# Existential Risk

Joseph Silk
Gresham College
4 April 2018

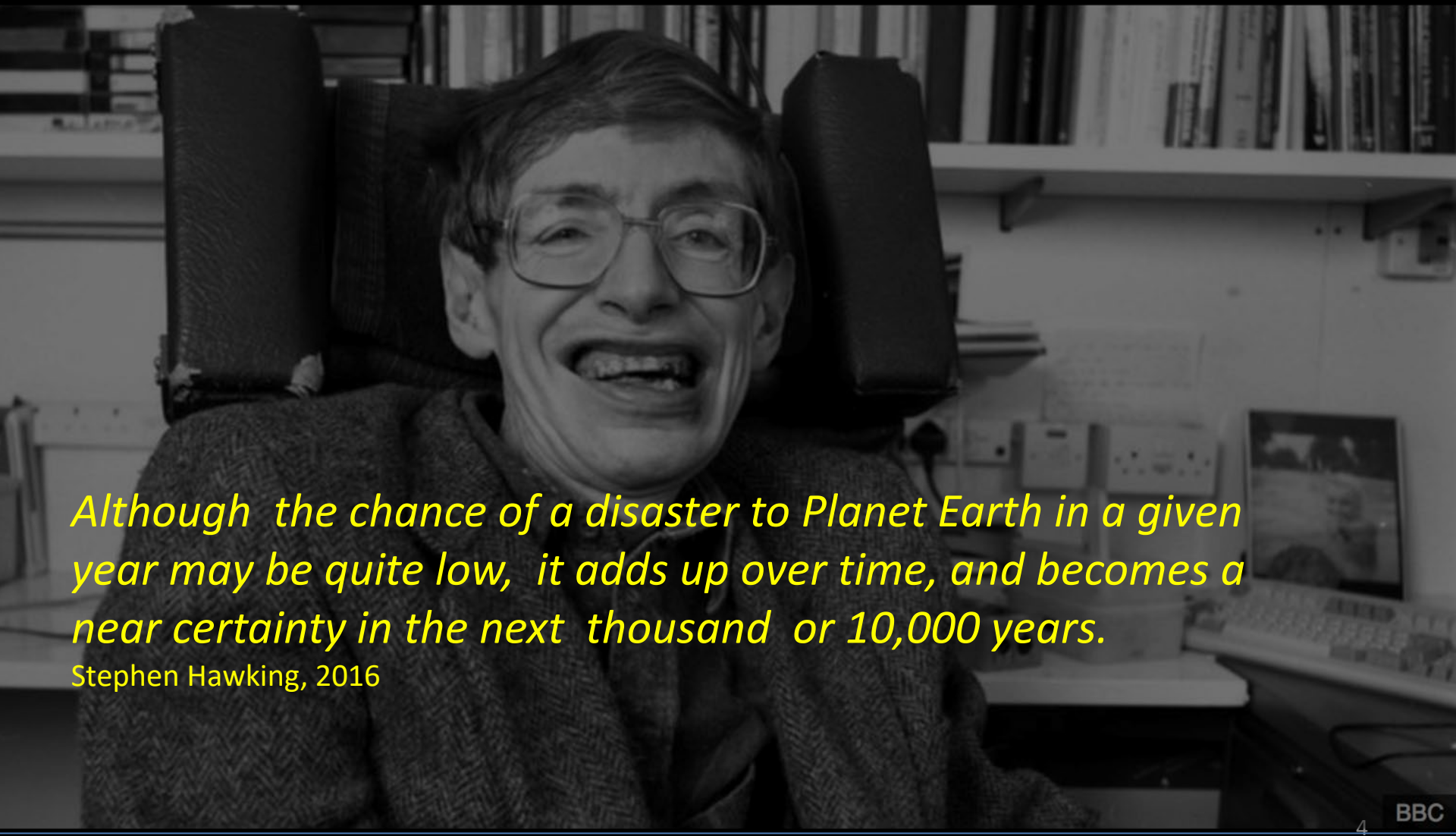
Existential risk is where an outcome would either annihilate Earth-originating intelligent life or permanently and drastically curtail its potential.

N. Bostrom 2002

# Examples of existential risk

- Asteroid impact
- Nuclear holocaust
- Nanotechnology misuse: nanobots and grey goo
- Artificial intelligence badly programmed
- Genetic engineering run amok
- We are living in a computer simulation that is shut down
- Something unforeseen

# Meteorite impact



*Although the chance of a disaster to Planet Earth in a given year may be quite low, it adds up over time, and becomes a near certainty in the next thousand or 10,000 years.*

Stephen Hawking, 2016

BBC


Pingualuit crater 1.4 M yrs ago, Canada
3 km


Meteor Crater, Arizona: 50000 yrs ago
1km

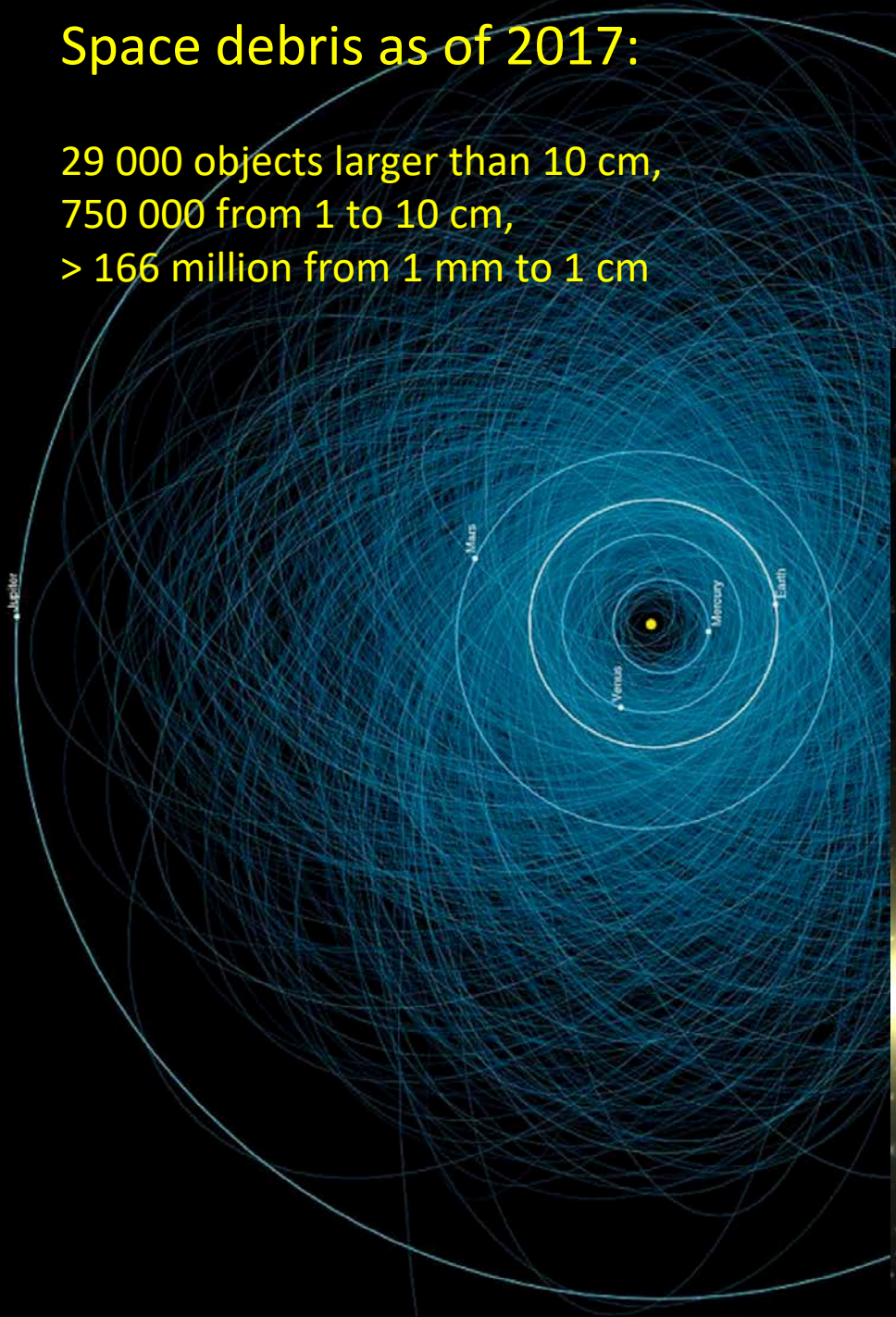
Vredefort Dome,  SA, 2 billion yrs ago

300km

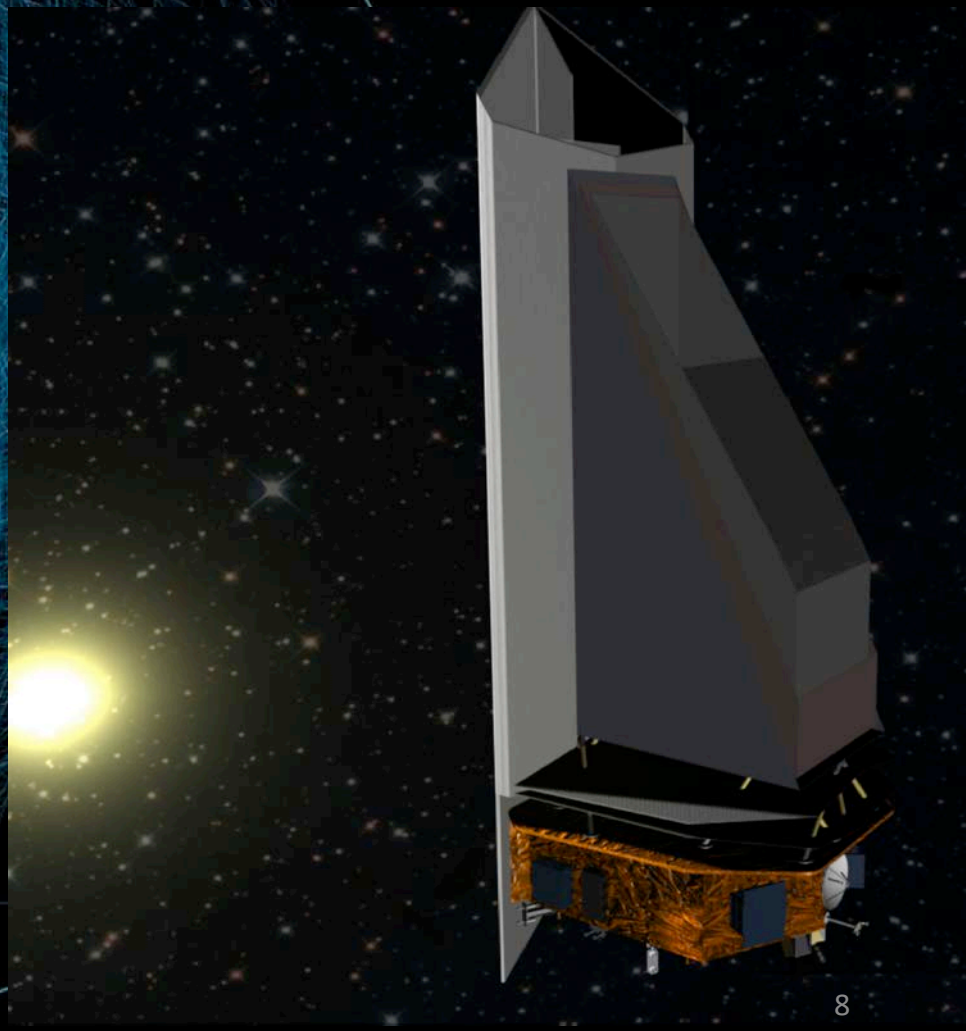
# This will happen…in 50 million years?

# Space debris as of 2017:

29 000 objects larger than 10 cm,
750 000 from 1 to 10 cm,
> 166 million from 1 mm to 1 cm




proposed NEOCam
50 cm IR space
telescope, 12 deg field



# Odds of death from a meteorite impact

- 60 million years ago lets say all the dinosaurs died
- So one could say lose six billion people in 60 million years
- That's 100 per year, or about the probability of dying in a plane crash

# Artificial intelligence

Computers are becoming ever more powerful

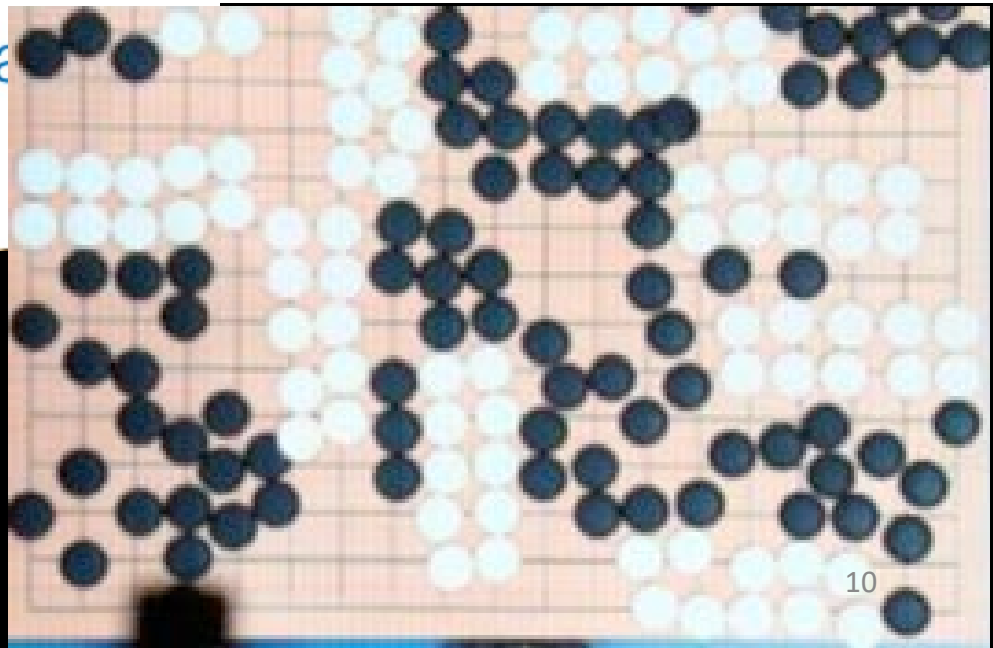
*The development of full artificial intelligence could spell the end of the human race.* *S. Hawking 2014*

Google's AI just beat the world's best Go player

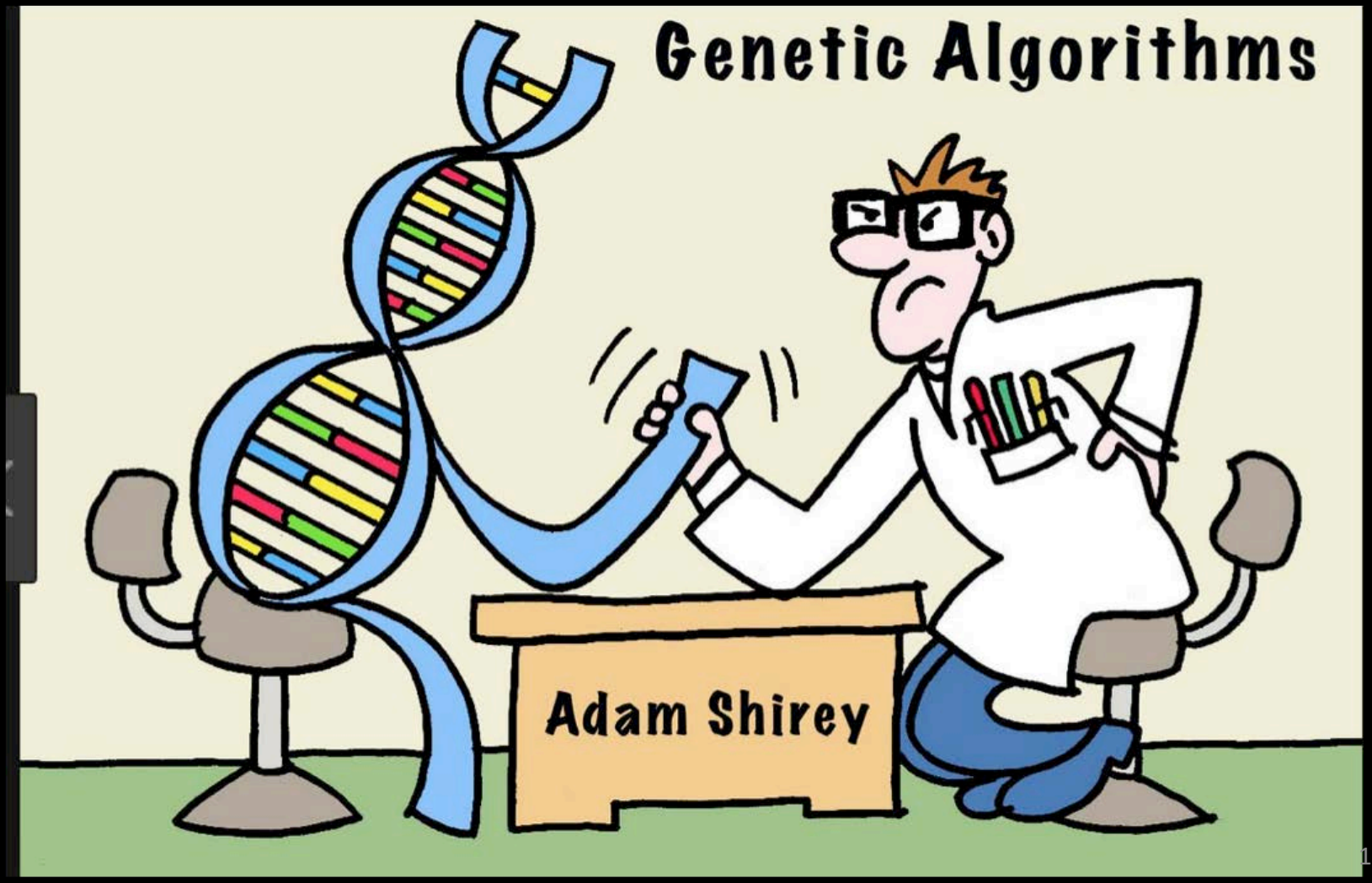
by Matt McFarland @mattmcfa

May 25, 2017: 10:05 PM ET

There are more moves in GO than atoms in the universe

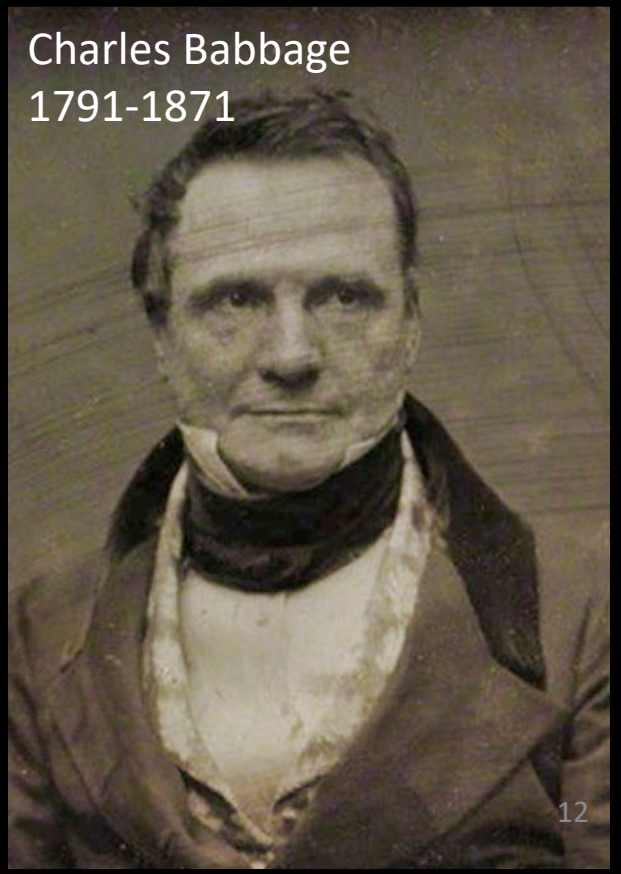


# Computers and omnipotence



# We are at the beginning

- The computer age began in the mid-19th century

# The sun is a middle aged star

- The  age of the Earth is 4.6 billion years
- Other sun-like stars are billions of years older
- Earth-like exoplanets are numerous
- Many have a head start on the Earth
- The potential of future technology is unknown

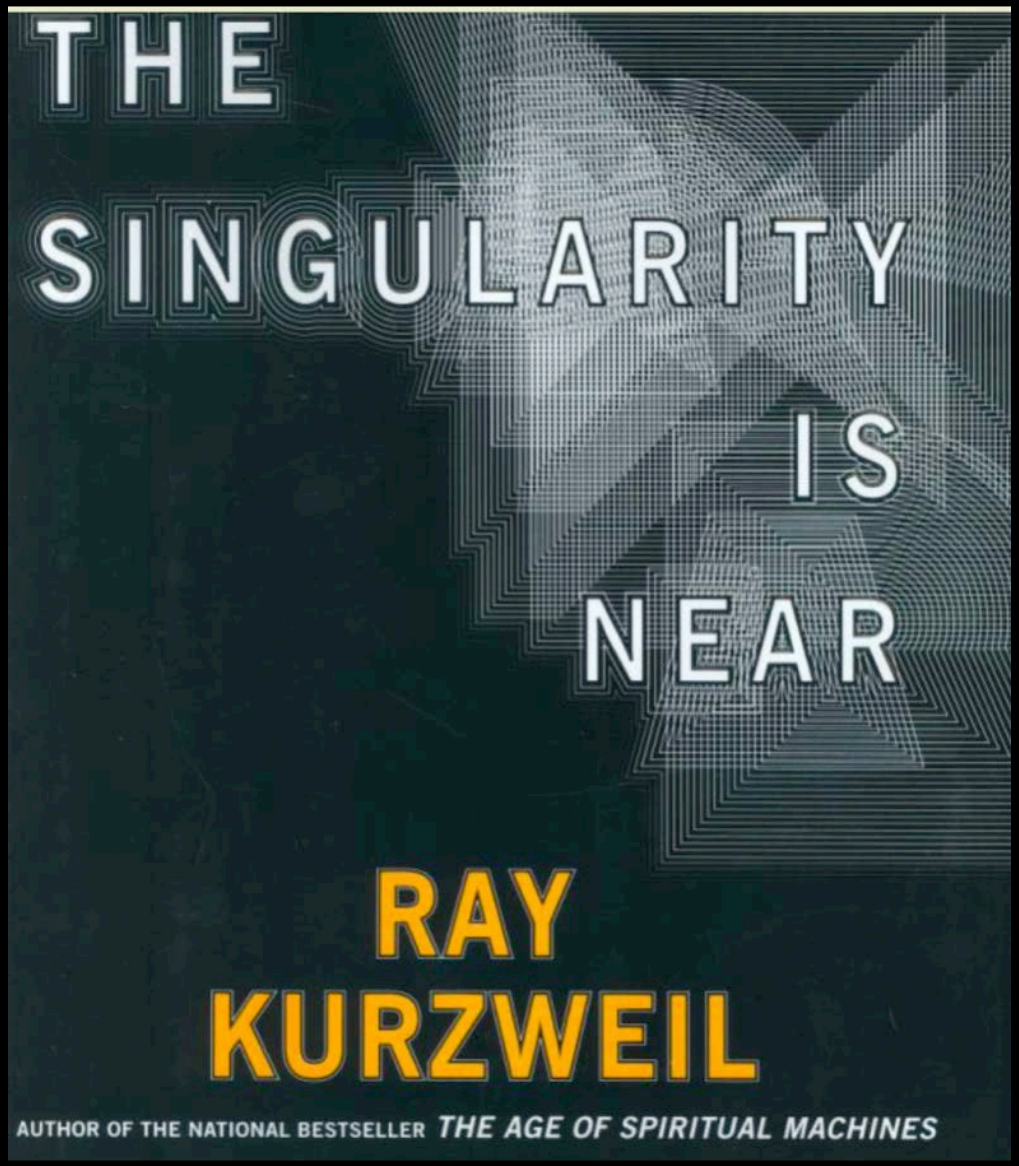
# 120 Years of Moore's Law




In 20 yrs, compute power should increase by $2^{20}$ or 1 million

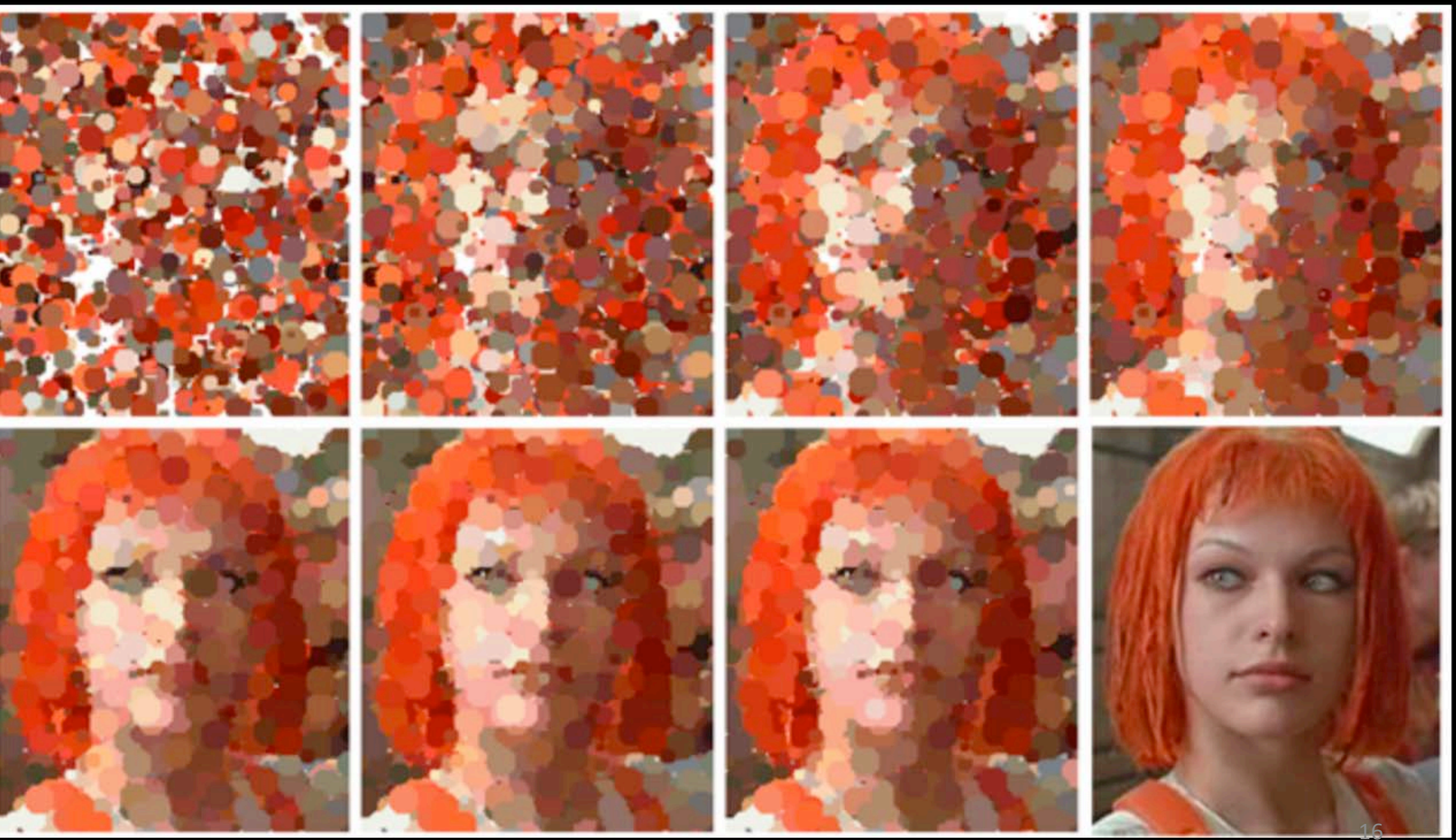
exponential growth of computing power

# Some say the turning point will be by 2030



# Computers and consciousness

## Is this attainable?



Bergen and Ross 2012

# Some existential threats that won't necessarily extinguish humanity

- nuclear weaponry
- environmental degradation
- disease
- global warming

# We have known the dangers for a while

Shortly after the end of World War II, the scientists who developed the atomic bombs dropped on Japan tried to envision the kind of nuclear event that could lead to the destruction of not just cities, but the entire world. The verdict that scientists at the Los Alamos laboratory and test site reached in 1945… found that "it would require only in the neighborhood of 10 to 100 Supers" to put the human race in peril.


Bikini atoll 1954
15 megatons


Tsar H-bomb 60 megatons, 1961

…

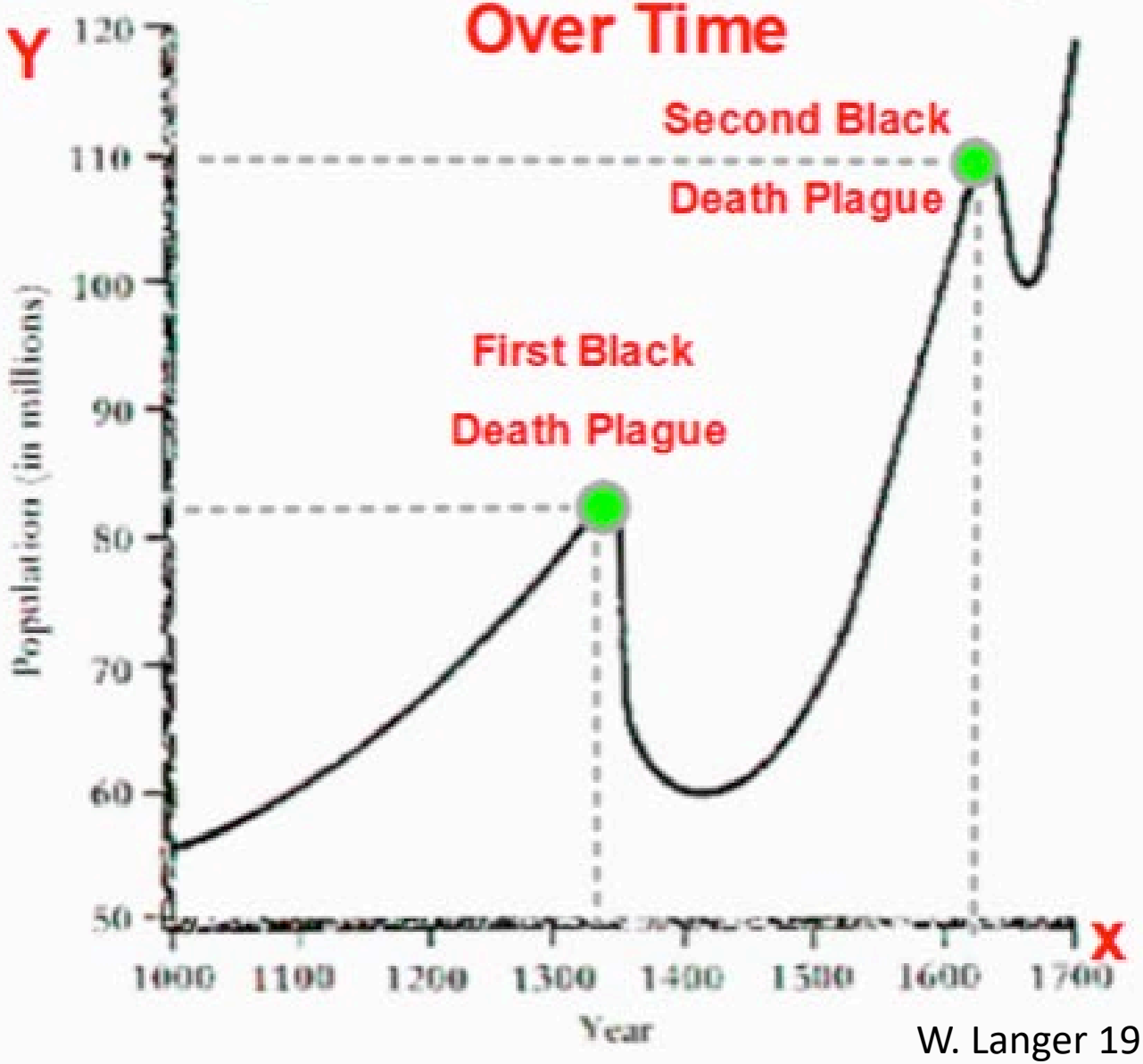
- In the Adirondack Mountains of New York the acid rain includes a mixture of sulfuric and nitric acids from the sulfur dioxide and nitrogen oxides pour¬ ing from the smokestacks of power plants, smelters, factories, and
- vehicle exhausts. Over 200 lakes are dead; their aquatic life gone or dwindling. And in Scandinavia acid rain has destroyed 15,000 lakes in recent years. Inevitably, the death of a lake affects other wildlife as well; fish-eating ducks, loons, otter, mink, and even birds begin to leave, because their food and shelter have been destroyed. On the ground, acid rain leaches essential nutrients from the soil--calcium, magnesium, potassium, and sodium. It prevents some seeds from germinating; it scars leaves..

D. Soran, D. Stillman 1982

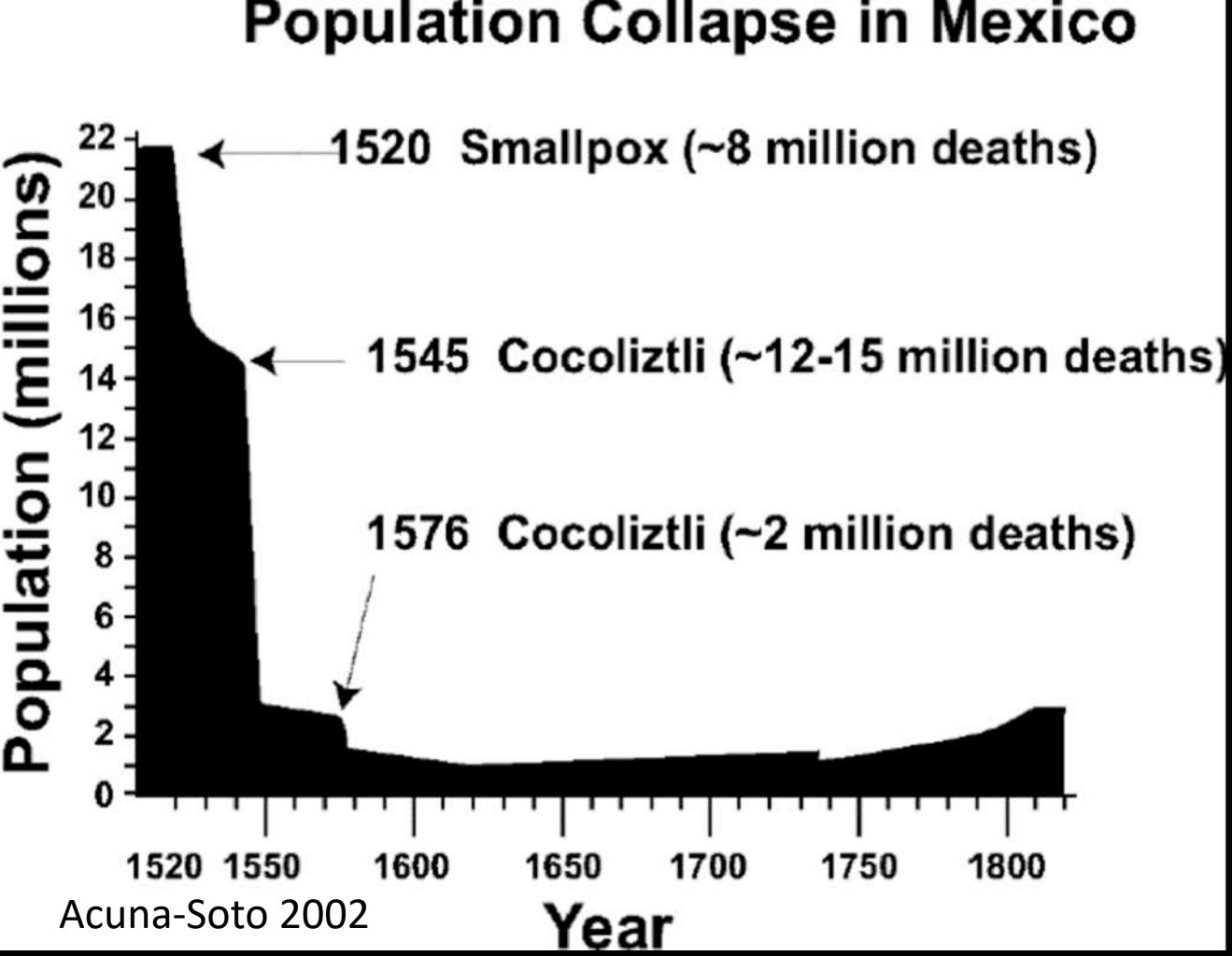
- About 100 kilometres from Sverdlovsk, a high¬ way sign warned drivers not to stop for the next 20 or 30 kilometres and to drive through at maximum speed. On both sides of the read, as far as one could see, the land was 'dead1: no villages, no towns, only the chimneys of destroyed houses, no cultivated fields or pastures, no herds, no people...nothing.
- What I saw personally, was a large area in the vicinity of Sverdlovsk (no less than 100 to 150 sq. km and probably much more), in which any normal human activity was forbidden, people were evacuated and villages razed, evidently to prevent inhabitants from returning, there was no agriculture or live-stock raising, fishing and hunting were forbidden, ..."

L. Tumerman 1972

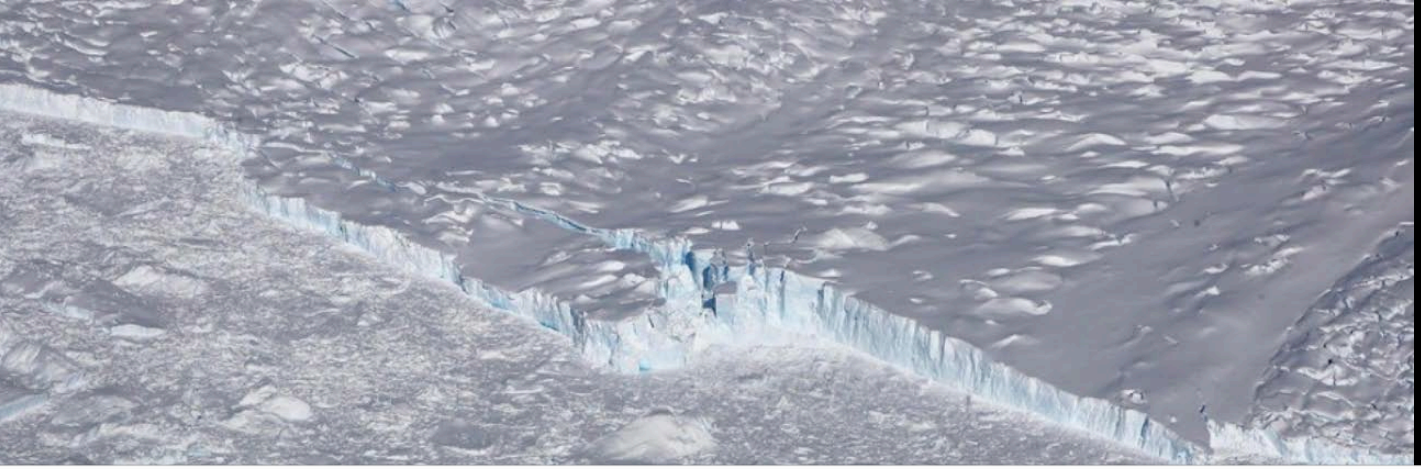
# Population Change in Europe Over Time




W. Langer 1964



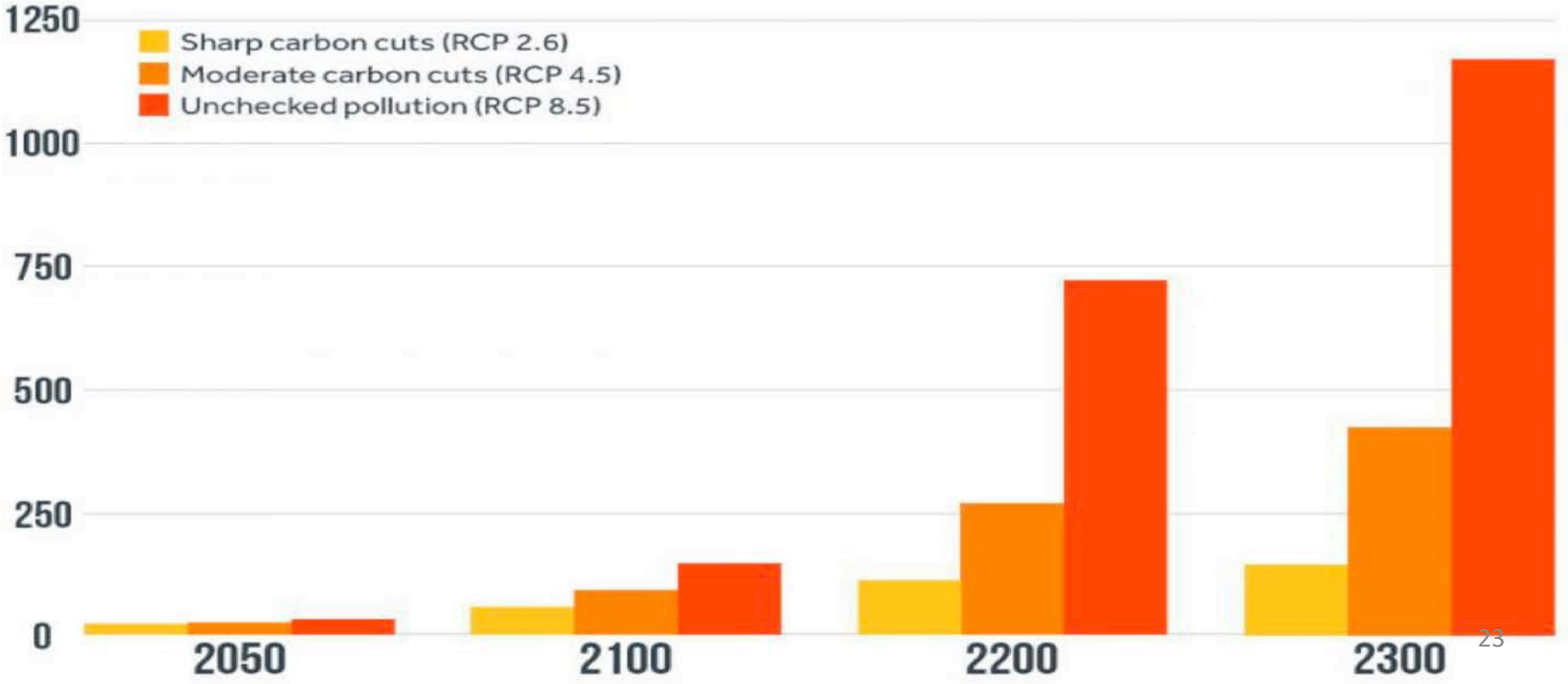

Acuna-Soto 2002



# Sea rise

**Median global sea-level rise projections**

Factoring in Antarctic research (centimeters)



# Global warming

*We are close to the tipping point where global warming becomes irreversible…to become like Venus with a temperature of 250 degrees and raining sulphuric acid.*

*S. Hawking 2016*

# genetic terrorism?

**Designer pathogens**

## The synthesis of horsepox virus and the failure of dual-use research oversight

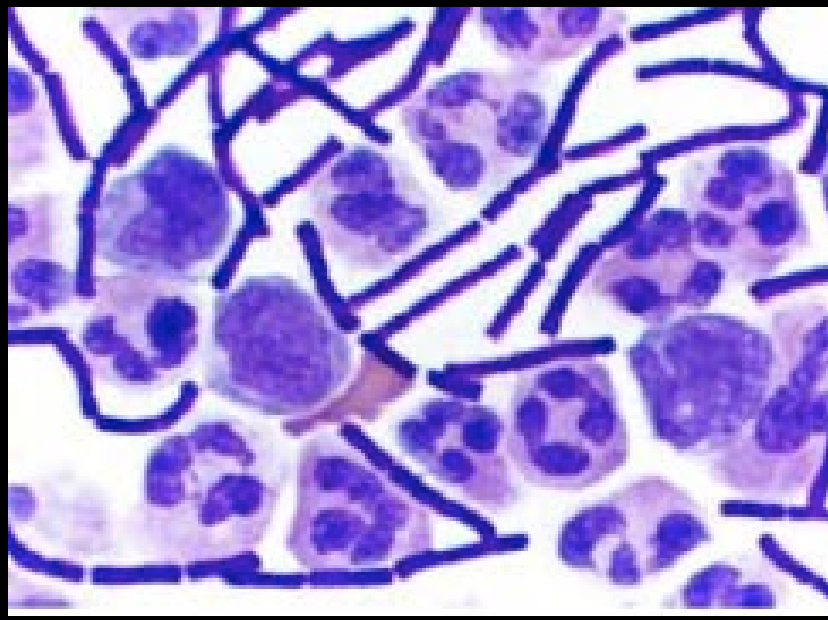
By Gregory Koblentz

Published 24 January 2018

Share |

**On 19 January 2018, the open access scientific journal *PLOS One* published an article that describes the de novo synthesis of horsepox virus, the first ever synthesis of a member of the orthopoxvirus family of viruses that includes the variola virus that causes smallpox. This research crosses a red line in the field of biosecurity. Given the high degree of homology between orthopoxviruses, the techniques described in this article are directly applicable to the recreation of variola virus. The synthesis of horsepox virus takes the world one step closer to the reemergence of smallpox as a threat to global health**

# Or just an accident?

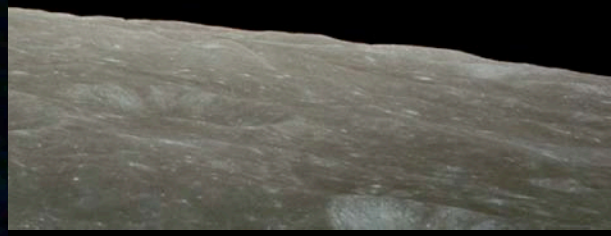



Anthrax virus

# Fragility

*Our posturings, our imagined self-importance, the delusion that we have some privileged position in the universe, are challenged by this point of pale light.*
Carl Sagan in Pale Blue Dot, 1994

Earth from Moon
by Apollo



Earth by Voyager
from 6 billion kilometers

# Large Hadron Collider: a threat to humanity?

# Could the LHC create miniblack holes?

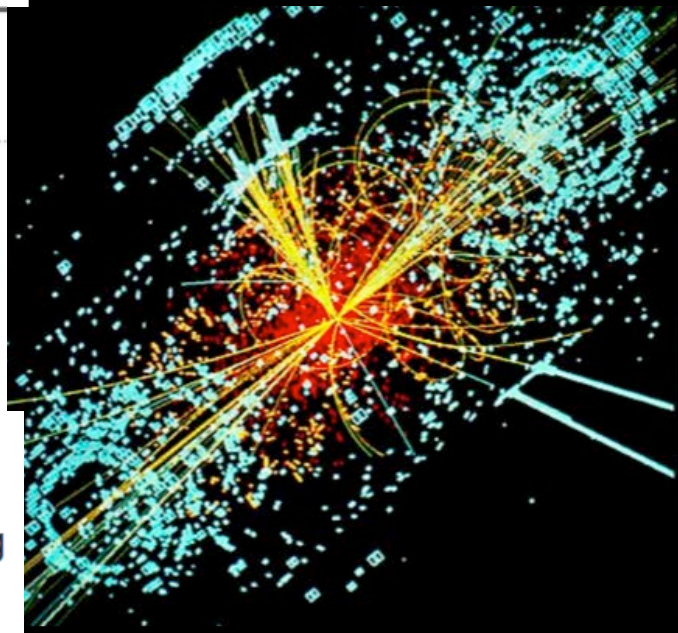
## Large Hadron Collider: Judge dismisses 'doomsday' lawsuit

By Catherine Elsworth in Los Angeles
3:00PM BST 29 Sep 2008

**By Catherine Elsworth in Los Angeles**

A judge in Hawaii has dismissed a so-called "doomsday" lawsuit seeking to halt operation of the Geneva-based atom-smashing Large Haldron Collider.

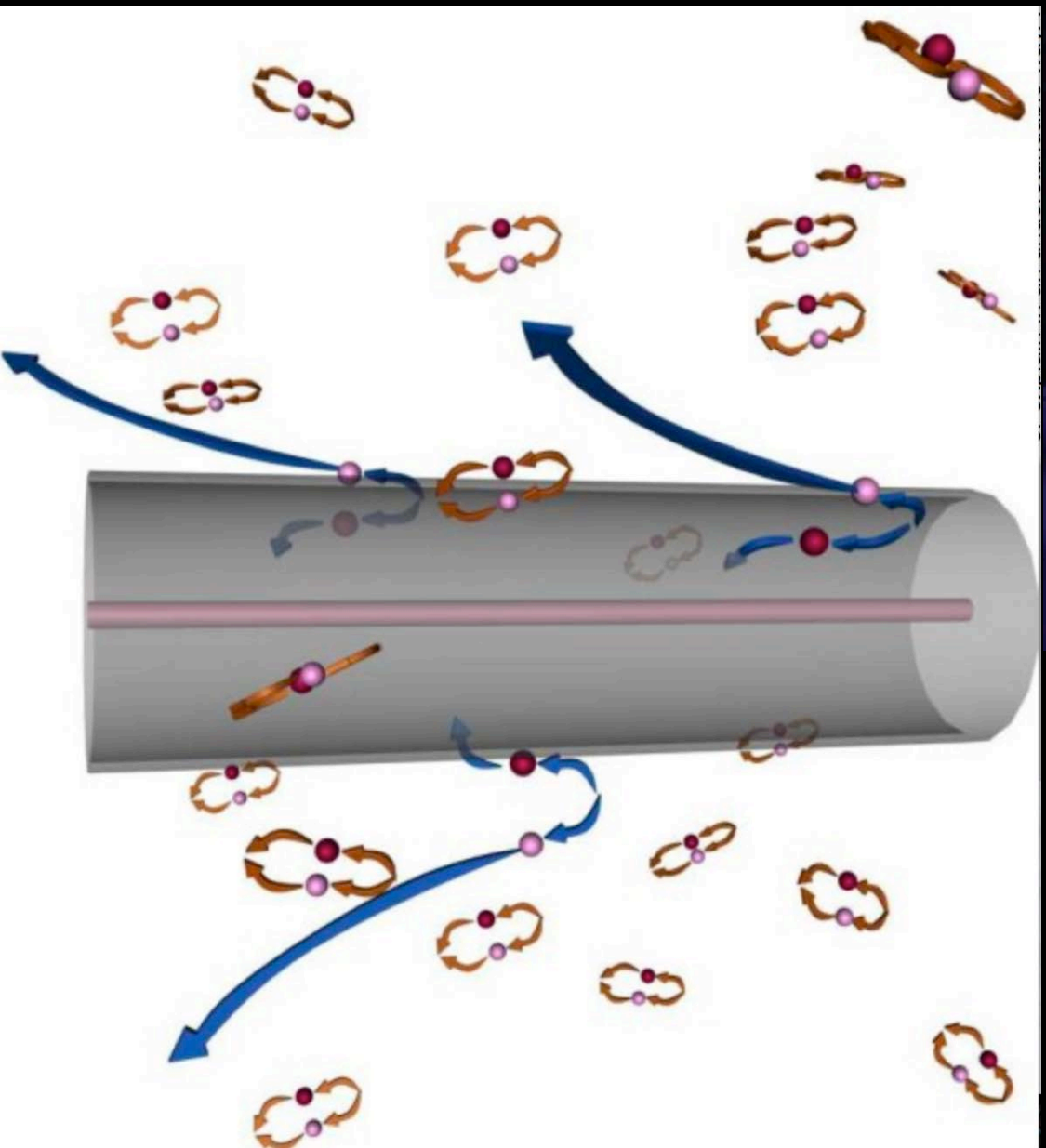
The two men who filed the suit, Walter Wagner, a retired nuclear safety officer, and Luis Sancho, a Spanish science writer, argued the vast experiment could create tiny black holes or trigger other matter-morphing effects that could threaten the Earth.



# Tiny black holes can be produced in colliders if extra dimensions exist

- $E=mc^2$ predicts a mass of $10^{-20}$gm for a particle collision of energy 14 TeV……..
- 1. but these evaporate rapidly by Hawking radiation

# Hawking radiation



Miniblack holes evaporate, very quickly!

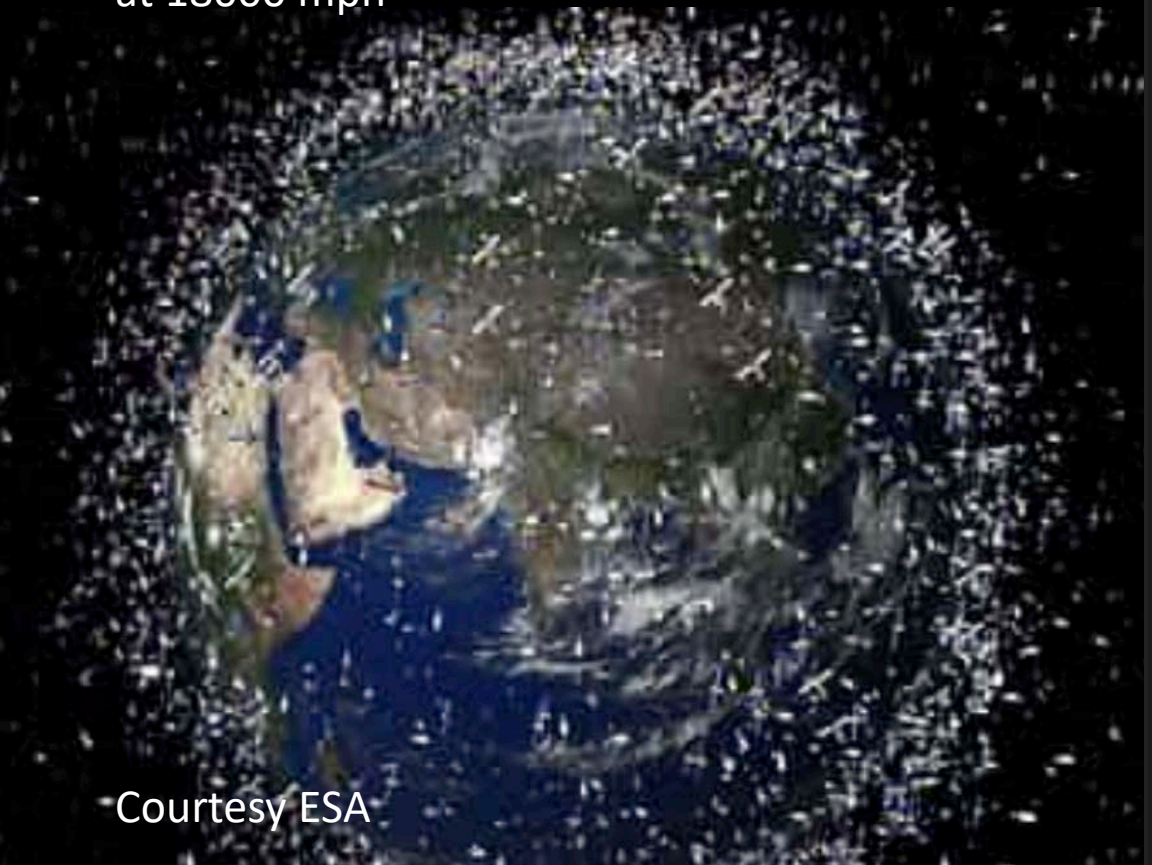
# Tiny black holes can be produced in colliders if extra dimensions exist

- $E=mc^2$ predicts a mass of $10^{-20}$gm for a particle collision of energy 14 TeV
- But
- 1. these evaporate rapidly by Hawking radiation
- 2. cosmic rays have bombarded the earth for billions of years at far higher energies, no black holes have been found
- 3. such a tiny black hole would accrete mass very slowly: the earth is safe

# Escape to Mars or beyond?

- Its dangerous!  space debris

180000  bits of metal
>10 cm
at 18000 mph



Courtesy ESA

S: Grey 2017

Space

# Apollo deep space astronauts five times more likely to die from heart disease

**First long-term study into health of Apollo crews shows deep space missions might take their toll, exposing astronauts to blood vessel-damaging radiation**

Nicola Davis
@NicolaKSDavis
Thu 28 Jul 2016
14.03 BST

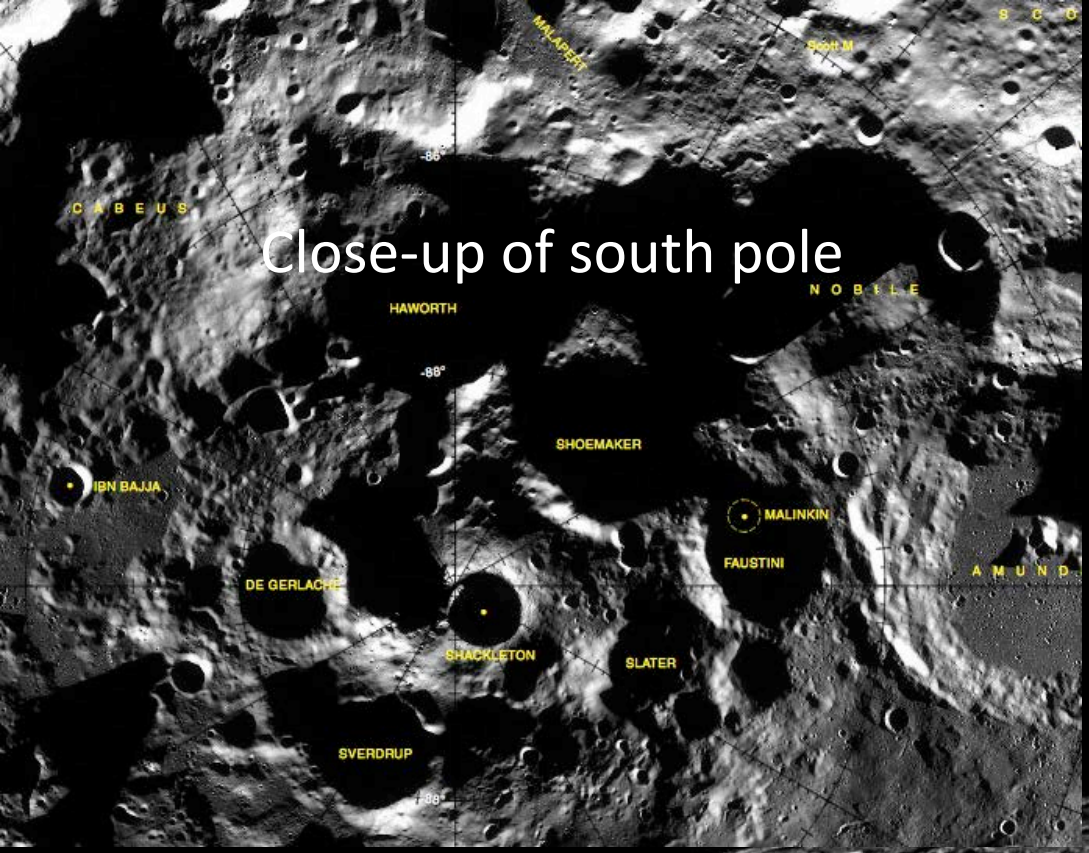


▲ A 1969 crew portrait of Apollo astronauts Neil Armstrong, left, Michael Collins, centre, and Buzz Aldrin. Photograph: AP/Nasa

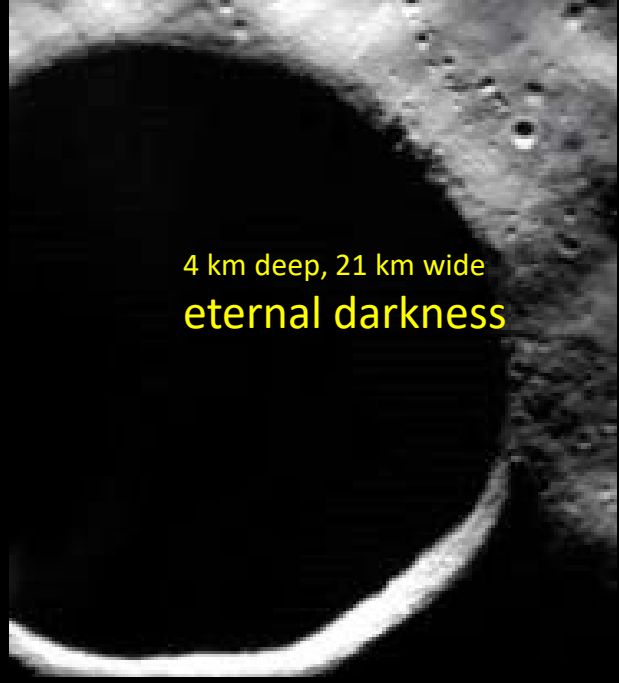
Travelling to the moon, Mars or beyond could dramatically increase an astronaut's risk of dying from cardiovascular disease, the first research into the long-term health of Apollo spacemen has revealed.

# First step: to the Moon!

- Ice in deep craters
- Hydrogen for rocket fuel, water, oxygen
- Fabrication of bricks
- Shade and proximity of solar power
- Helium-3 for clean thermonuclear power
- Mining of rare elements
- Hydroponic farms




Close-up of south pole

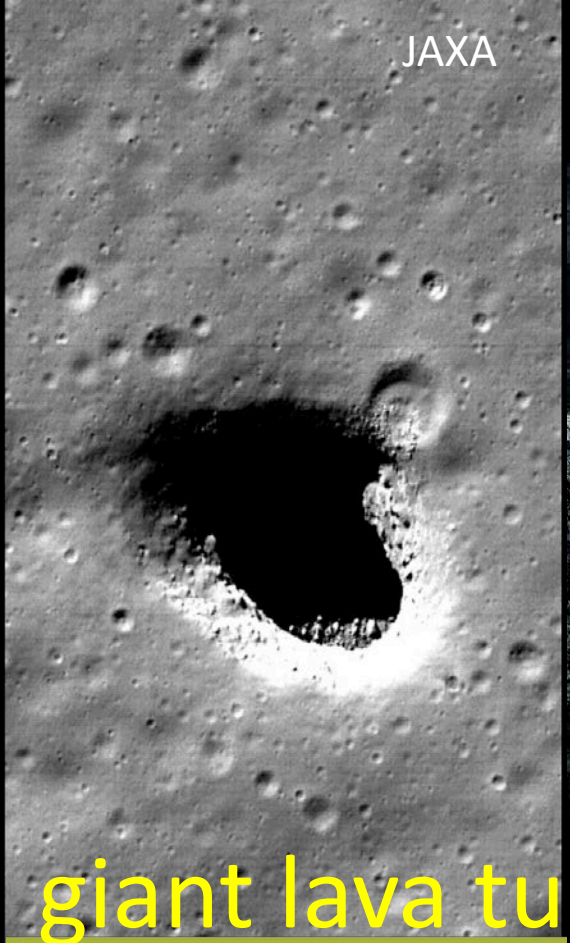


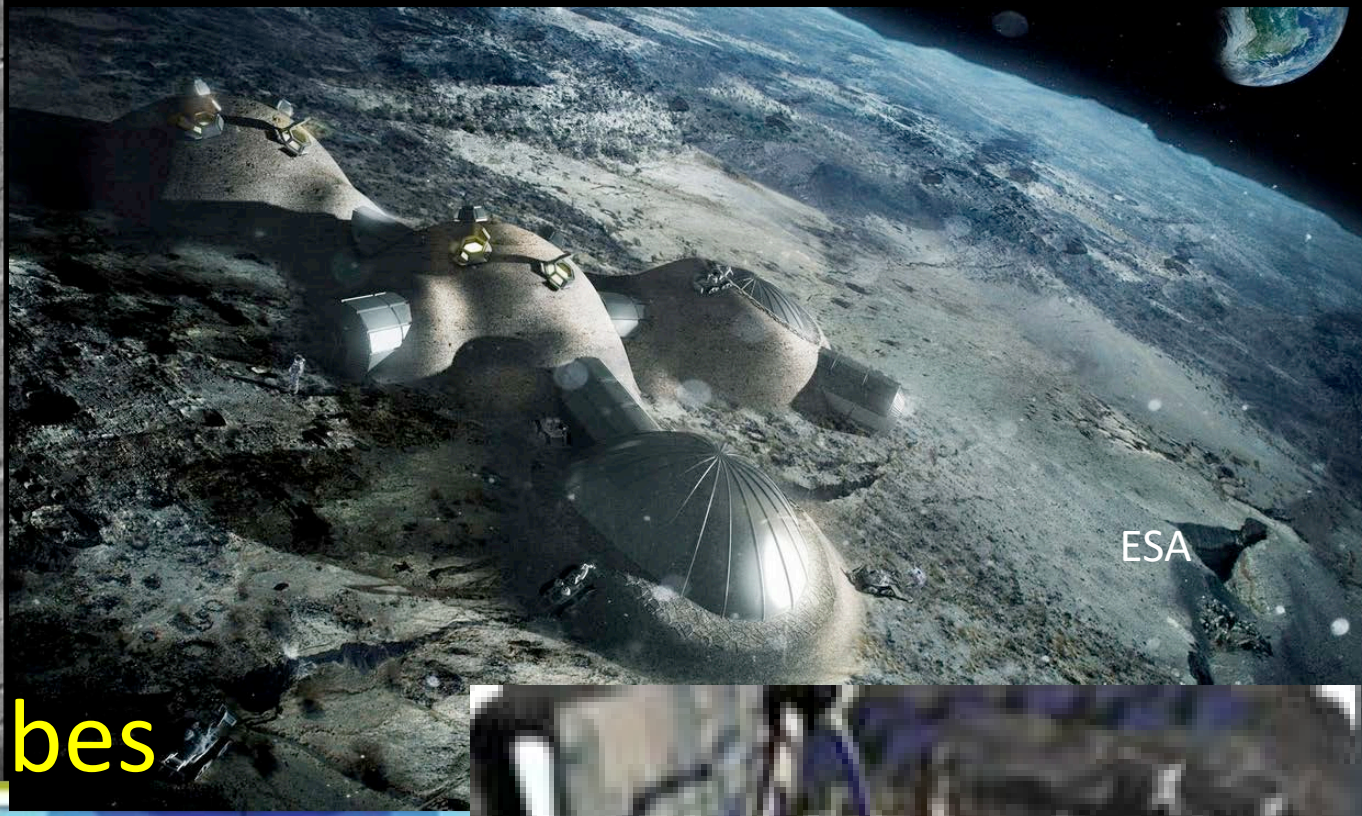
4 km deep, 21 km wide

eternal darkness

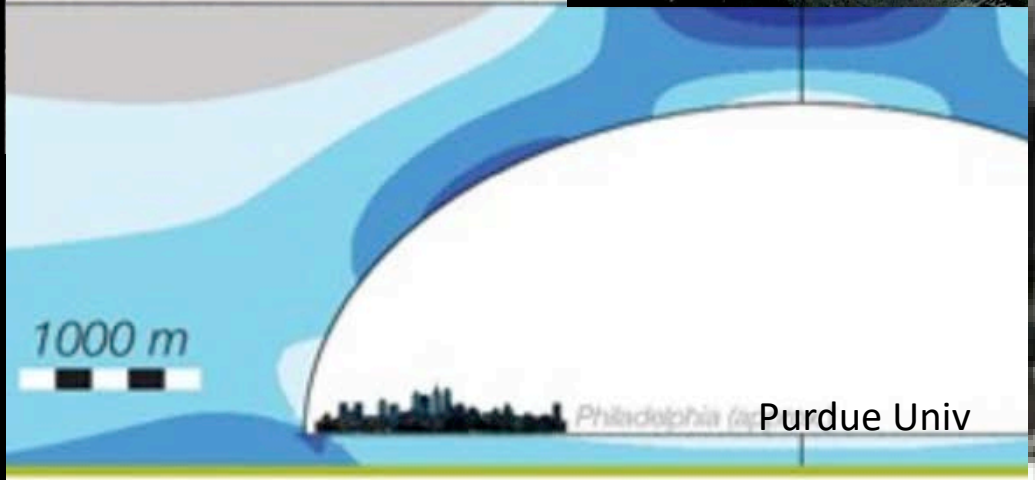
Close-up of north pole

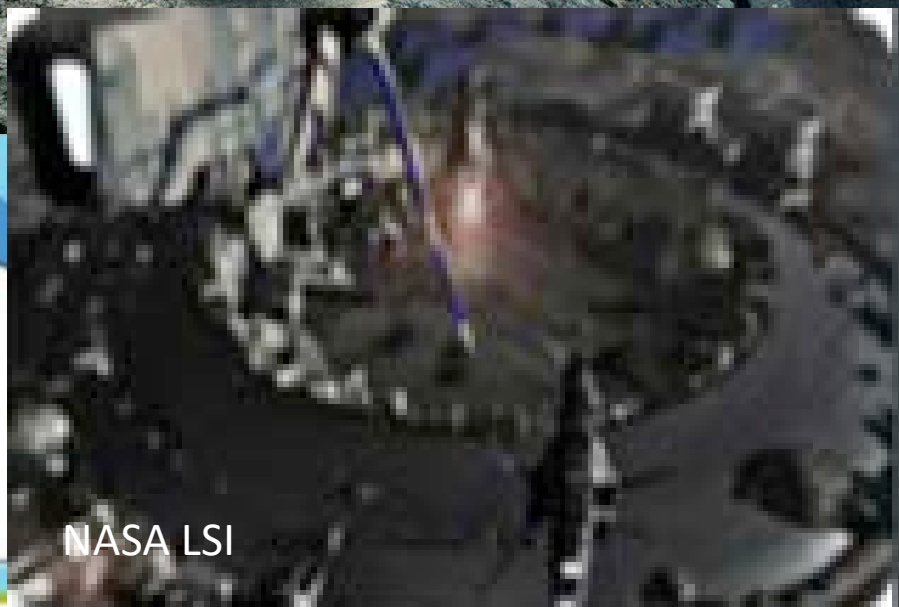
# ESA moon base, planned for 2040?




giant lava tubes



# a road to immortality

The INDEPENDENT

## Academics at Oxford Unive be cryogenically preserved be 'brought back to life in th

Some staff are having their heads frozen while others are havir procedure

Heather Saul

Tuesday, 11 June 2013

The belief that death is the only certainty in life is a concept senior academic staffs at an Oxford University Institute are hoping to dismantle, by paying to be cryogenically preserved and brought back to life in the future.

Nick Bostrom, professor of philosophy at the Future of Humanity Institute [FHI] and his co researcher Anders Sandberg have agreed to pay an American company to detach and deep freeze their heads in the advent of their deaths.

Colleague Stuart Armstrong is instead opting to have his whole body frozen. Preserving the full body is technically more difficult to achieve and can cost up to £130,000.

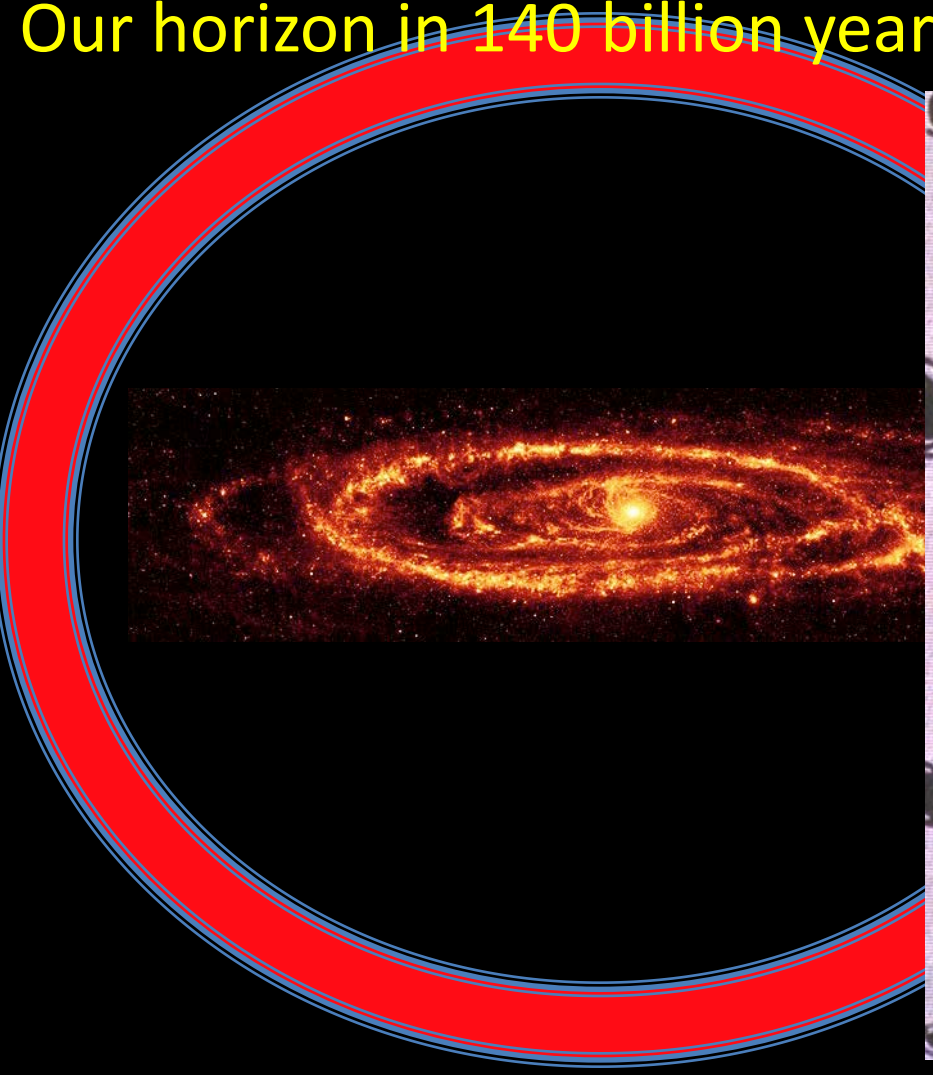
Alcor Life Extension Institute

# The very remote future

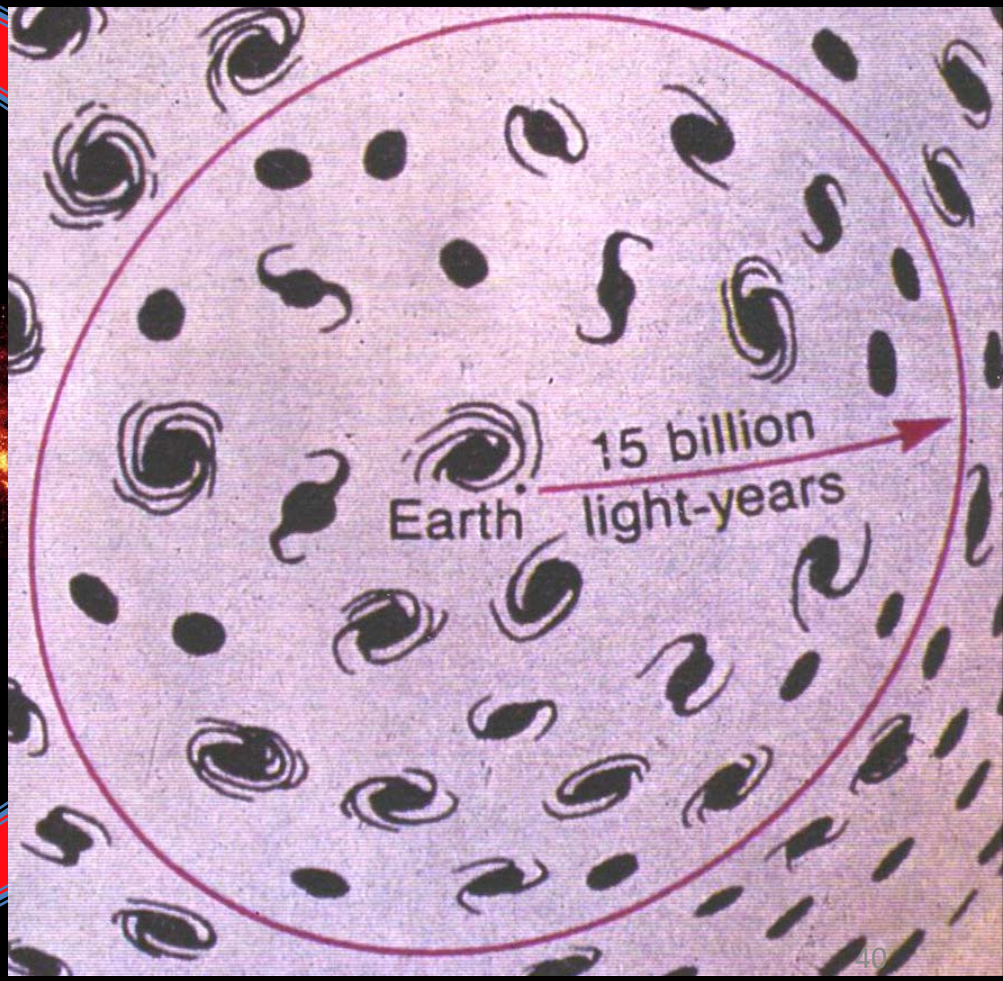
- The universe will grow darker and darker as the stars fade away, in about 100 billion years
- All galaxies will accelerate away from us
- The Milky Way will contain white dwarfs, neutron stars, black holes…and lots of planets

# the future of the universe

Our horizon in 140 billion years



today



# And in the really distant future

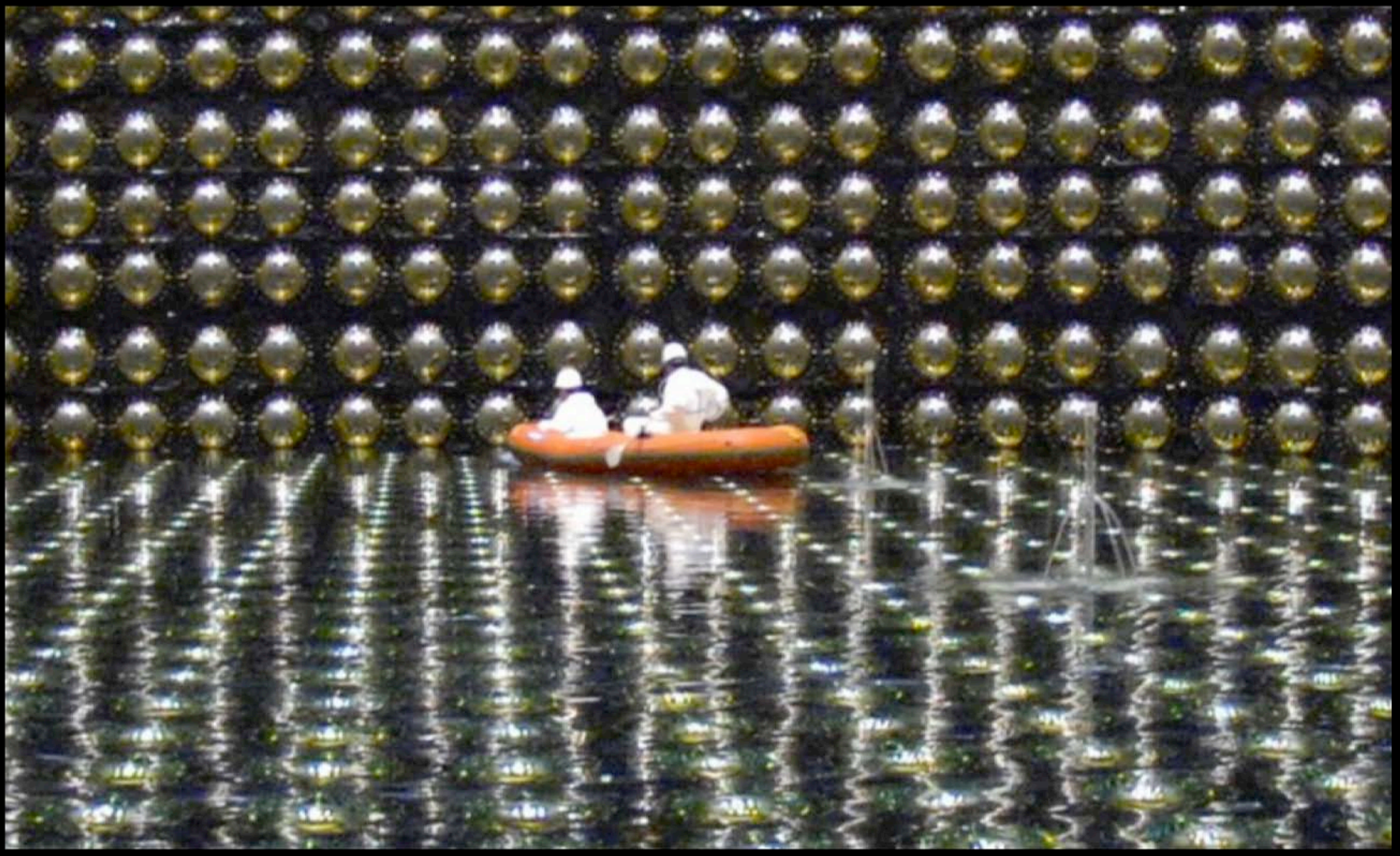
- protons decay in ~ $10^{36}$ yrs

  or a trillion trillion trillion years

2020:: Hyper-Kamiokande
with 500k tons of water

Super-Kamiokande, Japan, in an abandoned zinc mine monitors 50k tons of purified $H_2O$

Limit $>1.6 \times 10^{34}$ yrs

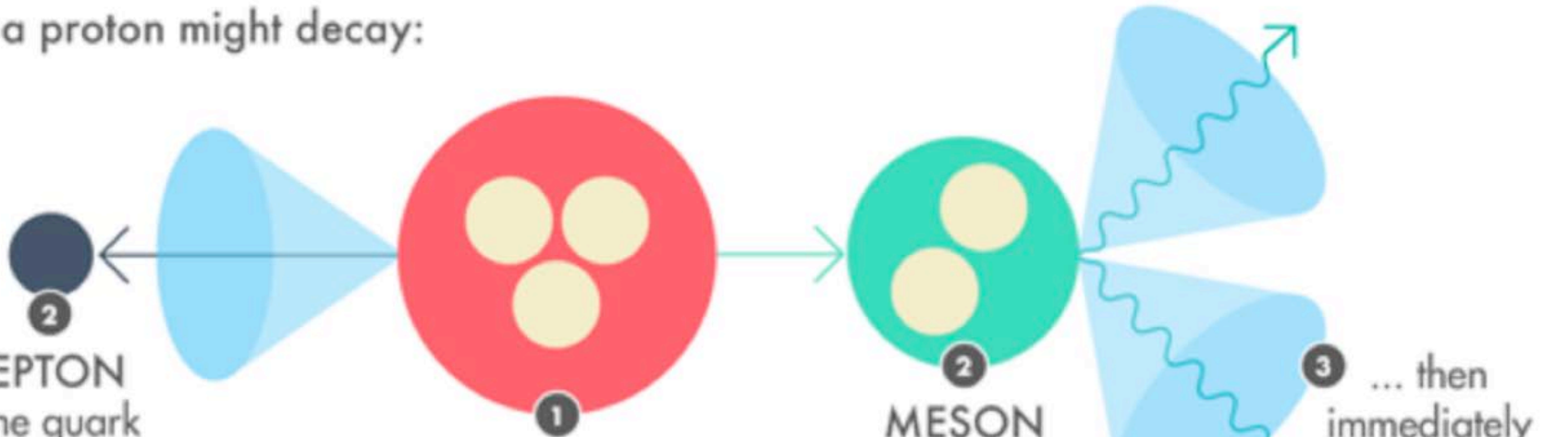


# Unification predicts protons decay in < $10^{36}$ yrs

## A PROTON'S FATE

Grand unified theories (GUTs) posit that a single initial fundamental force split into the strong, weak and electromagnetic forces that govern elementary particles today. If this is true, protons should decay when the grand unified force resurfaces, with a quark (the building block of protons) morphing into a corresponding lepton (the class of particles that includes electrons). The outgoing particles would generate three rings of blue light.

How a proton might decay:



# And in the really distant future

- protons decay in ~ $10^{36}$ yrs
- electrons are stable
- quantum fluctuations
- Boltzmann brains

# Boltzmann brains

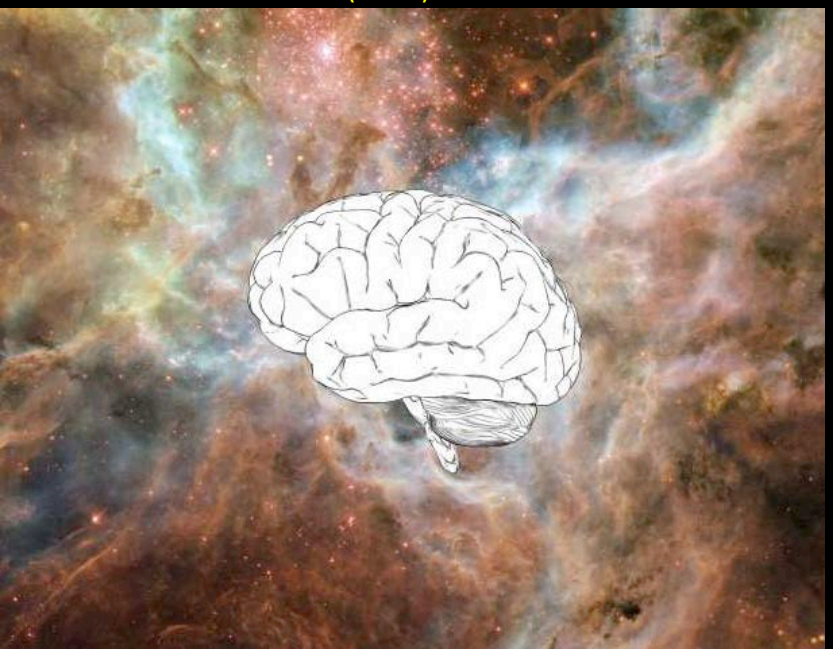
The second law of thermodynamics says we are very unlikely

All is chaos, we are a fluctuation

quantum gravity to the rescue!

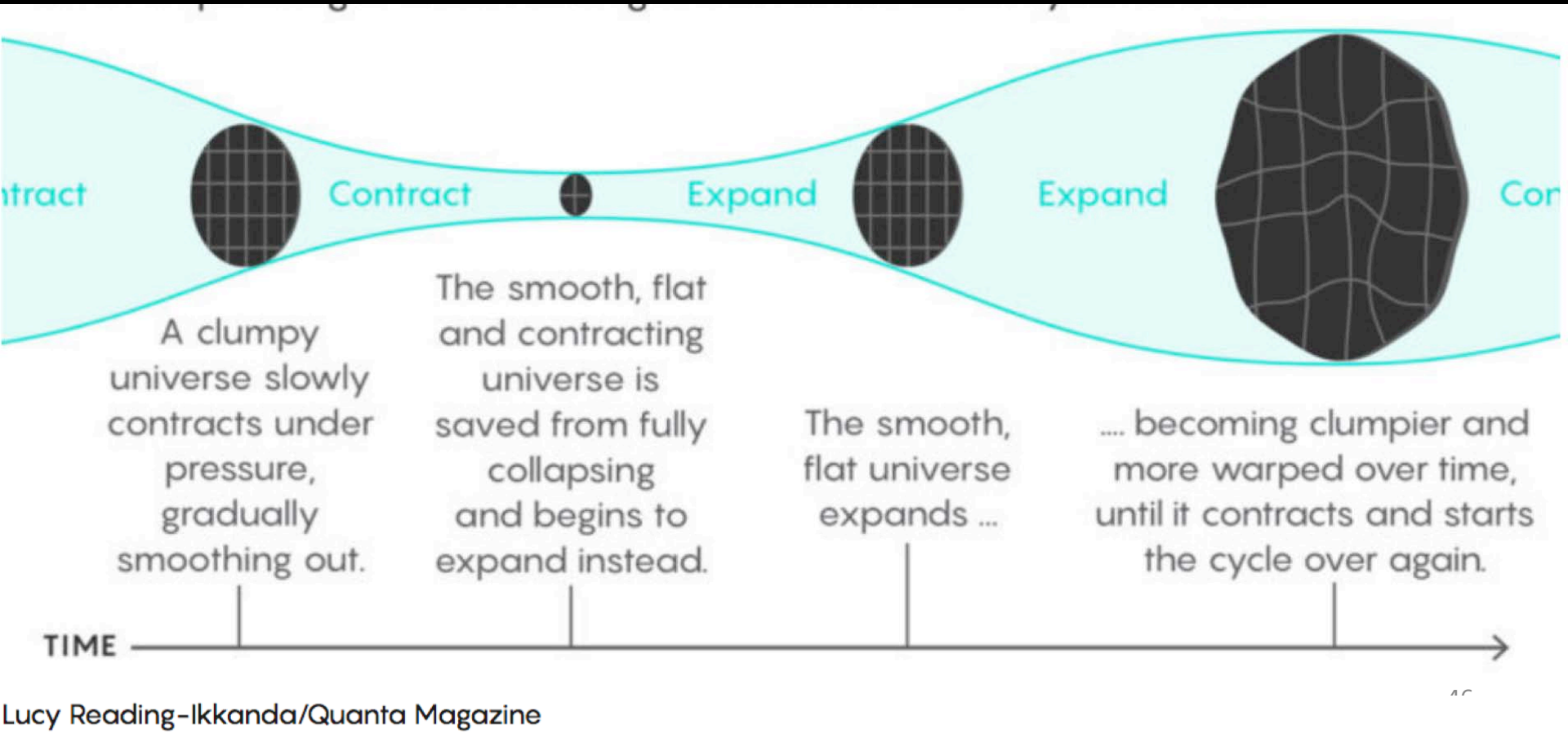
*The most likely fluctuation consistent with everything you know is simply your brain (complete with memories…) fluctuating briefly out of chaos and then immediately equilibrating back into chaos again.*

A. Albrecht and L. Sorbo (2004)



Ludwig Boltzmann
Austrian physicist 1844-1906

# A bouncing universe could recycle forever

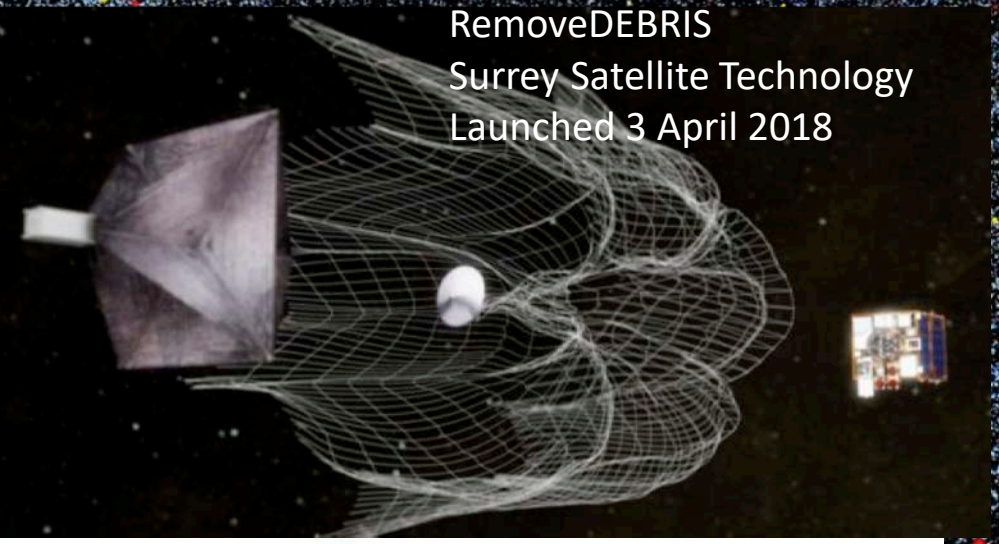



Lucy Reading-Ikkanda/Quanta Magazine

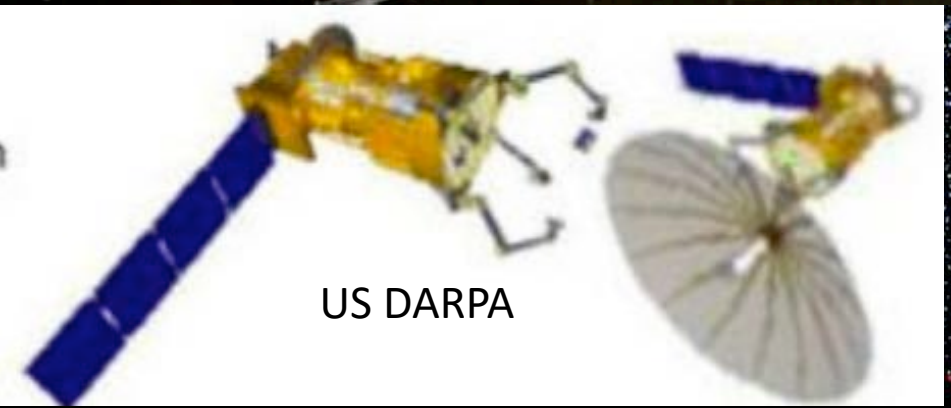
"Space-ship Earth" is hurtling through space. Its passengers are anxious and fractious. Their life-support system is vulnerable to disruption and breakdowns. But there is too little planning too little horizon-scanning, too little awareness of long-term risks.

Martin Rees 2015

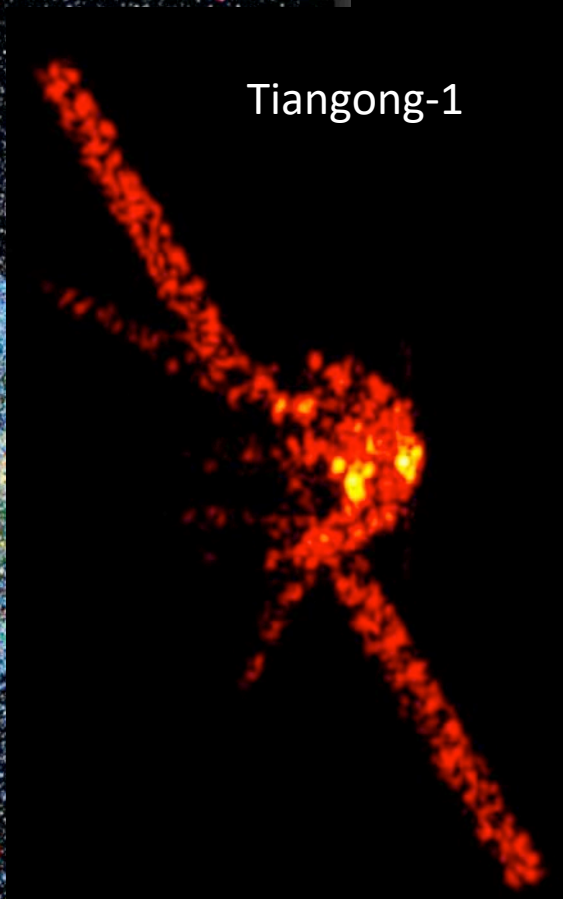
## Lets begin: space garbage, to be cleaned up….



RemoveDEBRIS
Surrey Satellite Technology
Launched 3 April 2018



US DARPA



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European Space Agency