account time dilation. For example, a spaceship could travel to a star 32 light-years away, initially accelerating at a constant 1. After a short visit the astronaut could return to Earth the same way. After the full round-trip, the clocks on board the ship show that 40 years have passed, but according to those on Earth, the ship comes back 76 years after launch. From the viewpoint of the astronaut, on-board clocks seem to be running normally. The star ahead seems to be approaching at a speed of 0. 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Thus, although these concepts seem to offer the best nearest-term prospects for travel to the nearest stars within a long human lifetime, they still involve massive technological and engineering difficulties, which may turn out to be intractable for decades or centuries. Although these are still far short of the requirements for interstellar travel on human timescales, the study seems to represent a reasonable benchmark towards what may be approachable within several decades, which is not impossibly beyond the current state-of-the-art. Antimatter rockets Main article: Antimatter rocket An antimatter rocket would have a far higher energy density and specific impulse than any other proposed class of rocket. Second, heat transfer from exhaust to the vehicle seems likely to transfer enormous wasted energy into the ship e. Even assuming shielding were provided to protect the payload and passengers on a crewed vehicle , some of the energy would inevitably heat the vehicle, and may thereby prove a limiting factor if useful accelerations are to be achieved. Landis has proposed for an interstellar probe , with energy supplied by an external laser from a base station powering an Ion thruster. Several concepts attempt to escape from this problem: Bussard proposed the Bussard ramjet , a fusion rocket in which a huge scoop would collect the diffuse hydrogen in interstellar space, "burn" it on the fly using a protonâ€”proton chain reaction , and expel it out of the back. Later calculations with more accurate estimates suggest that the thrust generated would be less than the drag caused by any conceivable scoop design. Beamed propulsion This diagram illustrates Robert L. Forward proposed a means for decelerating an interstellar light sail in the destination star system without requiring a laser array to be present in that system. In this scheme, a smaller secondary sail is deployed to the rear of the spacecraft, whereas the large primary sail is detached from the craft to keep moving forward on its own. Light is reflected from the large primary sail to the secondary sail, which is used to decelerate the secondary sail and the spacecraft payload. A magnetic sail could also decelerate at its destination without depending on carried fuel or a driving beam in the destination system, by interacting with the plasma found in the solar wind of the destination star and the interstellar medium.

Chapter 6 : Interstellar Travel as Delusional Fantasy [Excerpt] - Scientific American

Interstellar is a science fiction film directed, co-written, and co-produced by Christopher www.nxgvision.com stars Matthew McConaughey, Anne Hathaway, Jessica Chastain, Bill Irwin, Ellen Burstyn, and Michael Caine.

Pathological technologies are typically put forward, promoted, and developed despite the presence of substantial drawbacks or risks that, when considered at all, are commonly dismissed, downplayed, or passed over in silence by proponents. In the case of interstellar travel, the possible payoffs were substantially offset by a roster of downsides, dangers, and existential threats. One category of risk arose from factors or forces external to the spacecraftâ€"for example, collisions with objects in the interstellar medium. Collisions in space are by no means rare: After a while there had been such a rash of debris impacts that the shuttle, once it reached orbit, was intentionally flown tail-first to minimize the effect of collisions. To the contrary, the space between the stars contains volumes of interstellar gas and dust, along with cosmic rays, and possibly objects of unknown composition, size, mass, and density. And so it would be difficult to believe that on a journey of at least 4. But for a starship traveling at relativistic speeds, a collision with even a random small particle, according to Tom W. Gingell of Science Applications International Corporation, who did a study of the subject, would have the effect upon the spacecraft of an H-bomb explosion. Since quickly diverting a massive spacecraft from its course would be impossible, it would be necessary instead to detect, deflect, or destroy the object within a matter of milliseconds before impact, by means of a system that would have to work perfectly and virtually instantaneously the first time out. But no such highly sensitive, fail-safe, and fast-acting detection and deflection systems existed or were in prospect. A second category of risk consisted of threats arising from within the spacecraft itself to the physical and mental well-being of those aboard it throughout the whole of its interstellar journey. Since the size, structure, internal environment, and population of the starship were unknowns, any attempt at assessing what the probable onboard living conditions would be like was essentially an exercise in guesswork. Although there were numerous designs of interstellar craft on paper, there was one concept that had remained relatively consistent across time: An early description of it was given by the British crystallographer J. The great bulk of the structure would be made out of the substance of one or more smaller asteroids, rings of Saturn or other planetary detritus. The globe would fulfill all the functions by which our earth manages to support life. After all, where human beings went, so too did their religions, even in the space age, as the history of American spaceflight has well demonstrated. During the Apollo 8 mission in , and while in orbit around the moon, astronauts Bill Anders, Jim Lovell, and Frank Borman took turns reading verses 1 through 10 of the Book of Genesis. Later, after the landing of Apollo 11, Buzz Aldrin, the second man on the moon, administered the Eucharist to himself during his short stay on the surface. As he later revealed to a Christian periodical: Further, in order for a space ark mission to be successful, there would have to be some sort of onboard government, including a constitution and legal system, a police force, courts, judges, juries, and prisons, both for purposes of effective law enforcement and to avoid tyranny, mutiny, civil war, or other forms of chaos, unrest, or revolt. As human beings, we would be bringing all of our conflicts, differences, and sources of division along with us, albeit now while confined inside an inescapable pressure-cooker located somewhere in space. And as was well known from all earthly experience, governments and their various subsidiary elements would be subject to corruption, rebellion, replacement, and destruction. Still, in the unlikely event that the starship made it all the way through interstellar space without hitting anything, without the crew members suffering mass sickness, hallucinations, or epidemic death, civil war, or descent into religious fanaticism or ordinary secular madness, what an embarrassment it would be for the voyagers to discover, upon reaching their coveted new home in space, Earth 2. One might suppose that this possibility would have been entertained and guarded against well before launch, and that the travelers would have verified that their prospective extrasolar earth was uninhabited, or at least that any natives in the area were friendly, warm, and charming, with a wide variety of interesting restaurants. But any number of difficulties would suffice to throw cold water upon that rosy picture. For one thing, since the extrasolar planet was an unknown number of light-years distant, there would be a substantial delay between the possible sending of an unmanned exploratory probe and the arrival back at home of its report, during which time conditions on the target planet could have changed to the point that it could have been colonized by aliens who had already exhausted its resources, turned it into a trash dump or a penal colony, moved it out of its orbit, or destroyed it altogether. Other scenarios were, of course, possible. An exploratory probe could in fact fail to discover hostile natives because they were intentionally hiding themselves from detection or even posing as friendly in order to lure starry-eyed intruders to their doom. Finally, supposing that none of these catastrophes ever happened and that our group of interstellar voyagers, or more likely their remote descendants, reached their destination safely and intact; what would they then do with the pristine and virgin extrasolar planet they colonized? But there was another, closer analogue to the probable legacy of human action on a another celestial body, to wit, our treatment of our own celestial companion, the moon. By the end of , human beings had deposited approximately , pounds of man-made objects, debris, and space junk on the moon. Most of the total was spacecraft wreckage, the bits and pieces of more than 70 rockets that had landed upon or crashed into the moon, starting with the pound Russian Luna 2 vehicle in In addition, there was the collection of objects left behind by the Apollo astronauts, who took more than pictures and left a lot more than footprints. Indeed, more than items were abandoned or intentionally placed on the Sea of Tranquility by Neil Armstrong and Buzz Aldrin alone, including shovels, rakes, an American flag, geological tools, lunar experiment packages, reflectors, and the Lunar Plaque that read: Here men from the planet Earth first set foot upon the moon July , A. We came in peace for all mankind. But did we leave the place as good as, or even better than, we found it? Was the moon actually improved by our presence? This, then, was the situation. There appeared to be no good reason for going to the stars to begin with, and no good way to get there, particularly in any sort of reasonable, human time frame. A starship would confront ample physical dangers from without, while its population would face substantial hazards of their own arising from conditions inside the ship itself. The interstellar travelers could face further unpleasant surprises upon arrival at their destination. What, then, was the point of it all? In the annals of pathological technologies, there was no other idea that depended for its plausibility on such an extreme degree of juvenile aspiration, magical thinking, systematic denial, and sheer silliness than the imaginary technologies of interstellar flight. It did not follow from this that manned spaceflight per se was inherently pathological, nor that any or all of the exploits in its past history fell into that category. The Apollo program, for example, did not meet the criteria of pathology, for two main reasons. Although it was wildly expensive, the cost was not out of proportion to its benefits, which included, among other things, clear proof that human travel to other celestial bodies was in fact possible. If humans were to migrate from the home planet, to Mars or elsewhere, then the moon flight was the first and most important milestone in that direction. Second, the risks of manned spaceflight were too obvious, substantial, and well known for them to be ignored, minimized, or papered over. Indeed, in the public addresses in which he made a case for going to the moon, President John F. Kennedy not only portrayed the moon flight as a stepping-stone to the rest of space but also acknowledged its difficulty. No single project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish. Astronauts or others involved in the enterprise could die horrible deaths which some of them did , the entire project could fail, rockets could get lost in space. Pictures of spacecraft exploding on launch pads were pervasive in the mass media, and the threats they posed to astronauts were impossible, even for politicians, to cover up or deny. The situation has not changed significantly during these early days of private spaceflight, a set of ventures that are neither large in scale nor all that expensive: Nor are the risks of private trips into space hidden from the public, ignored, or downplayed. Indeed, it would be impossible to do so: Technologies may, of course, be criticized on other grounds than being pathological: Both have been big, expensive programs, and the risks of shuttle flights were minimized until the Challenger and Columbia disasters made that procedure impossible. There is also the problem that the scientific returns of both projects are disproportionately small in relation to their expense, and the likelihood of a big payoff is remote. The two projects seem to be mired in a loop of mutual justification: The principal scientific justification for the space station was to study the effects of long-term exposure to zero-gravity conditions on the human body. Traveling to the stars, by contrast, suffers from no such ambiguities or uncertainty. Indeed, it is a special case of manned spaceflight, more daunting than near-Earth spaceflight by many orders of magnitude. Star travel in fact occupies a special niche in the long career of human aspiration and desire. Arguably, the building and launching of a manned interstellar starship would be one of the most wasteful, expensive, dangerous, and foolish projects in all of human historyâ€”a pathological technology for the ages.

Chapter 7 : Interstellar travel | Hyperspace Wiki | FANDOM powered by Wikia

Is interstellar travel doomed to remain in the realm of science fiction? Sticking to near future space propulsion only, how close can we get to the speed of light? This video looks at the current.

At the highest possible rate at which CERN facilities would be capable of generating antimatter, it would take about one hundred billion years to generate one gram of antihydrogen. Proposals have been made to build facilities that would be capable of generating and capturing antimatter far more economically than CERN facilities, but would be extremely expensive to develop and still only generate minute quantities of antimatter. Naturally-occurring antimatter could exist in the Van Allen belts of Earth and Jupiter, and if this could be collected with magnetic scoops, it may prove more economically viable than artificially generating antimatter. Antimatter Ablated Light Sail Given how expensive it is to create antimatter, we have to work with vanishingly small amounts. One possibility, analyzed by physicist Steve Howe Hbar Technologies, LLC is to store anti-hydrogen aboard the spacecraft and let it be released so that it interacts with a small five-meter sail impregnated with U The antimatter reacts with the uranium to produce neutrons and various secondary emissions, fission fragments that leave the sail at enormous speeds. The push is essentially a nuclear-stimulated ablation, one that can produce specific power on the order of kilowatts per kilogram. Propulsion Sail Antimatter ablated Image via E Lanana Antimatter-catalyzed Fusion No nuclear fusion reactor has yet been built that is capable of generating more energy than what is needed to operate the reactor. One proposed solution to this is to use antimatter-catalyzed fusion. In this concept, a small number of antiprotons are injected into a fusion fuel, which then undergoes annihilation. The large amount of energy released from this reaction generates plasma which then initiates fusion reactions within the rest of the fuel. Theoretically, this could enable fusion more economically than any of the other fusion ignition concepts currently being explored. The major disadvantage to this is that producing antimatter is an extremely expensive and inefficient process. Bussard Interstellar Ramjet The biggest problem with propulsion at starflight levels is having to carry the propellant. All that fuel adds up, and the faster you want to go, the more you need, hence the more mass you need to push. Envisioned by Robert Bussard in , a Bussard ramjet gets around the problem by collecting interstellar hydrogen in a vast electromagnetic scoop, using hydrogen fusion to drive the vehicle. Unlike any other interstellar propulsion method, a Bussard ramjet would actually become more efficient the faster it went, allowing travel at a high percentage of the speed of light. Subsequent studies, though, have shown that a ramscoop like this also causes serious drag issues, problems that will have to be addressed if the ramjet is ever to become a viable candidate for our starships. The kind of proton fusion Bussard imagined occurs only in the heart of stars. Other kinds of fusion may be more practical for future ramjet designs. However, there is a fixed upper limit for the amount of energy that can be stored in the chemical bonds of propellants. This imposes an upper limit on the specific impulse that can be offered. This is the reason why chemical rockets offer small payload mass fractions while requiring large propellant mass fractions. This severely limits the capability of using chemical propulsion for manned interplanetary missions, and makes it completely impractical for interstellar missions. Electric Propulsion Electric propulsion systems are not limited by the chemical energy stores in propellants due to their usage of an external power source. This enables them to deliver arbitrarily large amounts of energy to propellant, and as such offer specific impulses far beyond the capabilities of chemical systems. However, the power that they can deliver to propellant is limited by the mass of the onboard power source. An electric propulsion system capable of generating thrust levels comparable to that offered by chemical propulsion would necessitate a prohibitively massive power system. This is the reason why current electric propulsion systems have very low thrust levels, which are orders of magnitude lower than thrust levels offered by chemical rockets. Such systems can only be used on satellites and small deep-space probes. Electric Solar Wind Sail Not all space sail concepts use solar photons as their driving force. In Finland, Pekka Janhunen has championed the idea of an electric sail, one that would use long, thin conductive wires that are kept at a positive potential through the use of an onboard electron gun. The electric sail takes advantage of the solar wind, the stream of charged particles that streams constantly from the Sun at speeds ranging from to kilometers per second. Gravitational Dipole Robert Forward Description pending Magnetic Solar Wind Sail Winglee Magnetic sails ride the solar wind â€" the high speed stream of ions and electrons shed constantly by the sun â€" via creating an artificial magnetosphere. Made possible by the invention of high-temperature superconductors, magnetic-sails allow space vehicles to maneuver in interplanetary space without expelling propellant. Magnetic sails can also be deployed as interstellar brakes, allowing rockets and laser sails to brake from their high cruising speeds to relatively low speeds, saving fuel. A large unknown is just how dense the interstellar medium is between the Sun and nearby stars, which makes use of magnetic sails for braking potentially risky for early interstellar missions. Negative Mass Propulsion In the s physicist Hermann Bondi suggested the existence of negative mass â€" mass with an opposite gravitational polarity to regular mass. Normal mass and negative mass repel each other and this feature lead Robert Forward to propose using their mutual repulsion to propel starships â€" without expending propellant or energy. Negative mass has yet to be observed and there are strong theoretical reasons to suggest it is impossible to create in stable form, but it remains an intriguing possibility. Nuclear Electric Ion Propulsion A nuclear electric rocket converts the thermal energy generated by an onboard nuclear reactor into electrical energy, which is then used to drive an electric propulsion system. This could generate thrust levels while also offer a specific impulse greater than that offered by nuclear thermal rockets. A drawback is that the efficiency of nuclear electric systems is limited to about thirty percent due to the Carnot cycle. The rest of the energy is produced in the form of waste heat that must be rejected with radiators. This contributes greatly to the mass of the spacecraft. Propulsion Electric Ion Nuclear Powered Nuclear Fusion Propulsion A nuclear fusion propulsion system can overcome the limitations of nuclear electric rockets because the plasma exhaust can be converted directly into thrust, eliminating the need for an inefficient conversion between thermal and electric power. Because of this, fusion systems offer much higher specific power ratios than nuclear electric systems, as well as high specific impulses. A major obstacle that has held back the development of fusion propulsion is that no reactor has been built that is capable of generating more energy than what is needed to operate the reactor. A proposed solution to this is antimatter-catalyzed fusion, described above. Nuclear Pulse Propulsion A spacecraft that uses nuclear pulse propulsion carries a large number of nuclear explosives, which are then dropped behind the vehicle and detonated. Such a system would offer very high thrust and specific impulse. Unfortunately, like nuclear thermal propulsion, this would also generate large amount of hazardous radioactive byproducts. The political obstacles to launching a spacecraft carrying a substantial nuclear arsenal may be next to impossible to overcome. Nuclear Thermal Propulsion Nuclear thermal propulsion systems increase the enthalpy of a propellant fluid by passing it through a reactor and then expelling it through a nozzle. Like electric propulsion systems, nuclear reactors offer energy densities orders of magnitude beyond what can be stored in chemical propellants. Unfortunately, many nuclear thermal rocket designs generate highly radioactive exhaust products. Political hurdles present an additional obstacle to any system that utilizes nuclear propulsion. Solar Sail A solar sail takes advantage of the fact that while photons have no mass, they do impart momentum. Hence a large enough, and thin enough, structure can get a push from sunlight itself. But a close pass by the Sun could theoretically accelerate a sail to significant speeds for missions to the outer Solar System, or even a flight to Alpha Centauri that would last, in the best case, just over a thousand years. Beamed Sail Concepts The momentum of solar photons can be imparted to a solar sail, but it falls off dramatically with distance. By the time we reach roughly the orbit of Jupiter, solar sails have given us about as much of a propulsive kick as they can. However, Robert Forward realized 50 years ago that a powerful laser directed at a large sail could keep it accelerating well past the outer edge of the Solar System. Similar concepts have evolved to use microwave and even particle beams to drive a sail. The necessary power technologies and lensing structures to manage this kind of mission are well in our future, but these are engineering challenges that do not involve moving beyond known physics. Warp drive and wormholes are two examples which rely on known solutions to the equations of General Relativity, but other concepts have been proposed that are much more speculative. A short list â€" Diametric, Bias, Disjunction and Pitch Drives, all of which involve creating a gradient in space-time that is mobile. A Disjunction Drive would separate fields from the particles that react to them, creating a permanent imbalance that would propel a vehicle. Finally, a Pitch Drive would work like a

Diametric Drive, but without the source and sink being required to create the gradient. Presently there is no evidence for any such effects. Alternatively Space-Drives might use space itself as propellant. Marc Millis proposed three different sails that would operate by manipulating the weak energy flows that fill space-time, such as the Cosmic Microwave Background. Such sails would allow energy to flow one way, but not the other, creating an effective pressure difference for propulsion. Such a Quantum Vacuum Plasma Thruster QVPT would use crossed magnetic and electric fields to generate thrust from ejecting the virtual particles in a particular direction.

Chapter 8 : Is Warp Drive Real? | NASA

Project Daedalus is a concept design for an interstellar probe, developed in the s by a group of technical specialists for the British Interplanetary Society.

Planck energy propulsion Propulsion systems may be ranked by two quantities: Specific impulse equals thrust multiplied by the time over which the thrust acts. At present, almost all our rockets are based on chemical reactions. We see that chemical rockets have the smallest specific impulse, since they only operate for a few minutes. Their thrust may be measured in millions of pounds, but they operate for such a small duration that their specific impulse is quite small. NASA is experimenting today with ion engines, which have a much larger specific impulse, since they can operate for months, but have an extremely low thrust. For example, an ion engine which ejects cesium ions may have the thrust of a few ounces, but in deep space they may reach great velocities over a period of time since they can operate continuously. They make up in time what they lose in thrust. Eventually, long-haul missions between planets may be conducted by ion engines. For a Type I civilization, one can envision newer types of technologies emerging. Ram-jet fusion engines have an even larger specific impulse, operating for years by consuming the free hydrogen found in deep space. However, it may take decades before fusion power is harnessed commercially on earth, and the proton-proton fusion process of a ram-jet fusion engine may take even more time to develop, perhaps a century or more. Laser or photonic engines, because they might be propelled by laser beams inflating a gigantic sail, may have even larger specific impulses. One can envision huge laser batteries placed on the moon which generate large laser beams which then push a laser sail in outer space. This technology, which depends on operating large bases on the moon, is probably many centuries away. For a Type II civilization, a new form of propulsion is possible: However, anti-matter is an exotic form of matter which is extremely expensive to produce. The atom smasher at CERN, outside Geneva, is barely able to make tiny samples of anti-hydrogen gas anti-electrons circling around anti-protons. It may take many centuries to millennia to bring down the cost so that it can be used for space flight. Given the astronomical number of possible planets in the galaxy, a Type II civilization may try a more realistic approach than conventional rockets and use nano technology to build tiny, self-replicating robot probes which can proliferate through the galaxy in much the same way that a microscopic virus can self-replicate and colonize a human body within a week. Such a civilization might send tiny robot von Neumann probes to distant moons, where they will create large factories to reproduce millions of copies of themselves. Such a von Neumann probe need only be the size of bread-box, using sophisticated nano technology to make atomic-sized circuitry and computers. Then these copies take off to land on other distant moons and start the process all over again. Such probes may then wait on distant moons, waiting for a primitive Type 0 civilization to mature into a Type I civilization, which would then be interesting to them. There is the small but distinct possibility that one such probe landed on our own moon billions of years ago by a passing space-faring civilization. This, in fact, is the basis of the movie , perhaps the most realistic portrayal of contact with extra-terrrestrial intelligence. The problem, as one can see, is that none of these engines can exceed the speed of light. Hence, Type 0,I, and II civilizations probably can send probes or colonies only to within a few hundred light years of their home planet. Even with von Neumann probes, the best that a Type II civilization can achieve is to create a large sphere of billions of self-replicating probes expanding just below the speed of light. To break the light barrier, one must utilize General Relativity and the quantum theory. Special Relativity states that no usable information can travel locally faster than light. One may go faster than light, therefore, if one uses the possibility of globally warping space and time, i. In other words, in such a rocket, a passenger who is watching the motion of passing stars would say he is going slower than light. But once the rocket arrives at its destination and clocks are compared, it appears as if the rocket went faster than light because it warped space and time globally, either by taking a shortcut, or by stretching and contracting space. There are at least two ways in which General Relativity may yield faster than light travel. The first is via wormholes, or multiply connected Riemann surfaces, which may give us a shortcut across space and time. One possible geometry for such a wormhole is to assemble stellar amounts of energy in a spinning ring creating a Kerr black hole. Centrifugal force prevents the spinning ring from collapsing. Anyone passing through the ring would not be ripped apart, but would wind up on an entirely different part of the universe. This resembles the Looking Glass of Alice, with the rim of the Looking Glass being the black hole, and the mirror being the wormhole. The problems with wormholes are many: Positive energy wormholes have an event horizon s and hence only give us a one way trip. One would need two black holes one for the original trip, and one for the return trip to make interstellar travel practical. Most likely only a Type III civilization would be able harness this power. They may close up as soon as you try to enter them. Or radiation effects may soar as you entered them, killing you. Negative energy does exist in the form of the Casimir effect but huge quantities of negative energy will be beyond our technology, perhaps for millennia. The advantage of negative energy wormholes is that they do not have event horizons and hence are more easily transversable. Unfortunately, negative matter has never been seen in nature it would fall up, rather than down. Any negative matter on the earth would have fallen up billions of years ago, making the earth devoid of any negative matter. The second possibility is to use large amounts of energy to continuously stretch space and time i. Since only empty space is contracting or expanding, one may exceed the speed of light in this fashion. Empty space can warp space faster than light. For example, the Big Bang expanded much faster than the speed of light. The problem with this approach, again, is that vast amounts of energy are required, making it feasible for only a Type III civilization. Energy scales for all these proposals are on the order of the Planck energy 10 to the 19 billion electron volts, which is a quadrillion times larger than our most powerful atom smasher. General Relativity allows for closed time-like curves and wormholes often called Einstein-Rosen bridges , but it unfortunately breaks down at the large energies found at the center of black holes or the instant of Creation. It is the only theory in which quantum forces may be combined with gravity to yield finite results. No other theory can make this claim. With only mild assumptions, one may show that the theory allows for quarks arranged in much like the configuration found in the current Standard Model of sub-atomic physics. Because the theory is defined in 10 or 11 dimensional hyperspace, it introduces a new cosmological picture: Unfortunately, although black hole solutions have been found in string theory, the theory is not yet developed to answer basic questions about wormholes and their stability. Within the next few years or perhaps within a decade, many physicists believe that string theory will mature to the point where it can answer these fundamental questions about space and time. The problem is well-defined. Unfortunately, even though the leading scientists on the planet are working on the theory, no one on earth is smart enough to solve the superstring equations. Conclusion Most scientists doubt interstellar travel because the light barrier is so difficult to break. However, to go faster than light, one must go beyond Special Relativity to General Relativity and the quantum theory. Therefore, one cannot rule out interstellar travel if an advanced civilization can attain enough energy to destabilize space and time. Perhaps only a Type III civilization can harness the Planck energy, the energy at which space and time become unstable. Various proposals have been given to exceed the light barrier including wormholes and stretched or warped space but all of them require energies found only in Type III galactic civilizations. On a mathematical level, ultimately, we must wait for a fully quantum mechanical theory of gravity such as superstring theory to answer these fundamental questions, such as whether wormholes can be created and whether they are stable enough to allow for interstellar travel.

Chapter 9 : Interstellar () - IMDb

Directed by Christopher Nolan. With Matthew McConaughey, Anne Hathaway, Jessica Chastain, Mackenzie Foy. A team of explorers travel through a wormhole in space in an attempt to ensure humanity's survival.

Unfortunately, we still have more than a few technical limitations to overcome â€" like the laws of physics as we understand them â€" before we can start colonising new worlds beyond our Solar System and galaxy. That said, several privately funded or volunteer initiatives such as the Tau Zero Foundation , Project Icarus and Breakthrough Starshot have emerged in recent years, each hoping to bring us a little bit closer to reaching across the cosmos. The discovery in August of an Earth-sized planet orbiting our nearest star has also raised fresh hopes about visiting an alien world. Is travelling to other galaxies possible? And if so, what kinds of spacecraft might we need to achieve it? Read on to get up to warp speed: The planet, named Proxima b, is at least 1. What has astronomers and exoplanet hunters especially hot under the collar is that this planet is in the right temperature range for liquid water, which is a useful proxy for habitability. View image of Proxima Centauri, our closest stellar neighbour Credit: It is also tidally-locked, which means the planet always presents the same face to its star; something that would completely alter our notions of night and day. But many smart minds â€" and deep pockets â€" are being turned to the challenge of finding a faster way to cross vast distances of space. View image of Credit: The Milners are counting on miniaturisation technologies to enable this tiny craft to carry a camera, thrusters, a power supply, communication and navigation equipment so it can report on what it sees as it flashes past Proxima b. Hopefully the news will be good, because that will lay the foundation for the next and more difficult stage of interstellar travel: Find out more about the inspiring people coming to the meeting , including: Star Trek made it all look so easy, but everything we currently know about the laws of physics tells us that faster-than-light travel â€" or even travel at the speed of light â€" is not possible. Not that science is throwing in the towel. Until we work out how to warp time and space, interstellar travel is going to be a very slow boat to the future. It might even be better to think of that travel period as the end itself, rather than a means to an end. View image of Light-speed travel is beyond reach, and likely impossible Credit: The inside of a spacecraft or space-station today is sterile, and industrial, she argues. Armstrong believes we instead need to think ecologically about our vessels â€" about the vegetation that is grown, and even the kinds of soils we take with us. In the future, she envisages giant biomes, full of organic life, not the cold, metal boxes of today. Cryosleep, hibernation or some form of stasis are favoured solutions to the prickly problem of how to keep people alive on a voyage that might take longer than a human lifespan a subject explored in the upcoming movie Passengers. If you liked this story, sign up for the weekly bbc.