The Athens Institute
A World Association of Academics and Researchers

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A Roundtable Discussion: "The Future of Science and Technology"

DISASTROUS CHALLENGES TO THE HUMANITY

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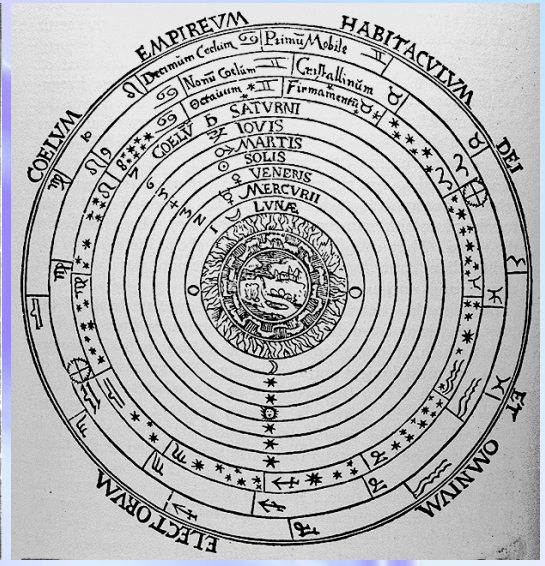
STRENGTHING HUMANITY'S SELF-DEVELOPMENT

1. **Exploring Mystic Universe** [1-16]
2. **Challenges for the Life on Our Planet** [1, 17-30]
3. **Self-Destructive Behavior of Human Civilizations** [1, 31-46]
4. **In Search of Common Goals for the Humanity** [1, 47-50]
5. **Discussing a Well-forgotten Mission for Scientists** [1, 4, 51-56]

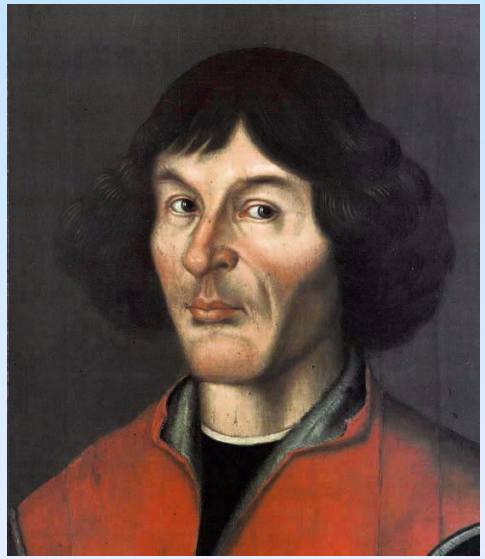
1. EXPLORING MYSTIC UNIVERSE: Models of the Universe

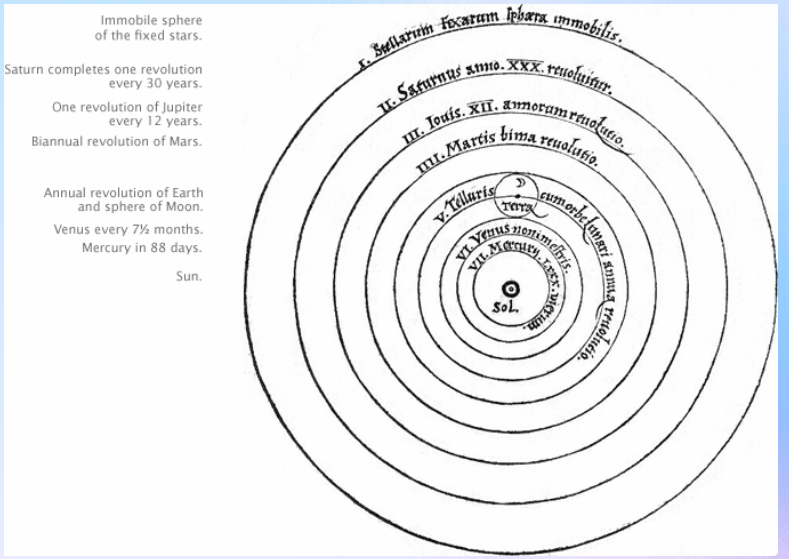
A geocentric universe



Ptolemy (Claudius Ptolemaeus) (100 AD-168 AD) was an Egyptian astronomer, mathematician and geographer who believed that the Earth was in the centre of the universe. Actually, he refined ideas of Greek philosophers and astronomers (e.g., **Eudoxus** and **Aristotle**), who believed that **if the heavens are divine, and the gods created man, then the universe must be geocentric** [2]

A heliocentric universe

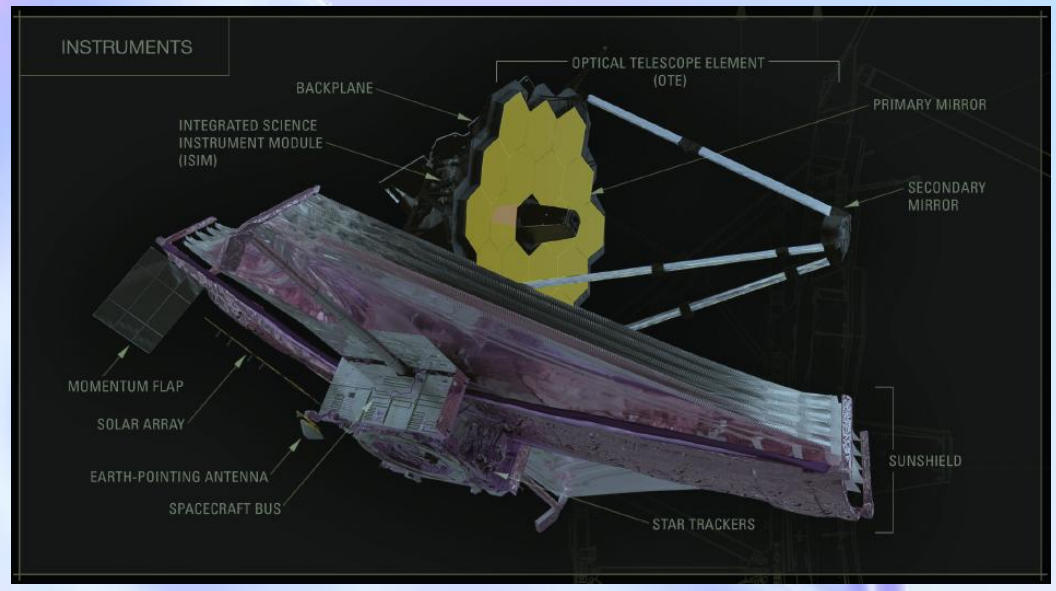




Nicolaus Copernicus (1473-1543) was a Polish astronomer, mathematician, translator, artist, and physicist, best known as the first astronomer to posit the idea of a heliocentric solar system, in which the planets and planetary objects orbit the sun [3,4]. The final version of his theory, *De revolutionibus orbium coelestium libri vi* ("*Six Books Concerning the Revolutions of the Heavenly Orbs*"), was printed in 1543. His theory had important consequences for **Galileo**, **Kepler**, **Descartes**, and **Newton**.

EXPLORING UNIVERSE WITH MODERN TECHNOLOGIES

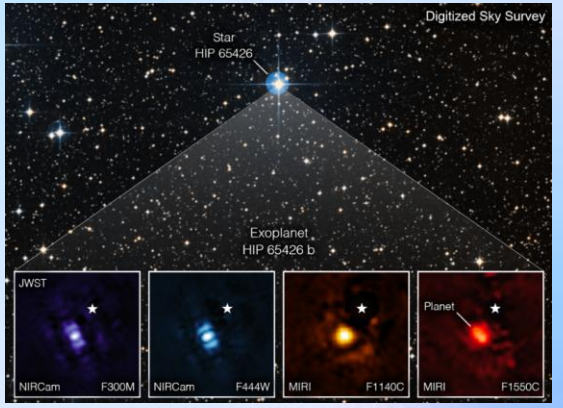
The James Webb Space Telescope (JWST)



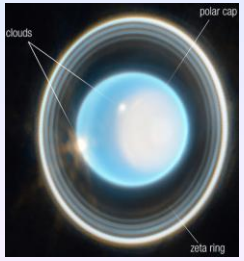
The **James Webb Space Telescope infrared technology** [5] studies phases of cosmic history—from within the Solar system to the most distant observable galaxies in the early universe formed over 13.5 billion years ago. It was launched from ESA's spaceport in French Guiana on Dec. 25, 2021.

JWST Images

"Cosmic Cliffs" at the edge of a star-forming region NGC 3324 in the **Carina Nebula**, 7,600 light-years away [6].



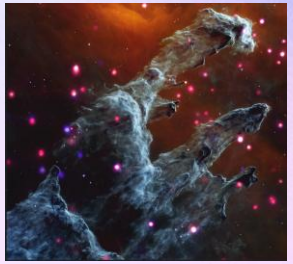
The **exoplanet HIP 65426b** in different bands of infrared light [7].



Rings around **Uranus** [5]

Prelude to Supernova [5]

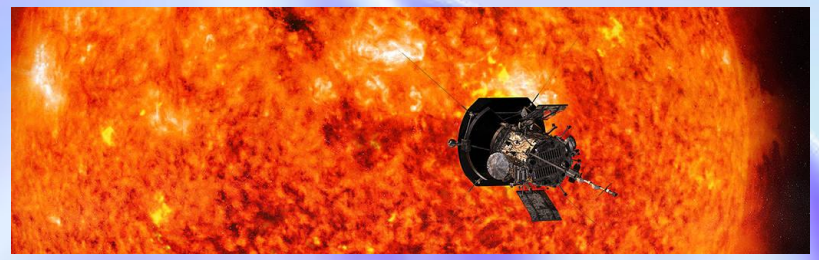
A **spiral galaxy** Messier 74 like our Milky Way [5].



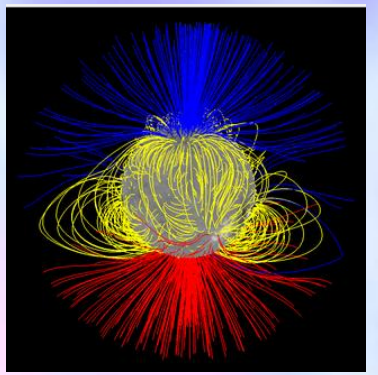
The **Eagle Nebula M16** "Pillars of Creation" [8]

MISSIONS FOR EXPLORING THE UNIVERSE

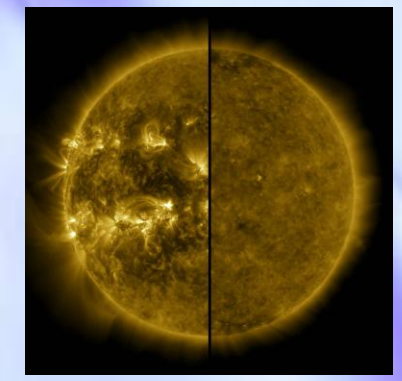
The **NASA Heliophysics Living with a Star** program explores aspects of the Sun-Earth system that directly affect life and society. [9]



The fourth solar flyby of the **Parker Solar Probe** (2020) [9].

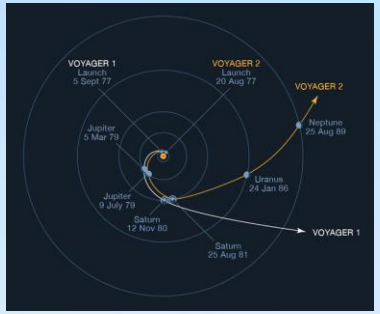


The Sun magnetic field [9,10]



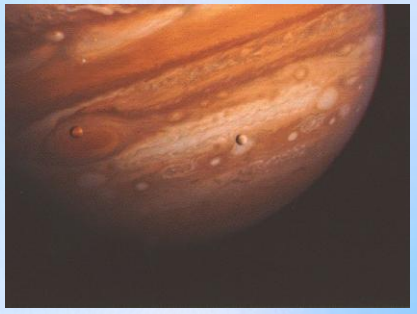
The difference between an active Sun (*left*) in April 2014 and a quiet Sun (*right*) in Dec. 2019 that marked the start of the **25-Year Solar Cycle** [11].

Voyager 1 and 2 probes flight across the Solar system for 45+ years



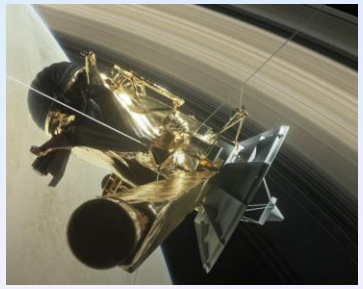
The Voyager probes were designed to visit Jupiter and Saturn [12]

Saturn's rings. Voyager, August 23, 1981. NASA. [12]



Jupiter and two of its moons, Thebe and Metis. NASA/JPL. [12]

NASA's Cassini spacecraft mission [13]

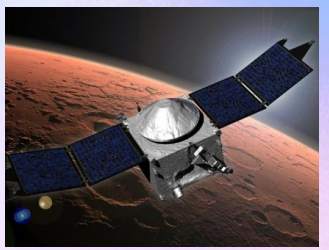


NASA's Cassini spacecraft explored Saturn and its icy moons for 13 years [13]

Energy for Life? Hydrogen gas is pouring into the Enceladus ocean from the hot seafloor [13]

Mars Exploration [14]

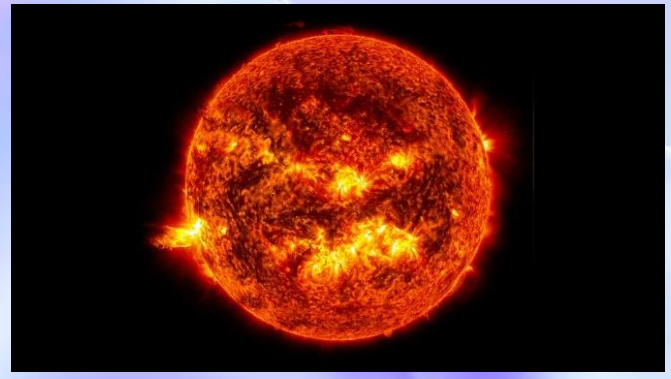
Mars Perseverance Rover searches the potential for life on Mars [15]



NASA's MAVEN Orbiter measures Martian atmosphere to help understand climate change [16]

2. CHALLENGES FOR LIFE ON THE EARTH: The Universe Evolution

The Future Timeline of the Sun



This image captured by NASA's Solar Dynamics Observatory on June 20, 2013, shows the bright light of a solar flare on the left side of the sun. NASA/SDO. [18]

At present, our sun is in the prime of its life. The star is of **4.57 billion years old**, productively fusing hydrogen into helium.

The sun will reach its maximum temperature in 3.5 billion years, after which it'll cool down but continue to increase in size. 2-3 billion years later, the sun will become a **red giant** with the radius of Mercury's current orbit.

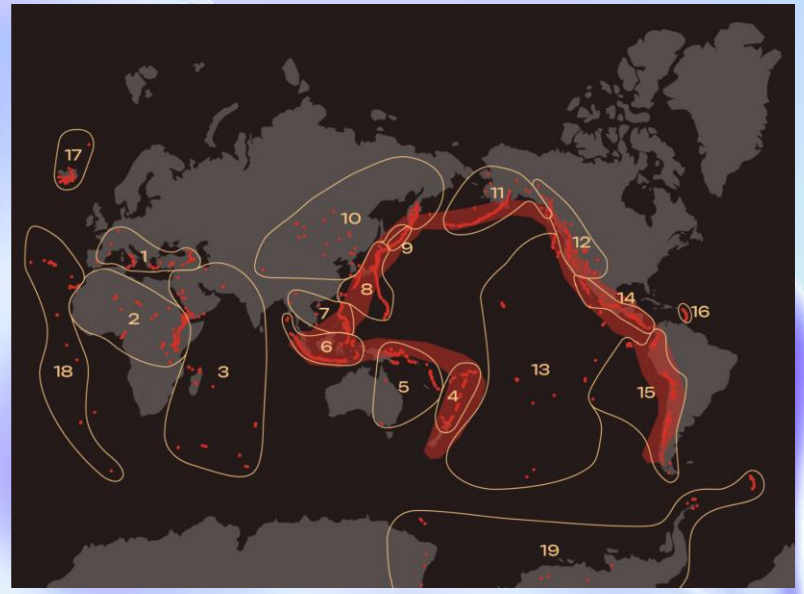
In 5-7 billion years, **our sun will reach the end of its life**. Its hydrogen supply will fizzle out, and the star will cool, dim, and turn into a stellar corpse, or white dwarf. [18]

NOTE: Also, read [17]: Asimov, Isaak. (1979). *A choice of catastrophes: The Disasters That Threaten Our World*.

Years +	Events [19]
10K	Sea levels would rise 3-4 meters, as a long-term effect of global warming.
11-15K	Earth's axial tilt will reverse, causing summer and winter to occur on opposite sides of Earth's orbit.
17K	A "civilization-threatening" super-volcanic eruption.
50K	The current interglacial period will end, sending the Earth back into a glacial period of the current ice age.
100K	The red hypergiant star VY Canis Majoris will likely have exploded in a supernova.
500K	Earth will likely have been hit by an asteroid of roughly 1 km in diameter.
1M	The red supergiant star Betelgeuse explodes in a supernova that will be visible from Earth.
2M	The full recovery of coral reef ecosystems from human-caused ocean acidification.
10M	The Red Sea will flood the East African Rift valley, causing a division of the continent of Africa.
10M	Estimated time for full recovery of biodiversity after a potential Holocene extinction.
50M	Africa's collision with Eurasia will create a mountain range like Himalayas.
100K	Earth will likely have been hit by an asteroid comparable in size to the one that triggered the K–Pg extinction 66 million years ago.
>250M	Rapid biological evolution may occur due to the formation of a supercontinent and high volcanic activity. Increased competition between species. The global warming from a brighter Sun could result in a mass extinction event.

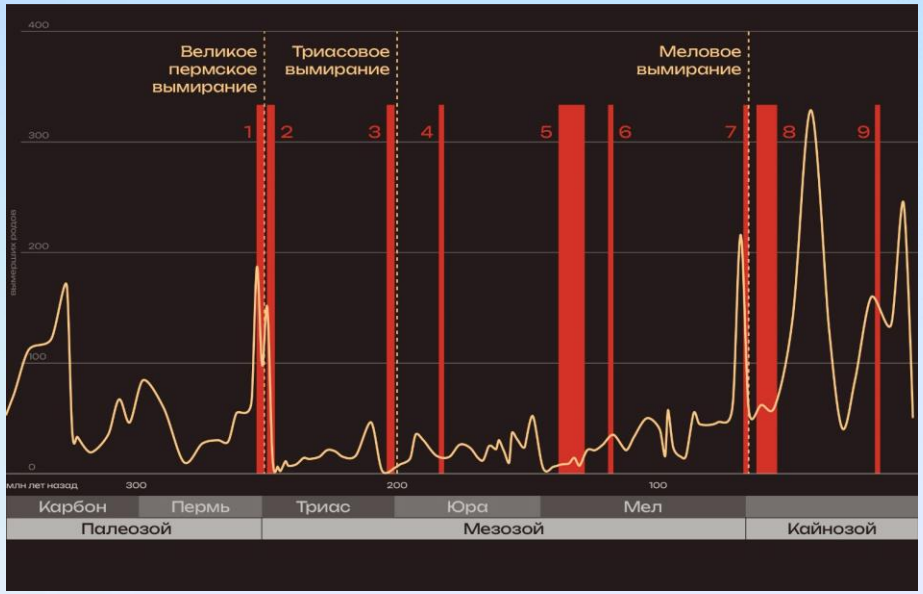
CHALLENGES FOR LIFE ON THE EARTH: Destructive Volcanoes

Volcanic Regions of The World [20-22]



Regions: 1. From Europe to the Caucasus, 2. Africa and the Red Sea, 3. Middle East and Indian Ocean, 4. From New Zealand to Fiji, 5. Melanesia and Australia, 6. Indonesia and Andaman Islands, 7. Philippines and Southeast Asia, 8. Japan, Taiwan and the Marianas, 9. the Kamchatka Peninsula and the Kuril Islands, 10. Mainland Asia, 11. Alaska, 12. Canada and Western USA, 13. Pacific Ocean, 14. Mexico and Central America, 15. South America, 16. West Indies, 17. Iceland and the Arctic Ocean, 18. Atlantic Ocean, 19. Antarctica and the South Sandwich Islands.

Mass Extinctions of Species and Volcanism [20,23-25]



1. Emeishan traps, 2. Siberian traps, 3. Central Atlantic Igneous Province, 4. Karoo and Ferrar provinces, 5. Trape Province of Paraná Etendeka, 6. Rajmahal Trappa, 7. Traps of the Deccan Plateau, 8. North Atlantic Igneous Province, 9. Columbia River Basalt Group.

The Permian mass extinction (on the border of Paleozoic and Mesozoic eras) was the largest in the history of the Earth. Then, 251 million years ago, 96% of the species of marine organisms, about three-quarters of terrestrial vertebrates and 83% of insect species became extinct. Likely, it was a result of the eruption of the Siberian traps.

- **Eruptions of 1328 volcanoes occurred for last 10,000 years** [21].
- Eruptions of 560 volcanoes were observed and documented [20-22]..
- 20-30 volcanoes erupt on Earth **daily**.

Grand Prismatic Spring in Yellow-stone National Park (USA) [20]

Eyjafjallajökull volcano eruption (Iceland), 2010 [20]

Eruption of Mount Etna (Sicily, Italy), 2022 [20]

Historical Mass ~~Extinction~~ Events on Earth

Part 1:

Images	Extinction Event Name & Period	Organisms Involved	What happened?	Possible Reasons of Catastrophes
	The Oxygen Catastrophe, about 2,300 M years ago, Paleo-proterozoic era	Culprit, one of Earth's earliest prokaryotic organisms (*cyanobacteria*) that photosynthesize and release oxygen.	The planet's atmosphere had just 0.03% of today's oxygen levels	The oxygen levels started to rise, driving much of Earth's life to extinction.
	End-Botomian mass extinctions about 513 to 509 million years ago, during the Cambrian Period	Organisms made the transition from unicellular to multicellular, including hard-shelled animals (e.g., trilobites).	This mass extinction wiped about 83% of these organisms from Earth.	The reasons: sea-level change, marine anoxia, carbon isotope excursions, and eruptions of large igneous provinces.
	The Ordovician–Silurian extinction occurred between 450 and 440 million years ago	One of the largest extinction events on Earth. Trilobites, graptolites, bryozoans, brachiopods, conodonts were wiped out.	The extinction of 85% of all marine species on Earth. Rise of volcanism.	Cooling and widespread glaciation, followed by warming and low oxygen levels.
	Lau/Kozlowskii extinction, during the Silurian period, 420 million years ago	Some species, such as graptolite, saw a reduction as high as 70%.	The extinction of 23% of all marine animals.	Deoxygenation of the ocean and the proliferation of sulfidic ocean conditions.

Source: [26] The history of mass extinction events on Earth. Stars Insider. April 29, 2023, https://www.msn.com/en-us/travel/news/the-history-of-mass-extinction-events-on-earth/

Historical Mass Extinction Events on Earth

Part 2:

Images	Extinction Event Name & Period	Organisms Involved	What happened?	Possible Reasons of Catastrophes
	Late Devonian extinction (8-10 events lasted 2-4 and 20-25 Ms).	It affected mostly marine life.	The extinction of 70-80% of all animal species.	Low levels of oxygen in the oceans.
	Carboniferous rainforest collapse, around 307 M years ago	It had a huge impact on Earth's flora and overall landscape.	"Coal forests" were wiped out.	Likely, climate change and rise of volcanic activities.
	The Permian–Triassic extinction, 251.9 million years ago.	77-96% of all invertebrate marine species were wiped out, as well as numerous insect species.	On land, 70% of all vertebrate species went extinct.	No evidence that it was preceded by an atmospheric or oceanic change.
	The Triassic–Jurassic events, about 201 million years ago.	34% of marine genera and up to 20% of marine families went extinct.	76% of marine and terrestrial species were wiped out.	Climate change, ocean acidification, increase in CO_2 in atmosphere (linked to volcanism).

Source: [26] The history of mass extinction events on Earth. Stars Insider. April 29, 2023, https://www.msn.com/en-us/travel/news/the-history-of-mass-extinction-events-on-earth/

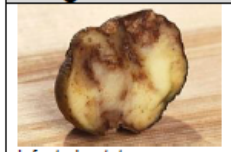
Historical Mass Extinction Events on Earth

Part 3:

Images	Extinction Event Name & Period	Organisms Involved	What happened?	Possible Reasons of Catastrophes
	The Cretaceous–Paleogene event, around 65 million years ago.	About 75% of all life on Earth went extinct. Large animals (e.g., dinosaurs) were unable to survive.	A prolonged period of cold and darkness, "impact winter".	It was caused by an asteroid impact at Yucatán Peninsula in Mexico.
	Eocene–Oligocene event, around 33.9 million years ago.	About 66% of all species in Europe and Asia went extinct.	The climate was likely affected by Earth's cooling.	Less CO2 in the atmosphere and changes in ocean circulation.
	The Pliocene–Pleistocene event occurred 2.6 million years ago.	36% of marine genera became extinct. Giant marine fauna (megalodon, giant shark) disappeared.	Particles from a supernova (exploding star) entered Earth.	Mutations and cancers that affected mostly larger animals.
	The Holocene (Anthropocene) undergoing extinction	The species extinction rate being between 100 to 1,000 times higher than it would naturally occur.	477 vertebrates have gone extinct since 1900.	This extinction event caused by human activity.

Source: [26] The history of mass extinction events on Earth. Stars Insider. April 29, 2023, https://www.msn.com/en-us/travel/news/the-history-of-mass-extinction-events-on-earth/

The most devastating infections are spreading

Images	Infection name	Time Period	Brief Description	Major Effects
 Infected potato. Phytophthora infestans. Wikipedia [54]	The fungus *Phytophthora infestans* [55]	In the mid-19th century, potatoes infected with fungus *Phytophthora infestans* arrived in Europe either from Peru or Mexico.	Similar fungal infections affected crops of rice, wheat, corn, and soybeans. The worldwide loss would be enough for 4.3 billion people.	The crops failed time after time. The Irish had a particularly hard time: a terrible famine broke out on the island. One in eight residents died between 1841 and 1851, and the same number emigrated.
 Banana plantation in Costa Rica affected by Panama disease, 1919 © The Library of Congress	The fungus *Fusarium oxysporum* [53]	It was first documented in Australia in 1876. The causative agent (TR4) was only identified in 1994.	The disease causes *Gros Michel* banana plants to rot from the inside.	Fungus spread in Central America, where it caused one of the largest ***epiphytoties*** (plant pandemic) called *Panamanian*. it also devastated *Cavendish* banana plantations in Taiwan, Southeast Asia, Africa, and Australia in the 1960s.
 © Marek R. Swadzba/ Shutterstock/Fotodom	The fungus *Chytridiomycosis* [53]	Nowadays	*Chytridiomycosis* has already wiped out dozens of amphibian species.	It drastically affects the reproductive behavior of orange toads. It threatens hundreds of other species.
 © Nick Greaves/ Shutterstock/Fotodom	The fungus *Cryphonectria parasitica (Chestnut blight)* [53]	The diseased tree was first noticed at the New York Zoo in 1904. By 1940, 3.5 billion chestnut trees had died.	The fungus has likely entered with seedlings from Japan.	The Chestnut blight has changed the face of the US East Coast. (In Asia, trees coexisted with the pathogen for centuries).
 © Marvin Moriarty/USFW/ Public Domain/Wikimedia	*Pseudogymnoascus destructans* (White nose syndrome) [53]	It was found on bats in a cave in New York State in 2006.	A fungal coating was found on the muzzles, ears, and wings of bats.	Affect species with weakened immune systems. During hibernation in bats, the body temperature drops and processes in the body slow down. In total, millions of bats died.

Fungal infections sometimes affect humans, but **the truly catastrophic damage is done to plants and animals.** [27-29]

Beetles that infect trees with the fungus *Grosmania clavigera* have destroyed 16.3 million hectares of forest in Canada. [27]

The estimated damage from tree diseases: by 2020 dead trees could absorb 230-580 million tons of CO_2 from the air, but this is a small portion of 34.9 billion tons emitted into the atmosphere in 2021. [30]

Source: [27] Kuzaev, Marat. (2022). The most devastating infection is spreading right now. But few have heard of her. TASS New Agency, September 19, 2022. https://nauka.tass.ru/nauka/15751575

3. SELF-DESTRUCTIVE BEHAVIOR OF HUMAN CIVILIZATIONS

A French lieutenant wrote, "***Humanity is mad.*** *It must be mad to do what it is doing. What a massacre! What scenes of horror and carnage! I cannot find words to translate my impressions. Hell cannot be so terrible. Men are mad!*" — (Diary, 23 May 1916) [32]

World War I began in 1914 and lasted until 1918. During the conflict, Germany, Austria-Hungary, Bulgaria and the Ottoman Empire (the Central Powers) fought against Great Britain, France, Russia, Italy, Romania, Canada, Japan and the United States (the Allied Powers). **More than 16 million people—soldiers and civilians alike—were dead** [31].

The **Battle of Verdun**, (Febr. 21–Dec. 18, 1916), was among the longest and bloodiest conflicts of World War I. casualties numbered about 400,000 for the French and 350,000 for the Germans. In total, about 300,000 were killed. [31]

The **40,000,000–50,000,000 deaths** incurred in **World War II (1939-1945)** make it the bloodiest conflict, as well as the largest war, in history [33].

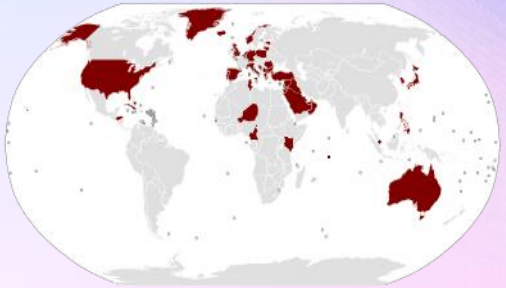
Auschwitz II-Birkenau gatehouse; the train track led directly to the gas chambers. [34]

Auschwitz was a complex of **over 40 concentration and extermination camps** operated by Nazi Germany in occupied Poland during WWII and the Holocaust. Of the 1.3 million people sent to camps, **1.1 million were murdered**, including 960,000 Jews (865,000 of whom were gassed on arrival), 74,000 Poles, 21,000 Romani, and 15,000 Soviet prisoners of war. Those not gassed were murdered via starvation, exhaustion, disease, executions, beatings, and during medical experiments. [34]

Fights continued for global power and additional natural resources

"The Terror of War" ("Napalm girl"). Nick Ut/AP/June 8, 1972, South Vietnam. [35]

Cpl. Graner and Spc. Sabrina Harman pose for picture behind nude detainees. Abu Ghraib prison, Iraq. 7 Nov. 2003. [36]



Countries with U.S. military bases and facilities ("around" 5,000 bases total, with "around" 600 of them overseas). [37,38]

ARMS SALES – "*BUSINESS AS USUAL*"

The arms sales of the top 100 arms-producing and military-services companies were **$531 billion** in 2020 [39]

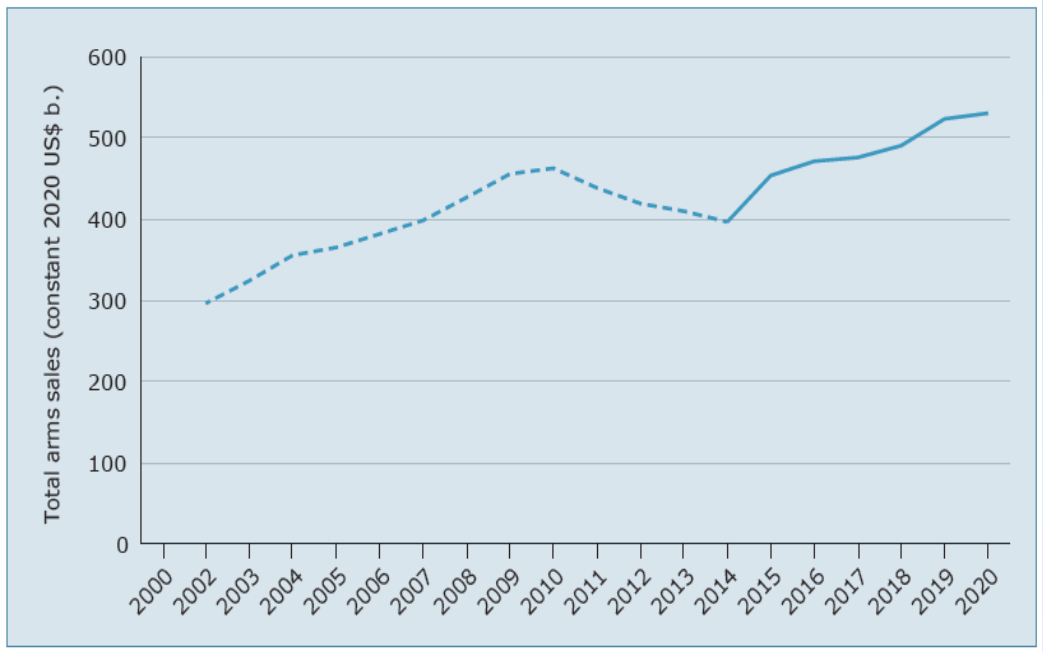


Figure: Total arms sales of companies in the SIPRI List of Top 100, 2002–2020 [39].
Note: The data in this graph refers to the companies in the SIPRI Top 100 in the respective year.
Source: SIPRI Arms Industry Database, Dec. 2021. [40]

Table: The 10 largest increases in arms sales as a share of total sales among arms companies in the SIPRI Top 100, 2020 [39].
Note: All sales figures are in millions of constant (2020) US dollars.

Company	Country	Arms sales, 2020	Arms sales, 2019	Total sales, 2020	Total sales, 2019	Arms sales as a % of total sales, 2020
Boeing	United States	32 130	34 090	58 158	77 722	*55*
Safran	France	4 510	3 631	18 805	28 214	*24*
Curtiss-Wright Corp.	United States	1 260	1 096	2 391	2 526	*53*
Meggitt	United Kingdom	980	1 064	2 159	2 944	*46*
Israel Aerospace Industries	Israel	3 510	3 173	4 184	4 233	*84*
Oshkosh Corp.	United States	2 260	2 061	6 857	8 509	*33*
Hanwha Corp.	South Korea	1 170	983	3 398	3 786	*34*
Rolls-Royce	United Kingdom	4 870	4 771	15 159	19 986	*32*
Fincantieri	Italy	2 660	2 171	6 701	6 675	*40*
Rheinmetall	Germany	4 240	4 031	6 697	7 165	*63*

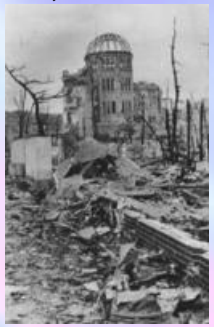
Source: SIPRI Arms Industry Database, Dec. 2021. [66]

- The **41 US companies** accounted for **54% ($285 billion)** of the Top 100's total arms sales in 2020 [39, 40].
- The **26 European companies** accounted for **21% ($109 billion)** of the Top 100's total arms sales in 2020 [39, 40].
- **China - 13% ($66.8 billion)**; **Russia – 5% ($26.4 billion)** in 2020 [39, 40].

PREPARING FOR A SUICIDAL MISSION: NUCLEAR WARS

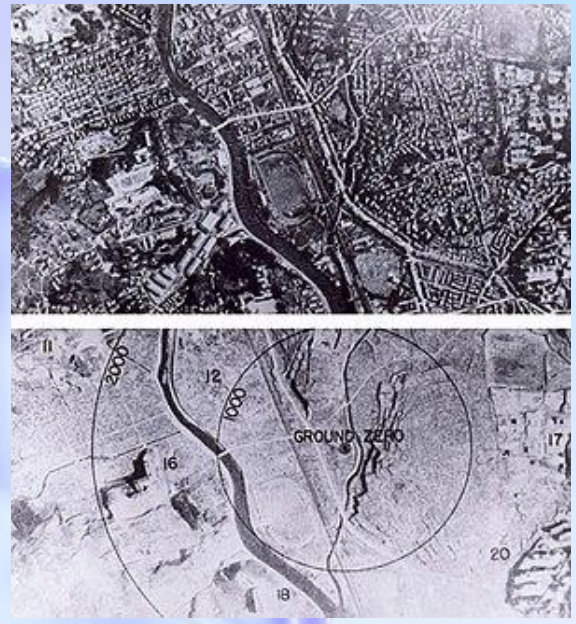
Since 1945, the terror-bombing of civilians became an accepted method of making war using atom bombs [41]

Pyrocumulonimbus cloud over Hiroshima, Aug. 6, 1945. [42] 70,000 inhabitants were killed.



The Hiroshima Genbaku Dome after the bombing

22-year-old victim being treated at the Hiroshima Red Cross Hospital.



Nagasaki before and after the bombing (Aug. 9, 1945), after the fires had burned out. [42]

Destroyed Nagasaki Temple. [42]

"Little Boy" atomic bomb dropped on Hiroshima. [42]

B61 nuclear bunker buster bomb. [44]

US forces used **depleted uranium** (DU) **shells** [45] during the second battle of Fallujah in Iraq. Medical teams reported increases in infant mortality, cancer, and birth defects.

During the Russian-Ukrainian conflict, the **Zaporizhzhia Nuclear Power Plant** has become the center of a **nuclear safety crisis**.[46]

Country	Warheads[a]	
	Total	Deployed
United States[21]	5,244	1,670
Russia[21]	5,889	1,674
United Kingdom[1][24][4]	225	120
France[1][24]	290	280
China[1][24][4]	410	0[24]
India[1][24][4]	164	0
Pakistan[1][4]	170	0
North Korea[1][24][4]	30	0
Israel[1][4]	90[1][4]	0

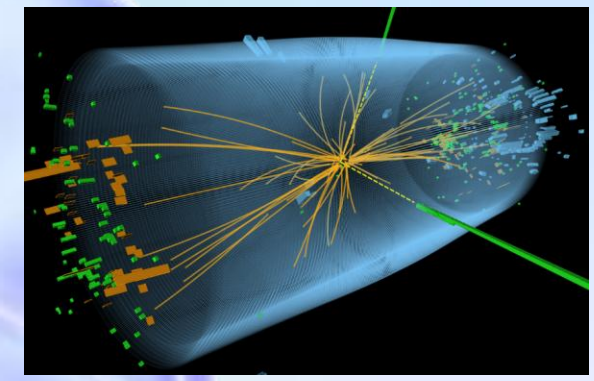
Nuclear states and their capacities. [43]

4. IN SEARCH OF COMMON GOALS FOR THE HUMANITY

Understanding the realities of catastrophes and Working together on global mutual projects

The **European Organization for Nuclear Research (CERN)** is an intergovernmental organization that operates the largest particle physics laboratory in the world. Established in 1954, it comprises **23 member states**. [47]

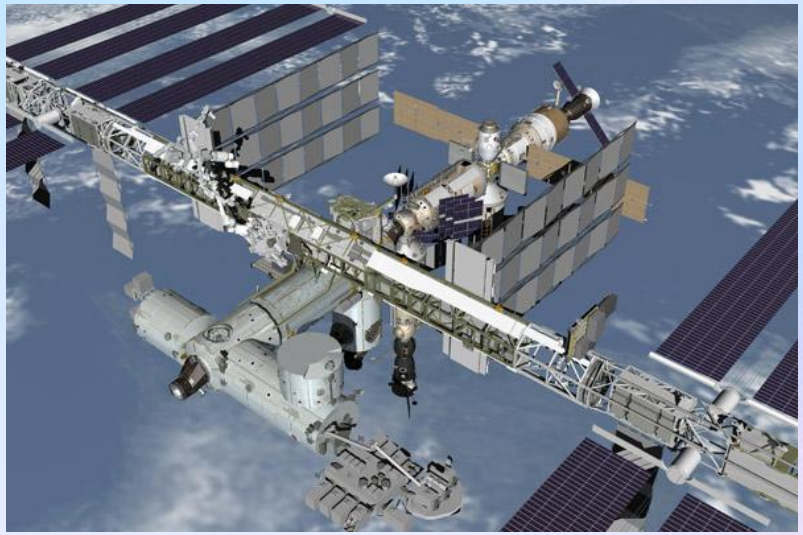
The **Large Hadron Collider (LHC)** is the world's largest and most powerful particle accelerator (Image: Anna Pantelia/CERN) [48]. It first started up on 10 Sept. 2008.



CMS Experiment at the LHC, CERN. Recorded May 13, 2012. CERN [49]. The event shows the decay of the SM Higgs boson to a pair of photons (dashed yellow lines and green towers).

The Higgs field was proposed in 1964 as a new kind of field that fills the entire Universe and gives mass to all elementary particles. The Higgs boson is a wave in that field. [49]

The International Space Station (ISS) Mission



The ISS effort involves more than 100,000 people in space agencies and at 500 contractor facilities in 37 U.S. states and in 16 countries. Assembled on the orbit in 2010, the station could safely operate beyond 2030, [50] Boeing Corp.

"*The International Space Station's role as a scientific laboratory and test bed for deep-space technology is crucial to humanity's ability to improve life on Earth while pursuing opportunities in space*". [50]

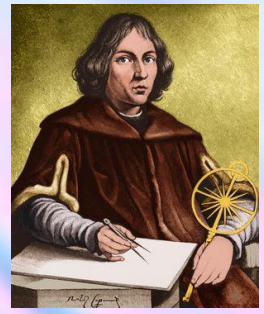
The other Global Projects [1]: The Internet, ResearchGate, ACM Digital Library, Svalbard Global Seed Vault, UNESCO, WHO, Doctors Without Borders, etc.

5. DISCUSSING A NEW (OR WELL-FORGOTTEN) MISSION FOR SCIENTISTS

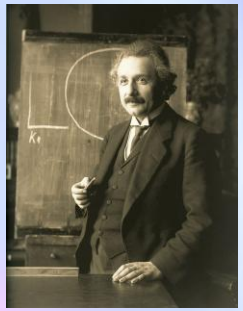
Challenges of the astrophysical and planetarian scales require paramount *mutual* efforts of the mankind in the long perspective.

> Will this spirit of collaboration prevail, or shall we continue glorifying warfare and dominance of some "technologically-advanced" nations in this fragile world? – **Hopefully, the answer to this moral question will be found by the Humanity**.

Movies, paintings, books, and life stories of philosophers, scholars, artists, composers, historians, and writers have motivated me to discuss these natural, technological, social and moral challenges.



Nicolaus Copernicus, Polish astronomer. [4]



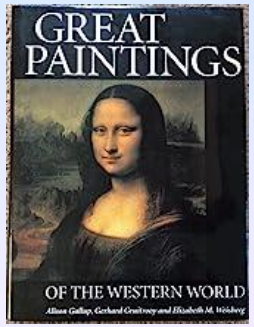
Albert Einstein, German-born theoretical physicist. [54]

Isaac Asimov, American writer and humanist. [55]

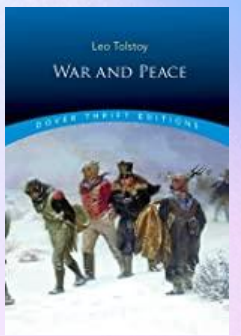
Kevin Gill, Rivier's alumni, holds NASA JPL's Emmy Award' 2018. He created unforgettable computer-generated images of thermo-nuclear explosions and magnetic storms on the Sun and produced the first-ever close views of the Saturn planet, winning an *Emmy Award* in 2018. [56]

Contact (1997 film). Theatrical release poster. [51].

The Silence of Doctor Ivens (1973 film). [52]



Great Paintings of The Western World. [57]



War and Peace, Novel by Leo Tolstoy. [53]

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