INSS'18 Mini Projects

Schloss Waldthausen
21 May 2018
Michael Wurm

Motivation

Physics lives from back-of-the-envelope estimations

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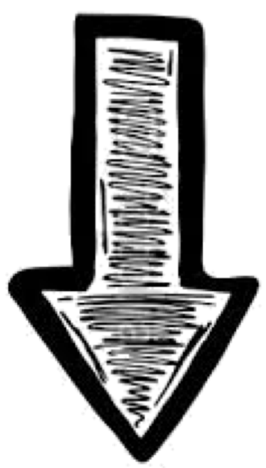
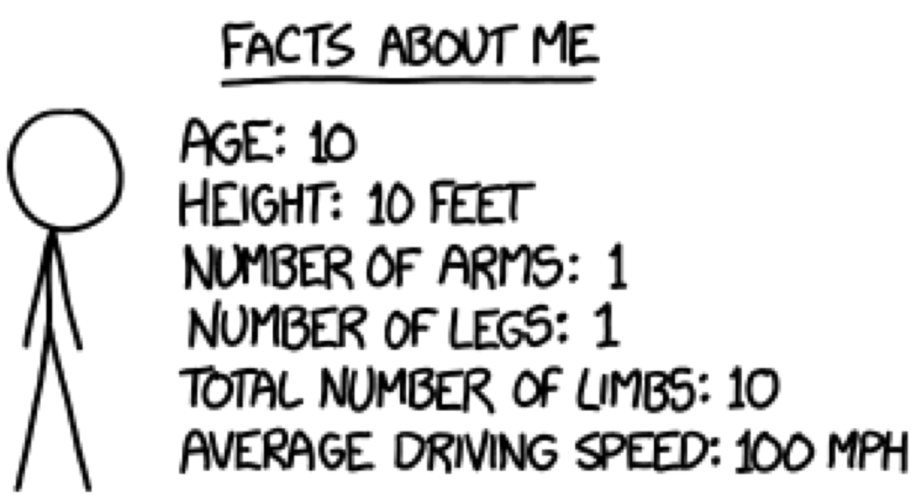
Nothing beats learning-by-doing

(or at least staying-awake-by-doing)



Mini Projects



The benefits of Fermi estimation

General conditions

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- Project teams: 3-5 members
- Selection of topics **today**
  → sign up in the project list during the following coffee break
  → not more than 2 groups per topic
- During the school:
  4 dedicated time slots for project work
  (feel free to do more!)
- **Project presentation** (15 minutes) on the **last two days** of the school
  → dates will be fixed next Monday

WEEK 1 Times and dates	Day 1 Whitmonday 21.05.2018	Day 2 Tuesday 22.05.2018	Day 3 Wednesday 23.05.2018	Day 4 Thursday 24.05.2018	Day 5 Friday 25.05.2018	Day 6 Saturday 26.05.2018
9:00 - 10:30	theory (Kayser)	solar v (Peña-Garay)	theory (Kayser)	sterile v (Link)	statistics (Cowan)	v telescopes (Samtleben)
10:30 - 11:00	coffee	coffee	coffee	coffee	coffee	coffee
11:00-12:30	solar v (Peña-Garay)	theory (Kayser)	abs. mv (Valerius)	theory (Kayser)	sterile v (Link)	statistics (Cowan)
12:30-14:30	lunch	lunch	lunch	lunch	lunch	lunch
14:40-16:00	tutorial	tutorial	detectors (Seckel)		v telescopes (Samtleben)	early universe (Wong)
16:00-16:30	coffee	coffee	coffee	free	coffee	coffee
16:30-18:00	abs. mv (Valerius)	detectors (Seckel)	v telescopes (Samtleben)		Poster session	tutorial
18:00 - 19:00	dinner	BBQ	dinner	dinner	dinner	dinner
19:00 - 20:30						

WEEK 2 Times and dates	Day 7 Sunday 27.05.2018	Day 8 Monday 28.05.2018	Day 9 Tuesday 29.05.2018	Day 10 Wednesday 30.05.2018	Day 11 Corpus Christi 31.05.2018	Day 12 Friday 01.06.2018
9:00 - 10:30		early universe (Wong)	interactions (Betancourt)	beams (Tanaka)	reactors (Huber)	supernova (Dasgupta)
10:30 - 11:00		coffee	coffee	coffee	coffee	coffee
11:00-12:30		beams (Tanaka)	early universe (Wong)	reactors (Huber)	supernova (Dasgupta)	0v2β (Schönert)
12:30-14:30	free	lunch	lunch	lunch	lunch	lunch
14:40-16:00		tutorial	tutorial		0v2β (Schönert)	reactors (Huber)
16:00-16:30		coffee	coffee	free	coffee	coffee
16:30-18:00		interactions (Betancourt)	beams (Tanaka)		tutorials	tutorial
18:00 - 19:00	dinner	dinner	dinner	dinner	dinner	departure
19:00 - 20:30	Evening Talk: Kajita Takaaki	Movie night: Winter at the South Pole			Grande finales: foosball, billard, table tennis	

Overview of Topics

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1 – Are neutrinos Dirac or Majorana particles?	3 – CP violation from flavor fractions	4 – Coherence in neutrino oscillations	11 – Statistical test for discovery
10 – Sensitivity studies with GLoBES	5 – Cross sections for long-baseline experiments	14 – The future of long-baseline neutrino physics	8 – Neutrino telescopes meet neutrino beams
2 – Atmospheric neutrinos from Earth, Sun and planets	6 – Find the Supernova!	9 – Pre-Supernova Neutrinos	12 – The Hunt for Red October
7 – Low-energy neutrino target isotopes	13 – Vertex reconstruction in scintillator	15 – Neutrino detection at 30 PeV	16 – Separation of hadronic and electromagnetic cascasdes

Neutrino Physics & Oscillations

1) Are neutrinos Dirac or Majorana particles?
Invent novel experimental approaches to determine whether neutrinos are Dirac or Majorana particles.
Focus: Neutrino physics
Requirements: Analytical calculations
Author: Boris Kayser

3) CP violation from flavor fractions
Analyze the structure of the leptonic mixing matrix and of neutrino oscillation probabilities to understand the conditions under which CP is violated in the neutrino sector.
Focus: Oscillation physics
Requirements: Analytical calculations
Author: Boris Kayser

4) Coherence in neutrino oscillations
A project about the subtle quantum mechanics of neutrino oscillations, including several potential brain-teasers.
Focus: Neutrino oscillations
Requirements: Analytical calculations
Author: Joachim Kopp

Long-baseline oscillations

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10) Sensitivity studies with GLoBES
Learn to use the software package GLoBES and study the sensitivity of current and future experiments.
Focus: Neutrino oscillations
Requirements: Numerical calculation/GLoBES software
Author: Joachim Kopp

14) The future of LBL neutrino physics
Perform a MC-based study to project the final sensitivity of the T2K experiment
Focus: Neutrino oscillations
Requirements: Numerical calculations
Author: Hiro Tanaka

5) Cross sections for LBL experiments
In this activity, you will learn the steps necessary to calculate the neutrino interaction total cross section as function of the neutrino energy.
Focus: Neutrino physics
Requirements: Numerical calculation
Author: Minerba Betancourt

8) Neutrino telescopes meet ν beams
Explore the potential of the future low-energy neutrino telescopes PINGU and ORCA to study oscillations from atmospheric and beam neutrinos.
Focus: Oscillation physics
Requirements: Numerical calculation / PISA
Author: Sebastian Böser

Observation of neutrinos

6) Find the Supernova
In this activity, you will learn the steps necessary to calculate the neutrino interaction total cross section as function of the neutrino energy.
Focus: Supernova and detector physics
Requirements: Toy MC
Author: Basudeb Dasgupta

9) Pre-Supernova Neutrinos
Be the first one to see the next Supernova coming! Learn to distinguish the faint neutrino signal of remote sSi-burning stars from other neutrino background fluxes.
Focus: Low-energy ν‘s, stellar physics
Requirements: Analytical and numerical calculations
Author: Michael Wurm

2) Atmospheric neutrinos from Earth, Sun and planets
Learn about the physics of atmospheric neutrinos and its dependence on atmospheric properties.
Focus: Atmospheric showers, particle decay and absorption
Requirements: analytical calculations
Author: Lutz Köpke

12) The Hunt for Red October
Come up with a neutrino-based scheme to pinpoint nuclear submarines or an evasion strategy for detection.
Focus: Reactor neutrinos, applied neutrino physics
Requirements: simple analytical and numerical estimates
Author: Patrick Huber

Neutrino detectors & analysis

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7) Low-energy neutrino target isotopes
Select a suitable target isotope for a low-energy neutrino detector.
Focus: Low-energy neutrinos,
nuclear physics
Requirements: Analytical calculation
Author: Jonathan Link

15) Detection of 30 PeV neutrinos
Assess a possible detector design for cosmic neutrinos at the very highest energies
Focus: High- energy neutrinos,
detector physics
Requirements: analytical and
numerical calculations
Author: Dave Seckel

13) Vertex reconstruction in scintillator
Build your own virtual solar neutrino detector! Learn to reconstruct the position of neutrino events in your liquid scintillator target to reject external background.
Focus: Low-energy neutrinos,
event reconstruction algorithms
Requirements: Toy Monte Carlo
Author: Michael Wurm

16) Separation of hadronic and electro-magnetic cascades
Explore methods to separate hadronic from electromagnetic cascades in a high-energy neutrino telescope
Focus: High- energy neutrino detectors
Requirements: analytical calculation
or GEANT
Author: Dave Seckel

Statistical analysis

11) Statistical test for discovery

Design a statistical test for discovery of a signal process such as dark matter by counting events in a detector.

Focus: High-level analysis,
statistics

Requirements: analytical calculation

Author: Glen Cowan

Support

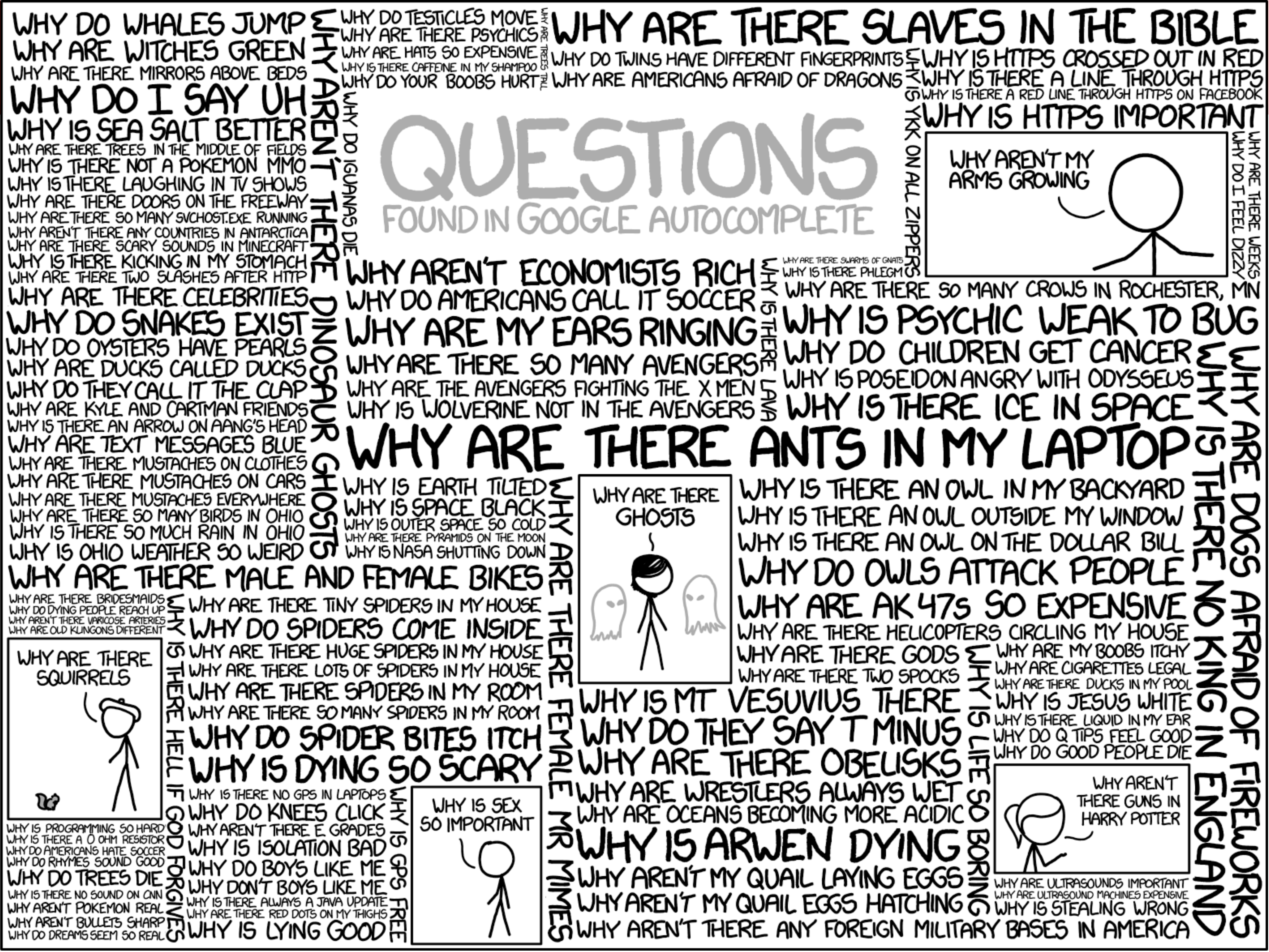
- In case you need **computing power**:
  we provide access to a Jupiter server to use
  Python, ROOT and PISA ...

  Log in at https://etap1.physik.uni-mainz.de:8888
  Speak to us for user name and password

- In case you need help with the project:

  general advice: organizers

  or – if you can lay hands on them –
  the mini-project authors


QUESTIONS
FOUND IN GOOGLE AUTOCOMPLETE
WHY DO WHALES JUMP
WHY ARE WITCHES GREEN
WHY ARE THERE MIRRORS ABOVE BEDS
WHY DO I SAY UH
WHY IS SEA SALT BETTER
WHY ARE THERE TREES IN THE MIDDLE OF FIELDS
WHY IS THERE NOT A POKEMON MMO
WHY IS THERE LAUGHING IN TV SHOWS
WHY ARE THERE DOORS ON THE FREEWAY
WHY ARE THERE SO MANY SVCHOST.EXE RUNNING
WHY AREN'T THERE ANY COUNTRIES IN ANTARCTICA
WHY ARE THERE SCARY SOUNDS IN MINECRAFT
WHY IS THERE KICKING IN MY STOMACH
WHY ARE THERE TWO SLASHES AFTER HTTP
WHY ARE THERE CELEBRITIES
WHY DO SNAKES EXIST
WHY DO OYSTERS HAVE PEARLS
WHY ARE DUCKS CALLED DUCKS
WHY DO THEY CALL IT THE CLAP
WHY ARE KYLE AND CARTMAN FRIENDS
WHY IS THERE AN ARROW ON AANG'S HEAD
WHY ARE TEXT MESSAGES BLUE
WHY ARE THERE MUSTACHES ON CLOTHES
WHY ARE THERE MUSTACHES ON CARS
WHY ARE THERE MUSTACHES EVERYWHERE
WHY ARE THERE SO MANY BIRDS IN OHIO
WHY IS THERE SO MUCH RAIN IN OHIO
WHY IS OHIO WEATHER SO WEIRD
WHY AREN'T THERE DINOSAUR GHOSTS
WHY DO TESTICLES MOVE
WHY ARE THERE PSYCHICS
WHY ARE HATS SO EXPENSIVE
WHY IS THERE CAFFEINE IN MY SHAMPOO
WHY DO YOUR BOOBS HURT
WHY ARE TREES TALL
WHY DO IGUANAS DIE
WHY ARE THERE SLAVES IN THE BIBLE
WHY DO TWINS HAVE DIFFERENT FINGERPRINTS
WHY ARE AMERICANS AFRAID OF DRAGONS
WHY IS YKK ON ALL ZIPPERS
WHY IS HTTPS CROSSED OUT IN RED
WHY IS THERE A LINE THROUGH HTTPS
WHY IS THERE A RED LINE THROUGH HTTPS ON FACEBOOK
WHY IS HTTPS IMPORTANT
WHY AREN'T MY ARMS GROWING
WHY ARE THERE WEEKS
WHY DO I FEEL DIZZY
WHY ARE THERE SWARMS OF GNATS
WHY IS THERE PHLEGM
WHY ARE THERE SO MANY CROWS IN ROCHESTER, MN
WHY AREN'T ECONOMISTS RICH
WHY DO AMERICANS CALL IT SOCCER
WHY ARE MY EARS RINGING
WHY ARE THERE SO MANY AVENGERS
WHY ARE THE AVENGERS FIGHTING THE X MEN
WHY IS WOLVERINE NOT IN THE AVENGERS
WHY IS THERE LAVA
WHY IS PSYCHIC WEAK TO BUG
WHY DO CHILDREN GET CANCER
WHY IS POSEIDON ANGRY WITH ODYSSEUS
WHY IS THERE ICE IN SPACE
WHY ARE THERE ANTS IN MY LAPTOP
WHY IS EARTH TILTED
WHY IS SPACE BLACK
WHY IS OUTER SPACE SO COLD
WHY ARE THERE PYRAMIDS ON THE MOON
WHY IS NASA SHUTTING DOWN
WHY ARE THERE FEMALE MR MIMES
WHY ARE THERE GHOSTS
WHY IS THERE AN OWL IN MY BACKYARD
WHY IS THERE AN OWL OUTSIDE MY WINDOW
WHY IS THERE AN OWL ON THE DOLLAR BILL
WHY DO OWLS ATTACK PEOPLE
WHY ARE AK 47S SO EXPENSIVE
WHY ARE THERE HELICOPTERS CIRCLING MY HOUSE
WHY ARE THERE GODS
WHY ARE THERE TWO SPOCKS
WHY IS THERE NO KING IN ENGLAND
WHY ARE DOGS AFRAID OF FIREWORKS
WHY ARE THERE MALE AND FEMALE BIKES
WHY ARE THERE BRIDESMAIDS
WHY DO DYING PEOPLE REACH UP
WHY AREN'T THERE VARICOSE ARTERIES
WHY ARE OLD KLINGONS DIFFERENT
WHY ARE THERE SQUIRRELS
WHY IS THERE HELL IF GOD FORGIVES
WHY ARE THERE TINY SPIDERS IN MY HOUSE
WHY DO SPIDERS COME INSIDE
WHY ARE THERE HUGE SPIDERS IN MY HOUSE
WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE
WHY ARE THERE SPIDERS IN MY ROOM
WHY ARE THERE SO MANY SPIDERS IN MY ROOM
WHY DO SPIDER BITES ITCH
WHY IS DYING SO SCARY
WHY IS PROGRAMMING SO HARD
WHY IS THERE A 0 OHM RESISTOR
WHY DO AMERICANS HATE SOCCER
WHY DO RHYMES SOUND GOOD
WHY DO TREES DIE
WHY IS THERE NO SOUND ON CNN
WHY AREN'T POKEMON REAL
WHY AREN'T BULLETS SHARP
WHY DO DREAMS SEEM SO REAL
WHY IS THERE NO GPS IN LAPTOPS
WHY DO KNEES CLICK
WHY AREN'T THERE E GRADES
WHY IS ISOLATION BAD
WHY DO BOYS LIKE ME
WHY DON'T BOYS LIKE ME
WHY IS THERE ALWAYS A JAVA UPDATE
WHY ARE THERE RED DOTS ON MY THIGHS
WHY IS LYING GOOD
WHY IS GPS FREE
WHY IS SEX SO IMPORTANT
WHY IS MT VESUVIUS THERE
WHY DO THEY SAY T MINUS
WHY ARE THERE OBELISKS
WHY ARE WRESTLERS ALWAYS WET
WHY ARE OCEANS BECOMING MORE ACIDIC
WHY IS ARWEN DYING
WHY AREN'T MY QUAIL LAYING EGGS
WHY AREN'T MY QUAIL EGGS HATCHING
WHY AREN'T THERE ANY FOREIGN MILITARY BASES IN AMERICA
WHY IS LIFE SO BORING
WHY ARE MY BOOBS ITCHY
WHY ARE CIGARETTES LEGAL
WHY ARE THERE DUCKS IN MY POOL
WHY IS JESUS WHITE
WHY IS THERE LIQUID IN MY EAR
WHY DO Q TIPS FEEL GOOD
WHY DO GOOD PEOPLE DIE
WHY AREN'T THERE GUNS IN HARRY POTTER
WHY ARE ULTRASOUNDS IMPORTANT
WHY ARE ULTRASOUND MACHINES EXPENSIVE
WHY IS STEALING WRONG