

How Science Fiction Becomes Science— or Doesn't

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For many important things... success actually requires avoiding many separate causes of failure.

Jared

Diamond



Jared Diamond

Source: Wikipedia, Aude

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Routes to Failure

It's just impossible

It would be too costly

It would be too dangerous

It would violate moral or societal norms

Case Study 1: Warp Drive



It's probably impossible
It breaks too many known
laws of Physics

Source: Wikipedia

https://en.wikipedia.org/wiki/Star_Trek#/media/File:Leonard_Nimoy_William_Shatner_Star_Trek_1968.JPG

Relativity

Nothing can travel through space faster than

Workarounds

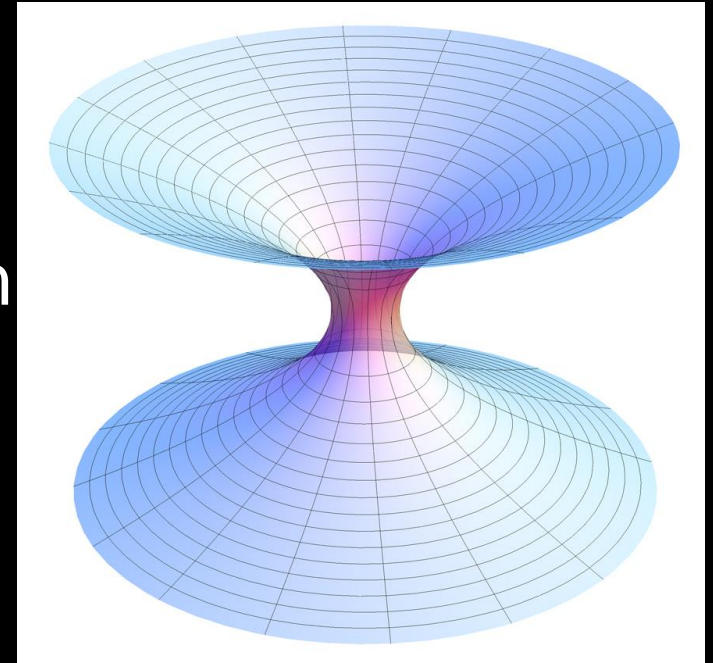
Wormholes

Bubbles of spacetime (“warp drive”)

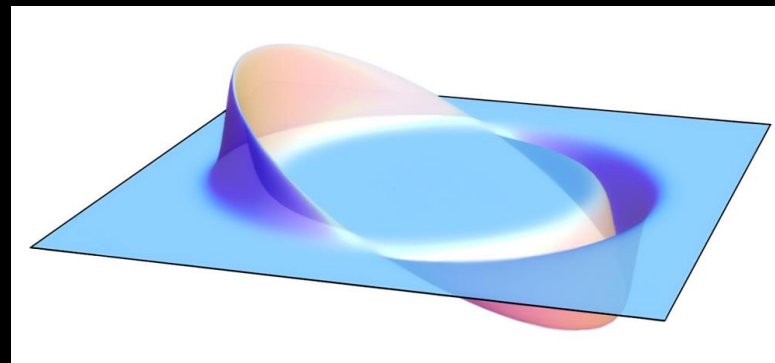
Problems

Exotic Matter

Connection to the Universe

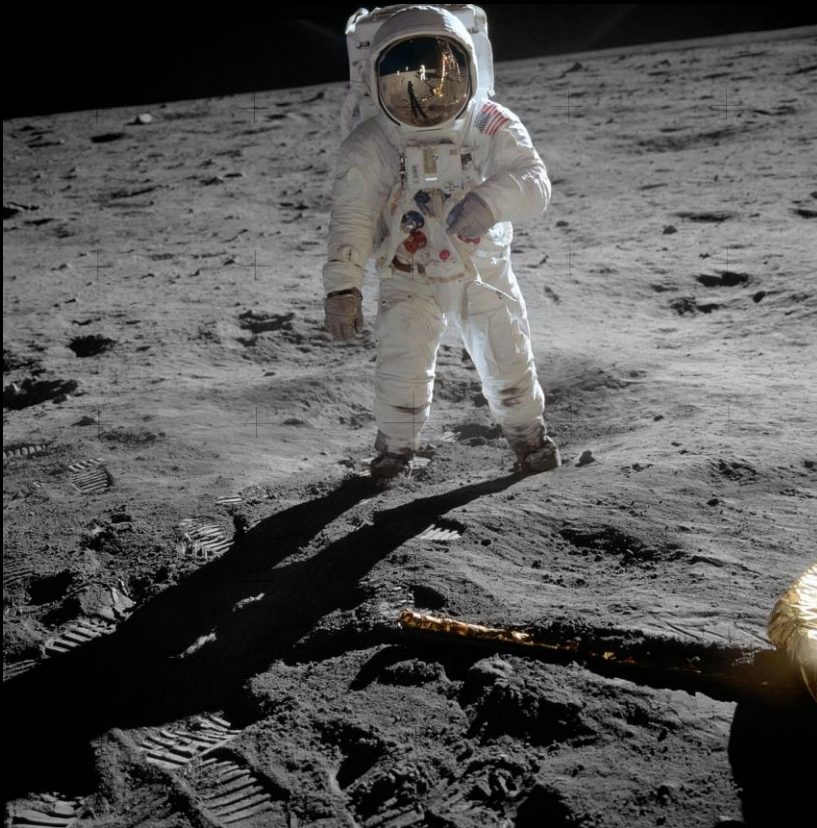


Source: Wikipedia, AllenMcC.
<https://commons.wikimedia.org/wiki/File:LorentzianWormhole.jpg>
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Source: Wikipedia, AllenMcC.
https://en.wikipedia.org/wiki/Alcubierre_drive#/media/File:Alcubierre.png.jpg
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Case Study 2: Space Travel – Success or Failure?



Buzz Aldrin on the Moon
Image take by Neil Armstrong

Public Domain Image: https://en.wikipedia.org/wiki/Apollo_11#/media/File:Aldrin_Apollo_11_original.jpg

Science Fiction Tropes

Almost entirely concerned with crewed missions
And colonies on the moon and planets

Why? Drama.

Also, no one foresaw Moore's law...

Uncrewed Space Missions

Huge scientific success

Huge commercial success



Pluto, taken by New Horizons Spacecraft

Public Domain Image

https://en.wikipedia.org/wiki/Pluto#/media/File:Pluto_in_True_Color_-_High-Res.jpg

Crewed Space Mission

Possible, but:
Relatively costly
Dangerous



Space Shuttle Discovery
Source: NASA
Public Domain Image

https://en.wikipedia.org/wiki/Space_Shuttle#/media/File:STS120LaunchHiRes-edit1.jpg

Nuclear Powered Spacecraft

Programs in the '50s and '60s

Makes crewed spaceflight cheaper

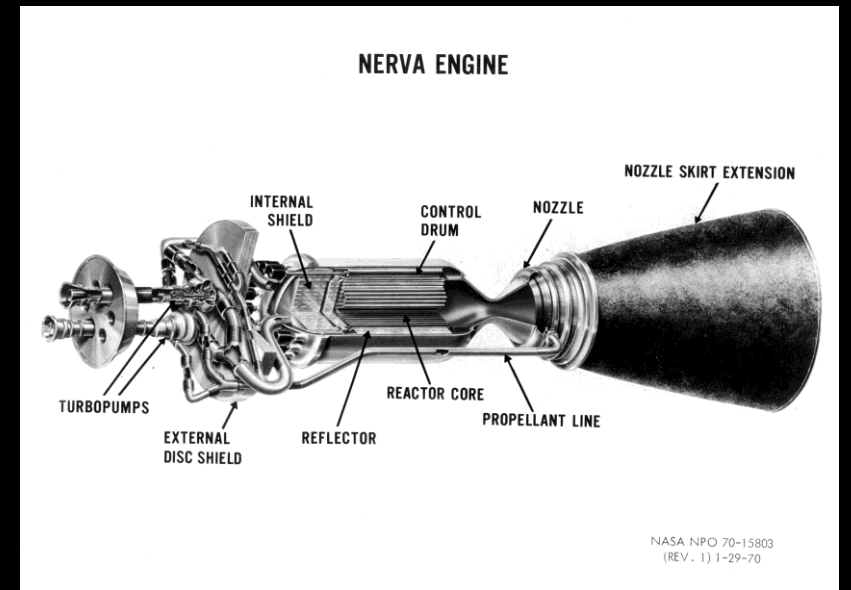
Predicted by science fiction

Possible

Relatively inexpensive

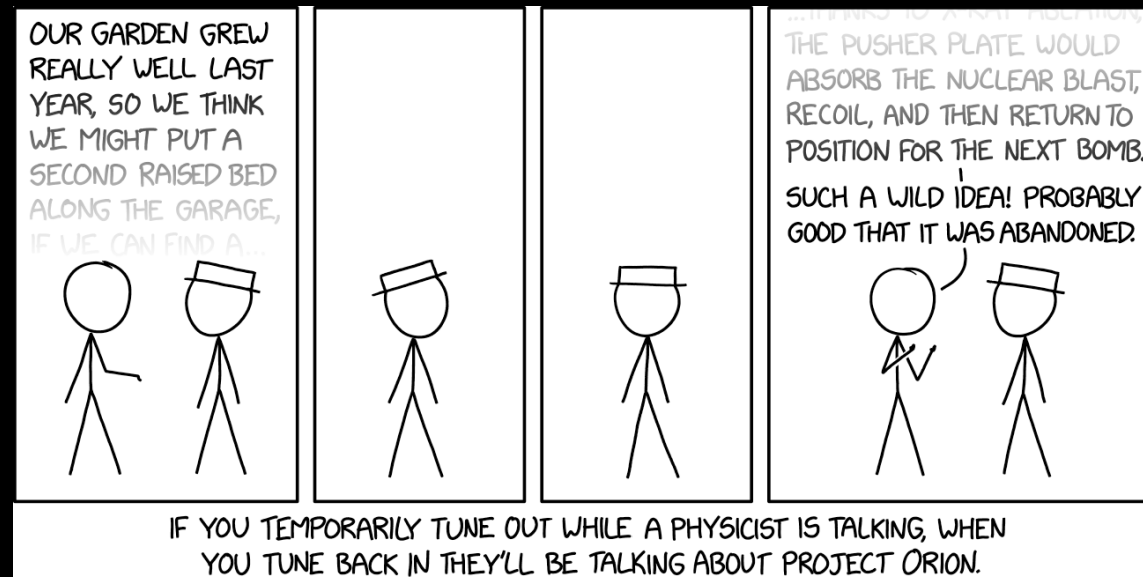
Probably dangerous

Societally prohibited



Source: Wikipedia, NASA
Public domain image

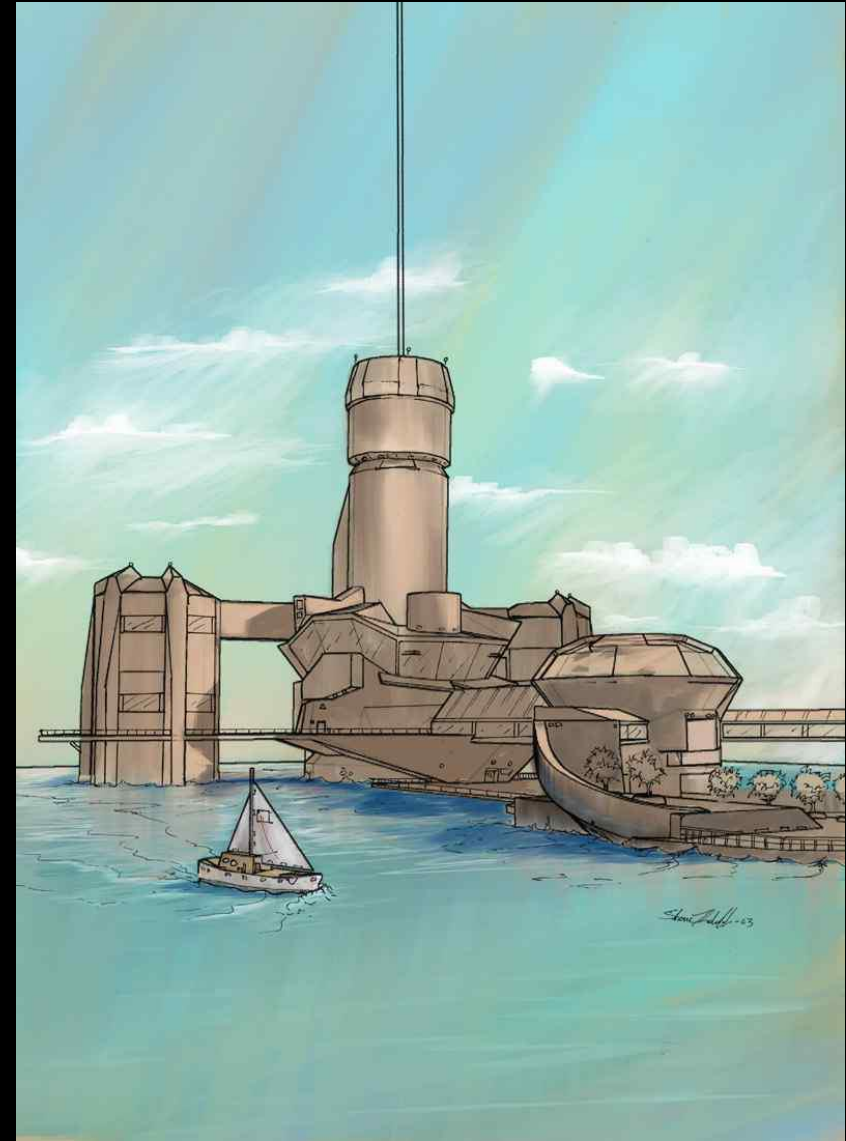
https://en.wikipedia.org/wiki/NERVA#/media/File:Drawing_of_the_NERVA_nuclear_rocket_engine_GRC-2003-C-00851.jpg



Source: xkcd 2423,
Randall Munroe

The Space Elevator

- Original idea due to Tsiolkovsky
- Popularized in the 1980's by Arthur Clarke and others
- Three issues:
 - Scientific: materials don't really exist
 - Engineering: Suspension bridge 150,000 km long
 - Economic: building, infrastructure, and competition with traditional space travel



Source: Wikipedia (Liftport),
<https://commons.wikimedia.org/wiki/File:SpaceElevatorAnchor.jpg>

Plenty of Room at the Bottom

“If cars had gotten as good as computers

There are good physics reasons why:
Computers got faster, smaller, cheaper
Cars didn't



Richard P. Feynman
Source: Wikipedia, Tamika Thiel
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Case Study 3: Flying vs. Self-Driving Cars

Flying Cars do exist

But is there a future for them?



Terrafugia flying car
Wikipedia, MarkWarren
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https://commons.wikimedia.org/wiki/File:Terrafugia_--_2012_NYIAS_cropped.jpg



Aerocar
Source: Wikipedia, Chris857
Reproduced under a Creative Commons 3.0 License
https://en.wikipedia.org/wiki/Flying_car#/media/File:Aerocar_at_EAA.jpg

Computers and Diamond's Principle

Improvements:

Not forbidden by fundamental physics

Not expensive

Not dangerous

Not morally or societally prohibited

They got better over time!

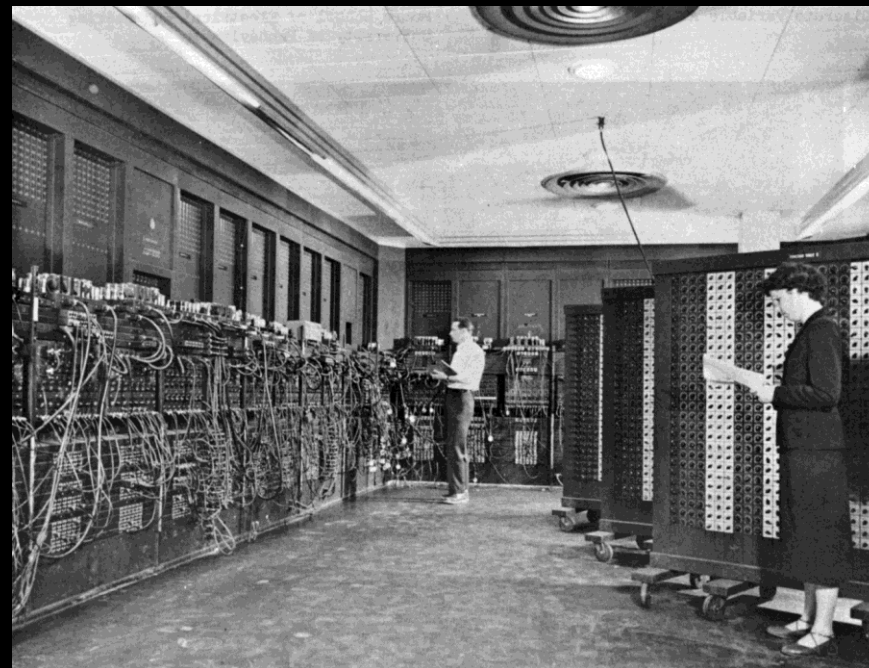


iPhone Innards

Source: Wikipedia, Tyler Love

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https://upload.wikimedia.org/wikipedia/commons/7/72/1Phone_Internals.jpg



Eniac

Public domain photograph

<https://en.wikipedia.org/wiki/ENIAC#/media/File:Eniac.jpg>

Flying Cars and Diamond's Principle

Not forbidden by basic science, but:

Expensive – fundamental laws ensure this

Also, infrastructure doesn't exist

Dangerous

I don't see much of a future

Self-Driving Cars

Computers make these possible

Also, new sensors

So:

Not forbidden by physical laws

Not expensive

Not immoral or forbidden by society

Dangerous? Open question



Autonomous Waymo-Chrysler Pacific Hybrid

Source: Wikipedia, Dllu

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https://commons.wikimedia.org/wiki/File:Waymo_Chrysler_Pacifica_in_Los_Altos,_2017.jpg

Case Study 4: Teleportation

- Let's finish with two ideas that are still science fiction
- Teleportation first
- Almost certainly impossible
- BUT: let's relax our skepticism a bit
- If one could make a teleporter, should one?
- I am going to claim, NO
 - It fails for economic and moral reasons

The Transporter/Replicator

- “Tea, Earl Grey, hot”
- Assume: $m = 250 \text{ g}$
- 99.9% efficient
- Let's use $E = mc^2$
- Waste heat can boil 1.5 billion cups of tea
 - On the other hand, electric kettles are incredibly efficient
- Why are we doing it this way, again?



Problems with the Process

- They scramble your atoms
 - Turn them into “pure energy”
 - How? Antimatter?
- “Beam” you somewhere
- Reconstruct you
- Problem:

This is murder!

Case Study 5: Alien Life

Another route to failure: Improbability of detection

Two means of detection

- Radio telescopes (SETI)

- Visible or IR Telescopes (Exoplanets)

Life in the Universe

Is possible!

May even be common!

But stellar distances are huge

Planets are small and dim

SETI

Detection of radio signals from alien intelligences

Possible

Cheap

Safe

Not immoral or taboo

BUT: relies on many unknown factors

Main one: lifetime of advanced civilizations

$$N = R_* \times f_p \times n_c \times f_l \times f_c \times L$$

Exoplanet Searches

More than 4,000 exoplanets have been found

Looking for evidence of microbial life

Not as exciting as finding Spock, but:

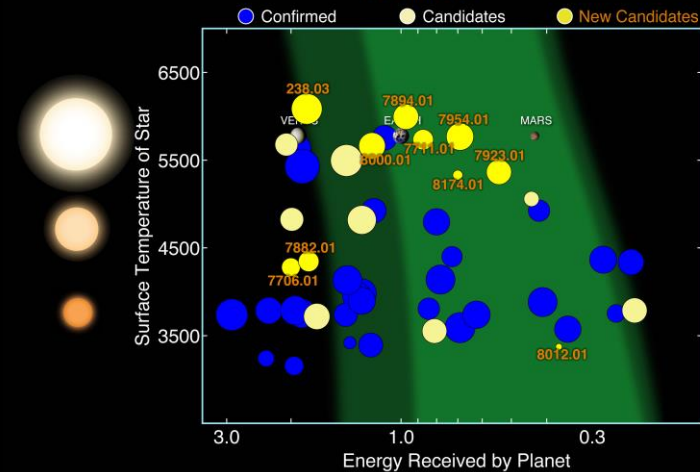
Scientists know where to look

Know basic science of life on Earth

Much higher chance of success

Kepler Habitable Zone Planets

As of June 2017



Kepler habitable zone planets

Source: Wikipedia, Wendy Stenzel

Public Domain Image

<https://en.wikipedia.org/wiki/Exoplanet#/media/File:KeplerHabitableZonePlanets-20170616.png>

Wrapping Up

Just because something is possible doesn't mean it will happen

Impossibility is the *least* interesting reason for failure

Science fiction stories are *stories*

They can highlight science

Don't expect them to be predictions

Questions?