

THE SCIENCE
OF DOCTOR WHO

BBC





I'll do my best not to
ruin too much...

Spoilers.

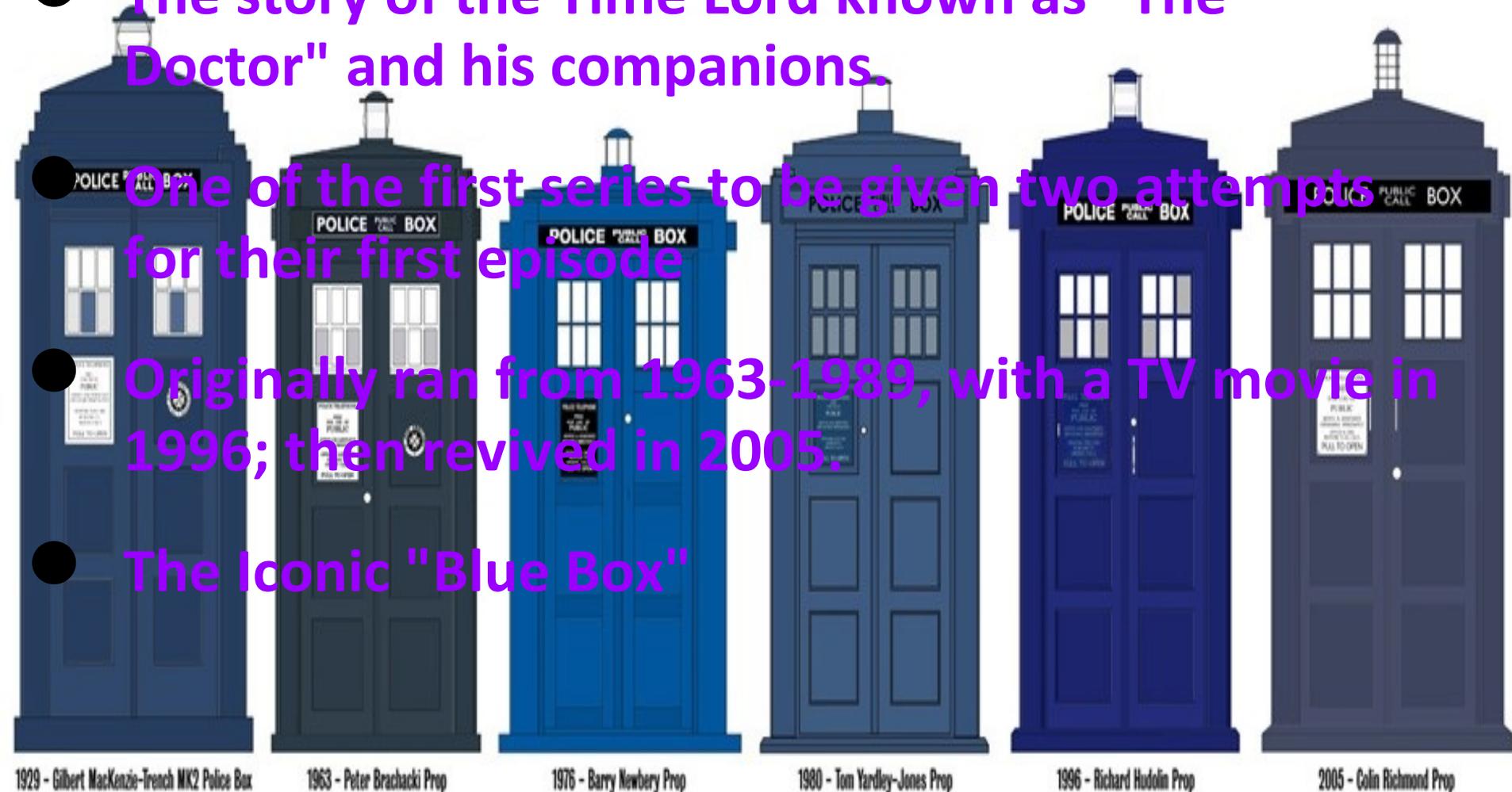
A Thousand Years of Phone Box Travel

- 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"



1929 - Gilbert MacKenzie-Trench MK2 Police Box

1963 - Peter Brachacki Prop

1976 - Barry Newbery Prop

1980 - Tom Yardley-Jones Prop

1996 - Richard Hudolin Prop

2005 - Colin Richmond Prop



ReGeneration!

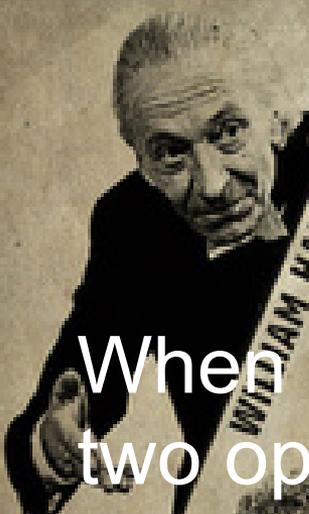
Choices

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.

DOCTOR WHO
SO MANY CHOICES



WILLIAM HARTNELL



PATRICK TROUGHTON



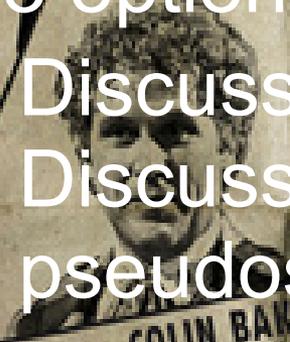
JON PERTWEE



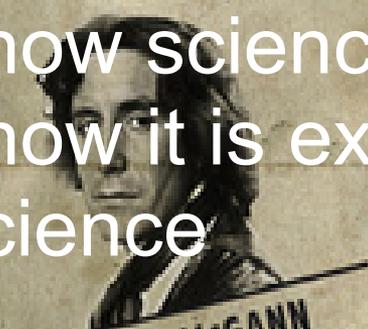
TOM BAKER



PETER DAVISON



COLIN BAKER



PAUL MCGANN



DAVID TENNANT



MATT SMITH



SYLVESTER MCGOY



CHRISTOPHER ECCLESTON

BIGGER ON THE INSIDE

www.hellowithcheese.com - by Dern & O Abnormal

timeline

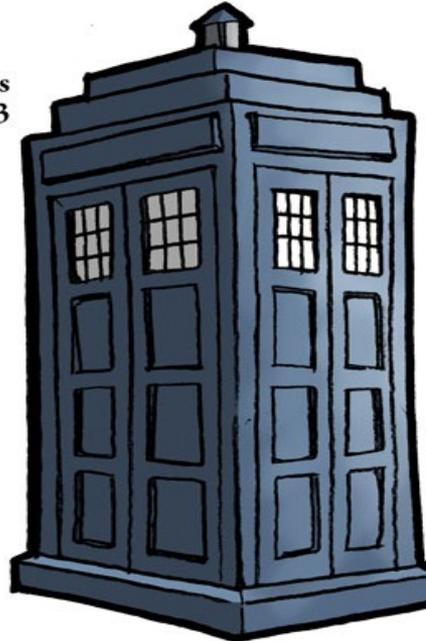


Mary Poppins carpetbag
1934



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

TECHNICAL READOUT CLASS: MARK I

BLOCK MATH TRANSFER EXTERIOR SHELL

(Rooms, Corridors, Hallways, levels, and Decks)

RECEPTOR ANTENNA

(The Prime Eye of Harmony on Gallifrey broadcasts Artron energy into the Space-Time Vortex. This energy travels through the Vortex's Time Contours and is picked up by the Receptor Antenna and collects artron energy using chronon transduction.)

"OBSOLETE" OBSERVATION TOWERS

(Most of the TARDIS Decks and Sections are topped by a large Observation platform to give an external view of the TARDIS interior Dimensions and allow for accurate repairs via its Architectural Configurations Program.)

FORCE FIELD GENERATORS

(Each Tardis section houses a Forcefield Generator to protect the integrity of the machine as it traverses time-space and the tremendous gravitational forces encountered in the vortex.)



DIMENSIONAL FIELD GENERATORS

(Power Room 4)

MAGNETIC CONTAINMENT SYSTEMS

(Continuously discharge temporal plasma fields in a wave-loop pattern from the Dynamorphic Generators.)

CLOISTER ROOM

(The room is located at bottom of the Transpower segment of the Time Sceptre. Artron energy travels up the Time Sceptre's central shaft to the Transpower Systems and from there onwards to the Control Room Sphere. Not only does the Eye provide energy for the Transpower System, it also balances all of a TARDIS's multiple dimensions.)

DYNAMORPHIC GENERATOR POWER STATIONS

(Each station is dimensionally linked and commonly referred to as Power Station 3. Because of the link, it may appear as though these rooms have no walls, but in fact they loop around back to each other giving a false perception.)

EMERGENCY STORAGE CELLS (These quantum-field generators serve as a non-Artron auxiliary power source if the Eye of Harmony should prove insufficient. The Transpower System charges them whenever a TARDIS is in Normal Space. Minor life support needs, like interior lighting, are usually powered by the auxiliary power source. A TARDIS can be put on Emergency Power to prevent it being detected and is commonly referred to as STEALTH MODE.)

"UPGRADED" OBSERVATION TOWERS

(The TARDIS can upgrade various sections of its structure with new software input into the Architectural Configuration Program, these Towers are the Last Upgrades for the TYPE 4D Series, and are structurally more stable. Once Landed on Gallifrey, a TARDIS will automatically scan the Panopticon Data base and Download new software and applications for its systems.)

SCANNERS AND COMMUNICATIONS ARRAY

CENTRAL CORE STRUCTURE

TARDIS DEFAULT CONSTRUCT

(The Tardis Original Exterior door is a gray box with sliding shelf, when in chameleon mode this structure changes into something meant to blend in to its surrounding. The Doctor's Tardis is stuck in a 1950's Police Call Box.)



"NEW" TARDIS DECK SECTIONS

(The Doctor jettisoned 25% of the TARDIS into the vortex, new section growth is denoted in its basic Block Math form, white and gray colours.)



"ANCIENT" TARDIS DECK SECTIONS

(Older Tardis Sections are Red and adorned with golden Time Lord symbols and writing. Some sections are in the process of repair and reflect the new white and gray colours indicating their new growth.)

SCANNING/SCIENTIFIC RESEARCH EQUIPMENT

(The Doctor's Tardis Type 4D, is a Science vessel and was used to measure, scan, and record planetary history, flora, fauna, geology, and chemical composition.)

DIMENSIONAL-BRIDGE PORT GENERATORS

(TARDIS Decks and Sections are connected to each other via these generators and allows for any section to be accessed. Some of these sections in the Doctor's TARDIS are suffering from a fault, and randomly access sections some last days, some last years.)

EARTHSHOCK BOMB STATION

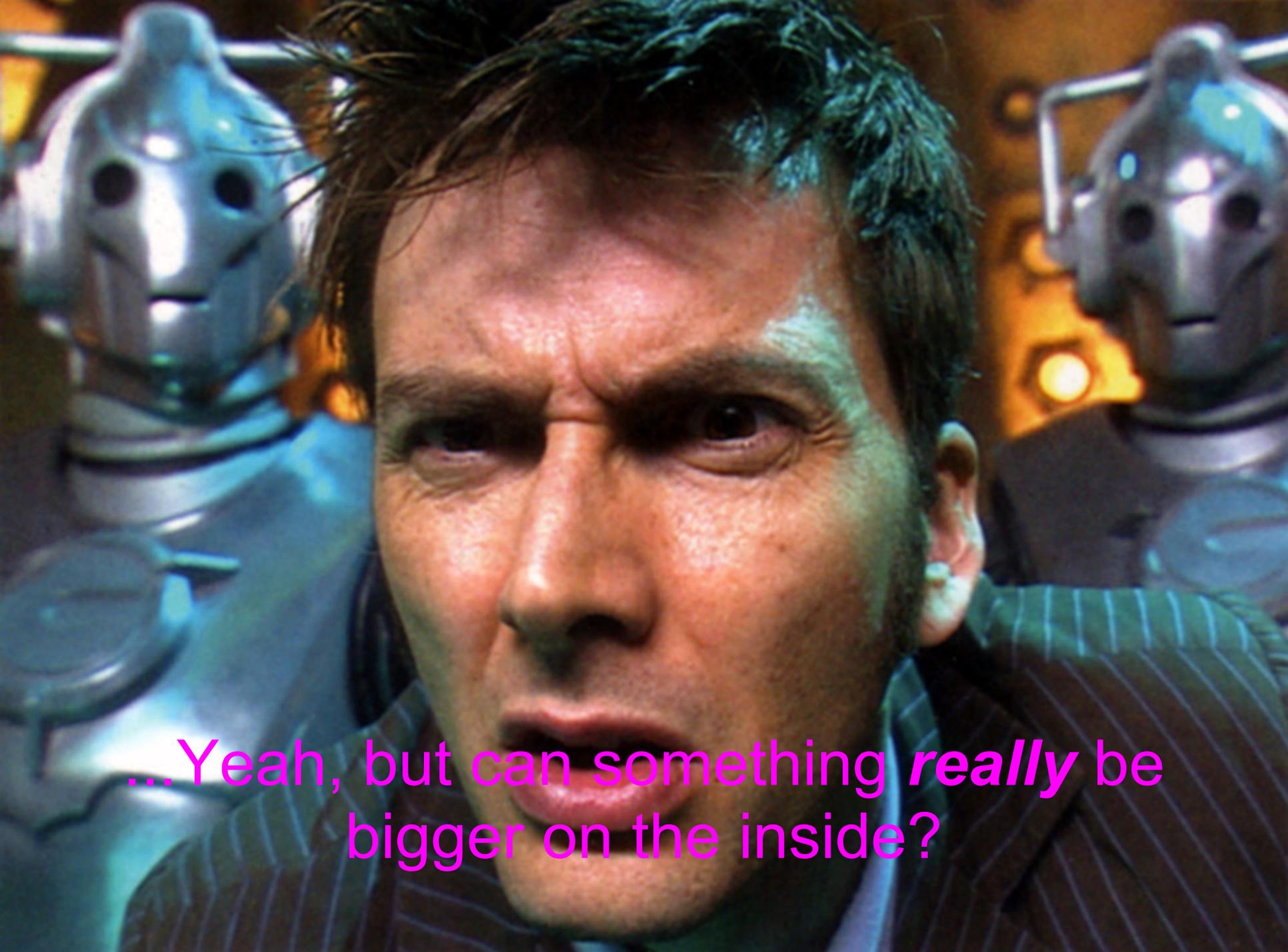
(consist of fission-fusion devices that create a tiny hole in the Space-Time Continuum. This creates massive amounts of radiation and intertemporal shock waves. These weapons were occasionally mounted on Type 4D TARDISes and were capable of reducing large asteroids to rubble.)

REVERSE GRAVITATIONAL FIELD GENERATORS

(Using the magnetism of Huan Particles the Orbital Energy (energetic muons) created by the Dynamorphic Generators is accelerated into counter magnetization thrust. This energy is released through the Heart's space-time portal into the Vortex to push the TARDIS through the 5th Dimension.)

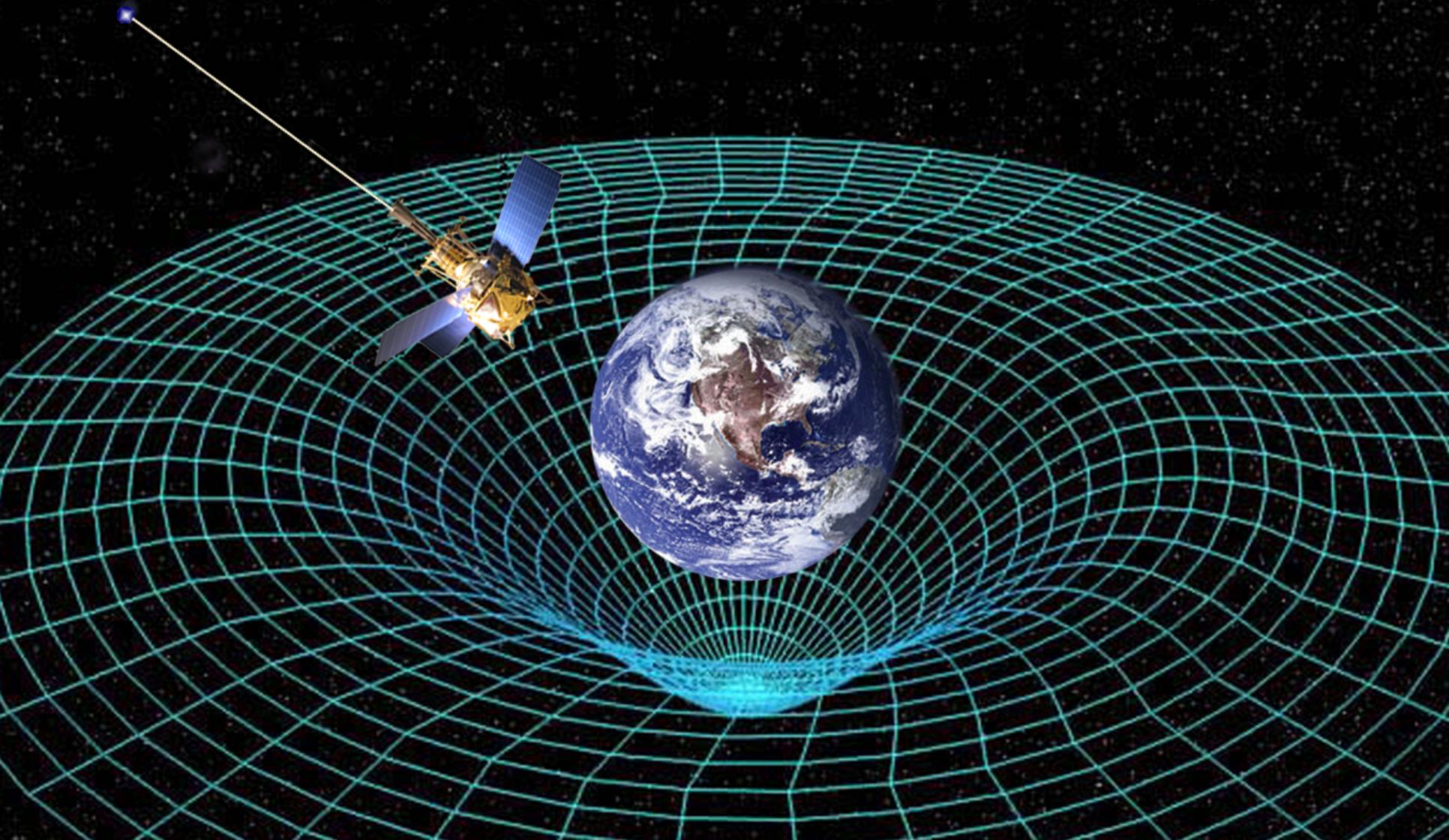
DIMENSIONAL STABILISERS

(Keep the Tardis in a stable Position and Recalibrates its Vectors within its own Dimension, relative to the exterior. If the Tardis exterior is on its side, the Stabilizers can compensate and allow the interior to remain in a normal upright position.)



...Yeah, but can something *really* be bigger on the inside?

Yep!



With $G = c = 1$

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

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

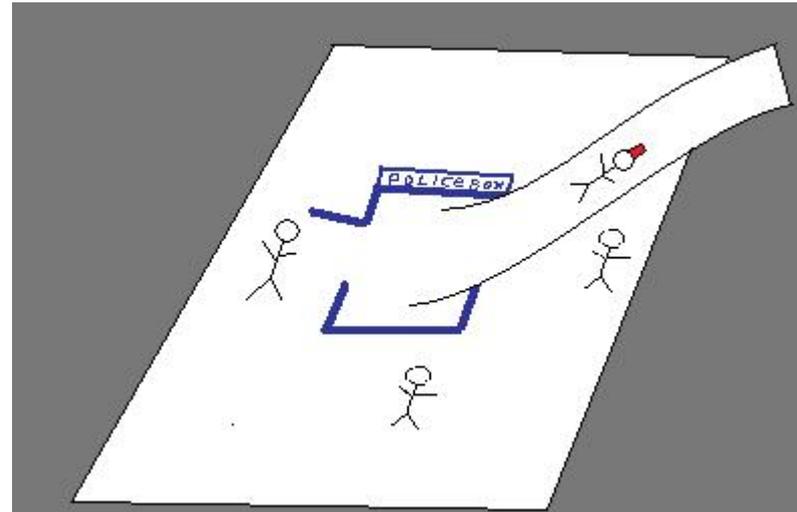
$$dV = \left(1 - \frac{2M}{r}\right) - \frac{1}{2} dr (rd\theta)(r \sin \theta d\phi) = \left(1 - \frac{2M}{r}\right) - \frac{1}{2} dr dA$$

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

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>



Wormholes;
one of the crazier
explanations...

SPACE OUTSIDE WORMHOLE

LIGHT RAY

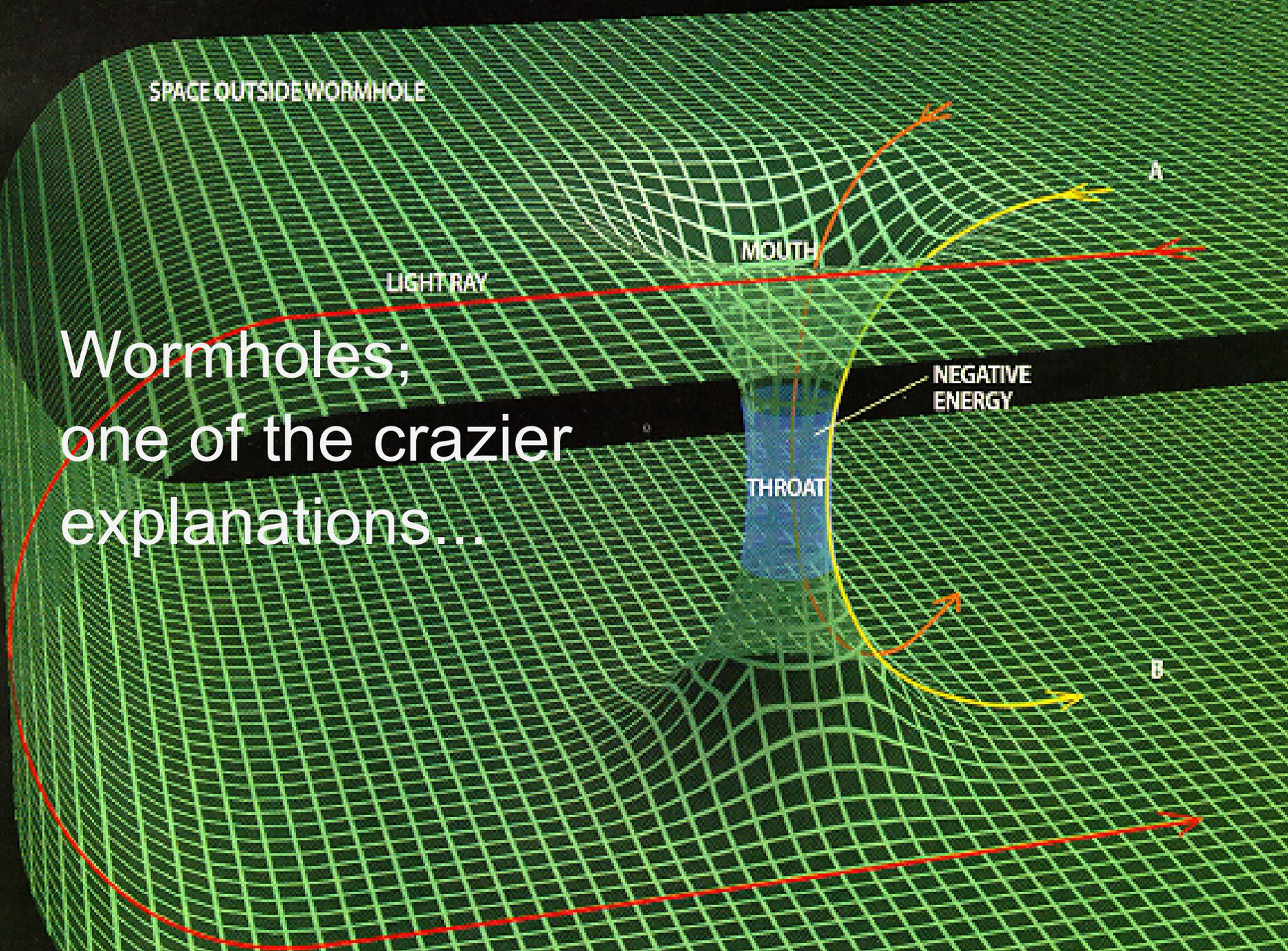
MOUTH

THROAT

NEGATIVE ENERGY

A

B



Wormholes, Time Machines, and the Weak Energy Condition

Michael S. Morris, Kip S. Thorne, and Ulvi Yurtsever

Theoretical Astrophysics, California Institute of Technology, Pasadena, California 91125

(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

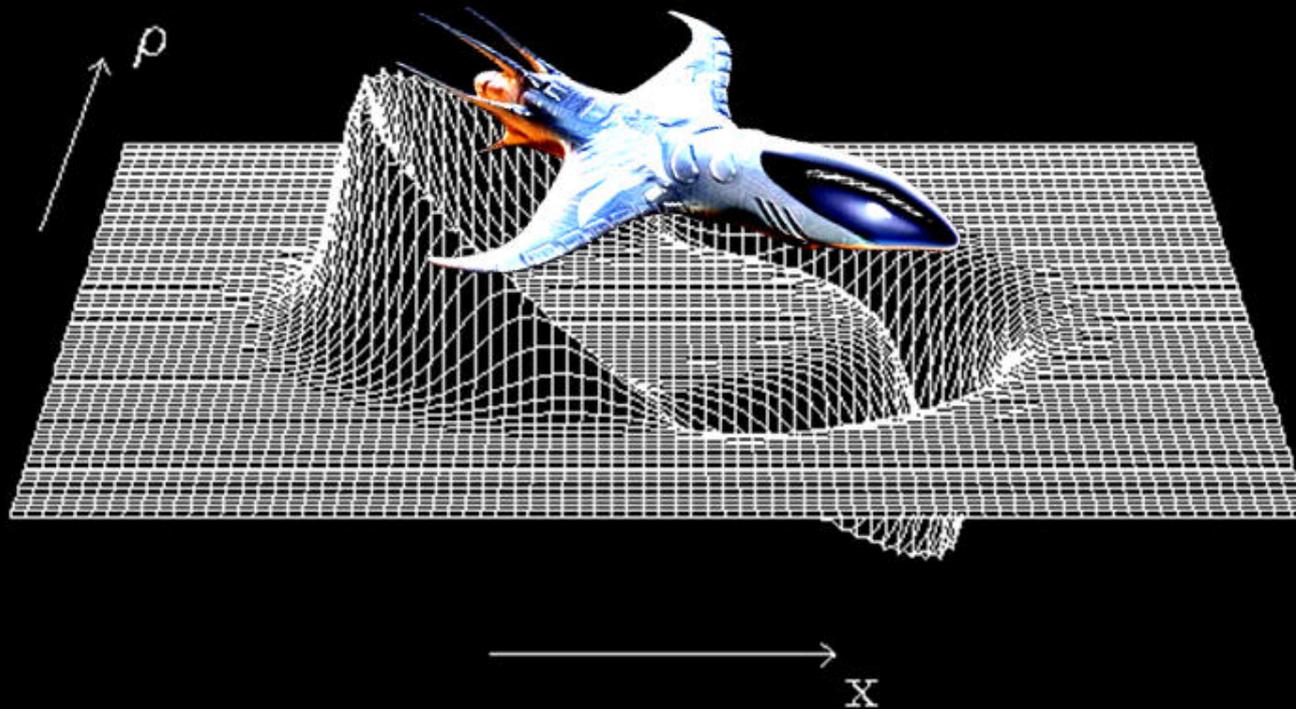
Normally theoretical physicists ask, "What are the laws of physics?" and/or, "What do those laws predict about the Universe?" In this Letter we ask, instead, "What constraints do the laws of physics place on the activities of an arbitrarily advanced civilization?" This

into time machines.

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 fu-

Alcubierre Warp Drive

$$\psi = -\alpha \text{Tr}(K)$$



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?

Maybe.

Meet Alcubierre ->

- Mexican Theorist @ Universidad Nacional Autónoma de México
- Famous paper of 1994 "The Warp Drive: Hyperfast travel within general relativity" appears in Classical and Quantum Gravity.



Quantum inequalities do not forbid spacetime shortcuts

S. Krasnikov

The Central Astronomical Observatory at Pulkovo, St. Petersburg, Russia

(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_{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_{tot}^- , and (3) large E_{tot}^- being physically meaningless in some relevant situations does not necessarily exclude shortcuts.

DOI: 10.1103/PhysRevD.67.104013

PACS number(s): 04.20.Gz, 04.20.Cv

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 L^4 by replacing a flat cylinder $C \subset L^4$ with something else so that some spacelike separated (in L^4)

The TARDIS Traversing the Time Vortex



~Time Travel~

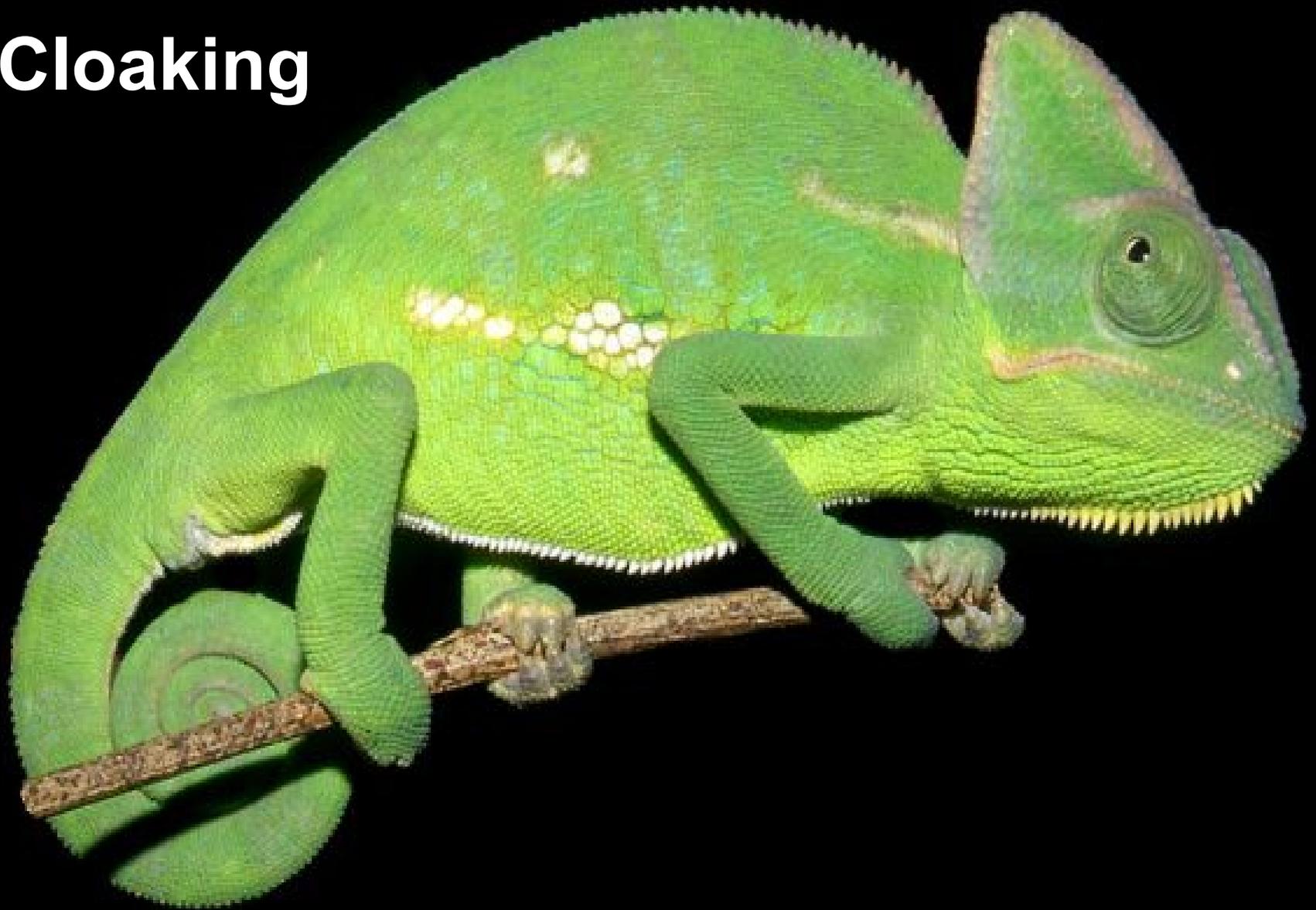
- Earliest mentions date back to ~700s BCE in the Mahabharata
- 1895 brings H.G. Wells' infamous "The Time Machine"
- Forward travel in time has few controversies
- Backward travel on the other hand...
- First serious physics was performed by Gödel in the "Gödel metric" solution to Einstein's field equations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

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/EAS13/time13/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

- a. Projection of environment onto a fabric, typically. Rumors of British Army testing out an invisible tank? <http://www.dailymail.co.uk/news/article-490669/Army-tests-James-Bond-style-tank-invisible.html>

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>

THANK YOU!

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