

Glossary

ablation: effect of a flow of matter or **radiation** flux on a body's surface, resulting in the latter's loss of substance through chemical decomposition, change of state or mechanical erosion.

absorption: process whereby a **radiation**'s intensity decreases as it goes through a material medium, to which it transfers all or part of its energy.

accretion disk: region where matter (dust and gas) is captured, by gravitation, by a heavenly body, accumulation of this matter resulting in the emergence of more massive objects, such as the planets around a **star**.

activation (of a gene): activation of the **expression** of that **gene**.
Inactivation: repression of the expression of that gene.

activation: process whereby a stable **nuclide** is transformed into a **radioactive** nuclide, for instance within structural materials in nuclear reactors, through the effect of a flux of **neutrons** or other particles.

activation products: see **activation**.

active site: region of an **enzyme** allowing **catalysis** of a particular reaction.

activity: number of spontaneous nuclear transitions (**decays**) occurring in a given quantity of **radionuclides** over a sufficiently short time interval, divided by that time interval. This is expressed in **becquerels (Bq)**, this unit corresponding to one transition per second; thus, this is a near-infinitesimal unit.

adiabatic: refers to transformations occurring with no exchange of energy with the outside environment.

advection: transport of a property through the motion of a fluid (for instance, the natural horizontal motion of a mass of air).

alpha (α) particles: helium nuclei, comprising two **protons** and two **neutrons**. Spontaneously emitted by the major part of natural **radioactive elements** as **radiation**, they are, together with protons, the fundamental constituents of primary **cosmic radiation**. They exhibit high **ionization** power, but a low penetration capacity.

amino acid: organic molecule featuring an amino (NH_2) group and a carboxyl (COOH) group. Twenty different amino acids, whose concatenation is encoded by **DNA**, enter into the composition of **proteins**.

angstrom (\AA): $1 \text{\AA} = 10^{-10}$ meter.

anion: negative **ion**.

antineutrino: the **antiparticle** of the neutrino.

antiparticle: to every particle of matter there corresponds an antiparticle of **antimatter** having the same mass but the opposite electric charge. When the two collide, they mutually annihilate each other, the energy being released in the form of **photons** or other particles.

atom: the basic constituent of common matter, comprising a **nucleus** (made up of **neutrons** and **protons**) around which **electrons** orbit.

atomic number: the number of **protons** in an **atom**'s **nucleus**, or the number of orbiting **electrons**.

ATP (adenosine triphosphate): an energy-transporting molecule involved in a large number of steps in cell **metabolism**. Composed of a base (adenine) and a sugar (ribose), together with a chain of three phosphate groups, it is mainly produced in mitochondria, and in the **chloroplasts** of plant cells.

aurora borealis (and australis): also known as northern (and southern) lights, a colored, luminous phenomenon generated in the **ionosphere** (region of charged particles in the upper atmosphere, extending, on Earth, from 40 km to 460 km or higher) of an Earth-like planet. It is caused by interaction (collisions) of the **ionized** particles in the **solar wind** trapped by the planet's **magnetic field**, and the **atoms** of the upper atmosphere, close to the magnetic poles (aurora borealis in the northern hemisphere; aurora australis in the southern hemisphere).

bacterium: living microorganism, usually unicellular, featuring no distinct nucleus, breeding and propagating rapidly, and measuring less than a few **micrometers**.

bar: unit of pressure. $1 \text{ bar} = 0.987 \text{ atmosphere} = 1.02 \text{ kg/cm}^2 = 10^5 \text{ pascals (Pa)}$.

becquerel: unit (**Bq**) of **activity**, measuring the number of nuclear transitions (**decays**) per second inside a given quantity of matter.

beta (β) radiation: radiation consisting in charged particles, **electrons** (beta- **radioactivity**) or **positrons** (beta+ **radioactivity**).

big bang: the standard theoretical model for cosmology, according to which the presently-observable Universe is expanding as a result of a singularity (primordial explosion) which occurred 12–15 billion years ago.

biomimetic: refers to a compound or process made by analogy with a biological substance or process.

biosphere: the ensemble of ecosystems on the planet, comprising all living beings and the environments in which they live.

black hole: one of the finite products of stellar evolution. A region of space-time from which nothing – neither matter nor light – can escape, as gravity is too high in it.

blanket (in a thermonuclear-fusion reactor): a component fulfilling a threefold role: recovery of the energy of the **neutrons** released by **thermonuclear fusion** reactions; *in situ* generation of the **tritium** involved in these reactions, through neutron bombardment of **lithium**; and shielding the reaction-chamber wall, through absorption of the flux of high-energy neutrons.

breakeven: in a **thermonuclear-fusion** device, the domain boundary (in terms of density, **confinement time**, temperature) for which the energy expended to heat the system is exactly compensated for by the energy generated by the reactions.

carbon dioxide or carbon gas (CO_2): gas generated in the burning of organic materials, responsible for part of the **greenhouse effect**.

carbon gas: see **carbon dioxide**.

carcinogenesis: the ensemble of stages leading to onset of a cancer.

catalyze: to accelerate a chemical reaction without the accelerator substance (the **catalyst**, or **enzyme** in biology) itself becoming altered, or only temporarily so.

cation: positive **ion**.

Cerenkov light: emission of **visible light**, occurring when a charged particle moves through a given medium at a velocity greater than that of light in that medium.

charge carriers: conduction electrons; electric current is the displacement of charge carriers. In **photovoltaics**, **photon**-generated electrons and holes.

chloroplast: an organelle in plant cells, containing the main part of the molecular machinery of photosynthesis.

CNO cycle: also known as the **carbon–nitrogen(–oxygen) cycle**, from the names of the **elements** appearing in it, involved in the reactions as **catalysts**, or **Bethe cycle** – from the name of US physicist Hans Bethe, 1967 Nobel Prizewinner. Cycle of thermonuclear reactions occurring inside **stars**, in the course of which four **hydrogen nuclei** are transformed into a **helium** nucleus, with release of energy. This cycle is believed to account for only 1.5% of the Sun's energy.

code (or program), computation: the assemblage, in a computer program, in the form of coded mathematical expressions, of the simplified representation (**model**) of a system or process, for the purposes of simulating it.

complex: a neutral or charged structure, comprising **ions** and molecules (organic or mineral), more rarely **atoms**, bound to a metal ion.

conduction: the transfer of energy through random collisions of **atoms** and **electrons** in motion. Its **electric conductivity** is the characteristic capacity for electric conduction of a substance.

convection: the ensemble of motions generated inside a fluid mass owing to differences in density and temperature at various points in this mass, contributing to heat transport. **Natural convection:** automatic transfer of heat through such circulation.

conversion efficiency: for a **photovoltaic** cell, this is the ratio of maximum output **electric power**, over the product of generator surface by measured incident illumination.

cosmic radiation: a stream of charged particles (**protons**, **helium nuclei** and **heavy-element** nuclei) travelling through interstellar space at **relativistic** velocities. Some of these particles originate outside the solar system, others inside the Sun, escaping through the holes in the corona; they interact with **atoms** in the upper atmosphere, before reaching the Earth's surface.

Coulomb barrier: electric repulsion impeding the coming together of two charged particles (the **protons** from two **nuclei**, in particular) having same-sign charges. This barrier may be overcome if the relative velocities of the two particles are sufficiently large. Through *nuclear interaction*, which makes itself felt at very short ranges, they may then undergo a **thermonuclear fusion** reaction.

cross-section: the measure of the probability of interaction between a particle and a target **nucleus**, expressed in **barns** ($1 \text{ barn} = 10^{-24} \text{ cm}^2$).

cryogenic: literally, "cold-generating," hence "relating to low temperatures." Cryogenic liquids, for instance, have boiling points lower than $-150 \text{ }^\circ\text{C}$.

cytoplasm: interior compartment of a cell, bounded by a plasmic membrane, and containing various organelles (mitochondria, vacuoles, **chloroplasts**...).

cytotoxic: toxic to the living cell.

decay: spontaneous transformation of a **radioactive nucleus** into a stable or unstable nucleus, through emission of one or more particles.

degree (of a solar acoustic mode): the number of times the mode considered is reflected on the Sun's surface.

deuterated: containing **deuterium**.

deuterium: "heavy" **isotope** of **hydrogen**, featuring a **nucleus** comprising one **proton** and one **neutron**. Cosmic deuterium is thought to have been formed during the **primordial nucleosynthesis**, which entails that, since deuterium cannot be *durably* generated inside **stars**, the presently occurring quantity is an essential indication as to the density of matter in the Universe. In **heavy water**, the hydrogen **atoms** are substituted by deuterium atoms.

dimer: aggregate of two identical molecules, bound together by covalent bonds, or weaker bonds, e.g. hydrogen bonds.

discharge (in a thermonuclear-fusion device): a term indicating the presence of a **plasma** in the confinement vessel (not to be confused with **confinement time**, i.e. the time span for which temperature and density conditions for such a plasma must be maintained, to allow **fusion** reactions).

disk: the visible surface of a heavenly body, projected onto the heavenly canopy.

divertor (ergodic): a device, in a **magnetic-confinement thermonuclear-fusion** machine, serving as an "ashtray," dedicated to continuous recovery of the **helium** generated in the **plasma** core, drawing out the flow lines at the plasma edge to direct them to pumping points. It also has the function of improving plasma-wall interaction conditions, through better distribution of energy fluxes at the edge of the **discharge**, and generation of a layer of cold, radiating plasma.

DNA: see **nucleic acids**.

doping agent: an extraneous **atom** introduced into the lattice of a **semiconductor**, to alter its electric properties, this manifesting itself by the presence of a discrete permitted energy level within the forbidden **band gap**, close to the **valence band** or the **conduction band**. This atom thus releases a mobile **electron** or hole to one or the other of the permitted bands, increasing the material's **electric conductivity**.

DT: **deuterium–tritium**.

dynamo effect: an effect converting mechanical energy into an electric current.

electric power: the product of output voltage by intensity of the current supplied.

electromagnetic radiation: a form of **radiation** that propagates in a vacuum at the velocity of light, through the interaction of oscillating electric and **magnetic fields**, and transports energy (**photons**).

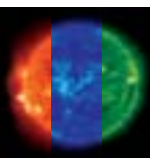
electron: negatively-charged elementary particle (lepton).

electron–hole pair: a pair of **carriers**, not bound to an **atom**, and thus able to move through the entire crystal in which they were formed, one of which is negative (**electron** in the **conduction band**), the other positive (absence of an electron in the **valence band**).

electronic bands: ranges of energies available to **electrons** in matter, linked to the periodic character of the **atomic** arrangement inside a crystal, and the wave character of electrons.

electronic band gap, direct or indirect: a **semiconductor** has an **electronic band** structure characterized by presence of a forbidden band, or band gap, between a permitted, filled (or nearly filled, at nonzero temperatures) band, the **valence band**, and an unfilled, empty or nearly empty, band, the **conduction band**. **Photons** with energy greater than the band gap generate **charge carriers** through **electron** transitions from one permitted band to the other. Depending on **atomic** arrangement and peripheral-electron energies, the band gap may be crossed with emission of *phonons* (lattice vibration *quanta*) – one then speaks of **indirect** band gap (this being the case of **silicon**) – or with no such emission (this is referred to as **direct** band gap).

electronvolt (eV): unit of energy, equal to about $1.6 \cdot 10^{-19}$ joule, or $1.6 \cdot 10^{-12}$ **erg**. This is equal to the energy gained by an **electron** accelerated by a potential of 1 volt. 1 **keV** (thousand electronvolts) = 11.6 million **kelvins**. The main multiples are the **MeV** (one million electronvolts) and **GeV** (one billion electronvolts).



electrostatic: only involving Coulomb attraction and repulsion forces, in other words based on non-moving electric charges (constant electric field).

element: an **atom** defined by the number of its **electrons** (**atomic number**). A distinction is made between **light elements** (**hydrogen, helium, lithium, beryllium, boron**) and **heavy elements** (all others, from carbon to uranium as far as natural elements are concerned).

enzyme: substance having the nature of a **protein**, which activates a biochemical reactions by **catalyzing** it.

erg: unit of energy, equal to 10^{-7} joule (J). Ten million (10^7) ergs per second correspond to 1 **watt** ($1\text{ W} = 1\text{ J/s}$).

expression (of a gene): the production by a **gene** of an observable **phenotype** (the manifest characters of an individual), usually through synthesis of a **protein**.

field lines (magnetic): imaginary lines, showing the intensity and direction of a **magnetic field**, around and along which charged particles spiral in a helical motion.

fission: splitting of a heavy **nucleus** into two fragments, accompanied by emission of **neutrons** and **radiation**, and considerable release of heat.

fossil energy: energy generated from fuels extracted from the Earth, such as coal, petroleum and natural gas.

free electron: an **electron**, normally bound, at a distance, to an **atom's nucleus**, which has broken from its bond with that atom.

fuel (thermonuclear): **light elements** having the ability to undergo **fusion** inside a **thermonuclear** reactor (or a **star**) and generate energy.

fusion (thermonuclear): nuclear reaction whereby small atomic nuclei combine at high temperature to form larger nuclei having a mass lower than the sum of the masses of the initial nuclei, the difference in mass being converted into energy in accordance with the Einsteinian mass-energy equivalence law: $E = mc^2$. This reaction is the source of the Sun's energy, and, directly or indirectly, the source for nearly all energy on Earth.

galaxy: a huge isolated aggregate of **stars** and interstellar gaseous matter.

gamma (γ) radiation: the most energetic form of **radiation** in the electromagnetic spectrum. Gamma **photons** have energies in a range extending from 10 **keV** to over 1 **MeV**.

gene: **DNA sequence** on a chromosome representing a unit of hereditary information, enabling the production of a **phenotypic** character through production of one or more **proteins**.

genetic engineering: ensemble of techniques allowing the **genetic** material of a cell or living organism to be modified.

genome: the ensemble of **genetic** material of a living organism.

genotoxic: toxic with respect to **genes**, as causing damage to **DNA**.

GeV: see **electronvolt**.

gigabar (Gbar): $1\text{ Gbar} = 10^9\text{ bars} = 0.987 \cdot 10^9\text{ atmospheres} = 1.02 \cdot 10^9\text{ kg/cm}^2 = 10^{14}\text{ pascals}$.

gigapascal (GPa): $1\text{ GPa} = 10^9\text{ pascals}$.

gravitational confinement: natural confinement, through the effects of gravitation, of a **light-element plasma** inside a **star**, such as the Sun in particular, bringing about the conditions for **fusion**.

greenhouse effect: a rise in temperature attributable to solar **radiation** being able to enter the atmosphere, whereas the consequent thermal radiation cannot escape. This effect increases with higher concentrations of "**greenhouse-effect gases**" in the atmosphere.

greenhouse-effect gas (GEG): a gas the presence of which in the atmosphere tends to increase the natural **greenhouse effect**. **Carbon dioxide** (CO_2), water vapor, **methane** and chlorofluorocarbons (which also attack the Earth's **ozone** layer) are the main GEGs.

heat conduction: the phenomenon whereby, within a medium, heat flows from a high-temperature region to another, lower-temperature region, or from one medium to another coming into contact with it.

heavy metals: metals having a density greater than 4.5 g/cm^3 . These include zinc (7.14), cadmium (8.6), lead (11.35)...

heavy water: see **deuterium**.

helioseismology: investigation of the solar interior through analysis of the Sun's natural oscillation modes. Observation of the Sun's vibrations, propagating from the surface and reflected by the various internal layers, allows measurement of such parameters as the speed of sound or rotation speed.

helium: the lightest chemical **element** (He) after **hydrogen**. Its **nucleus** comprises two **protons** and two **neutrons**, for helium 4, the most common **isotope** (the nucleus of helium 3 features one single neutron). The helium present in the Universe was formed during the **primordial nucleosynthesis**. Rare in the Earth's atmosphere, it is abundant in **stars**, where it is the product from the burning of hydrogen.

hohlraum: a cylindrical cavity holding the target of an **indirect-drive inertial-confinement thermonuclear-fusion** device.

hydrocarbon: a molecule composed solely of carbon and **hydrogen**.

hydrogen: the simplest **atom**, comprising one **proton** and one **electron**.

hydrolysis: decomposition of a chemical species (molecule or **ion**) by water.

hydrostatic equilibrium: equilibrium prevailing in a fluid when the force of gravity (and hence weight) exactly compensates the vertical pressure gradient.

ignition: self-sustenance of the **plasma** temperature in a **thermonuclear-fusion** device, at a level sufficient for reactions to proceed continuously.

incidence: the number of *new cases* identified for a condition (e.g. cancer) over a given period (usually one year), in a given population.

inertial confinement: see **magnetic confinement** and **inertial confinement**.

infrared (IR) radiation: a segment of the electromagnetic spectrum covering **radiation** of wavelengths ranging from 760–780 **nm** to 1 mm. IR-A radiation extends from 760–780 nm to 1,400 nm, IR-B from 1,400 nm to 3,000 nm (3 μm), and IR-C from 3 μm to 1 mm. Physicists divide infrared into near infrared (760 nm–4 μm), intermediate infrared (4–14 μm), far infrared (14–100 μm), and submillimeter infrared (100 μm –1 mm).

ion: an **atom** or molecule that has lost, or gained, one or more **electrons**, and has thus become electrically charged.

ionization: state of matter in which **electrons** are separated from the **nuclei**. The process whereby **ions** are produced, through collision with **atoms** or electrons (collision ionization) or interaction with **electromagnetic radiation** (**photoionization**).

isotopes: forms of the same chemical **element**, having **nuclei** comprising identical numbers of **protons**, and featuring the same number of **electrons**, but whose nuclei comprise different numbers of **neutrons**, and hence have different masses.

isotropic: presenting identical physical properties in all directions (antonym: **anisotropic**).

kelvin (K): unit of temperature (in the International System of Units, SI). The kelvin scale features just one fixed point, this being, by convention, the thermodynamic temperature of the triple point of water (i.e. the point at which the three phases, solid, liquid, and vapor, coexist) at 273.16 K, i.e. 0.01 °C. Ice melts at 273.15 K (0 °C); water boils at 373.15 K (100 °C). Zero kelvin ("absolute zero") is the temperature corresponding to zero molecular agitation.

keV: see **electronvolt**.

kilojoule (kJ): 1 kJ = 10³ joules.

kWh (kilowatt-hour): 1 kWh = 3.6 million joules. The principal multiple of the **watt-hour**, a unit of work and energy, the product of power by time.

Lagrangian points: from the name of Italian-born French mathematician and astronomer Joseph Louis Lagrange (1736–1813), who mathematically deduced that a pair of heavenly bodies undergoing gravitational interaction would have in its vicinity five points of equilibrium, the Lagrangian points (L1–L5). At these points, the gravitational forces prevailing between two bodies (the two heavenly bodies) can hold in equilibrium a third body keeping to the same orbital plane, provided its mass be much smaller than theirs. The SOHO solar observation satellite is thus positioned at **Lagrangian point L1**, between the Sun and the Earth, 1.5 million kilometers from the latter.

laser: a light source yielding waves that are monochromatic (of a single wavelength) and coherent (always in phase).

lipids: organic molecules containing a fatty acid, or a fatty-acid derivative, not water-soluble, but soluble in nonpolar (hydrophobic) organic solvents.

lithium: light chemical **element** (Li), coming third in the classification after **hydrogen** and **helium**. Its **nucleus** comprises three **protons** and four **neutrons**. It was mainly formed during the **primordial nucleosynthesis**.

magnetic confinement and inertial confinement: the two main methods, currently, for the artificial confinement of a **light-element plasma**, to set up the conditions for **fusion**.

magnetic field: a force field generated by electric currents.

magnetosphere: region in space where a planet's **magnetic field** preponderates over that of the **solar wind**, shielding the planet from the wind's **ionized** particles. In the case of the Earth, it is positioned beyond the **ionosphere**, starting at about a thousand kilometers above the surface, and extending out to the *magnetopause*, this marking the separation with interplanetary space. The tail of the Earth's magnetosphere (on the night side of the planet) is that part of it which is drawn out to the outer reaches of the solar system by the solar wind.

main sequence: the region in the **star** luminosity–temperature diagram bringing together those stars for which the energy source is the **fusion of hydrogen into helium**: the present-day Sun is one of these.

mass fraction: unit of concentration, expressed as a percentage, equal to the product of *molecular concentration by molar mass*.

massively parallel computer: a computing system comprising a large number of elementary units (up to several hundred, or even several thousand processors) simultaneously carrying out different tasks in parallel. Processors may share a common memory within a "node," these "nodes" in turn being connected by means of a high-performance interconnection network.

megabar (Mbar): 1 Mbar = 10⁶ **bars** = 987,000 atmospheres = 1.02 · 10⁶ kg/cm² = 10¹¹ pascals.

megajoule (MJ): 1 MJ = 10⁶ joules.

metabolism: the ensemble of chemical processes occurring in living organisms and in every cell.

methane: a gas (CH₄), the main constituent of natural gas. It is released during decomposition of organic matter.

MeV: see **electronvolt**.

micron or micrometer (μm): 1 μm = 10⁻⁶ meter.

millibar (mbar): 1 mbar = 10⁻³ **bar** = 0.000 987 atmosphere = 1.02 g/cm² = 100 pascals (1 hectopascal).

modeling: providing a simplified representation (**model**) of a system or process, for the purposes of simulating it.

mole: unit of quantity of matter (symbol: **mol**), equal to the quantity of matter in a system comprising as many elementary units as there are **atoms** in 0.012 kg of carbon 12.

molecular modeling: an approach of molecular structure through numerical computation, on the basis of a number of instruments (quantum chemistry, molecular dynamics, molecular mechanics), allowing prediction of molecule behavior as a function of structure, or the design of molecules according to the desired behavior.

mRNA: see **nucleic acids**.

mutation: a transmissible alteration of the **genetic** message, occurring through alteration of a **nucleotide sequence in DNA**; a *point mutation* is an alteration restricted to a single nucleotide.

nanojoule (nJ): 1 nJ = 10⁻⁹ joule.

nanometer (nm): 1 nm = 10⁻⁹ meter.

nanosecond (ns): 1 ns = 10⁻⁹ second.

neutron: electrically neutral particle. A neutron is 1,839 times heavier than an **electron**. Neutrons and **protons** are the constituents of **atomic nuclei (nucleons)**.

neutron absorber: absorber of **neutrons**.

northern (and southern) lights: see **aurora borealis (and australis)**.

nucleic acids: polymers formed by the concatenation of **nucleotides**. There are two types of nucleic acid: **DNA** (deoxyribonucleic acid), which serves as the carrier for the **genetic** information inside every living cell, and **RNAs** (ribonucleic acids), in particular **messenger RNA**, which, from the coding carried by the DNA, specifies the **sequence of amino acids** in a **protein**.

nucleons: constituent particles of the **atomic nucleus**, bound together by *strong interaction*, ensuring cohesion. **Protons** and **neutrons** are nucleons.

nucleotide: elementary component unit of **nucleic acids**, comprising a *purine* base (adenine, guanine, for instance) or *pyrimidine* base (e.g. cytosine, thymine), a sugar and one or more phosphate groups.

nucleus (atomic): the essential constituent of an **atom**, bearing a positive charge and comprising **protons** and **neutrons** (except in the case of **hydrogen**), around which **electrons** orbit.

nuclide: a nuclear species characterized by its *mass number A* (the sum of the number of **neutrons N** and number of **protons Z**) and its *atomic number* (number of protons Z).

opacity: the capacity of matter to **absorb radiation**.

oxidation: a reaction whereby an **atom** or **ion** loses **electrons**.

oxidation state (or number): a figure representing the number of **electrons** that must added to, or subtracted from, an **atom** in a combined form (within a compound) to make it neutral. A decrease of this figure corresponds to a **reduction**, an increase to an **oxidation**.

oxidation stress: in an organism, the outcome of an imbalance between oxygen **free radicals** (**atoms** or molecules, resulting from the decomposition of a water molecule) and antioxidants. Oxidation stress can cause cell damage, which may result in cell death, since free radicals are highly reactive, as they carry an unpaired **electron**.

oxidizer: a chemical compound causing an **atom** or **ion** to lose **electrons**.

ozone: a molecule comprising three **atoms** of oxygen, present in the Earth's atmosphere. It is generated, on the one hand, at high altitude by the Sun's **ultraviolet radiation**, and, on the other, at ground level, by combustion of organic materials (automobile fuels, in particular).

peptide: a **protein**-type molecule, formed from a small number of **amino acids**.

period (radioactive or physical): the time interval required for the **decay** of half of the **atoms** in a sample of a **radioactive nuclide** to occur.

permeation: molecular diffusion of a substance through a membrane, under the motive power of a pressure gradient.

petawatt (PW): 1 PW = 10^{15} **watts**.

photon: the *quantum* of energy of **electromagnetic radiation**. An elementary particle having neither mass nor electric charge, associated to such radiation [**visible light**, **infrared** or **ultraviolet radiation**, **gamma radiation**, **X-radiation**, according to its energy].

photovoltaic: effect whereby the energy of light is directly transformed into electric energy in a **semiconductor**.

picometer (pm): 1 pm = 10^{-12} meter.

picosecond (ps): 1 ps = 10^{-12} second.

plasma: a gas brought to a temperature such that **atoms** are **ionized**. Its properties are determined by the electromagnetic forces prevailing between its constituents [**ions** and **electrons**], leading to various types of behavior. Seen on Earth as the fourth state of matter, it is actually, through the Universe, the main form of matter.

polarized: having an electric-field vector which, as it describes an electromagnetic vibration, remains in a definite plane.

polymerase: an **enzyme** that **catalyzes** the synthesis of **sequenced** macromolecules, such as **DNA** (DNA polymerase) and **RNA** (RNA polymerase).

positron: positively charged **antiparticle** of the **electron**.

primordial: relating to the very dense, very hot, and very short (a few minutes) phase in cosmic evolution during which the **lightest elements** in the Universe (**deuterium**, **helium**), were generated.

primordial nucleosynthesis: the synthesis of **deuterium**, **helium-3**, **helium-4** and **lithium-7 nuclei** during the first three minutes of the Universe following the **big bang**, as its temperature went from 10 billion to 1 billion degrees.

protein: the main macromolecular component in cells, comprising a definite **sequence** of **amino acids**, from a set of twenty, encoded by **DNA**.

proton: particle bearing an electric charge equal to that of the electron, and of opposite sign. A proton is 1,836 times heavier than an electron.

radiation: energy emitted in the form of electromagnetic waves, or a flow of particles.

radical species (or **free radical**): an **atom** or molecule carrying an unpaired **electron** (i.e. one not forming with another electron an energetically stable pair). A **radical** is a group of atoms that remains unchanged through the chemical alterations affecting the rest of the molecule.

radioactive (or **decay**) **chain** of an **element**: the succession of distinct **elements** arising as a result of the spontaneous transformation, over time, of an unstable **nucleus**. This chain ends in a stable (non-**radioactive**) element.

radioactivity: a property, exhibited by some natural or artificial **elements**, of emitting spontaneously **alpha particles** (**helium nuclei**), **beta particles** (**positrons** [beta⁺ emission] or electrons [beta⁻ emission]), and/or **gamma radiation** (high-energy **photons**). More generally, this term is used to refer to the emission of **radiation** accompanying the **decay** of an unstable element, or **fission**.

radionuclide: a **radioactive isotope**, sometimes also termed a **radioisotope**, of an **element**.

redox equilibrium: equilibrium between **reduction** and **oxidation** reactions (**electron** transfers between **atoms** or **ions**).

reducer: a chemical compound yielding **electrons** to an **atom** or **ion**.

reduction: a reaction whereby an **atom** or **ion** gains **electrons**, yielded by a **reducer**.

relativistic: matter is said to be relativistic when thermal agitation velocity is close to the speed of light.

replication: the duplication of the **DNA** molecule, occurring in a living cell prior to its division into two daughter cells.

resolution: the smallest distinguishable value, for the acquisition or restitution of information. In particular, this is the measure of the ability of an optical system to discriminate or reproduce details in a scene or its image. The *resolution of a model* is the *mesh* size, in terms of space and time, used for a **modeling** run.

RNA; mRNA: see **nucleic acids**.

semiconductor: a material characterized by an electronic **band gap**, which is neither solely an insulator nor solely a conductor at nonzero temperatures. Some of its **electrons**, being very weakly bound to their **atoms**, can become **conduction** electrons. A semiconductor can be of the *n* type (with mainly electron **charge carriers**), or the *p* type (mainly hole charge carriers), according to the **doping agents** used.

sequence: the order in which the constituent elements are concatenated in biological polymers (**DNA**, **RNA**, **proteins**). **Sequencing** is the determination of that order.

silicon: the most common **semiconductor**. In the *amorphous* form, in the noncrystalline state, deposited onto a substrate having a thickness of the order of 1 μm , it is employed for the fabrication of **photovoltaic** cells and modules. The term *crystalline silicon* (*c-Si*) covers the various crystalline forms. *Microcrystalline silicon* ($\mu\text{c-Si}$) is a material employed, in thicknesses of the order of 1 μm , in the fabrication of photovoltaic cells and modules (grain size < 1 μm). *Mono-crystalline silicon* (*sc-Si*) is used to produce ingots and wafers, or cells, obtained by the Czochralski pulling method, or by the float-zone method. A wafer contains a single grain. *Multicrystalline silicon* (*mc-Si*) is grown by directional solidification in a crucible, to produce ingots, wafers or cells (grain size: 0.1–10 μm). *Polycrystalline silicon* (*pc-Si*), in thicknesses of 10–30 μm , is deposited onto a substrate to produce ingots, wafers or cells (grain size: 1 μm –1 mm).

solar cycle: periodic variation in the Sun's activity. The most well-defined cycle has an approximate duration of 11 years. This activity manifests itself through the rise and growth of sunspots. The **solar maximum** is the period (of the order of a few months), within the solar cycle, during which the number of sunspots reaches a maximum, the last such period being recorded in mid-2001 (antonym: **solar minimum**).

solar wind: a flow of charged high-energy particles, mainly **protons** and **electrons** forming a **plasma**, emanating from the Sun's corona with velocities of several hundred kilometers per second.

spin: the intrinsic angular momentum (or intrinsic torque) of a particle.

star: heavenly body consisting in a large mass of gas (essentially **hydrogen** and **helium**) that generates and emits energy.

stellarator: configuration for a **magnetic-confinement thermonuclear-fusion** device not involving an electric current inside the **plasma**; it ensures, through a complex geometry for its windings, compensation for the drift that tends to bring closer to the wall the plasma particles placed in the **magnetic field**.

sublimation: the transition from the solid state to the gaseous state, without passing through the liquid state.

superconductor: a metal or alloy in which resistivity (the specific resistance to **electron** travel) suddenly vanishes to a near-zero value, at a so-called critical temperature.

superfluid: the quantum property exhibited by a fluid that flows viscosity-free at ultra-low temperatures. When a fluid becomes superfluid, **atom** motions become collective motions. This is the case, on Earth, for **helium** 3, which liquefies at 4 **kelvins** (K), and, at 1.8 K, undergoes transition from the ordinary fluid state to the superfluid state.

supernova: the final, exploding state for massive **stars**, or for a white dwarf (the final state for stars of low mass) coupled to a red giant (the phase of strong expansion in stars of intermediate mass).

terabar (Tbar): 1 Tbar = 10^{12} bars = $0.987 \cdot 10^{12}$ atmospheres = $1.02 \cdot 10^{12}$ kg/cm² = 10^{17} pascals.

teraflops (Tflops): 1 Tflops = one thousand billion floating-point computation operations per second.

thermalization: the gradual bringing of **radiation** or a particle stream into thermal equilibrium with the environment into which it diffuses.

tokamak: the name is an acronym, derived from the Russian *toroidal'naja kamera s aksial'nym magnitnym polem* ("toroidal chamber with axial magnetic field"), defining toroidal devices for the investigation of **magnetic-confinement thermonuclear fusion** through confinement of the plasma, where the fusion reactions occur, by means of **magnetic fields**.

transcription: the first stage of **gene expression**, consisting in the transcription of the coded **sequence** from a **DNA** strand into a **messenger RNA** sequence. This is initiated and controlled by complex ensembles of **proteins**, known as **transcription factors** and **RNA polymerases**.

transcription factor: any **protein** involved in the initiation or control of **gene expression**.

transgenesis: the ensemble of operations carried out to obtain an organism stably incorporating one or more **genes** from another cell or organism, and having the ability to transmit this to subsequent generations.

tritium: the heaviest **isotope** of **hydrogen**, and the only **radioactive** one. Its **nucleus** comprises one **proton** and two **neutrons**. Toxic in the tritiated water (HTO) form.

tritium breeder: generating **tritium**. This term is used, in particular, to refer to the **blankets** in a thermonuclear reactor, in which **lithium** is transformed into tritium through **neutron** bombardment.

tunnel effect: effect, of quantum character, which can allow a particle (**proton**, **electron**) that does not have, in terms of classical physics, sufficient energy to overcome a potential barrier of given value to cross that barrier nonetheless, since the *wave function* associated to this particle is not null-valued on the other side of the barrier. The tunnel effect can thus allow two protons to circumvent their electric repulsion, at relative velocities lower than those indicated by classical calculus.

turbulence: a flow mode in fluids, for which, onto the mean motion, a random agitation motion is superimposed.

ultraviolet (UV) radiation: a segment of the electromagnetic spectrum covering **radiation** with wavelengths ranging from 400–380 **nm** to 10 nm, that fall between those of **visible light** and of **X-rays**. Ultraviolet is divided into near ultraviolet (380–200 nm) and extreme ultraviolet (200–10 nm). For physiologists, ultraviolet is divided into three broad categories: UVA (400–380 nm to 315 nm), UVB (315–280 nm), and UVC (280–100 nm). Vacuum ultraviolet covers wavelengths in the 100–10 nm range. A large proportion of UV radiation is **absorbed** by the Earth's atmosphere.

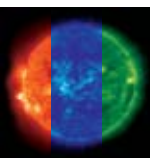
visible light: the part of the electromagnetic spectrum that is visible to the human eye, i.e. **radiation** having wavelengths ranging from 380–400 **nanometers** (violet) to 760–780 nm (red), bounded on the one hand by **ultraviolet**, and, on the other, by **infrared**.

watt (W): unit of power, corresponding to 1 joule per second. Main multiples are the kilowatt (1 **kW** = 1,000 watts), the megawatt (1 **MW** = 1 million watts) and the terawatt (1 **TW** = 1,000 billion watts).

WIMPs (weakly interacting massive particles): hypothetical massive particles, interacting only very weakly with common matter, which might form all or part of the "missing", hidden mass in the Universe.

X-rays: electromagnetic radiation with wavelengths ranging from a few fractions of a **nanometer** (0.005 nm) to 10 nm, and energies ranging from a few **kiloelectronvolts** to several hundred kiloelectronvolts. A distinction is made between **soft X-rays** (for the longer wavelengths) and **hard X-rays** (of shorter wavelength). Since X-rays are **absorbed** by the Earth's atmosphere, X-ray astronomy is carried out in space.

yeast: a microscopic unicellular fungus, representative of all living cells featuring a nucleus, and for that reason serving as a model for biologists.



Glossary

ablation: effect of a flow of matter or **radiation** flux on a body's surface, resulting in the latter's loss of substance through chemical decomposition, change of state or mechanical erosion.

absorption: process whereby a **radiation**'s intensity decreases as it goes through a material medium, to which it transfers all or part of its energy.

accretion disk: region where matter (dust and gas) is captured, by gravitation, by a heavenly body, accumulation of this matter resulting in the emergence of more massive objects, such as the planets around a **star**.

activation (of a gene): activation of the **expression** of that **gene**.
Inactivation: repression of the expression of that gene.

activation: process whereby a stable **nuclide** is transformed into a **radioactive** nuclide, for instance within structural materials in nuclear reactors, through the effect of a flux of **neutrons** or other particles.

activation products: see **activation**.

active site: region of an **enzyme** allowing **catalysis** of a particular reaction.

activity: number of spontaneous nuclear transitions (**decays**) occurring in a given quantity of **radionuclides** over a sufficiently short time interval, divided by that time interval. This is expressed in **becquerels (Bq)**, this unit corresponding to one transition per second; thus, this is a near-infinitesimal unit.

adiabatic: refers to transformations occurring with no exchange of energy with the outside environment.

advection: transport of a property through the motion of a fluid (for instance, the natural horizontal motion of a mass of air).

alpha (α) particles: helium nuclei, comprising two **protons** and two **neutrons**. Spontaneously emitted by the major part of natural **radioactive elements** as **radiation**, they are, together with protons, the fundamental constituents of primary **cosmic radiation**. They exhibit high **ionization** power, but a low penetration capacity.

amino acid: organic molecule featuring an amino (NH_2) group and a carboxyl (COOH) group. Twenty different amino acids, whose concatenation is encoded by **DNA**, enter into the composition of **proteins**.

angstrom (\AA): $1 \text{\AA} = 10^{-10}$ meter.

anion: negative **ion**.

antineutrino: the **antiparticle** of the neutrino.

antiparticle: to every particle of matter there corresponds an antiparticle of **antimatter** having the same mass but the opposite electric charge. When the two collide, they mutually annihilate each other, the energy being released in the form of **photons** or other particles.

atom: the basic constituent of common matter, comprising a **nucleus** (made up of **neutrons** and **protons**) around which **electrons** orbit.

atomic number: the number of **protons** in an **atom**'s **nucleus**, or the number of orbiting **electrons**.

ATP (adenosine triphosphate): an energy-transporting molecule involved in a large number of steps in cell **metabolism**. Composed of a base (adenine) and a sugar (ribose), together with a chain of three phosphate groups, it is mainly produced in mitochondria, and in the **chloroplasts** of plant cells.

aurora borealis (and australis): also known as northern (and southern) lights, a colored, luminous phenomenon generated in the **ionosphere** (region of charged particles in the upper atmosphere, extending, on Earth, from 40 km to 460 km or higher) of an Earth-like planet. It is caused by interaction (collisions) of the **ionized** particles in the **solar wind** trapped by the planet's **magnetic field**, and the **atoms** of the upper atmosphere, close to the magnetic poles (aurora borealis in the northern hemisphere; aurora australis in the southern hemisphere).

bacterium: living microorganism, usually unicellular, featuring no distinct nucleus, breeding and propagating rapidly, and measuring less than a few **micrometers**.

bar: unit of pressure. $1 \text{ bar} = 0.987 \text{ atmosphere} = 1.02 \text{ kg/cm}^2 = 10^5 \text{ pascals (Pa)}$.

becquerel: unit (**Bq**) of **activity**, measuring the number of nuclear transitions (**decays**) per second inside a given quantity of matter.

beta (β) radiation: radiation consisting in charged particles, **electrons** (beta- **radioactivity**) or **positrons** (beta+ **radioactivity**).

big bang: the standard theoretical model for cosmology, according to which the presently-observable Universe is expanding as a result of a singularity (primordial explosion) which occurred 12–15 billion years ago.

biomimetic: refers to a compound or process made by analogy with a biological substance or process.

biosphere: the ensemble of ecosystems on the planet, comprising all living beings and the environments in which they live.

black hole: one of the finite products of stellar evolution. A region of space-time from which nothing – neither matter nor light – can escape, as gravity is too high in it.

blanket (in a thermonuclear-fusion reactor): a component fulfilling a threefold role: recovery of the energy of the **neutrons** released by **thermonuclear fusion** reactions; *in situ* generation of the **tritium** involved in these reactions, through neutron bombardment of **lithium**; and shielding the reaction-chamber wall, through absorption of the flux of high-energy neutrons.

breakeven: in a **thermonuclear-fusion** device, the domain boundary (in terms of density, **confinement time**, temperature) for which the energy expended to heat the system is exactly compensated for by the energy generated by the reactions.

carbon dioxide or carbon gas (CO_2): gas generated in the burning of organic materials, responsible for part of the **greenhouse effect**.

carbon gas: see **carbon dioxide**.

carcinogenesis: the ensemble of stages leading to onset of a cancer.

catalyze: to accelerate a chemical reaction without the accelerator substance (the **catalyst**, or **enzyme** in biology) itself becoming altered, or only temporarily so.

cation: positive **ion**.

Cerenkov light: emission of **visible light**, occurring when a charged particle moves through a given medium at a velocity greater than that of light in that medium.

charge carriers: conduction electrons; electric current is the displacement of charge carriers. In **photovoltaics**, **photon**-generated electrons and holes.

chloroplast: an organelle in plant cells, containing the main part of the molecular machinery of photosynthesis.

CNO cycle: also known as the **carbon–nitrogen(–oxygen) cycle**, from the names of the **elements** appearing in it, involved in the reactions as **catalysts**, or **Bethe cycle** – from the name of US physicist Hans Bethe, 1967 Nobel Prizewinner. Cycle of thermonuclear reactions occurring inside **stars**, in the course of which four **hydrogen nuclei** are transformed into a **helium** nucleus, with release of energy. This cycle is believed to account for only 1.5% of the Sun's energy.

code (or program), computation: the assemblage, in a computer program, in the form of coded mathematical expressions, of the simplified representation (**model**) of a system or process, for the purposes of simulating it.

complex: a neutral or charged structure, comprising **ions** and molecules (organic or mineral), more rarely **atoms**, bound to a metal ion.

conduction: the transfer of energy through random collisions of **atoms** and **electrons** in motion. Its **electric conductivity** is the characteristic capacity for electric conduction of a substance.

convection: the ensemble of motions generated inside a fluid mass owing to differences in density and temperature at various points in this mass, contributing to heat transport. **Natural convection:** automatic transfer of heat through such circulation.

conversion efficiency: for a **photovoltaic** cell, this is the ratio of maximum output **electric power**, over the product of generator surface by measured incident illumination.

cosmic radiation: a stream of charged particles (**protons**, **helium nuclei** and **heavy-element** nuclei) travelling through interstellar space at **relativistic** velocities. Some of these particles originate outside the solar system, others inside the Sun, escaping through the holes in the corona; they interact with **atoms** in the upper atmosphere, before reaching the Earth's surface.

Coulomb barrier: electric repulsion impeding the coming together of two charged particles (the **protons** from two **nuclei**, in particular) having same-sign charges. This barrier may be overcome if the relative velocities of the two particles are sufficiently large. Through **nuclear interaction**, which makes itself felt at very short ranges, they may then undergo a **thermonuclear fusion** reaction.

cross-section: the measure of the probability of interaction between a particle and a target **nucleus**, expressed in **barns** ($1 \text{ barn} = 10^{-24} \text{ cm}^2$).

cryogenic: literally, "cold-generating," hence "relating to low temperatures." Cryogenic liquids, for instance, have boiling points lower than $-150 \text{ }^\circ\text{C}$.

cytoplasm: interior compartment of a cell, bounded by a plasmic membrane, and containing various organelles (mitochondria, vacuoles, **chloroplasts**...).

cytotoxic: toxic to the living cell.

decay: spontaneous transformation of a **radioactive nucleus** into a stable or unstable nucleus, through emission of one or more particles.

degree (of a solar acoustic mode): the number of times the mode considered is reflected on the Sun's surface.

deuterated: containing **deuterium**.

deuterium: "heavy" **isotope** of **hydrogen**, featuring a **nucleus** comprising one **proton** and one **neutron**. Cosmic deuterium is thought to have been formed during the **primordial nucleosynthesis**, which entails that, since deuterium cannot be *durably* generated inside **stars**, the presently occurring quantity is an essential indication as to the density of matter in the Universe. In **heavy water**, the hydrogen **atoms** are substituted by deuterium atoms.

dimer: aggregate of two identical molecules, bound together by covalent bonds, or weaker bonds, e.g. hydrogen bonds.

discharge (in a thermonuclear-fusion device): a term indicating the presence of a **plasma** in the confinement vessel (not to be confused with **confinement time**, i.e. the time span for which temperature and density conditions for such a plasma must be maintained, to allow **fusion** reactions).

disk: the visible surface of a heavenly body, projected onto the heavenly canopy.

divertor (ergodic): a device, in a **magnetic-confinement thermonuclear-fusion** machine, serving as an "ashtray," dedicated to continuous recovery of the **helium** generated in the **plasma** core, drawing out the flow lines at the plasma edge to direct them to pumping points. It also has the function of improving plasma-wall interaction conditions, through better distribution of energy fluxes at the edge of the **discharge**, and generation of a layer of cold, radiating plasma.

DNA: see **nucleic acids**.

doping agent: an extraneous **atom** introduced into the lattice of a **semiconductor**, to alter its electric properties, this manifesting itself by the presence of a discrete permitted energy level within the forbidden **band gap**, close to the **valence band** or the **conduction band**. This atom thus releases a mobile **electron** or hole to one or the other of the permitted bands, increasing the material's **electric conductivity**.

DT: **deuterium–tritium**.

dynamo effect: an effect converting mechanical energy into an electric current.

electric power: the product of output voltage by intensity of the current supplied.

electromagnetic radiation: a form of **radiation** that propagates in a vacuum at the velocity of light, through the interaction of oscillating electric and **magnetic fields**, and transports energy (**photons**).

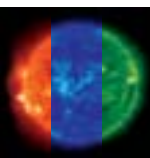
electron: negatively-charged elementary particle (lepton).

electron–hole pair: a pair of **carriers**, not bound to an **atom**, and thus able to move through the entire crystal in which they were formed, one of which is negative (**electron** in the **conduction band**), the other positive (absence of an electron in the **valence band**).

electronic bands: ranges of energies available to **electrons** in matter, linked to the periodic character of the **atomic** arrangement inside a crystal, and the wave character of electrons.

electronic band gap, direct or indirect: a **semiconductor** has an **electronic band** structure characterized by presence of a forbidden band, or band gap, between a permitted, filled (or nearly filled, at nonzero temperatures) band, the **valence band**, and an unfilled, empty or nearly empty, band, the **conduction band**. **Photons** with energy greater than the band gap generate **charge carriers** through **electron** transitions from one permitted band to the other. Depending on **atomic** arrangement and peripheral-electron energies, the band gap may be crossed with emission of **phonons** (lattice vibration *quanta*) – one then speaks of **indirect** band gap (this being the case of **silicon**) – or with no such emission (this is referred to as **direct** band gap).

electronvolt (eV): unit of energy, equal to about $1.6 \cdot 10^{-19}$ joule, or $1.6 \cdot 10^{-12}$ **erg**. This is equal to the energy gained by an **electron** accelerated by a potential of 1 volt. 1 **keV** (thousand electronvolts) = 11.6 million **kelvins**. The main multiples are the **MeV** (one million electronvolts) and **GeV** (one billion electronvolts).



electrostatic: only involving Coulomb attraction and repulsion forces, in other words based on non-moving electric charges (constant electric field).

element: an **atom** defined by the number of its **electrons** (**atomic number**). A distinction is made between **light elements** (**hydrogen, helium, lithium, beryllium, boron**) and **heavy elements** (all others, from carbon to uranium as far as natural elements are concerned).

enzyme: substance having the nature of a **protein**, which activates a biochemical reactions by **catalyzing** it.

erg: unit of energy, equal to 10^{-7} joule (J). Ten million (10^7) ergs per second correspond to 1 **watt** ($1\text{ W} = 1\text{ J/s}$).

expression (of a gene): the production by a **gene** of an observable **phenotype** (the manifest characters of an individual), usually through synthesis of a **protein**.

field lines (magnetic): imaginary lines, showing the intensity and direction of a **magnetic field**, around and along which charged particles spiral in a helical motion.

fission: splitting of a heavy **nucleus** into two fragments, accompanied by emission of **neutrons** and **radiation**, and considerable release of heat.

fossil energy: energy generated from fuels extracted from the Earth, such as coal, petroleum and natural gas.

free electron: an **electron**, normally bound, at a distance, to an **atom's nucleus**, which has broken from its bond with that atom.

fuel (thermonuclear): **light elements** having the ability to undergo **fusion** inside a **thermonuclear** reactor (or a **star**) and generate energy.

fusion (thermonuclear): nuclear reaction whereby small atomic nuclei combine at high temperature to form larger nuclei having a mass lower than the sum of the masses of the initial nuclei, the difference in mass being converted into energy in accordance with the Einsteinian mass-energy equivalence law: $E = mc^2$. This reaction is the source of the Sun's energy, and, directly or indirectly, the source for nearly all energy on Earth.

galaxy: a huge isolated aggregate of **stars** and interstellar gaseous matter.

gamma (γ) radiation: the most energetic form of **radiation** in the electromagnetic spectrum. Gamma **photons** have energies in a range extending from 10 **keV** to over 1 **MeV**.

gene: **DNA sequence** on a chromosome representing a unit of hereditary information, enabling the production of a **phenotypic** character through production of one or more **proteins**.

genetic engineering: ensemble of techniques allowing the **genetic** material of a cell or living organism to be modified.

genome: the ensemble of **genetic** material of a living organism.

genotoxic: toxic with respect to **genes**, as causing damage to **DNA**.

GeV: see **electronvolt**.

gigabar (Gbar): $1\text{ Gbar} = 10^9\text{ bars} = 0.987 \cdot 10^9\text{ atmospheres} = 1.02 \cdot 10^9\text{ kg/cm}^2 = 10^{14}\text{ pascals}$.

gigapascal (GPa): $1\text{ GPa} = 10^9\text{ pascals}$.

gravitational confinement: natural confinement, through the effects of gravitation, of a **light-element plasma** inside a **star**, such as the Sun in particular, bringing about the conditions for **fusion**.

greenhouse effect: a rise in temperature attributable to solar **radiation** being able to enter the atmosphere, whereas the consequent thermal radiation cannot escape. This effect increases with higher concentrations of "**greenhouse-effect gases**" in the atmosphere.

greenhouse-effect gas (GEG): a gas the presence of which in the atmosphere tends to increase the natural **greenhouse effect**. **Carbon dioxide** (CO_2), water vapor, **methane** and chlorofluorocarbons (which also attack the Earth's **ozone** layer) are the main GEGs.

heat conduction: the phenomenon whereby, within a medium, heat flows from a high-temperature region to another, lower-temperature region, or from one medium to another coming into contact with it.

heavy metals: metals having a density greater than 4.5 g/cm^3 . These include zinc (7.14), cadmium (8.6), lead (11.35)...

heavy water: see **deuterium**.

helioseismology: investigation of the solar interior through analysis of the Sun's natural oscillation modes. Observation of the Sun's vibrations, propagating from the surface and reflected by the various internal layers, allows measurement of such parameters as the speed of sound or rotation speed.

helium: the lightest chemical **element** (He) after **hydrogen**. Its **nucleus** comprises two **protons** and two **neutrons**, for helium 4, the most common **isotope** (the nucleus of helium 3 features one single neutron). The helium present in the Universe was formed during the **primordial nucleosynthesis**. Rare in the Earth's atmosphere, it is abundant in **stars**, where it is the product from the burning of hydrogen.

hohlraum: a cylindrical cavity holding the target of an **indirect-drive inertial-confinement thermonuclear-fusion** device.

hydrocarbon: a molecule composed solely of carbon and **hydrogen**.

hydrogen: the simplest **atom**, comprising one **proton** and one **electron**.

hydrolysis: decomposition of a chemical species (molecule or **ion**) by water.

hydrostatic equilibrium: equilibrium prevailing in a fluid when the force of gravity (and hence weight) exactly compensates the vertical pressure gradient.

ignition: self-sustenance of the **plasma** temperature in a **thermonuclear-fusion** device, at a level sufficient for reactions to proceed continuously.

incidence: the number of *new cases* identified for a condition (e.g. cancer) over a given period (usually one year), in a given population.

inertial confinement: see **magnetic confinement** and **inertial confinement**.

infrared (IR) radiation: a segment of the electromagnetic spectrum covering **radiation** of wavelengths ranging from 760–780 **nm** to 1 mm. IR-A radiation extends from 760–780 nm to 1,400 nm, IR-B from 1,400 nm to 3,000 nm (3 μm), and IR-C from 3 μm to 1 mm. Physicists divide infrared into near infrared (760 nm–4 μm), intermediate infrared (4–14 μm), far infrared (14–100 μm), and submillimeter infrared (100 μm –1 mm).

ion: an **atom** or molecule that has lost, or gained, one or more **electrons**, and has thus become electrically charged.

ionization: state of matter in which **electrons** are separated from the **nuclei**. The process whereby **ions** are produced, through collision with **atoms** or electrons (collision ionization) or interaction with **electromagnetic radiation** (**photoionization**).

isotopes: forms of the same chemical **element**, having **nuclei** comprising identical numbers of **protons**, and featuring the same number of **electrons**, but whose nuclei comprise different numbers of **neutrons**, and hence have different masses.

isotropic: presenting identical physical properties in all directions (antonym: **anisotropic**).

kelvin (K): unit of temperature (in the International System of Units, SI). The kelvin scale features just one fixed point, this being, by convention, the thermodynamic temperature of the triple point of water (i.e. the point at which the three phases, solid, liquid, and vapor, coexist) at 273.16 K, i.e. 0.01 °C. Ice melts at 273.15 K (0 °C); water boils at 373.15 K (100 °C). Zero kelvin ("absolute zero") is the temperature corresponding to zero molecular agitation.

keV: see **electronvolt**.

kilojoule (kJ): 1 kJ = 10³ joules.

kWh (kilowatt-hour): 1 kWh = 3.6 million joules. The principal multiple of the **watt-hour**, a unit of work and energy, the product of power by time.

Lagrangian points: from the name of Italian-born French mathematician and astronomer Joseph Louis Lagrange (1736–1813), who mathematically deduced that a pair of heavenly bodies undergoing gravitational interaction would have in its vicinity five points of equilibrium, the Lagrangian points (L1–L5). At these points, the gravitational forces prevailing between two bodies (the two heavenly bodies) can hold in equilibrium a third body keeping to the same orbital plane, provided its mass be much smaller than theirs. The SOHO solar observation satellite is thus positioned at **Lagrangian point L1**, between the Sun and the Earth, 1.5 million kilometers from the latter.

laser: a light source yielding waves that are monochromatic (of a single wavelength) and coherent (always in phase).

lipids: organic molecules containing a fatty acid, or a fatty-acid derivative, not water-soluble, but soluble in nonpolar (hydrophobic) organic solvents.

lithium: light chemical **element** (Li), coming third in the classification after **hydrogen** and **helium**. Its **nucleus** comprises three **protons** and four **neutrons**. It was mainly formed during the **primordial nucleosynthesis**.

magnetic confinement and inertial confinement: the two main methods, currently, for the artificial confinement of a **light-element plasma**, to set up the conditions for **fusion**.

magnetic field: a force field generated by electric currents.

magnetosphere: region in space where a planet's **magnetic field** preponderates over that of the **solar wind**, shielding the planet from the wind's **ionized** particles. In the case of the Earth, it is positioned beyond the **ionosphere**, starting at about a thousand kilometers above the surface, and extending out to the *magnetopause*, this marking the separation with interplanetary space. The tail of the Earth's magnetosphere (on the night side of the planet) is that part of it which is drawn out to the outer reaches of the solar system by the solar wind.

main sequence: the region in the **star** luminosity–temperature diagram bringing together those stars for which the energy source is the **fusion of hydrogen into helium**: the present-day Sun is one of these.

mass fraction: unit of concentration, expressed as a percentage, equal to the product of *molecular concentration by molar mass*.

massively parallel computer: a computing system comprising a large number of elementary units (up to several hundred, or even several thousand processors) simultaneously carrying out different tasks in parallel. Processors may share a common memory within a "node," these "nodes" in turn being connected by means of a high-performance interconnection network.

megabar (Mbar): 1 Mbar = 10⁶ **bars** = 987,000 atmospheres = 1.02 · 10⁶ kg/cm² = 10¹¹ pascals.

megajoule (MJ): 1 MJ = 10⁶ joules.

metabolism: the ensemble of chemical processes occurring in living organisms and in every cell.

methane: a gas (CH₄), the main constituent of natural gas. It is released during decomposition of organic matter.

MeV: see **electronvolt**.

micron or micrometer (μm): 1 μm = 10⁻⁶ meter.

millibar (mbar): 1 mbar = 10⁻³ **bar** = 0.000 987 atmosphere = 1.02 g/cm² = 100 pascals (1 hectopascal).

modeling: providing a simplified representation (**model**) of a system or process, for the purposes of simulating it.

mole: unit of quantity of matter (symbol: **mol**), equal to the quantity of matter in a system comprising as many elementary units as there are **atoms** in 0.012 kg of carbon 12.

molecular modeling: an approach of molecular structure through numerical computation, on the basis of a number of instruments (quantum chemistry, molecular dynamics, molecular mechanics), allowing prediction of molecule behavior as a function of structure, or the design of molecules according to the desired behavior.

mRNA: see **nucleic acids**.

mutation: a transmissible alteration of the **genetic** message, occurring through alteration of a **nucleotide sequence in DNA**; a *point mutation* is an alteration restricted to a single nucleotide.

nanojoule (nJ): 1 nJ = 10⁻⁹ joule.

nanometer (nm): 1 nm = 10⁻⁹ meter.

nanosecond (ns): 1 ns = 10⁻⁹ second.

neutron: electrically neutral particle. A neutron is 1,839 times heavier than an **electron**. Neutrons and **protons** are the constituents of **atomic nuclei (nucleons)**.

neutron absorber: absorber of **neutrons**.

northern (and southern) lights: see **aurora borealis (and australis)**.

nucleic acids: polymers formed by the concatenation of **nucleotides**. There are two types of nucleic acid: **DNA** (deoxyribonucleic acid), which serves as the carrier for the **genetic** information inside every living cell, and **RNAs** (ribonucleic acids), in particular **messenger RNA**, which, from the coding carried by the DNA, specifies the **sequence of amino acids** in a **protein**.

nucleons: constituent particles of the **atomic nucleus**, bound together by *strong interaction*, ensuring cohesion. **Protons** and **neutrons** are nucleons.

nucleotide: elementary component unit of **nucleic acids**, comprising a *purine* base (adenine, guanine, for instance) or *pyrimidine* base (e.g. cytosine, thymine), a sugar and one or more phosphate groups.

nucleus (atomic): the essential constituent of an **atom**, bearing a positive charge and comprising **protons** and **neutrons** (except in the case of **hydrogen**), around which **electrons** orbit.

nuclide: a nuclear species characterized by its *mass number A* (the sum of the number of **neutrons N** and number of **protons Z**) and its *atomic number* (number of protons Z).

opacity: the capacity of matter to **absorb radiation**.

oxidation: a reaction whereby an **atom** or **ion** loses **electrons**.

oxidation state (or number): a figure representing the number of **electrons** that must added to, or subtracted from, an **atom** in a combined form (within a compound) to make it neutral. A decrease of this figure corresponds to a **reduction**, an increase to an **oxidation**.

oxidation stress: in an organism, the outcome of an imbalance between oxygen **free radicals** (**atoms** or molecules, resulting from the decomposition of a water molecule) and antioxidants. Oxidation stress can cause cell damage, which may result in cell death, since free radicals are highly reactive, as they carry an unpaired **electron**.

oxidizer: a chemical compound causing an **atom** or **ion** to lose **electrons**.

ozone: a molecule comprising three **atoms** of oxygen, present in the Earth's atmosphere. It is generated, on the one hand, at high altitude by the Sun's **ultraviolet radiation**, and, on the other, at ground level, by combustion of organic materials (automobile fuels, in particular).

peptide: a **protein**-type molecule, formed from a small number of **amino acids**.

period (radioactive or physical): the time interval required for the **decay** of half of the **atoms** in a sample of a **radioactive nuclide** to occur.

permeation: molecular diffusion of a substance through a membrane, under the motive power of a pressure gradient.

petawatt (PW): 1 PW = 10^{15} **watts**.

photon: the *quantum* of energy of **electromagnetic radiation**. An elementary particle having neither mass nor electric charge, associated to such radiation [**visible light**, **infrared** or **ultraviolet radiation**, **gamma radiation**, **X-radiation**, according to its energy].

photovoltaic: effect whereby the energy of light is directly transformed into electric energy in a **semiconductor**.

picometer (pm): 1 pm = 10^{-12} meter.

picosecond (ps): 1 ps = 10^{-12} second.

plasma: a gas brought to a temperature such that **atoms** are **ionized**. Its properties are determined by the electromagnetic forces prevailing between its constituents [**ions** and **electrons**], leading to various types of behavior. Seen on Earth as the fourth state of matter, it is actually, through the Universe, the main form of matter.

polarized: having an electric-field vector which, as it describes an electromagnetic vibration, remains in a definite plane.

polymerase: an **enzyme** that **catalyzes** the synthesis of **sequenced** macromolecules, such as **DNA** (DNA polymerase) and **RNA** (RNA polymerase).

positron: positively charged **antiparticle** of the **electron**.

primordial: relating to the very dense, very hot, and very short (a few minutes) phase in cosmic evolution during which the **lightest elements** in the Universe (**deuterium**, **helium**), were generated.

primordial nucleosynthesis: the synthesis of **deuterium**, **helium-3**, **helium-4** and **lithium-7 nuclei** during the first three minutes of the Universe following the **big bang**, as its temperature went from 10 billion to 1 billion degrees.

protein: the main macromolecular component in cells, comprising a definite **sequence** of **amino acids**, from a set of twenty, encoded by **DNA**.

proton: particle bearing an electric charge equal to that of the electron, and of opposite sign. A proton is 1,836 times heavier than an electron.

radiation: energy emitted in the form of electromagnetic waves, or a flow of particles.

radical species (or **free radical**): an **atom** or molecule carrying an unpaired **electron** (i.e. one not forming with another electron an energetically stable pair). A **radical** is a group of atoms that remains unchanged through the chemical alterations affecting the rest of the molecule.

radioactive (or **decay**) **chain** of an **element**: the succession of distinct **elements** arising as a result of the spontaneous transformation, over time, of an unstable **nucleus**. This chain ends in a stable (non-**radioactive**) element.

radioactivity: a property, exhibited by some natural or artificial **elements**, of emitting spontaneously **alpha particles** (**helium nuclei**), **beta particles** (**positrons** [beta⁺ emission] or electrons [beta⁻ emission]), and/or **gamma radiation** (high-energy **photons**). More generally, this term is used to refer to the emission of **radiation** accompanying the **decay** of an unstable element, or **fission**.

radionuclide: a **radioactive isotope**, sometimes also termed a **radioisotope**, of an **element**.

redox equilibrium: equilibrium between **reduction** and **oxidation** reactions (**electron** transfers between **atoms** or **ions**).

reducer: a chemical compound yielding **electrons** to an **atom** or **ion**.

reduction: a reaction whereby an **atom** or **ion** gains **electrons**, yielded by a **reducer**.

relativistic: matter is said to be relativistic when thermal agitation velocity is close to the speed of light.

replication: the duplication of the **DNA** molecule, occurring in a living cell prior to its division into two daughter cells.

resolution: the smallest distinguishable value, for the acquisition or restitution of information. In particular, this is the measure of the ability of an optical system to discriminate or reproduce details in a scene or its image. The *resolution of a model* is the *mesh* size, in terms of space and time, used for a **modeling** run.

RNA; mRNA: see **nucleic acids**.

semiconductor: a material characterized by an electronic **band gap**, which is neither solely an insulator nor solely a conductor at nonzero temperatures. Some of its **electrons**, being very weakly bound to their **atoms**, can become **conduction** electrons. A semiconductor can be of the *n* type (with mainly electron **charge carriers**), or the *p* type (mainly hole charge carriers), according to the **doping agents** used.

sequence: the order in which the constituent elements are concatenated in biological polymers (**DNA**, **RNA**, **proteins**). **Sequencing** is the determination of that order.

silicon: the most common **semiconductor**. In the *amorphous* form, in the noncrystalline state, deposited onto a substrate having a thickness of the order of 1 μm , it is employed for the fabrication of **photovoltaic** cells and modules. The term *crystalline silicon* (*c-Si*) covers the various crystalline forms. *Microcrystalline silicon* ($\mu\text{c-Si}$) is a material employed, in thicknesses of the order of 1 μm , in the fabrication of photovoltaic cells and modules (grain size < 1 μm). *Mono-crystalline silicon* (*sc-Si*) is used to produce ingots and wafers, or cells, obtained by the Czochralski pulling method, or by the float-zone method. A wafer contains a single grain. *Multicrystalline silicon* (*mc-Si*) is grown by directional solidification in a crucible, to produce ingots, wafers or cells (grain size: 0.1–10 cm). *Polycrystalline silicon* (*pc-Si*), in thicknesses of 10–30 μm , is deposited onto a substrate to produce ingots, wafers or cells (grain size: 1 μm –1 mm).

solar cycle: periodic variation in the Sun's activity. The most well-defined cycle has an approximate duration of 11 years. This activity manifests itself through the rise and growth of sunspots. The **solar maximum** is the period (of the order of a few months), within the solar cycle, during which the number of sunspots reaches a maximum, the last such period being recorded in mid-2001 (antonym: **solar minimum**).

solar wind: a flow of charged high-energy particles, mainly **protons** and **electrons** forming a **plasma**, emanating from the Sun's corona with velocities of several hundred kilometers per second.

spin: the intrinsic angular momentum (or intrinsic torque) of a particle.

star: heavenly body consisting in a large mass of gas (essentially **hydrogen** and **helium**) that generates and emits energy.

stellarator: configuration for a **magnetic-confinement thermonuclear-fusion** device not involving an electric current inside the **plasma**; it ensures, through a complex geometry for its windings, compensation for the drift that tends to bring closer to the wall the plasma particles placed in the **magnetic field**.

sublimation: the transition from the solid state to the gaseous state, without passing through the liquid state.

superconductor: a metal or alloy in which resistivity (the specific resistance to **electron** travel) suddenly vanishes to a near-zero value, at a so-called critical temperature.

superfluid: the quantum property exhibited by a fluid that flows viscosity-free at ultra-low temperatures. When a fluid becomes superfluid, **atom** motions become collective motions. This is the case, on Earth, for **helium** 3, which liquefies at 4 **kelvins** (K), and, at 1.8 K, undergoes transition from the ordinary fluid state to the superfluid state.

supernova: the final, exploding state for massive **stars**, or for a white dwarf (the final state for stars of low mass) coupled to a red giant (the phase of strong expansion in stars of intermediate mass).

terabar (Tbar): 1 Tbar = 10^{12} bars = $0.987 \cdot 10^{12}$ atmospheres = $1.02 \cdot 10^{12}$ kg/cm² = 10^{17} pascals.

teraflops (Tflops): 1 Tflops = one thousand billion floating-point computation operations per second.

thermalization: the gradual bringing of **radiation** or a particle stream into thermal equilibrium with the environment into which it diffuses.

tokamak: the name is an acronym, derived from the Russian *toroidal'naja kamera s aksial'nym magnitnym polem* ("toroidal chamber with axial magnetic field"), defining toroidal devices for the investigation of **magnetic-confinement thermonuclear fusion** through confinement of the plasma, where the fusion reactions occur, by means of **magnetic fields**.

transcription: the first stage of **gene expression**, consisting in the transcription of the coded **sequence** from a **DNA** strand into a **messenger RNA** sequence. This is initiated and controlled by complex ensembles of **proteins**, known as **transcription factors** and **RNA polymerases**.

transcription factor: any **protein** involved in the initiation or control of **gene expression**.

transgenesis: the ensemble of operations carried out to obtain an organism stably incorporating one or more **genes** from another cell or organism, and having the ability to transmit this to subsequent generations.

tritium: the heaviest **isotope** of **hydrogen**, and the only **radioactive** one. Its **nucleus** comprises one **proton** and two **neutrons**. Toxic in the tritiated water (HTO) form.

tritium breeder: generating **tritium**. This term is used, in particular, to refer to the **blankets** in a thermonuclear reactor, in which **lithium** is transformed into tritium through **neutron** bombardment.

tunnel effect: effect, of quantum character, which can allow a particle (**proton**, **electron**) that does not have, in terms of classical physics, sufficient energy to overcome a potential barrier of given value to cross that barrier nonetheless, since the *wave function* associated to this particle is not null-valued on the other side of the barrier. The tunnel effect can thus allow two protons to circumvent their electric repulsion, at relative velocities lower than those indicated by classical calculus.

turbulence: a flow mode in fluids, for which, onto the mean motion, a random agitation motion is superimposed.

ultraviolet (UV) radiation: a segment of the electromagnetic spectrum covering **radiation** with wavelengths ranging from 400–380 **nm** to 10 **nm**, that fall between those of **visible light** and of **X-rays**. Ultraviolet is divided into near ultraviolet (380–200 **nm**) and extreme ultraviolet (200–10 **nm**). For physiologists, ultraviolet is divided into three broad categories: UVA (400–380 **nm** to 315 **nm**), UVB (315–280 **nm**), and UVC (280–100 **nm**). Vacuum ultraviolet covers wavelengths in the 100–10 **nm** range. A large proportion of UV radiation is **absorbed** by the Earth's atmosphere.

visible light: the part of the electromagnetic spectrum that is visible to the human eye, i.e. **radiation** having wavelengths ranging from 380–400 **nanometers** (violet) to 760–780 **nm** (red), bounded on the one hand by **ultraviolet**, and, on the other, by **infrared**.

watt (W): unit of power, corresponding to 1 joule per second. Main multiples are the kilowatt (1 **kW** = 1,000 watts), the megawatt (1 **MW** = 1 million watts) and the terawatt (1 **TW** = 1,000 billion watts).

WIMPs (weakly interacting massive particles): hypothetical massive particles, interacting only very weakly with common matter, which might form all or part of the "missing", hidden mass in the Universe.

X-rays: electromagnetic radiation with wavelengths ranging from a few fractions of a **nanometer** (0.005 **nm**) to 10 **nm**, and energies ranging from a few **kiloelectronvolts** to several hundred kiloelectronvolts. A distinction is made between **soft X-rays** (for the longer wavelengths) and **hard X-rays** (of shorter wavelength). Since X-rays are **absorbed** by the Earth's atmosphere, X-ray astronomy is carried out in space.

yeast: a microscopic unicellular fungus, representative of all living cells featuring a nucleus, and for that reason serving as a model for biologists.