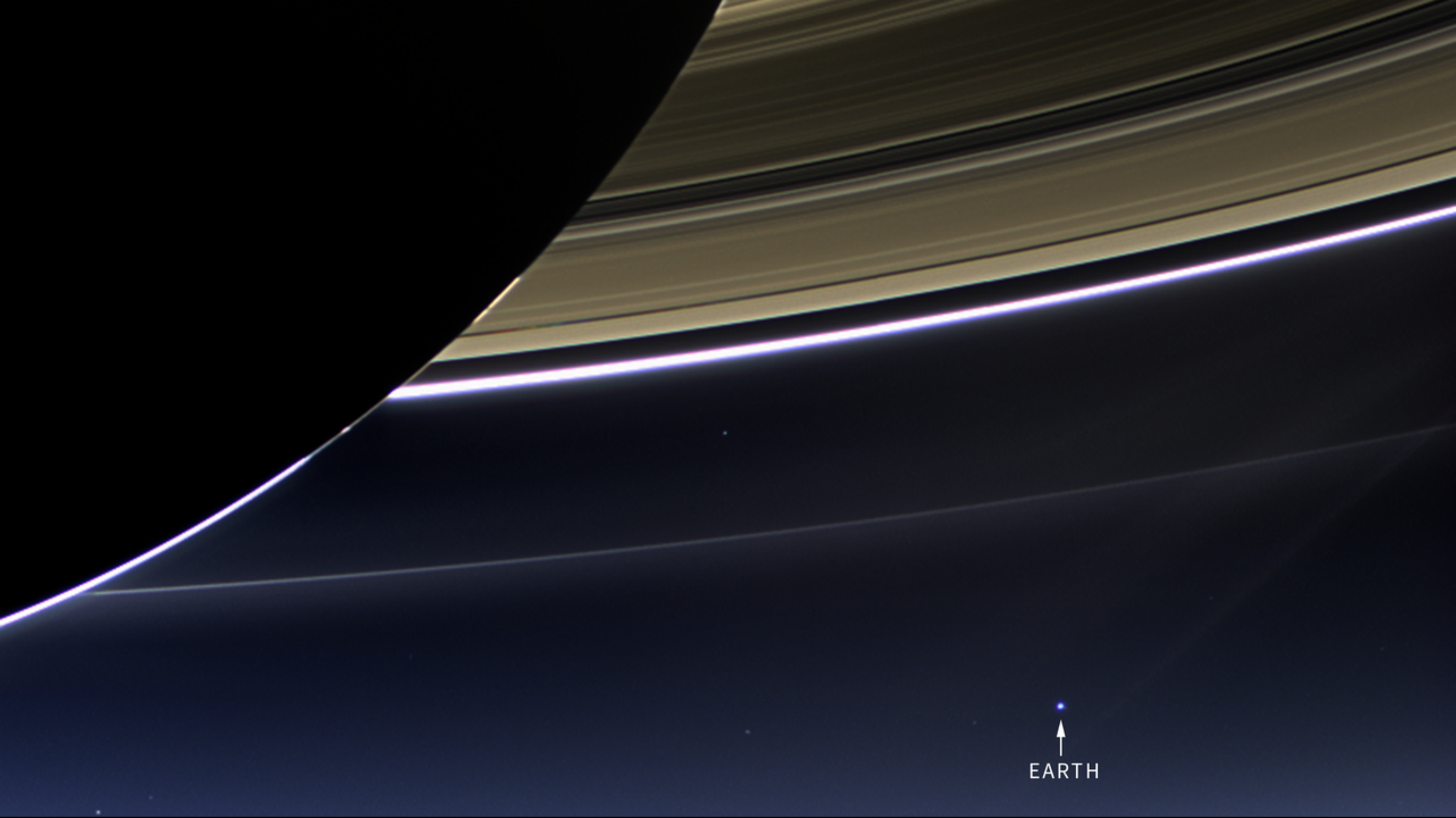
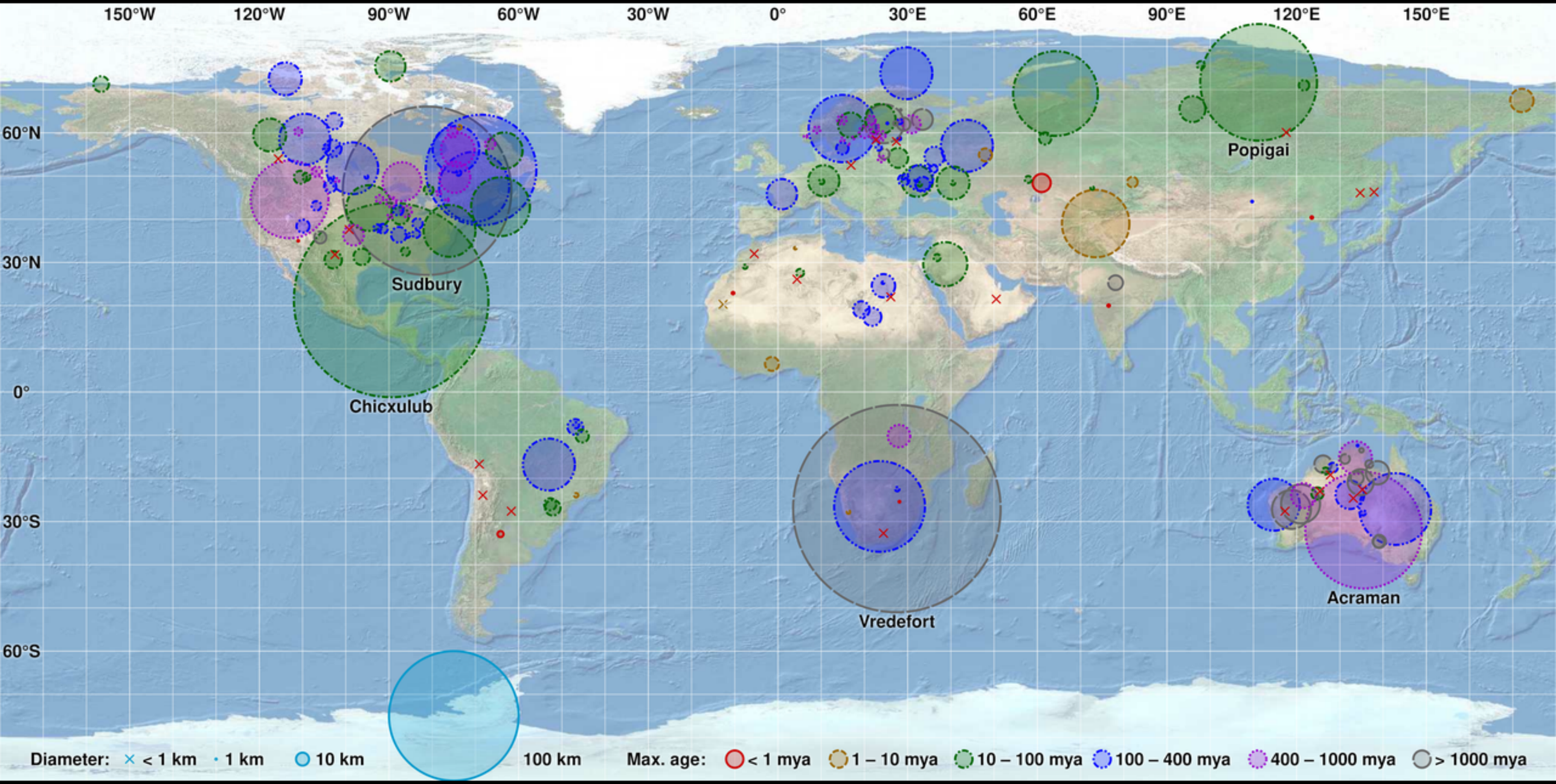
Humanity, Space, and Industrial Civilization

Marko Jukic

New York | November 14, 2026


EARTH

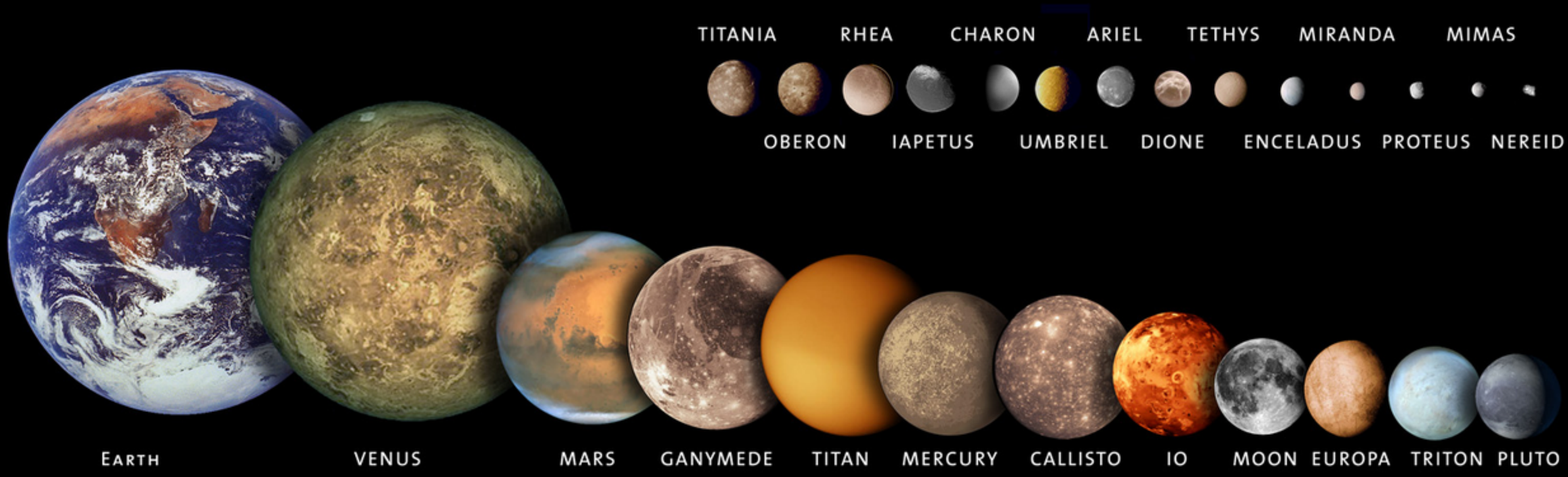



150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E
60°N
30°N
0°
30°S
60°S
Sudbury
Chicxulub
Popigai
Vredefort
Acraman
Diameter: < 1 km 1 km 10 km 100 km
Max. age: < 1 mya 1 – 10 mya 10 – 100 mya 100 – 400 mya 400 – 1000 mya > 1000 mya



The limit of physical possibility

- 2 trillion galaxies in the observable universe (radius of ~46.5 billion light-years)
- 6% of these are theoretically reachable: 120 billion reachable galaxies (radius of ~18 billion light-years)
- 1% of the reachable universe is ~1 billion galaxies
- The Milky Way has 100+ billion stars
- We live on one planet orbiting one star
- It will take 1 to 3 billion years for the Sun to make Earth uninhabitable


TITANIA
RHEA
CHARON
ARIEL
TETHYS
MIRANDA
MIMAS
OBERON
IAPETUS
UMBRIEL
DIONE
ENCELADUS
PROTEUS
NEREID
EARTH
VENUS
MARS
GANYMEDE
TITAN
MERCURY
CALLISTO
IO
MOON
EUROPA
TRITON
PLUTO

Energy and material resources

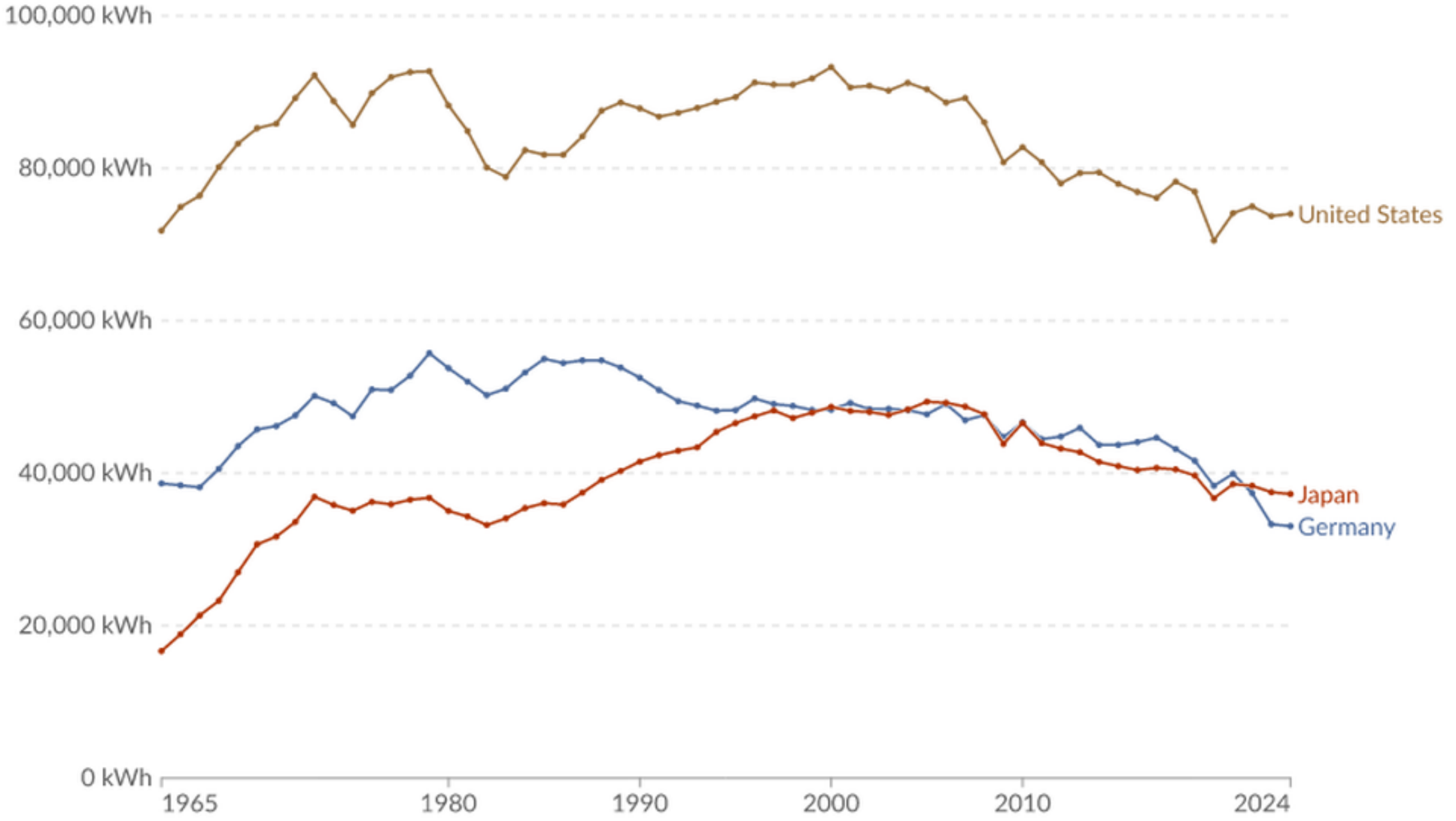
- Entire global energy consumption is ~150 petawatt-hours (PWh)
- Equivalent to 0.02% of the solar energy reaching the Earth’s surface (5,000× less)
- Earth’s crust makes up 0.5%–1% of the Earth’s mass
- 3.4 billion metric tons of matter in the Earth’s crust for every living person
- 2.6 billion metric tons of iron ore are mined every year



Primary energy use per person 1965 to 2024

Our World in Data

Measured in kilowatt-hours of total energy supply per person.



Data source: Energy Institute – Statistical Review of World Energy (2026) and other sources

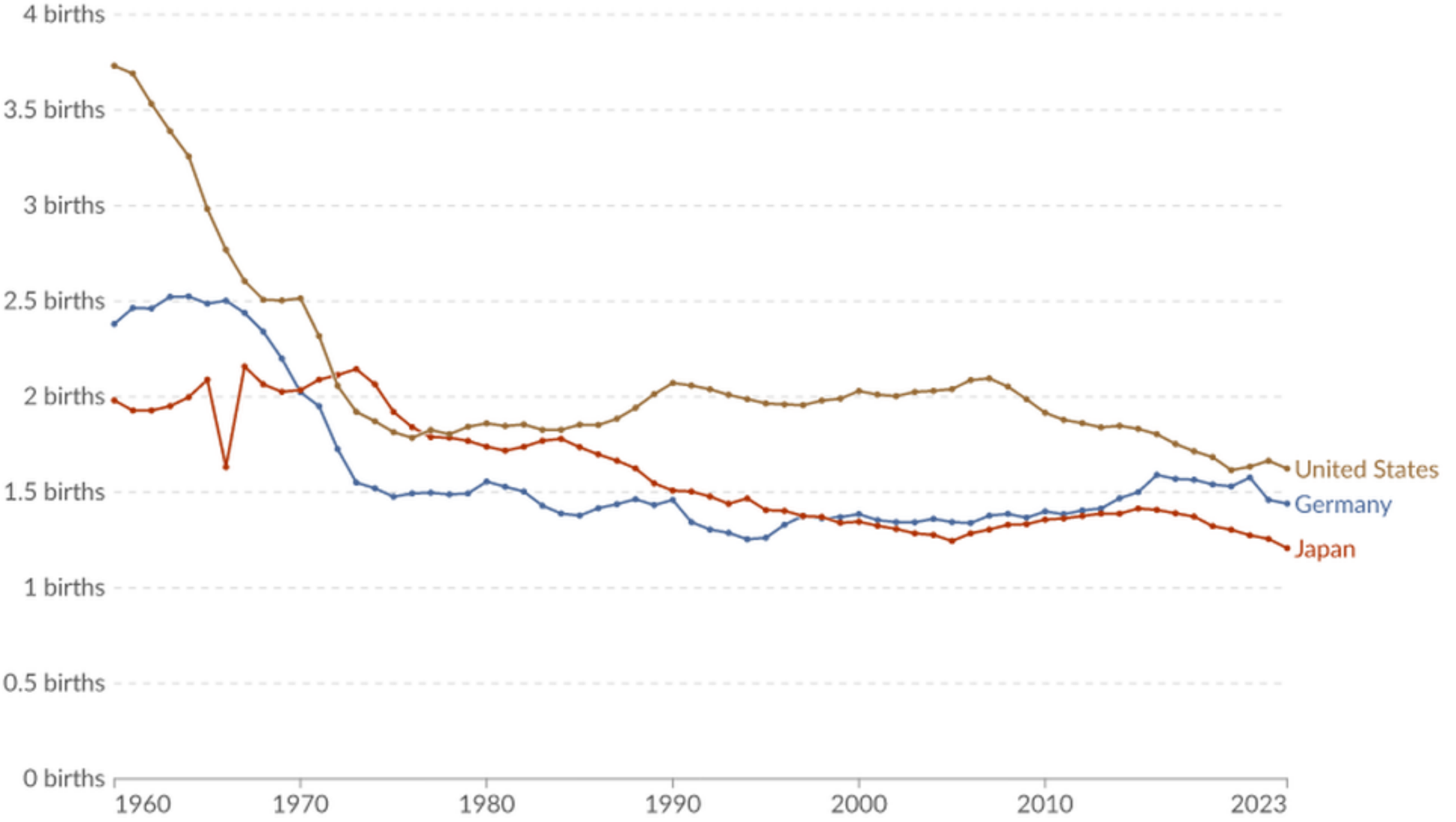
OurWorldinData.org/energy | CC BY

Note: Traditional biomass is not included.

Fertility rate: births per woman

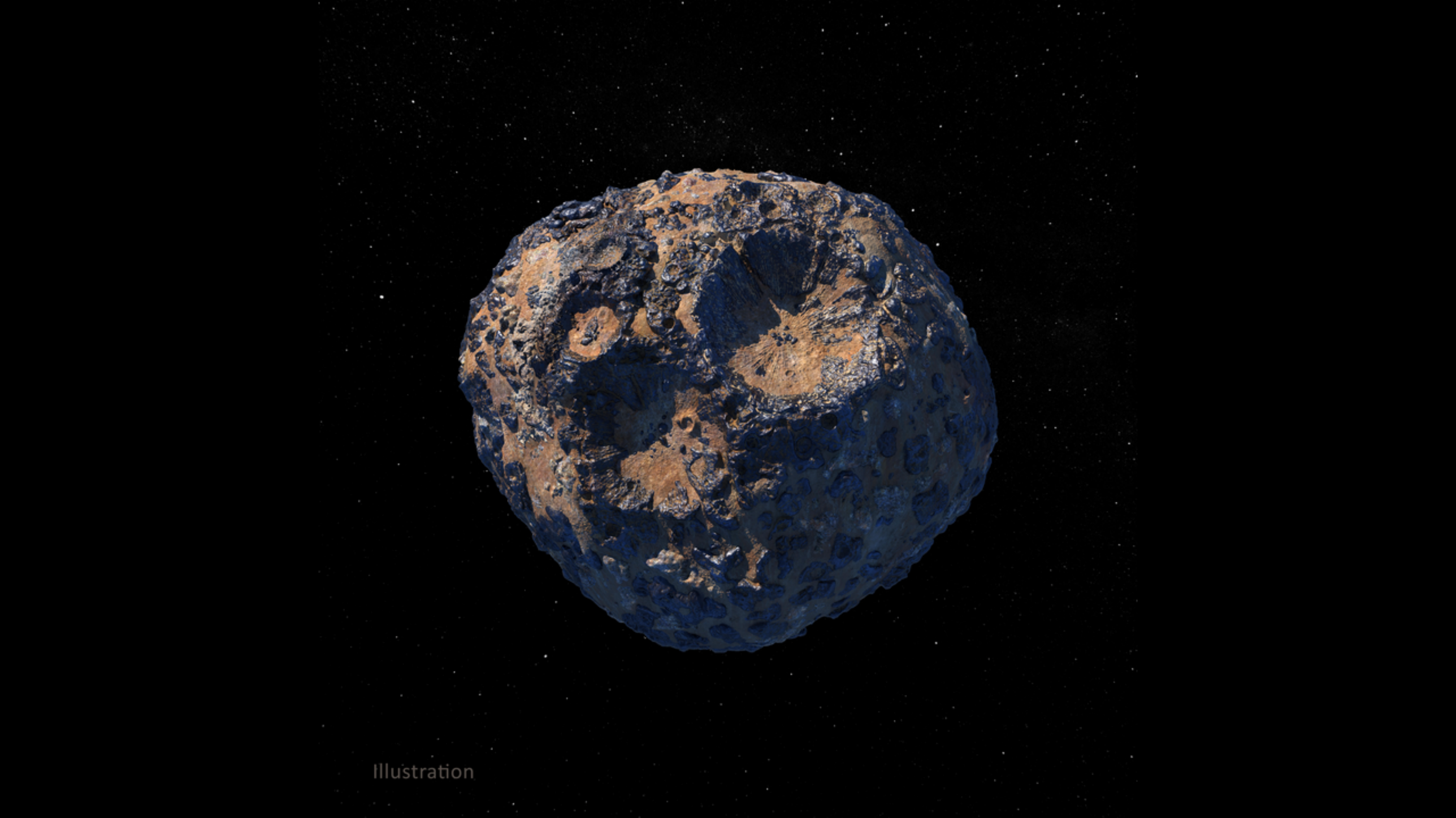
Our World in Data

The total fertility rate summarizes the total number of births a woman would have, if she experienced the birth rates seen in women of each age group in one particular year across her childbearing years.



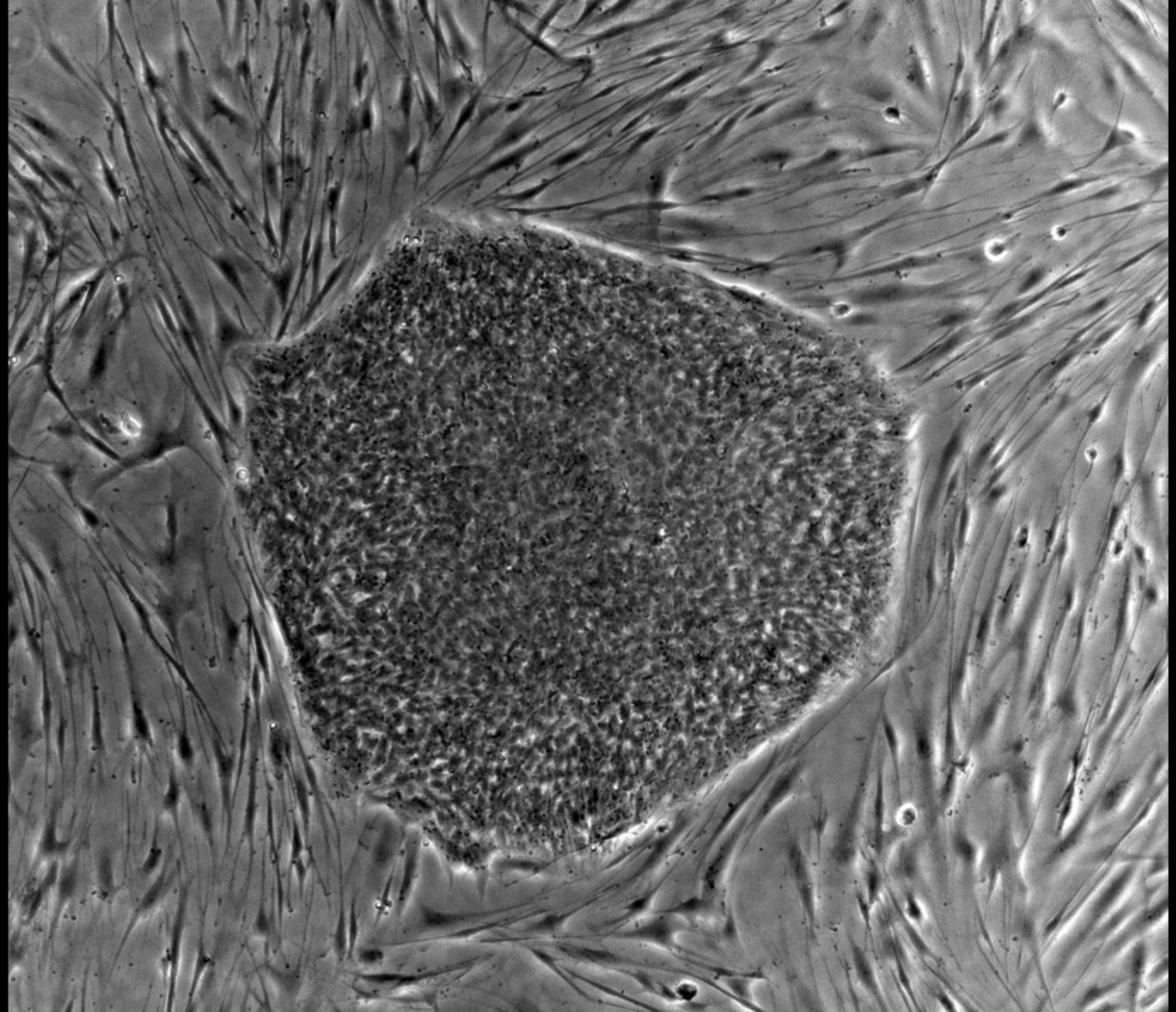
Data source: Human Fertility Database (2026); UN, World Population Prospects (2024)

OurWorldinData.org/fertility-rate | CC BY



Illustration





Sociality and toolmaking

- Sociality and toolmaking
- Artificial stupidity: predictable, reliable, standardized, manageably complex
- Material technology automates inert matter and energy
- Social technology automates the habits and behavior of other people
- All material technology is also social technology

Automation and human attention

- First iteration of an automated process is always the least efficient
- It requires the most un-automated human attention and labor
- Each subsequent iteration reduces marginal need for human labor
- We free up our remaining pool of human capital
- We can never reduce the need for human attention to zero because of entropy



Industry is dumb

Its designers are intelligent



Konstantin Tsiolkovsky

1903



Robert Goddard

1912



Hermann Oberth

1920



Sergei Korolev

Soviet space program



Wernher von Braun

NASA

“Virtually all of the civilian experimenters and promoters were much more interested in what the rocket could do, theoretically at least, to further their dreams of visiting the Moon and planets, than in rocketry itself.”

— Wernher von Braun



Tsiolkovsky's 16-point plan for space exploration (1926)

1. Design of rocket-propelled airplanes with wings.
2. Progressively increasing the speeds and altitudes reached with these airplanes.
3. Designing of a pure rocket without wings.
4. Developing the ability to land on the ocean surface by rocket.
5. Reaching of escape velocity and first flight into space.

[...]

14. Achievement of individual and social perfection.
15. Overcrowding of the solar system and galaxy colonization.
16. The sun begins to die and the people remaining in the solar system's population move to other solar systems.

Oberth's private ideas for topics to cover to promote space travel (1924)

- Rocket physics
- Habitability of other planets
- Is there a soul?
- The enigma of the universe
- Mechanical effects for the phenomena of consciousness
- Telepathy
- Why do all religions locate the seat of the good angels up above?
- The fiasco of the religions of revelation
- Parapsychologic experiments beyond the atmosphere of the Earth

Hanns Hörbiger

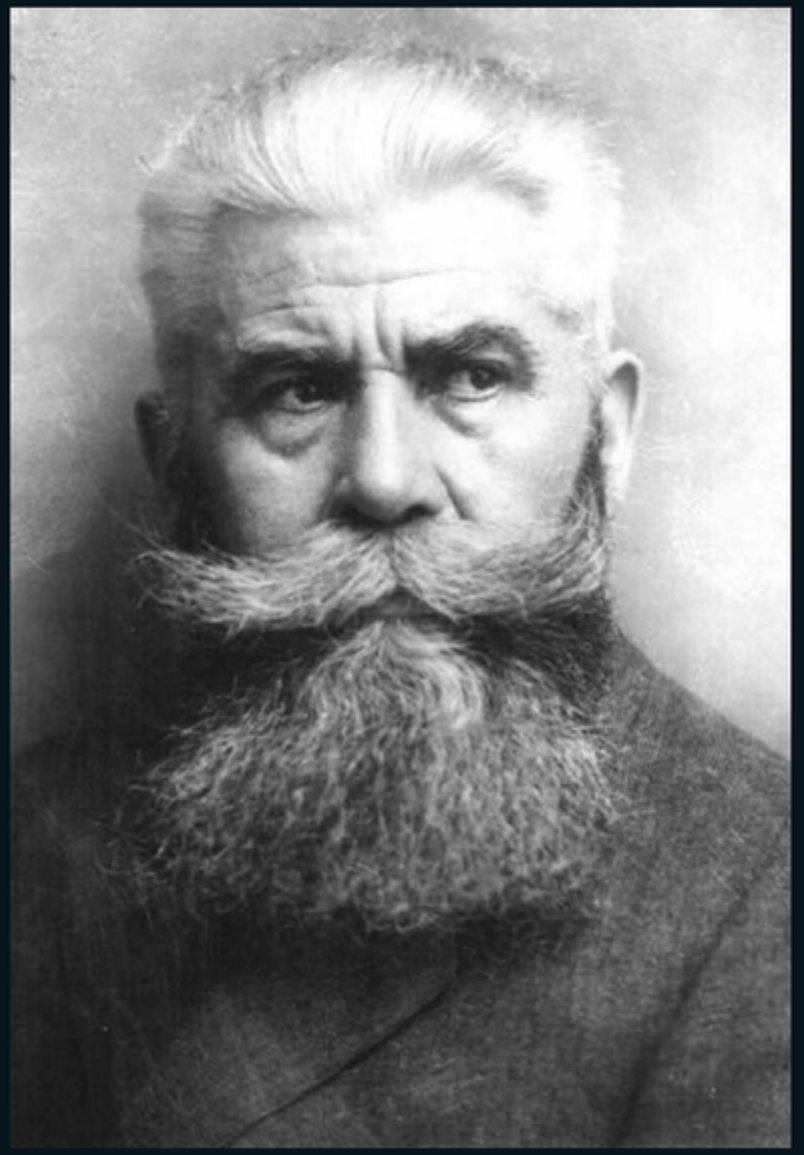
World Ice Theory

A discredited cosmology that cast ice as the key to the cosmos and Earth's catastrophes.

Max Valier supported rocketry partly to test whether the Moon had an icy crust.

"a new vision of the world and a new philosophy of life"

Max Valier to Hermann Oberth | 10 February 1924

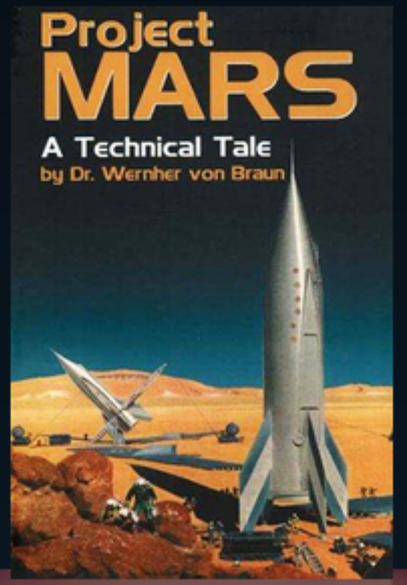


“...animated by secret visions of reaching into the heavens, of bringing their fellow men closer to what all our primitive ancestors felt was the outward manifestation of the Deity, and which was by them so worshiped.”

“...final confirmation of the universally held, deep, religious conviction that God had created Man in His own image, wherever Man was to be found.”

“...brought together the germ plasms of rational creation in our solar system that they may thrive and grow into a higher and more noble organism, which shall envelop the depths of space.”

— Wernher von Braun



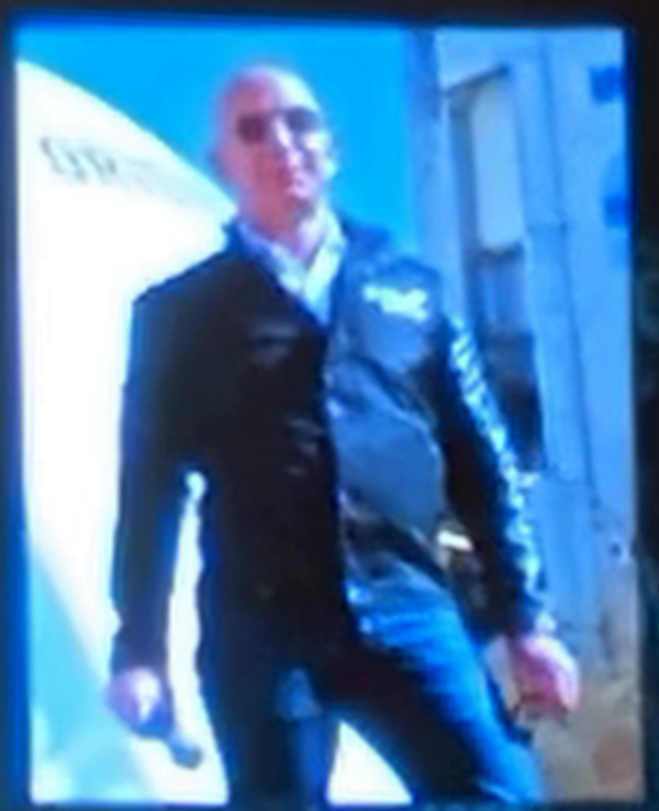






Elon Musk

SpaceX



Jeff Bezos

Blue Origin



Restrictions on industrial development

- 1970: Environmental Protection Agency — chemicals
- 1972: SALT I and Anti-Ballistic Missile Treaty — rocketry
- 1973: FAA bans supersonic jets overland — flight
- 1974: Nuclear Regulatory Commission — nuclear power
- 1979: Acronym NIMBY first appears in print — construction
- 1990: First carbon tax introduced in Finland — hydrocarbons
- 1922: Washington Naval Treaty — battleships and aircraft carriers
- 1938: Food, Drug, and Cosmetic Act — pharmaceuticals/biotech

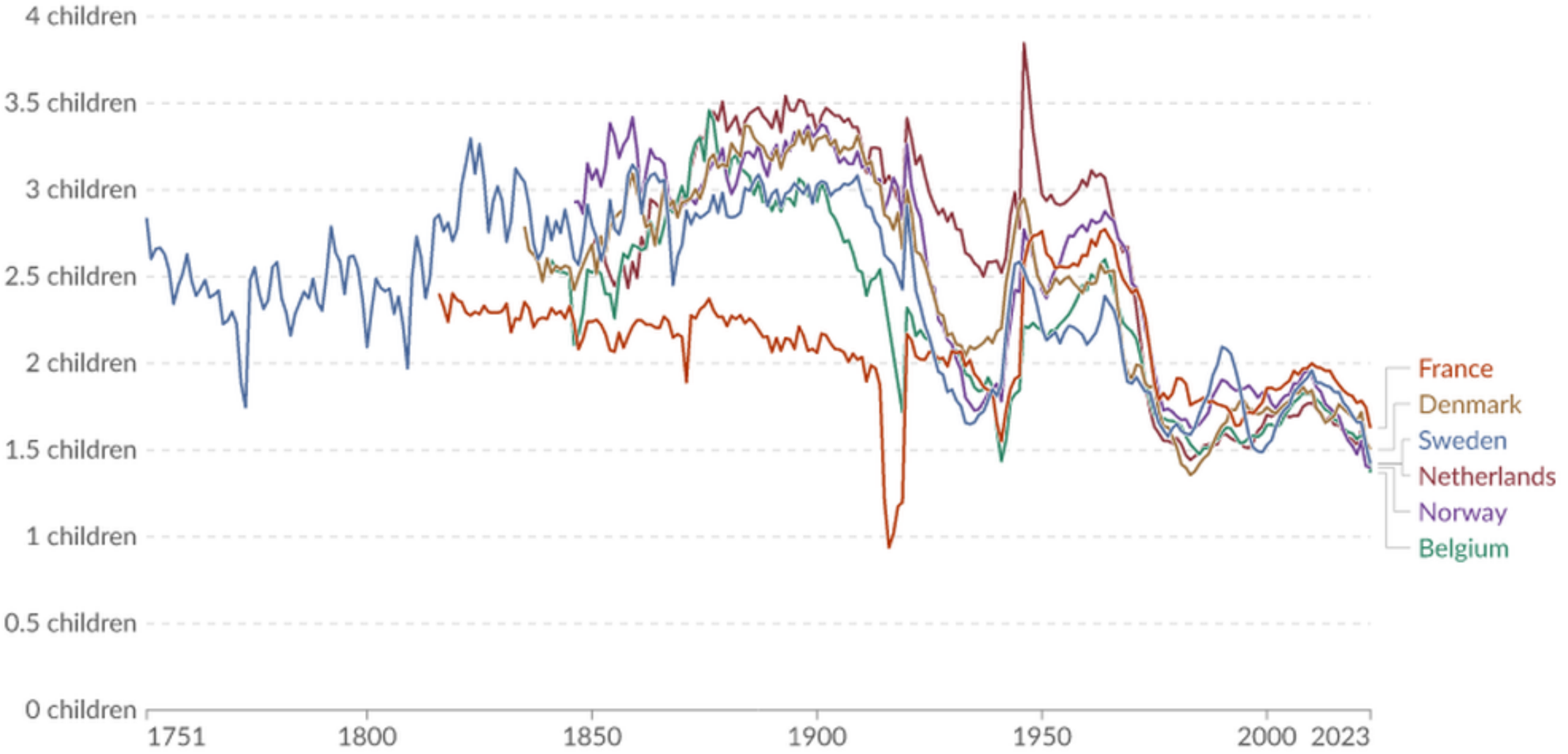
Restrictions on industry and population

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- 1968: The Population Bomb
- 1972: The Limits to Growth
- 1975: India begins sterilization campaigns
- 1979: One-Child Policy in China

Fertility rate accounting for survival until childbearing age

Our World in Data

While the total fertility rate considers all births, this measure of the effective fertility rate considers how many children per woman are expected to survive to childbearing age, using historical data and projections of mortality rates.



Data source: Malani and Jacob (2024); UN, World Population Prospects (2024); Human Mortality Database (2025)

Note: Childbearing age is defined by the authors as 15–49 years old, and the average survival across the age range is used.

OurWorldinData.org/fertility-rate | CC BY

Restrictions on industry and population

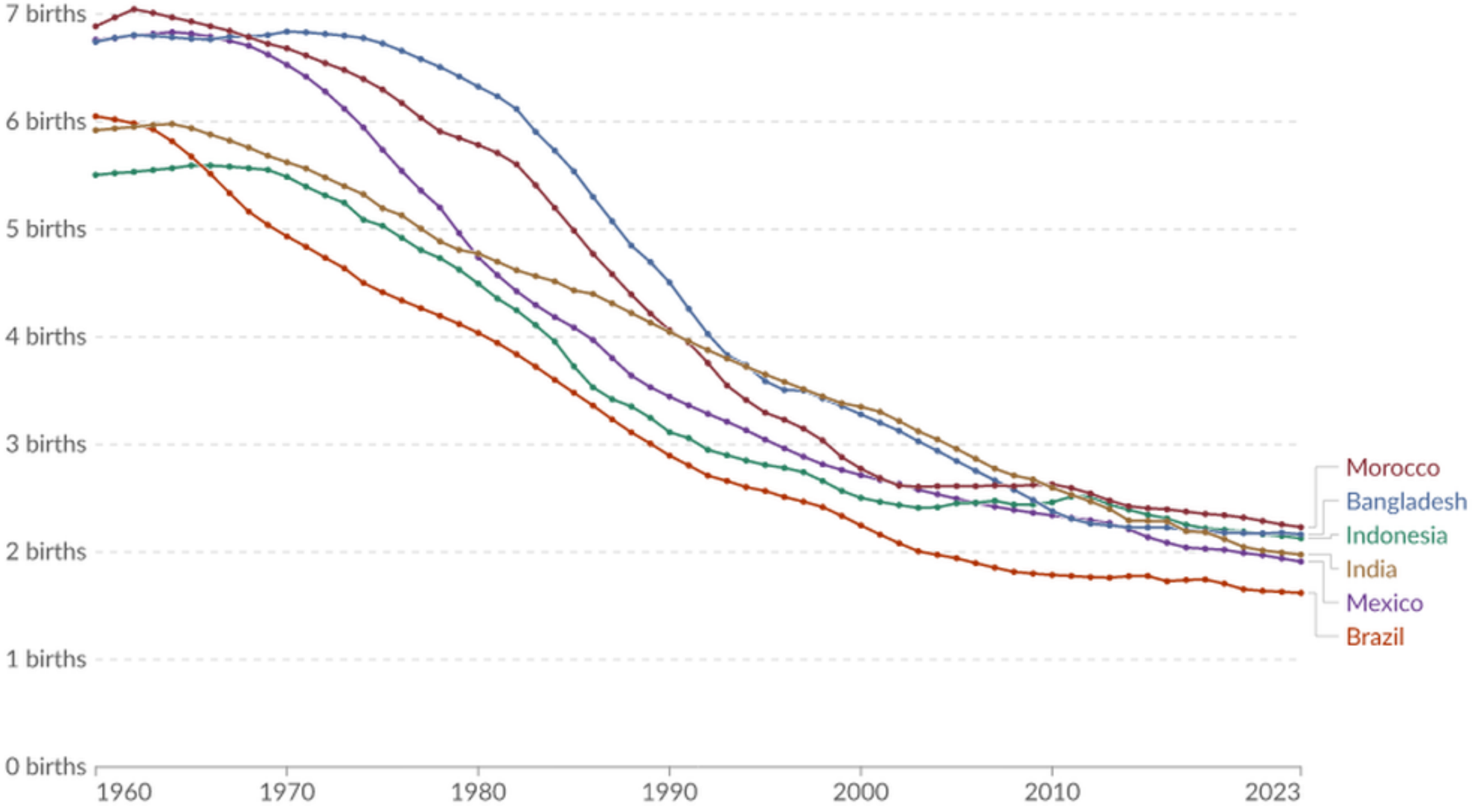
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- 1972: The Limits to Growth — people
- 1975: India begins sterilization campaigns — people
- 1979: One-Child Policy in China — people

A fake economy running harder to stay in place

Fertility rate: births per woman

Our World in Data

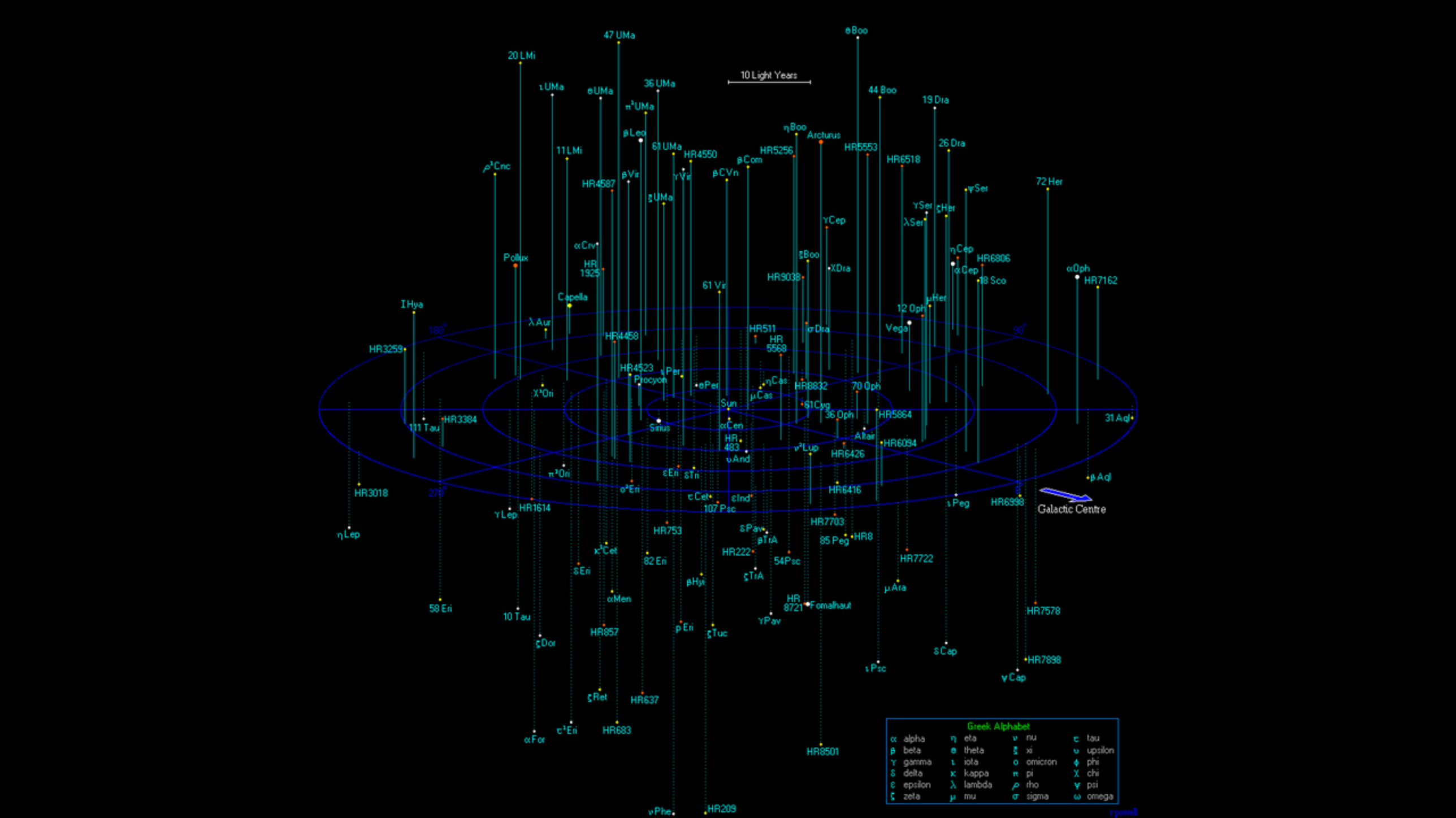
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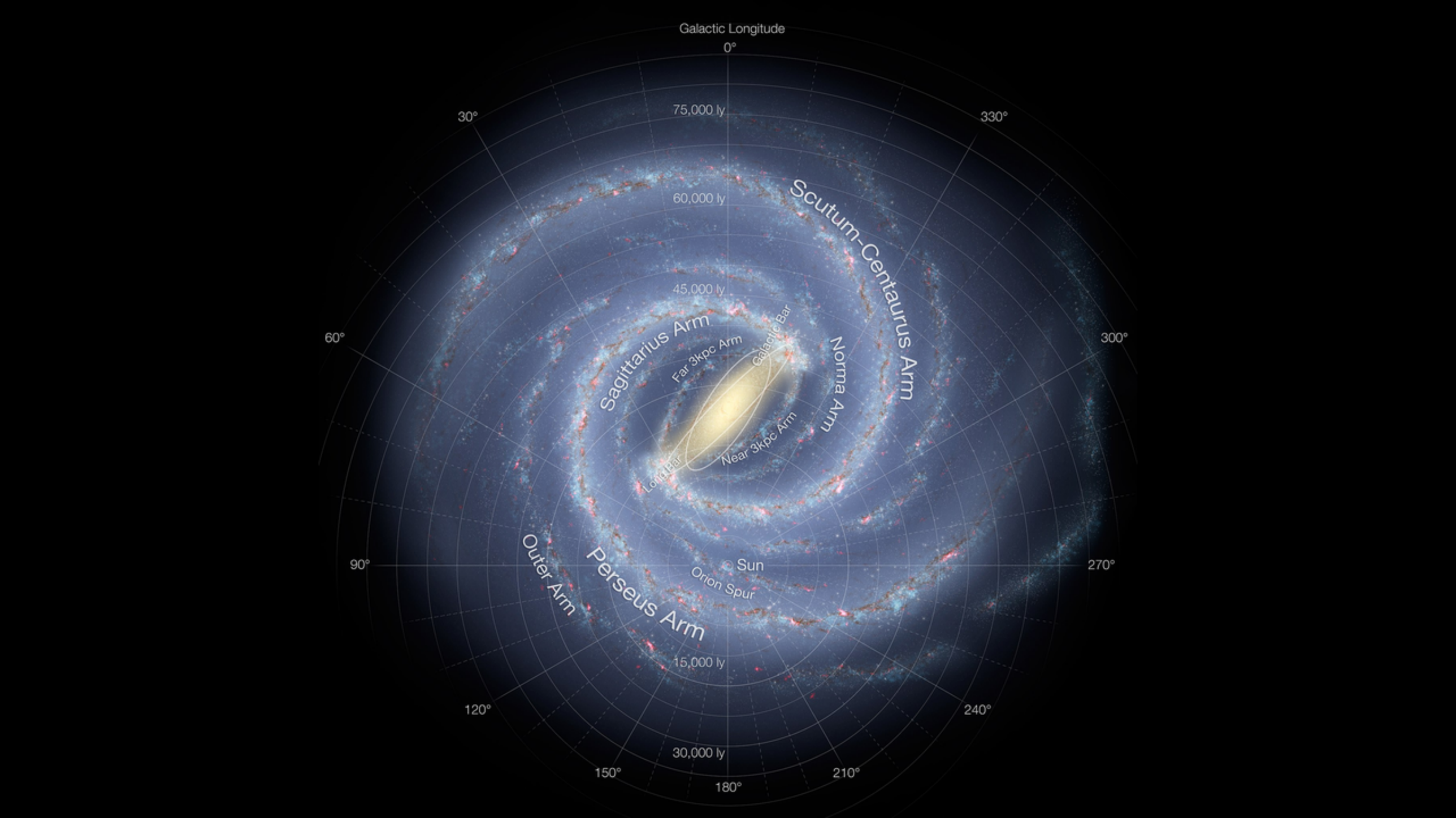


Data source: Human Fertility Database (2026); UN, World Population Prospects (2024)

OurWorldinData.org/fertility-rate | CC BY




10 Light Years
47 UMa
20 LMi
ιUMa
σUMa
36 UMa
π³UMa
θBoo
44 Boo
19 Dra
ηBoo
Arcturus
βLeo
61 UMa
HR4550
HR5256
HR5553
26 Dra
11 LMi
HR6518
ρ³Cnc
βVir
γVir
βCom
βCVn
HR4587
ζUMa
γSer
72 Her
γSer
ζHer
λSer
γCep
αCrv
ηCep
HR6806
Pollux
HR 1925
ξBoo
XDra
αCep
αOph
HR7162
HR9038
18 Sco
61 Vir
μHer
Capella
IHya
12 Oph
λAur
180°
HR511
σDra
Vega
90°
HR4458
HR 5568
HR3259
HR4523
ιPer
Procyon
ηCas
HR8832
70 Oph
εPer
X¹Ori
μCas
Sun
61Cyg
36 Oph
HR5864
31 Aql
111 Tau
HR3384
Sirius
αCen
Altair
HR6094
HR 483
ν²Lup
HR6426
υAnd
π³Ori
εEri
δTri
βAql
HR3018
270°
σ²Eri
HR6416
εCet
εInd
ιPeg
HR6998
Galactic Centre
γLep
HR1614
107 Psc
ηLep
HR753
δPav
HR7703
βTrA
85 Peg
HR8
κ²Cet
HR222
54Psc
HR7722
82 Eri
δEri
ζTrA
βHyi
μAra
αMen
HR 8721
Fomalhaut
58 Eri
HR7578
10 Tau
γPav
HR857
ρ Eri
ζTuc
δCap
ζDor
HR7898
ιPsc
γCap
ζRet
HR637
HR683
εFor
ε¹Eri
HR8501
νPhe
HR209
Greek Alphabet
α alpha
β beta
γ gamma
δ delta
ε epsilon
ζ zeta
η eta
θ theta
ι iota
κ kappa
λ lambda
μ mu
ν nu
ξ xi
ο omicron
π pi
ρ rho
σ sigma
τ tau
υ upsilon
φ phi
χ chi
ψ psi
ω omega
cpowell


Galactic Longitude
0°
30°
330°
60°
300°
90°
270°
120°
240°
150°
210°
180°
75,000 ly
60,000 ly
45,000 ly
30,000 ly
15,000 ly
Scutum-Centaurus Arm
Sagittarius Arm
Norma Arm
Perseus Arm
Outer Arm
Far 3kpc Arm
Near 3kpc Arm
Galactic Bar
Long Bar
Sun
Orion Spur



Recreation notes and sources

About this edition

These slides were recreated from Marko Jukic's DeSciNYC 54 talk on November 14, 2026. The original slide file was not available. This PDF uses the reviewed images and text prepared for the edited recording; repeated bullet reveals are consolidated into their completed slides.

Some charts and illustrations are approved replacements rather than exact originals. Their differences and sources are noted below. Image-specific licenses remain with their respective assets. A few photographs are rectified captures from the recording.

Watch the recording | Event details | Marko's related article

Pingualuit crater

Exact photograph, 5442 x 3063; resized, no generated detail.

Credit: Denis Sarrazin, courtesy of NASA Earth Observatory · Public-domain status noted on Commons; original photographer credited

Original source

Earth Impact Database world map

Exact original map, 3840 x 1920 raster from SVG. Resized with letterboxing; map retains CC BY-SA 4.0.

Credit: CMG Lee; USGS base map; Earth Impact Database

CC BY-SA 4.0 | Original source

Recreation notes and sources

Human embryonic stem-cell colony

Exact micrograph, 1024 x 894. Natural grayscale and original proportions restored.

Credit: Id711 · Public domain, released by author

Original source

Psyche asteroid illustration

Exact artist illustration PIA24471; resized with original proportions and illustration label retained.

Credit: NASA/JPL-Caltech/ASU

NASA media usage guidelines | Original source

Relative sizes of Solar System bodies

Exact size-comparison image, 1575 x 525. Resized with letterboxing; original labels retained.

Credit: Tony g100

CC BY 3.0 | Original source

Recreation notes and sources

Earth seen beyond Saturn’s rings

Exact Cassini image PIA17171, 4104 × 2304. Resized with original proportions and Earth annotation retained.

Credit: NASA/JPL-Caltech/SSI

NASA media usage guidelines | Original source

Energy use per person

The complete original country selection and accounting method remain unreadable. This candidate uses the current total-energy-supply series, shown for 1965–2024. Some of his spoken peak-year examples concern total national use, rather than use per person.

Open the configured OWID chart | Energy Institute methodology

Fertility in developed countries

The original chart’s country list cannot be read. The United States and Germany are proposed examples carried over from his adjacent energy discussion. This OWID rendering uses UN/Human Fertility Database sources; the recorded slide appears to use World Bank data.

Open the configured OWID chart | Original World Bank indicator

Hörbiger and World Ice Theory

The lower quotation in the original slide has not been traced to its exact source. This proposed slide replaces that excerpt with a concise sourced summary and a different, verified quotation that he also discusses aloud.

Marko’s article | Matching portrait in Lapham’s Quarterly | NASA: Max Valier biography | Max Planck historical research

Recreation notes and sources

Effective fertility since 1751

The six European series shown here—Sweden, France, Denmark, Norway, Belgium and the Netherlands—are a proposed illustrative selection, not a recovered original legend. The source uses historical observations and mortality projections; the latest displayed year is 2023.

Open the configured OWID chart | Underlying research paper

Fertility in six developing countries

The public OWID figure ends in 2023 and uses its own source edition. Our existing World Bank reconstruction runs through 2024. The recording's exact endpoint and release remain uncertain.

Open the configured OWID chart | Original six-country World Bank chart

Wernher von Braun: matching NASA portrait

Original source

Project Mars: matching cover and portrait

Original source