

Antimatter weapon

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[Jump to navigation](#) [Jump to search](#)

Theoretical weapon using antimatter

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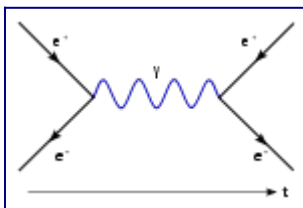
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[Antimatter](#)



show

[Antiparticles](#)

- [Positron](#)
- [Antiproton](#)
- [Antineutron](#)

- [Antihydrogen](#)
- [Antihelium](#)

Onia

- [Antiprotonic hydrogen](#)
- [Antiprotonic helium](#)
- [Muonium](#)
- [True muonium](#)
- [Pionium](#)
- [Positronium](#)
- [Quarkonium](#)

show

Concepts and phenomena

- [Annihilation](#)
- [Baryogenesis](#)
- [Baryon asymmetry](#)
- [Comet](#)
- [CP violation](#)
- [Gravitational interaction](#)
- [Positron emission](#)

show

Devices

- [Cloud chamber](#)
- [Particle accelerator](#)
 - [Antiproton decelerator](#)
 - [Relativistic Heavy Ion Collider](#)
- [Penning trap](#)

show

Uses

- [Positron emission tomography](#)
- [Fuel](#)
- [Weapon](#)

show

People and bodies

- [Carl David Anderson](#)
- [Paul Dirac](#)
- [Andrei Sakharov](#)
- [CERN](#)

- [v](#)
- [t](#)
- [e](#)

Weapons of mass destruction



By type

- [Biological](#)
- [Chemical](#)
- [Nuclear](#)
- [Radiological](#)

By country

- [Albania](#)
- [Algeria](#)
- [Argentina](#)
- [Australia](#)
- [Brazil](#)
- [Bulgaria](#)
- [Canada](#)
- **[China](#)**
- [Egypt](#)
- **[France](#)**
- [Germany](#)
- **[India](#)**
- [Iran](#)
- [Iraq](#)
- **[Israel](#)**
- [Italy](#)
- [Japan](#)
- [Libya](#)
- [Mexico](#)
- [Myanmar](#)
- [Netherlands](#)
- **[North Korea](#)**
- **[Pakistan](#)**
- [Philippines](#)
- [Poland](#)
- [Rhodesia](#)
- [Romania](#)
- **[Russia](#)**
- [Saudi Arabia](#)
- [South Africa](#)
- [South Korea](#)
- [Sweden](#)
- [Switzerland](#)
- [Syria](#)

- [Taiwan](#)
- [Ukraine](#)
- [United Kingdom](#)
- [United States](#)

Proliferation

- [Chemical](#)
- [Nuclear](#)
- [Missiles](#)

Treaties

- [List of treaties \(treaty parties\)](#)

-
- [Category](#)

-
- [v](#)
 - [t](#)
 - [e](#)

An **antimatter weapon** is a theoretically possible device using [antimatter](#) as a power source, a [propellant](#), or an explosive for a [weapon](#). Antimatter weapons are currently too costly and unreliable to be viable in warfare, as producing antimatter is enormously expensive (estimated at \$6 billion for every 100 nanograms), the quantities of antimatter generated are very small, and current technology has great difficulty containing antimatter, which annihilates upon touching ordinary matter.^[1]

The paramount advantage of such a theoretical weapon is that antimatter and matter collisions result in the entire sum of their [mass energy equivalent](#) being released as energy, which is at least two orders of magnitude greater than the energy release of the most efficient [fusion weapons](#) (100% vs 0.4-1%).^[2] [Annihilation](#) requires and converts exactly equal masses of antimatter and matter by the collision which releases the entire mass-energy of both, which for 1 gram is $\sim 9 \times 10^{13}$ joules. Using the convention that 1 kiloton [TNT equivalent](#) = 4.184×10^{12} joules (or one trillion calories of energy), one half gram of antimatter reacting with one half gram of ordinary matter (one gram total) results in 21.5 kilotons-equivalent of energy (the same as the [atomic bomb](#) dropped on [Nagasaki](#) in 1945). ^[3]

Contents

- [1 Recent advances and physics obstacles](#)
- [2 Cost](#)
- [3 Antimatter catalyzed weapons](#)
- [4 In popular culture](#)
- [5 References](#)
- [6 External links](#)

Recent advances and physics obstacles^{[[edit](#)]}

Research conducted in 2008 dramatically increased the quantity of [positrons](#) (antielectrons) that can be produced. Physicists at the [Lawrence Livermore National Laboratory](#) in California used a short, ultra-intense

[laser pulse](#) to irradiate a millimeter-thick gold target which produced more than 100 billion positrons.[\[4\]\[5\]\[6\]](#)

Even if it were possible to convert energy directly into particle/antiparticle pairs without any loss, a large-scale [power plant](#) generating 2000 [MW](#) would take 25 hours to produce just one gram of antimatter. Given the average price of electric power of around US\$50 per megawatt hour, this puts a lower limit on the cost of antimatter at \$2.5 [million](#) per gram.[\[7\]](#) This would make antimatter very cost-effective as a rocket fuel, as just one milligram would be enough to send a probe to [Pluto](#) and back in a year, a mission that would be completely unaffordable with conventional fuels. Most scientists, however, doubt whether such efficiencies could ever be achieved.

The second problem is the containment of antimatter. Antimatter annihilates with regular matter on contact, so it would be necessary to prevent contact, for example by producing antimatter in the form of solid charged or magnetized particles, and suspending them using [electromagnetic fields](#), such as [magnetic bottle](#) in a near-perfect empty [vacuum](#). The obvious solution of confining a charged object inside a similarly charged container is not feasible as the electric field inside is uniform. For this reason it is necessary to have charged objects moving relative to the container which can be confined to a central region by magnetic fields; for example, in the form of a toroid or Penning trap (see below).

In order to achieve compactness given macroscopic weight, the overall electric charge of the antimatter weapon core would have to be very small compared to the number of particles. For example, it is not feasible to construct a weapon using positrons alone, due to their mutual repulsion. The antimatter weapon core would have to consist primarily of neutral antiparticles. Extremely small amounts of [antihydrogen](#) have been produced in laboratories, but containing them (by cooling them to temperatures of several [millikelvins](#) and trapping them in a [Penning trap](#)) is extremely difficult. And even if these proposed experiments were successful, they would only trap several antihydrogen atoms for research purposes, far too few for weapons or spacecraft propulsion. Antimatter Helium-4 has also been created.[\[8\]](#)

The difficulty of preventing accidental detonation of an antimatter weapon may be contrasted with that of a nuclear weapon. Whereas [nuclear weapons](#) are 'fail-safe', antimatter weapons are inherently 'fail-deadly': In an antimatter weapon, any failure of [containment](#) would immediately result in annihilation, which would damage or destroy the containment system and lead to the release of all of the antimatter material, causing the weapon to detonate entirely at full yield. By contrast, a modern nuclear weapon will explode with a significant yield if (and only if) the [nuclear trigger](#) is fired with absolute precision resulting in a neutron source wholly releasing promptly (< microseconds). In short, an antimatter weapon must be actively kept from detonating; whereas a nuclear weapon will not unless deliberately made to do so.

Cost[\[edit\]](#)

As of 2004[\[update\]](#), the cost of producing one millionth of a gram of antimatter was estimated at US\$60 billion.[\[1\]](#) By way of comparison, the cost of the [Manhattan Project](#) (to produce the first atomic bomb) is estimated at US\$23 billion in 2007 prices.[\[9\]](#)

Antimatter catalyzed weapons[\[edit\]](#)

[Antimatter-catalyzed nuclear pulse propulsion](#) proposes the use of antimatter as a "trigger"[\[10\]](#) to initiate small nuclear explosions; the explosions provide thrust to a spacecraft. The same technology could theoretically be used to make very small and possibly "fission-free" (very low [nuclear fallout](#)) weapons (see [pure fusion weapon](#)).[\[11\]\[12\]](#) Antimatter-catalyzed weapons could be more discriminate and result in less long-term contamination than conventional nuclear weapons, and their use might therefore be [more politically acceptable](#).

In popular culture[[edit](#)]

An antimatter weapon is a part of the plot of the [Dan Brown](#) book *Angels and Demons* and its [film adaptation](#).^[13]

[Photon torpedoes](#) in the *Star Trek* franchise utilize antimatter warheads.

In *Tiamat's Wrath*, the eighth novel in [The Expanse](#) series, Martian Marine Roberta Draper uses an antimatter-based explosive to destroy *The Tempest*, the flagship of the Laconian Empire in the Sol system.

[Megatron](#) of the [Transformers](#) possesses the ability draw on antimatter and utilize it for offensive purposes.

References[[edit](#)]

- ¹ ↑ [Jump up to: ^a ^b "Air Force pursuing antimatter weapons / Program was touted publicly, then came official gag order". *San Francisco Chronicle*. 4 October 2004. *Archived* from the original on 29 December 2014. Retrieved 17 January 2015.](#)
- ² ↑ ["Fusion Fuel". atomic rockets. Retrieved 2020-03-05.](#)
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- ⁴ ↑ [Bland, E. \(1 December 2008\). "Laser technique produces bevy of antimatter". *NBC News*. Retrieved 2009-07-16. The LLNL scientists created the positrons by shooting the lab's high-powered Titan laser onto a one-millimeter-thick piece of gold.](#)
- ⁵ ↑ ["Lasers creates billions of antimatter particles". *Cosmos Online*. *Archived* from the original on 2009-05-22.](#)
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- ⁷ ↑ ["U.S. Energy Information Administration \(EIA\)". www.eia.gov. *Archived* from the original on 28 January 2018. Retrieved 4 May 2018.](#)
- ⁸ ↑ ["heliums-antimatter-twin-created". Retrieved 16 December 2020.](#)
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- ¹⁰ ↑ ["Antimatter weapons". cui.unige.ch. *Archived* from the original on 24 April 2013. Retrieved 4 May 2018.](#)
- ¹¹ ↑ [Ramsey, Syed \(12 May 2016\). *Tools of War: History of Weapons in Modern Times*. Vij Books India Pvt Ltd. ISBN 9789386019837. *Archived* from the original on 16 August 2017. Retrieved 4 May 2018 – via Google Books.](#)
- ¹² ↑ ["Details on antimatter triggered fusion bombs - NextBigFuture.com". nextbigfuture.com. 22 September 2015. *Archived* from the original on 22 April 2017. Retrieved 4 May 2018.](#)
- ¹³ ↑ [Delphine. "Angels & Demons: The Physics Behind The Movie \(and The Book\)". *Wired*. Retrieved 13 March 2021.](#)

External links[[edit](#)]

- [Spotlight on "Angels and Demons"](#) – A discussion at CERN's public website on the viability of the use of antimatter for energy and weaponry
- ["Air Force pursuing antimatter weapons: Program was touted publicly, then came official gag order"](#)
- [Page discussing the possibility of using antimatter as a trigger for a thermonuclear explosion](#)
- [Paper discussing the number of antiprotons required to ignite a thermonuclear weapon](#)

show

- [v](#)
- [t](#)
- [e](#)

Weapons

History Premodern

- [Medieval](#)
- [Early Warfare](#)
- [Napoleonic Warfare](#)
- [Crimean War](#)
- [American Civil War](#)
- [Spanish–American War](#)

Modern

World War I

- [Chemical](#)
- [Australia](#)
- [Austria-Hungary](#)
- [Belgium](#)
- [Bulgaria](#)
- [Canada](#)
- [France](#)
- [Germany](#)
- [Greece](#)
- [Italy](#)
- [Japan](#)
- [Montenegro](#)
- [New Zealand](#)
- [Romania](#)
- [Russia](#)
- [Serbia](#)
- [Turkey](#)
- [United Kingdom](#)
- [United States](#)
- [Infantry](#)

World War II

- [Australia](#)
- [Austria](#)
- [Belgium](#)
- [Brazil](#)
- [Bulgaria](#)
- [Canada](#)
- [China](#)
- [Croatia](#)
- [Czechoslovakia](#)
- [Denmark](#)
- [Finland](#)
- [France](#)
- [Germany](#)
- [Greece](#)

- [Hungary](#)
- [Italy](#)
- [Japan](#)
- [Netherlands](#)
- [New Zealand](#)
- [Norway](#)
- [Poland](#)
- [Romania](#)
- [Soviet Union](#)
- [Thailand](#)
- [United Kingdom](#)
- [United States](#)
- [Yugoslavia](#)
- [Infantry](#)

Cold War

- [First Indochina War](#)
- [Korean War](#)
- [Vietnam War](#)
- [Six-Day War](#)
- [Cambodian–Vietnamese War](#)
- [Gulf War](#)

Types

- [Aircraft](#)
- [Ancillary](#)
- [Anti-aircraft](#)
- [Anti-ballistic](#)
- [Anti-personnel](#)
- [Anti-tank](#)
- [Area denial](#)
- [Artillery](#)
- [Biological](#)
- [Ceremonial](#)
- [Chemical](#)
- [Combat vehicle](#)
- [Conventional](#)
- [Crew-served](#)
- [Cyber](#)
- [Deadly](#)
- [Directed-energy](#)
- [Explosive](#)
- [Firearm](#)
- [Hunting](#)
- [Improvised](#)
- [Incendiary](#)
- [Martial arts](#)
- [Mass destruction](#)
- [Melee](#)
- [Non-lethal](#)
- [Nuclear](#)
- [Offensive](#)
- [Personal](#)
- [Pneumatic](#)

- [Practice](#)
- [Ranged](#)
- [Space](#)
- [Tectonic](#)
- [Torpedo](#)
- [Toy](#)

- Other**
- [Arsenal](#)
 - [Industry](#)
 - [Mount](#)
 - [Gun ownership](#)
 - [Science fiction](#)

- [Category](#)

show

- [v](#)
- [t](#)
- [e](#)

Emerging technologies

- Fields** [Military](#)
- [Antimatter weapon](#)
 - [Caseless ammunition](#)
 - [Directed-energy weapon](#)
 - [Laser](#)
 - [Maser](#)
 - [Particle-beam weapon](#)
 - [Sonic weapon](#)
 - [Coilgun](#)
 - [Railgun](#)
 - [Plasma weapon](#)
 - [Pure fusion weapon](#)
 - [Stealth technology](#)
 - [Vortex ring gun](#)

- Topics**
- [Collingridge dilemma](#)
 - [Differential technological development](#)
 - [Disruptive innovation](#)
 - [Ephemerization](#)
 - [Ethics](#)
 - [Bioethics](#)
 - [Cyberethics](#)
 - [Neuroethics](#)
 - [Robot ethics](#)
 - [Exploratory engineering](#)
 - [Fictional technology](#)
 - [Proactionary principle](#)
 - [Technological change](#)
 - [Technological unemployment](#)

- [Technological convergence](#)
- [Technological evolution](#)
- [Technological paradigm](#)
- [Technology forecasting](#)
 - [Accelerating change](#)
 - [Horizon scanning](#)
 - [Moore's law](#)
 - [Technological singularity](#)
 - [Technology scouting](#)
- [Technology readiness level](#)
- [Technology roadmap](#)
- [Transhumanism](#)

- [Category](#)
 - [List](#)

show

- [v](#)
- [t](#)
- [e](#)

Global catastrophic risks

- [Future of the Earth](#)
- [Future of an expanding universe](#)
 - [Ultimate fate of the universe](#)

Technological

- [Chemical warfare](#)
- [Cyberattack](#)
 - [Cyberwarfare](#)
 - [Cyberterrorism](#)
 - [Cybergeddon](#)
- [Doomsday Clock](#)
- [Gray goo](#)
- [Nanoweapons](#)
- [Kinetic bombardment](#)
 - [Relativistic kinetic kill vehicle](#)
- [Mutual assured destruction](#)
 - [Dead Hand](#)
 - [Doomsday device](#)
 - [Antimatter weapon](#)
- [Nuclear warfare](#)
- [Electromagnetic pulse \(EMP\)](#)
- [Safety of high-energy particle collision experiments](#)
 - [Micro black hole](#)
 - [Strangelet](#)
- [Synthetic intelligence / Artificial intelligence](#)
 - [Existential risk from artificial intelligence](#)
 - [AI takeover](#)
- [Technological singularity](#)
- [Transhumanism](#)
- [Year 2000 problem](#)
- [Year 2038 problem](#)
- [Year 10,000 problem](#)

Sociological

- [Anthropogenic hazard](#)
- [Doomsday argument](#)
 - [Self-Indication Assumption Doomsday argument rebuttal](#)
 - [Self-referencing doomsday argument rebuttal](#)
- [Economic collapse](#)
- [Malthusian catastrophe](#)
- [New World Order \(conspiracy theory\)](#)
- [Nuclear holocaust](#)
 - [winter](#)
 - [famine](#)
 - [cobalt](#)
- [Societal collapse](#)
- [Collapsology](#)
- [World War III](#)

Ecological

[Climate change](#)

- [Anoxic event](#)
- [Biodiversity loss](#)
 - [Mass mortality event](#)
- [Cascade effect](#)
- [Cataclysmic pole shift hypothesis](#)
- [Climate apocalypse](#)
- [Deforestation](#)
- [Desertification](#)
- [Extinction risk from global warming](#)

- [Tipping points in the climate system](#)
- [Flood basalt](#)
- [Global dimming](#)
- [Global terrestrial stilling](#)
- [Global warming](#)
- [Hypercane](#)
- [Ice age](#)
- [Ecocide](#)
- [Ecological collapse](#)
- [Environmental degradation](#)
- [Habitat destruction](#)
- [Human impact on the environment](#)
 - [coral reefs](#)
 - [on marine life](#)
- [Land degradation](#)
- [Land consumption](#)
- [Land surface effects on climate](#)
- [Ocean acidification](#)
- [Ozone depletion](#)
- [Resource depletion](#)
- [Sea level rise](#)
- [Supervolcano](#)
 - [winter](#)
- [Verneshot](#)
- [Water pollution](#)
- [Water scarcity](#)
- [Overexploitation](#)
- [Overpopulation](#)
 - [Human overpopulation](#)

Earth Overshoot Day

Biological

Extinction

- [Extinction event](#)
- [Holocene extinction](#)
- [Human extinction](#)
- [List of extinction events](#)
- [Genetic erosion](#)
- [Genetic pollution](#)

- [Biodiversity loss](#)
 - [Decline in amphibian populations](#)
 - [Decline in insect populations](#)
 - [Biotechnology risk](#)
 - [Biological agent](#)
 - [Biological warfare](#)
 - [Bioterrorism](#)
- Others**
- [Colony Collapse Disorder](#)
 - [Defaunation](#)
 - [Interplanetary contamination](#)
 - [Pandemic](#)
 - [Pollinator decline](#)
 - [Overfishing](#)

- [Big Crunch](#)
 - [Big Rip](#)
 - [Coronal mass ejection](#)
 - [Geomagnetic storm](#)
 - [False vacuum decay](#)
 - [Gamma-ray burst](#)
 - [Heat death of the universe](#)
 - [Proton decay](#)
 - [Virtual black hole](#)
 - [Impact event](#)
 - [Asteroid impact avoidance](#)
 - [Asteroid impact prediction](#)
 - [Potentially hazardous object](#)
 - [Near-Earth object](#)
 - [winter](#)
 - [Rogue planet](#)
 - [Near-Earth supernova](#)
 - [Hypernova](#)
 - [Solar flare](#)
 - [Stellar collision](#)
- Astronomical**

- [Eschatological](#)**
- [Buddhist](#)
 - [Maitreya](#)
 - [Three Ages](#)
 - [Hindu](#)
 - [Kalki](#)
 - [Kali Yuga](#)
 - [Last Judgement](#)
 - [Second Coming](#)
 - [1 Enoch](#)
 - [Daniel](#)
 - [Abomination of Desolation](#)
 - [Prophecy of Seventy Weeks](#)
 - [Messiah](#)
 - [Christian](#)
 - [Dispensationalism](#)
 - [Futurism](#)
 - [Historicism](#)

- [Interpretations of Revelation](#)
- [Idealism](#)
- [Preterism](#)
- [2 Esdras](#)
- [2 Thessalonians](#)
 - [Man of sin](#)
 - [Katechon](#)
- [Antichrist](#)
- [Book of Revelation](#)
 - [Events](#)
 - [Four Horsemen of the Apocalypse](#)
 - [Lake of fire](#)
 - [Number of the Beast](#)
 - [Seven bowls](#)
 - [Seven seals](#)
 - [The Beast](#)
 - [Two witnesses](#)
 - [War in Heaven](#)
 - [Whore of Babylon](#)
 - [Great Apostasy](#)
 - [New Earth](#)
 - [New Jerusalem](#)
 - [Olivet Discourse](#)
 - [Great Tribulation](#)
 - [Son of Perdition](#)
 - [Sheep and Goats](#)
- [Islamic](#)
 - [Al-Qa'im](#)
 - [Beast of the Earth](#)
 - [Dhul-Qarnayn](#)
 - [Dhul-Suwayqatayn](#)
 - [Dajjal](#)
 - [Israfil](#)
 - [Mahdi](#)
 - [Sufyani](#)
- [Jewish](#)
 - [Messiah](#)
 - [War of Gog and Magog](#)
 - [Third Temple](#)
- [Norse](#)
- [Zoroastrian](#)
 - [Saoshyant](#)

- [2011 end times prediction](#)
 - [2012 phenomenon](#)
 - [Apocalypse](#)
 - [Apocalyptic literature](#)
 - [Apocalypticism](#)
 - [Armageddon](#)
 - [Blood moon prophecy](#)
 - [Earth Changes](#)
 - [End time](#)
 - [Gog and Magog](#)
 - [List of dates predicted for apocalyptic events](#)
 - [Messianism](#)
 - [Messianic Age](#)
 - [Millenarianism](#)
 - [Millennialism](#)
 - [Premillennialism](#)
 - [Amillennialism](#)
 - [Postmillennialism](#)
 - [Nemesis \(hypothetical star\)](#)
 - [Nibiru cataclysm](#)
 - [Rapture](#)
 - [Prewrath](#)
 - [Post-tribulation rapture](#)
 - [Resurrection of the dead](#)
 - [World to come](#)
- Others**
- [Alien invasion](#)
 - [Apocalyptic and post-apocalyptic fiction](#)
 - [List of apocalyptic and post-apocalyptic fiction](#)
 - [List of apocalyptic films](#)
 - [Climate fiction](#)
 - [Disaster films](#)
 - [List of disaster films](#)
 - [List of fictional doomsday devices](#)
 - [Zombie apocalypse](#)
 - [Zombie](#)
- Fictional**
- [Centre for the Study of Existential Risk](#)
 - [Future of Humanity Institute](#)
 - [Future of Life Institute](#)
 - [Nuclear Threat Initiative](#)
- Organizations**
- [World portal](#)
 - Categories
 - [Apocalypticism](#)
 - [Future problems](#)
 - [Hazards](#)
 - [Risk analysis](#)
 - [Doomsday scenarios](#)

Categories:

- [Antimatter](#)
- [Proposed weapons](#)
- [Fictional energy weapons](#)

Hidden categories:

- [Articles with short description](#)
- [Short description is different from Wikidata](#)
- [Articles that may contain original research from March 2018](#)
- [All articles that may contain original research](#)
- [Articles needing additional references from August 2020](#)
- [All articles needing additional references](#)
- [Articles with multiple maintenance issues](#)
- [Articles containing potentially dated statements from 2004](#)
- [All articles containing potentially dated statements](#)

Navigation menu

Personal tools

- Not logged in
- [Talk](#)
- [Contributions](#)
- [Create account](#)
- [Log in](#)

Namespaces

- [Article](#)
- [Talk](#)

English

Views

- [Read](#)
- [Edit](#)
- [View history](#)

More

Search

Search

Go

Navigation

- [Main page](#)
- [Contents](#)
- [Current events](#)
- [Random article](#)
- [About Wikipedia](#)
- [Contact us](#)
- [Donate](#)

Contribute

- [Help](#)
- [Learn to edit](#)
- [Community portal](#)
- [Recent changes](#)
- [Upload file](#)

Tools

- [What links here](#)
- [Related changes](#)
- [Upload file](#)
- [Special pages](#)
- [Permanent link](#)
- [Page information](#)
- [Cite this page](#)
- [Wikidata item](#)

Print/export

- [Download as PDF](#)
- [Printable version](#)

Languages

- [Español](#)
- [فارسی](#)
- [Bahasa Indonesia](#)
- [Português](#)
- [Tiếng Việt](#)
- [中文](#)

[Edit links](#)

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- [Developers](#)
- [Statistics](#)
- [Cookie statement](#)
- [Edit preview settings](#)

