I'll do my best not to ruin too much...
The story of the Time Lord known as "The Doctor" and his companions.

One of the first series to be given two attempts for their first episode

Originally ran from 1963-1989, with a TV movie in 1996; then revived in 2005.

The Iconic "Blue Box"
When discussing science in fiction you have two options:

- Discuss how science could explain it
- Discuss how it is explained in pseudoscience

I will be attempting the former as best I can.
BIGGER ON THE INSIDE

Mary Poppins carpetbag 1934
Felix the Cat’s magic bag 1959
The Doctor’s Tardis 1963
Oscar the Grouch’s trash can 1969
Ghostbusters ghost trap 1984
The Lament Configuration 1987
Bag of Holding 1989
Pokeball 1996
Weasley family tent 2000
...Yeah, but can something really be bigger on the inside?
Yep!
With $G = c = 1$

$$ds^2 = (1 - \frac{2M}{r})dt^2 - (1 - \frac{2M}{r})^{-1}dr^2 - r^2 d\theta^2 - r^2 \sin^2 \theta d\phi^2$$

$$dA = r^2 \sin \theta d\theta d\phi$$

$$dV = (1 - \frac{2M}{r}) - \frac{1}{2} dr(rd\theta)(r \sin \theta d\phi) = (1 - \frac{2M}{r}) - \frac{1}{2} drdA$$

$$V \approx \frac{4\pi}{3} (r_2^3 - r_1^3) + 2\pi M (r_2^2 - r_1^2), \quad 2M \ll r$$

As compared with $V = \frac{4\pi}{3} (r_2^3 - r_1^3)$. 
Extra Dimensions?

- **Kaluza-Klein**
  - Attempted unification of gravity and electromagnetism, first published in 1921

- **ADD Model**
  - Proposed by Arkani-Hamed et al. in 1998; explains weakness of gravity through extra dimensions which are "large" compared to the Planck scale.

- **Superstrings**
  - Calabi-Yau manifolds

- **Limits on Extra Ds:** [http://pdg.lbl.gov/2012/listings/rpp2012-list-extra-dimensions.pdf](http://pdg.lbl.gov/2012/listings/rpp2012-list-extra-dimensions.pdf)
Wormholes; one of the crazier explanations...
Wormholes, Time Machines, and the Weak Energy Condition

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(Received 21 June 1988)

It is argued that, if the laws of physics permit an advanced civilization to create and maintain a wormhole in space for interstellar travel, then that wormhole can be converted into a time machine with which causality might be violatable. Whether wormholes can be created and maintained entails deep, ill-understood issues about cosmic censorship, quantum gravity, and quantum field theory, including the question of whether field theory enforces an averaged version of the weak energy condition.

PACS numbers: 04.60.+n, 03.70.+k, 04.20.Cv

Normally theoretical physicists ask, “What are the laws of physics?” and/or, “What do those laws predict about the Universe?” In this Letter we ask, instead, “What constraints do the laws of physics place on the activities of an arbitrarily advanced civilization?” This is because the laws of physics define the possible actions of the Universe, but it is not clear whether they can put constraints on the actions of a would-be designer of the Universe. Thus there are two types of questions: (1) those concerning the nature of the Universe and (2) those concerning what the Universe can do. This Letter is concerned with the second type of question, which we call “Wormhole creation.—Wormhole creation, with such mild spacetime curvature that classical general relativity is everywhere valid, must be accompanied by closed timelike curves and/or a noncontinuous choice of the future.

\[ \text{Continued...} \]
Alcubierre Warp Drive: stretches spacetime in a wave causing the fabric of space ahead of a spacecraft to contract and the space behind it to expand.

The ship can ride the wave to accelerate to high speeds and time travel.

...is it legitimate?
Meet Alcubierre ->

- Mexican Theorist @ Universidad Nacional Autónoma de México
Quantum inequalities do not forbid spacetime shortcuts

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(Received 3 January 2003; published 20 May 2003)

A class of spacetimes (comprising the Alcubierre bubble, Krasnikov tube, and a certain type of wormhole) is considered that admits “superluminal travel” in a strictly defined sense. Such spacetimes (they are called “shortcuts” in this paper) were suspected to be impossible because calculations based on “quantum inequalities” suggest that their existence would involve Planck-scale energy densities and hence unphysically large values of the “total amount of negative energy” $E_{\text{tot}}^{-}$. I argue that the spacetimes of this type may not be unphysical at all. By explicit examples I prove that (1) the relevant quantum inequality does not (always) imply large energy densities, (2) large densities may not lead to large values of $E_{\text{tot}}^{-}$, and (3) large $E_{\text{tot}}^{-}$ being physically meaningless in some relevant situations does not necessarily exclude shortcuts.

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I. INTRODUCTION

Suppose the distance from the Earth to a star, found by

In other words we call $M$ a shortcut if it can be obtained from Minkowski space $\mathbb{L}^4$ by replacing a flat cylinder $C \subseteq \mathbb{L}^4$ with something else so that some spacelike separated (in $\mathbb{L}^4$)
The TARDIS Traversing the Time Vortex
~Time Travel~

- Earliest mentions date back to ~700s BCE in the Mahabharata
- 1895 brings H.G. Wells' infamous "The Time Machine"
- Forward travel in time has few controversies
- Backward travel on the other hand...
- First serious physics was performed by Gödel in the "Gödel metric" solution to Einstein's field equations
- Serious work performed by many of relativity's greatests
The Paradox Machine

...forget the potential mechanics.

● Grandfather Paradox - causality damaging interactions should be impossible

● Rebuttals:
  ○ Basic; just don't change too much
  ○ Advanced; Novikov self-consistency principle - nothing that could damage causality is possible, the calculations gave zero probability. See [http://www.iap.fr/eas/EAS18/time18/ontime.html](http://www.iap.fr/eas/EAS18/time18/ontime.html)
  ○ Too advanced; Multiple world interpretations

● Tourism?
  ○ Hawking's "Where are the tourists" argument
    ■ Sagan says "disguised"
Cloaking
Modern Day Cloaking Attempts

Three main techniques:

1. **Metamaterials**
   a. Materials that have nice refractive properties because of their structure. Makes use of Transformation Optics to render an object invisible to certain wavelengths.

2. **Active Camouflage**

3. **Plasma stealth**
   a. Use of various density ranges to absorb broadband waves and render object invisible...currently too expensive to be feasible. See Defense patent: [http://www.google.com/patents?vid=4989006](http://www.google.com/patents?vid=4989006)
THANK YOU!

Images stolen from Google Images almost exclusively.