核融合 Nuclear Fusion

12.1 基本名詞	12.1 Basic Terms
12.1.1 核融合 輕原子核間相互融合之反應 中，其組成原子核重行組合，而形成較原反應核重之產品核。反應過程中並釋放出基本粒子和能量。此反應使總質量減少而轉變為能量。核融合發生於極高溫度的熱攪動下因而命名為「熱核融合」（參見 12.1.2）	12.1.1 Nuclear fusion Reaction between nuclei of light atoms in which their constituent nucleus are rearranged to form a product nucleus heavier than the reactant nuclei, accompanied by the release of elementary particles and energy. The resulting decrease in the overall mass appears as energy. Nuclear fusion brought about by thermal agitation at elevated temperature is termed “thermonuclear fusion” (see 12.1.2)
12.1.2 熱核反應 核融合反應中，參與的原子核由熱攪動獲得形成反應所需的能量，故稱為熱核反應。	12.1.2 Thermonuclear reaction Nuclear fusion reaction in which the participating nuclei acquire by thermal agitation the necessary energy to react.
12.1.3 融合能 核融合釋出之能量。	12.1.3 Fusion energy Energy released by nuclear fusion.
12.1.4 碳循環 在一連串熱核反應中，四個氫原子核在一個碳十二（C12）原子核作為觸媒之作用下，轉變為一個氦原子核，隨之釋出能量。 （註）採用「循環」一詞係因碳於最初反應時消耗後，於最終反應時再復原，如此完成一循環（參見 12.1.5）。	12.1.4 Carbon cycle A chain of thermonuclear reactions in which four hydrogen nuclei are transmuted into a helium nucleus with a C12 nucleus acting as catalyst, accompanied by the release of energy. Note The term “cycle” is employed because the carbon consumed in the first reaction is restored in the final reaction, thus completing the cycle. (See also note to 12.1.5.)

12.1.5 氫循環 在一連串熱核反應中，四個氫原子核先形成重氫和輕氦原子核後，再轉變為一個氦原子核，隨之釋出能量。 （註）根據貝斯學說，此循環與碳循環釋出的能量，可能為太陽能的起源。	12.1.5 Hydrogen cycle A chain of thermonuclear reactions in which four hydrogen nuclei are transmuted into a helium nucleus, with the intermediate formation of heavy hydrogen and light helium nuclei, accompanied by release of energy. Note According to Bethe the energy released by this cycle, as also by the carbon cycle, may be the origin of solar energy.
12.1.6 電漿 在核融合技術中，係指由帶電與準中性粒子所組成整體近乎中性之氣體。此氣體係物質在極高度溫度下，實際上完全離子化時所產生。電漿呈集體活動狀態，且在容積足夠時呈中性，並為良好之電導體。 多種技術可用於電漿加熱，如： —歐姆加熱。 —注入中性原子加熱。 —無線電頻率加熱。 —絕熱壓縮加熱。 —震波加熱。 —擾流加熱。	12.1.6 Plasma In nuclear fusion technology, a quasi-neutral gas of charged and neutral particles, produced when a gas becomes virtually completely ionised at very high temperature. A plasma exhibits collective behaviour and when in sufficient volume, it is electrically neutral and is a good electrical conductor. Various techniques may be employed to heat the plasma, e.g.: ohmic heating, heating by injection of neutral atoms, radio-frequency heating, adiabatic compression heating, shock wave heating, turbulence heating.
12.1.7 熱核條件 受拘限包容的電漿欲由融合反應產生顯著的能量，在溫度、密度和包容時間上必須維持之條件（參見 12.1.11 勞生準則）。 （註）當融合反應進行的速率可使粒子對電漿供應的熱能，足以補償因輻射及對流而損失的熱能時，即達到臨界或起燃條件。	12.1.7 Thermonuclear conditions Conditions of temperature, density and containment time (see 12.1.11: Lawson criteria) that a confined plasma must maintain to produce significant energy from fusion reactions. Note Critical or ignition conditions are achieved when the reactions are proceeding at a rate such that the heat supplied to the plasma by the particles compensates for that lost by radiation and convection.

12.1.8 臨界溫度；起燃溫度 對受拘限包容的電漿而論，指能量損失與電漿內由熱核反應產生的功率保持平衡時之啓始溫度，電漿溫度至少應達到此下限值，熱核反應才能自行持續進行。	12.1.8 Critical temperature; ignition temperature In the case of a confined plasma, the threshold temperature at which the energy losses are balanced by the thermonuclear power deposited in the plasma, so that it becomes self-sustaining.
12.1.9 拘限 對電漿而論，指用以保持電漿的粒子於一定的空間區域內的技術。 （註）現採用的拘限技術有兩種：一為電磁拘限，亦可歸類為靜態的拘限，另一為惰性拘限，亦可歸類為動態的拘限。	12.1.9 Confinement In the case of a plasma, the technique used to hold the particles of the plasma within a defined spatial zone. Note Two confinement techniques are employed: magnetic confinement, which may be classed as static and inertial confinement, which may be classed as kinetic.
12.1.10 拘限時間 欲使核融合釋出的能量超過加熱及拘限電漿所消耗的能量，應維持適宜電漿條件的最短時間。	12.1.10 Confinement time The minimum length of time during which adequate plasma conditions prevail for the fusion energy released to exceed the energy expended in heating and confining plasma.
12.1.11 勞生準則 支配核融合過程的主要參數間應符合之關係式。 （註）對最常用的氘—氚（D-T）融合反應而論，此準則可列如下： 電漿溫度 T>凱氏（即絕對溫度）1 億度。若 n 為電漿密度，以每立方厘米體積內粒子的數目表之；τ 是電漿拘限時間，以秒表示之；則 nτ≥1014 秒／立方厘米。	12.1.11 Lawson criteria Formulae which define the relationships between the main parameters governing the fusion process. Note In the case of the most favoured D-T (deuterium-tritium) reaction, the criterion is as follows: plasma temperature T>100 million degrees Kelvin, where: n is the plasma density expressed as the number of particles per cm^3,τ is the plasma confinement time expressed in seconds.

12.1.12 磁場配置 使離子化的粒子活動於一定空間區域內之磁場佈置。 （註）磁場的各種可能配置，中可列數種如下： —環狀配置。 —梅亞和史密德配置。 —磁井（在電漿中心的磁場感應為最小的一種配置）。 在電漿物理學中，將電漿拘限於磁井內的磁力線形狀，稱為「四面體」。	12.1.12 Magnetic field configuration Disposition of the magnetic field such that the ionised particles remain within the defined spatial zone. Note The following are among the various configurations possible: toroidal configuration, Mayer and Schmidt configuration, -magnetic well (a configuration with minimum magnetic field induction at the centre of the plasma). In plasma physics the form assumed by the lines of force of the magnetic field that confines a plasma in a magnetic well is termed a tetrahedron or humbug.
12.1.13 磁障壁；磁鏡 指磁場配置能反射帶電粒子的空間區域。廣義言之，亦指產生此種磁場配置的設施。	12.1.13 Magnetic barrier; magnetic mirror Spatial zone in which the configuration of the magnetic field is such that it reflects the charged particles. By extension, a device that creates this configuration of the magnetic field.
12.1.14 透鏡 利用電場和磁場的綜合作用使帶電粒子射柱集中於焦點的設施。 —透鏡可分為靜電的、磁的和電磁的透鏡。	12.1.14 Lens A device that employs a combination of electric and magnetic fields to focus a beam of charged particles. -Lenses may be divided into electrostatic, magnetic and electromagnetic lenses.
12.1.15 捏縮效應；捏縮 帶電流之電漿柱受到其本身產生的外在磁場所引致之壓縮作用。（註）依照磁場的方向，捏縮可分為線性捏縮或 θ 捏縮。	12.1.15 Pinch effect; pinch The construction of a current-carrying plasma column caused by its external self-magnetic field. Note Depending on the direction of the magnetic field, the pinch may be termed linear pinch or theta pinch.
12.1.16 漂移 在電漿物理學中，旋轉粒子引導軸心沿拘限磁場的法線方向移動的現象。	12.1.16 Drift In plasma physics, movement of the guiding centers of gyrating particles in a direction normal to the confining magnetic field.

12.1.17 漂移波 因溫度、密度、磁場或不純度隨距離逐漸遞變，導致電漿發生波動的現象。 （註）在常觀（肉眼可見）的電漿變化過程中，此式波動扮演重要部份，此現象隨漂移的不穩定性而發生，尤其在電漿／真空與電漿／牆的介面。	12.1.17 Drift wave A wave occurring in a plasma as a result of the presence of gradients of temperature, density, magnetic field or impurities concentration. Note This type of wave plays an important part in macroscopic plasma processes. It is associated with the occurrence of drift instability, particularly at the plasma/vacuum and plasma/wall interfaces.
12.1.18 磁泵 利用磁場的有規則振動導致電漿連續的壓縮與膨脹，以使電漿加熱的方法。	12.1.18 Magnetic pumping Method employed to heat a plasma by successively compressing and expanding the plasma through the application of a magnetic field that oscillates at regular intervals.
12.2 融合術語	12.2 Fusion Technology
12.2.1 融合反應器；核融合反應器 指由融合反應供應能量的核子反應器；其設計以達到控制自行持續的核融合鏈鎖反應且產生一淨輸出能量的反應器。	12.2.1 Fusion reactor; nuclear fusion reactor A nuclear reactor powered by fusion reactions, i.e. a reactor designed to achieve and control self-sustaining nuclear fusion chain reactions generating a net release of energy.
12.2.2 天星號環狀磁場配置 指一種環狀磁阱裝置，其磁場係完全由圍繞著環狀裝置周圍的導體產生的。導體繞成螺旋線圈，圍繞於此環狀裝置的圓管四周，因此其所形成的磁場對環狀裝置的圓管而言，有一方位分量和一軸向分量。 （註）在此型式的配置中，由電漿電流所產生的磁場，遠較拘限磁場為弱。	12.2.2 Stellarator A toroidal magnetic trap with the magnetic fields generated entirely by conductors placed around the torus. The conductors may be wound in helical coils around the tube of the torus so that the resultant magnetic field has an azimuthal as well as an axial component with respect to the tube of the torus. Note In this type of configuration the magnetic field created by currents in the plasma is much less powerful than the confinement field.

12.2.3 托卡馬 指一種環狀磁阱裝置，除環狀磁場外，尚有由流經電漿本身的電流所產生的第二個極向或徑向磁場（即環狀裝置圓管切線方向），因而給予此包容系統額外的穩定性。這兩個磁場的合成磁場構成了此配置的拘限磁場。	12.2.3 Tokamak A toroidal magnetic trap which, in addition to a toroidal magnetic field, also has a second, poloidal or azimuthal magnetic field (i.e. tangential to the tube of the torus) generated by an electric current circulating through the plasma itself and thus conferring additional stability on the containment system. The resultant of these two fields constitutes the confinement field for this configuration.
12.2.4 融合—分裂混合反應器；混合反應器 指一種核子反應器，其融合反應產生的高能中子，遭遇到大量（一般為次臨界質量）的可裂和可孕物質，因而達到額外的能量增殖和中子數目增殖，且生產可用於慣常核分裂反應器的可裂物質。	12.2.4 Hybrid fusion-fission reactor; hybrid reactor A nuclear reactor in which high energy neutrons proceeding from a fusion reaction encounter a mass of fissile and fertile material, generally subcritical, thus achieving additional multiplication of energy and of the number of neutrons produced, with production of fissile material for use in conventional nuclear fission reactors.
12.2.5 磁流體動力學 在準穩定電場和磁場 中，導電流體之動力學。這種流體可以是液態金屬（汞、熔態鹼金屬），弱離子化氣體和電漿。	12.2.5 Magnetohydrodynamics The dynamics of a conducting fluid in quasi-stationary electric and magnetic fields. Such fluids may be liquid metals (mercury, molten alkali metals),weakly ionised gas and plasmas.
12.2.6 磁流體動力轉換 由於電漿與外界磁場的交互作用而使電漿的動能直接轉換為電能的現象。	12.2.6 Magnetohydrodynamic conversion The direct conversion of the kinetic energy of a plasma into electricity by causing the plasma to interact with external magnetic fields.

12.2.7 雷射融合 指由燃料粒之惰性拘限達到融合之技術；也就是由集聚的脈衝雷射將燃料粒沿球面各不同方位向內壓縮加熱至熱核反應條件的融合技術。 （註 1）雷射是利用激發輻射的方法，加強光的強度；換言之，利用一光波激發已被升高至不穩定能階之原子或分子，使其發射光脈衝，加強發射由此光脈衝所產生同相單色光的裝置稱為雷射；激發光波之特性決定雷射光的頻率和相位。 （註 2）上文所述的燃料粒是一結凍氘一氚混合物小滴，直徑約一毫米，包封於一玻璃微球體中，許多雷射的集聚光束從不同方向朝此微球體中心照射，使然料粒的壓力和溫度狀況提高至符合融合啓始反應需要的水準，並靠惰性拘限力量將起燃狀況擴大至產生一受控制的核子微爆。	12.2.7 Laser fusion A fusion technique relying on the inertial confinement of a pellet of fuel which is spherically compressed and heated to thermonuclear conditions by convergent laser pulses. Note 1 The laser is a device that amplifies or emits coherent light produced by the emission of light pulses from atoms or molecules that have been raised to an unstable energy level due to excitation by a light wave, the characteristics of the latter determining its frequency and phase. Note 2 The pellet in this context is a frozen droplet of a deuterium-tritium mixture of approximately one millimeter in diameter and encapsulated in a glass microsphere, the centre of which has directed upon it a number of convergent laser beams that serve to raise pressure and temperature conditions to the levels required to initiate nuclear fusion reactions and, by virtue of inertial confinement, to propagate the initial ignition so as to generate a controlled nuclear micro-explosion.
12.2.8 核融合滋生器圍包 指圍繞核融合反應器之反應區周圍的圍包，具有熱移除和氚滋生之雙重功能，其所用材料可為鋰。 （註）中子與鋰的核反應形成氚，氚為核融合反應之燃料。	12.2.8 Nuclear fusion breeder blanket A blanket, that may be of lithium, surrounding the reaction zone of a fusion reactor, having the dual functions of heat removal and tritium breeding. Note The neutrons react with the lithium to form tritium, used as fuel for the fusion reaction.