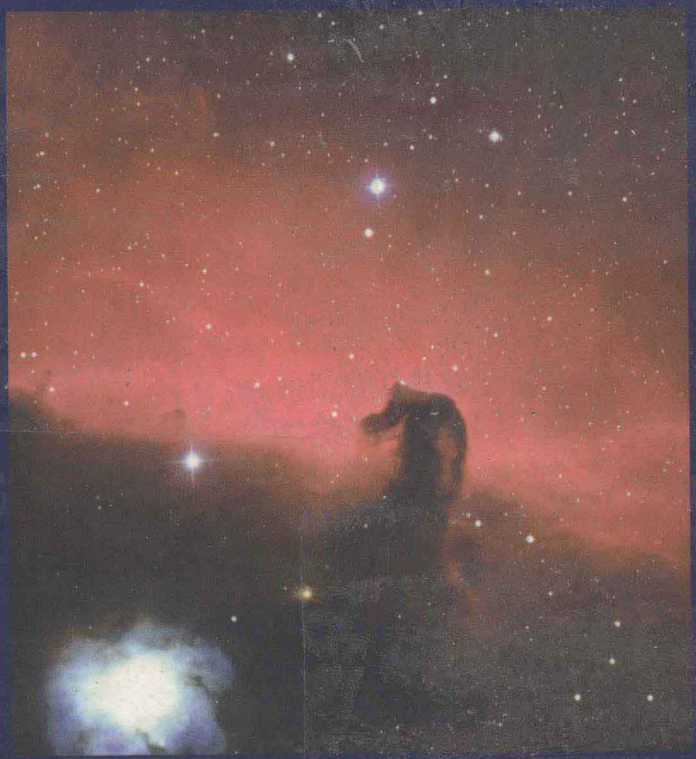
外教社 SFLEP

牛津英语百科分类词典系列

Oxford

DICTIONARY OF ASTRONOMY

牛津天文学词典



上海外语教育出版社
SHANGHAI FOREIGN LANGUAGE EDUCATION PRESS
外教社

牛津英语百科分类词典系列

Oxford Dictionary of

Astronomy

牛津天文学词典

Edited by

IAN RIDPATH

外教社

上海外语教育出版社

SHANGHAI FOREIGN LANGUAGE EDUCATION PRESS

图书在版编目（CIP）数据

牛津天文学词典 /（英）里德帕思（Ridpath，I.）编.
上海：上海外语教育出版社，2002
（牛津英语百科分类词典系列）
书名原文：Oxford Dictionary of Astronomy
ISBN 7-81080-392-1

Ⅰ.牛… Ⅱ.里… Ⅲ.天文学－词典－英文 Ⅳ.P1-61

中国版本图书馆CIP数据核字（2002）第011169号

图字：09-1999-311号

出版发行：上海外语教育出版社
（上海外国语大学内） 邮编：200083
电　　话：021-65425300（总机），65422031（发行部）
电子邮箱：bookinfo@sflep.com.cn
网　　址：http://www.sflep.com.cn　http://www.sflep.com
责任编辑：钱明丹

印　　刷：常熟市华顺印刷有限公司
经　　销：新华书店上海发行所
开　　本：850×1092　1/32　印张 17.125　字数 830 千字
版　　次：2002 年 3 月第 1 版　2002 年 3 月第 1 次印刷
印　　数：3 200 册

书　　号：ISBN 7-81080-392-1 / H • 159
定　　价：22.00 元

Oxford Dictionary of

Astronomy

Edited by

IAN RIDPATH

Oxford New York

OXFORD UNIVERSITY PRESS

Oxford University Press, Great Clarendon Street, Oxford OX2 6DP
Oxford University Press is a department of the University of Oxford.
Oxford New York

Oxford is a registered trade mark of Oxford University Press

British Library Cataloguing in Publication Data
Data available

Library of Congress Cataloging in Publication Data
A dictionary of astronomy / edited by Ian Ridpath.
1. Astronomy—Dictionaries. I. Ridpath, Ian.
QB14.D52 1997 520'.3—dc21 97-14619
ISBN 0-19-211596-0 (pbk.)

Published by permission of the Oxford University Press

Licenced for sale in the People's Republic of China only,
not for sale elsewhere.

本词典(重印本)由牛津大学出版社授权出版,

仅供在中华人民共和国境内销售。

出版说明

随着改革开放的不断深入以及国际交流的日趋广泛，外语学习已经不仅仅局限于语言技能的培养。通过英语获取专业知识、提高专业水平、跟踪学科的最新发展已经成为时代的要求。因此，目前国内急需一批用英语编纂的专业词典。

牛津英语百科分类词典系列是由牛津大学出版社组织编纂的一套工具书。该系列涉及语言学、文学、文化、艺术、社会学、数学、物理学、化学、生物学、医学、食品与营养、计算机等社会科学和自然科学门类近百种，均由造诣很深、经验丰富的专家撰写。作为第一批，我们从中精选了 52 本，以满足国内读者的需要。词典用浅显的英语，精确地解释了常用的专业词汇，充分体现了牛津大学出版社在出版工具书方面严谨的传统。

该系列词典可作为大专院校各专业的学生以及专业技术人员学习专业知识、提高专业英语能力的参考书。

本社编辑部

List of Contributors

Editor

Ian Ridpath FRAS

Contributors

M. A. Barstow BA, PhD, CPhys, MInstP, FRAS

Neil Bone BSc

P. A. Charles BSc, PhD

C. J. Clarke BA, DPhil

R. J. Cohen MSc, BSc, PhD

Peter Coles MA DPhil, FRAS

Storm Dunlop FRAS

M. G. Edmunds MA, PhD, FRAS

R. M. Green MA, PhD

D. H. P. Jones MA, BSc, PhD, FRAS

A. W. Jones PhD, CPhys, MInstP

C. Kitchin BA, BSc, PhD, FRAS

John W. Mason BSc, PhD, FRAS

Andrew Murray MA

J. B. Murray MA, MPhil, PhD

Gillian Pearce BSc, PhD, BM, BCh, FRAS

Kenneth J. H. Phillips BSc, PhD

Ian Ridpath FRAS

A. E. Roy BSc, PhD, FRSE, FRAS

Robin Scagell FRAS

John Woodruff FRAS

Preface

Nearly 4000 entries in this *Dictionary of Astronomy* cover all aspects of the subject, from the smallest and nearest objects in the Solar System to the largest and most remote structures in the Universe. The terms and names it defines range from those in common use by amateur astronomers to those familiar only to professionals. Certain entries – notably those dealing with the main objects in the Solar System, and the principal entries for stars and galaxies – provide coverage in greater depth. Relevant concepts from physics are also defined.

Entries are ordered alphabetically on a letter-by-letter basis up to the first comma. This principle gives, for example, the sequence of headwords **diverging lens**, **D layer**, **D lines**, **dMe star**, **Dobsonian telescope**; but **Hubble, Edwin Powell**, **Hubble classification**, **Hubble constant**. Headwords which include a number are ordered as though the numbers were written out in words. For example, **47 Tucanae** will be found under F, and **61 Cygni** under S. The same principle applies to headwords in which a number follows a letter, such as **H I region** ('H one'), **H II region** ('H two'), and **H_2O maser** ('H two O'). **S0 galaxy** is ordered as if spelt 'S nought', with apologies to American users who would look under 'S zero'. Similarly, headwords containing a Greek letter are ordered as if the letter is spelt out: for example, **Hα** is treated as 'H alpha'.

Where several variants of a given term exist, our choice of headword for the main entry was strongly influenced by *The Astronomy Thesaurus*, compiled for the International Astronomical Union by Robyn and Robert Shobbrook. The present dictionary is the first to benefit from this valuable listing, which helps to standardize astronomical terminology.

Variants of a term are included in the dictionary with a cross-reference directing the reader to the main entry. For example, a reader looking up either **microwave background radiation** or **cosmic microwave background** will be referred to the main headword, which is **cosmic background radiation**. Cross-references within an entry are indicated by prefixing the term with an asterisk, thus: *cosmic background radiation. Other cross-references are printed in small capitals, for example '*see* BIG BANG'.

Different senses of the same headword are numbered 1, 2, ... Where necessary, these numbers are appended to cross-references, as in *dispersion (1), for example.

Some terms do not have a full entry, but are defined in a different entry, in which they are printed in italic. For example, a reader looking

up **plutino** or **signal-to-noise ratio** will find a cross-reference to, respectively, **trans-Neptunian object** and **sensitivity**, under which the terms are defined.

As in all areas of science and technology, abbreviations are commonly encountered in modern astronomy, particularly in connection with the names of observatories, organizations, and telescopes. In this dictionary, such names are written out in full in the main headword, with a cross-reference from the abbreviated form: for example **Hubble Space Telescope**, cross-referenced at **HST**, **Infrared Astronomical Satellite**, cross-referenced at **IRAS**. Exceptions are made where an acronym has become the commonly accepted name, such as **MACHO**, **MERLIN**, **SIMBAD**, and **WIMP**.

We have tried to identify all those persons who are mentioned in the text by full name, nationality, and date(s). In a few cases we were unsuccessful in tracking down all these biographical details, and would be pleased to hear from anyone who can supply additional information. Seldom-used parts of personal names are enclosed in parentheses, especially if the forename by which someone is best known is not their first, for example (Alfred Charles) Bernard Lovell.

A book like this would not exist without its contributors. My grateful thanks go to those listed on p. vi, who wrote their entries skilfully and then had to endure what must at times have seemed a near-endless stream of editorial queries. My thanks go also to those staff members of observatories who provided information on their facilities. I owe a special debt to those who freely helped in tracking down biographical information, notably John Woodruff, Christof Plicht, and Thomas R. Williams. As ever, the resources of the Royal Astronomical Society proved invaluable, and the help of its librarian, Peter Hingley, is gratefully acknowledged.

Professor Archie Roy, who initiated the project, kept a paternal eye on it throughout. At Oxford University Press, Angus Phillips kept patience with an editing process that stretched out far longer than either of us had anticipated. John Woodruff's thorough copy-editing ensured a high degree of consistency and accuracy throughout.

Above all, I owe lasting gratitude to Andrea who, despite finding that I had a prior engagement with a dictionary, still decided to marry me.

IAN RIDPATH

Brentford, Middlesex
1997 June

Contents

A

Å Symbol for *angstrom.

AAO Abbr. for *Anglo-Australian Observatory.

AAS Abbr. for *American Astronomical Society.

AAT Abbr. for *Anglo-Australian Telescope.

AAVSO Abbr. for *American Association of Variable Star Observers.

A band A broad *Fraunhofer line in the Sun's spectrum at around 760 nm, due to absorption by oxygen in the Earth's atmosphere. Because the oxygen is in molecular form, the A band is actually a group of close, regularly spaced lines over the range 759–768 nm, unresolved at low resolution.

Abell Catalogue A catalogue of 2712 rich clusters of galaxies published in 1958 by the American astronomer George Ogden Abell (1927–83) from inspection of the *Palomar Observatory Sky Survey photographs. The catalogue had well-defined criteria for selection of the clusters (*see* ABELL CLUSTER). A later extension to the southern sky (published 1989) was based on photographs taken with the *United Kingdom Schmidt Telescope in Australia.

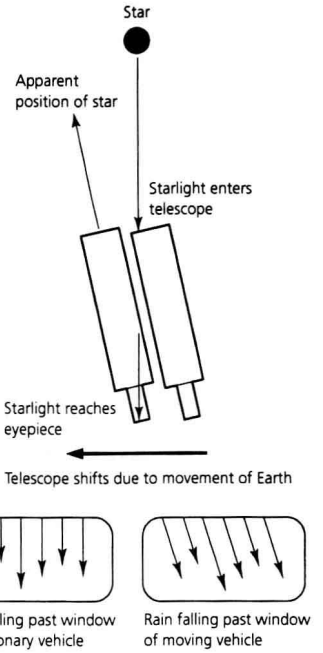
Abell cluster A cluster of galaxies listed in the *Abell Catalogue. To appear in the catalogue, a cluster must satisfy selection criteria which include containing more than 50 galaxies and having a dense concentration (richness). The clusters are classified as regular (R) or irregular (I) in appearance, ranked in increasing richness from 1 to 5, and increasing distance from 1 to 6. The approximate frequency of Abell clusters is one per 2.4×10^5 cubic megaparsecs.

Abell radius A radius of about 2 megaparsecs within which at least 50 galaxies of a particular range of brightness must be found if the cluster is to qualify as an *Abell cluster.

aberration, constant of *See* ANNUAL ABERRATION.

aberration, optical An imperfection or error in the image produced by a lens, mirror, or optical system. There are six types of aberration: *chromatic aberration, *spherical aberration, coma (*see* COMA, OPTICAL), *field curvature, *distortion, and *astigmatism. Chromatic aberration is not present in images formed by mirrors. All can be corrected to a greater or lesser extent by suitable optical design.

aberration of starlight The small apparent difference between the observed direction of a star and its true direction. It is due to the combined effect of the observer's motion across the path of incoming starlight and the finite velocity of light. The actual amount of displacement and its direction depend on the observer's speed and direction of motion. Aberration of starlight resulting from the Earth's orbital motion is termed *annual aberration; the much smaller effect resulting from the Earth's rotation is *diurnal aberration. *Planetary aberration is a combined result of the observer's motion and the time taken for light to travel from a body in the Solar System to the observer.



ABERRATION OF STARLIGHT: *The Earth's orbital motion alters the apparent direction of incoming starlight. In a similar effect, vertically falling raindrops appear to be travelling at an angle as seen from a moving vehicle.*

ablation The wearing away of the outer layers of a body by melting, erosion, vaporization, or some other process due to aerodynamic effects as the body moves at high speed through a planetary atmosphere. Ablation can affect natural bodies such as meteoroids, or artificial objects such as spacecraft. Ablation of a spacecraft's protective heat shield prevents overheating of the spacecraft's interior during atmospheric entry.

ablation age The period of time since the outer glassy layers of a tektite solidified following ablation during its re-entry into the Earth's atmosphere. The ablation ages of known tektites vary from about 600 000 to 35 million years.

absolute magnitude (symbol M) **1.** The brightness that a star would have if it were at a distance of 10 parsecs in perfectly clear space without *interstellar absorption. Absolute magnitude is usually deduced from the *visual magnitude measured through a V filter, and is then written M_V. If defined for another wavelength it carries a different subscript (U, B, etc.). When radiation at all wavelengths is included it becomes the absolute *bolometric magnitude, M_{bol}. The Sun has an absolute magnitude of +4.8. Most other stars range between −9 (supergiants) and +19 (red dwarfs). **2.** The brightness that an asteroid or comet

would have if it were at a distance of 1 AU from both the Sun and Earth and fully illuminated by the Sun (i.e. with a *phase angle of 0°).

absolute temperature Former name for *thermodynamic temperature.

absolute zero The zero point on the *thermodynamic temperature scale, equal to −273.16° Celsius or −459.69° Fahrenheit. It is often stated that all motion of atoms and molecules ceases at absolute zero, but in fact a small amount of energy (the *zero-point energy*) still remains. Absolute zero is the coldest temperature theoretically possible, but it can never be attained in practice.

absorption The transfer of energy from a photon to an atom or molecule. If the energy of a photon is equal to that needed to raise an electron from one *energy level to another, the result is an *absorption line at a particular wavelength. Absorption at other wavelengths is called *continuous absorption*. Absorption occurs whenever light traverses a plasma, in for example the outer layers of a star, the Earth's atmosphere, a nebula, or interstellar space (*see* INTERSTELLAR ABSORPTION).

absorption coefficient A measure of the decrease in intensity of radiation as it passes through a medium. It is the reciprocal of the distance required to reduce the radiation to $1/e$ of its original value (where e is a constant equal to 2.718).

absorption edge A limiting feature in a series of absorption lines from a single element (e.g. hydrogen), representing the wavelength at which the element becomes ionized. In the *Balmer series of hydrogen, the lines become closer together as the series limit of 364.6 nm is reached, forming an edge at that wavelength (*see* BALMER LIMIT).

absorption line A dark feature in the spectrum of a star, formed by cooler gas in the star's outer layers (the *photosphere) that absorbs radiation emitted by hotter gas below. The *Fraunhofer lines in the solar spectrum are the best-known examples. Each line is a unique signature of the element or molecule that forms it, which enables the chemical composition of the star to be determined. *See also* BAND.

absorption nebula *See* DARK NEBULA.

absorption spectrum A spectrum that consists only of dark *absorption lines, created when light from a hot source passes through cooler material. The spectra of normal, cool stars such as the Sun fall into this category.

abundance *See* ELEMENTS, ABUNDANCE OF.

Acamar The star Theta Eridani. It is a double star, consisting of an A4 subgiant and an A1 dwarf, magnitudes 3.4 and 4.4, about 90 l.y. away.

acceleration of free fall (symbol g) The acceleration experienced by an object falling freely in a gravitational field, also known as the *acceleration due to gravity*. Its mean value at the Earth's surface is 9.807 m/s^2; this varies slightly with latitude, because the Earth is not perfectly spherical. On any body the acceleration due to gravity can be found from the formula $g = GM/R^2$, where M is the mass of the body, R is its radius, and G is the universal *gravitational constant.

accretion The process by which the mass of a body increases by the accumulation of matter, in the form of either gas or small solid bodies which collide with and adhere to the body. The bodies in the Solar System are thought to have grown by accretion; some stars are surrounded by an *accretion disk.

accretion disk A structure that forms around a compact object (e.g. a white dwarf, neutron star, or black hole) when matter flows towards it. Accretion disks are found in interacting binary stars, and are assumed to exist in *active galactic nuclei and *quasars. In a binary, mass lost from the secondary star forms a disk of gas around the compact object. The disk may have a *hot spot (1) where the stream of material hits its outer edge. Material is fed from the inner edge of the disk through a *boundary layer* (which may radiate as much energy as the disk itself) on to the compact object. When the compact object has an extremely strong magnetic field, as in an *AM Herculis star, the material may form an *accretion column* over each magnetic pole, rather than a disk. The gravitational energy that is released can cause high ultraviolet or X-ray luminosities, and may accelerate jets of material from the disk to very high speeds.

Achernar The star Alpha Eridani, a B3 dwarf of magnitude 0.46, ninth-brightest in the sky, about 70 l.y. away. Its name comes from Arabic and means 'river's end'.

Achilles Asteroid 588, the first *Trojan asteroid to be discovered, by Max *Wolf in 1906. It is a member of the group of Trojans at the L_4 *Lagrangian point 60° ahead of Jupiter. Achilles is a D-class asteroid of diameter 116 km. Its orbit has a semimajor axis of 5.175 AU, period 11.77 years, perihelion 4.40 AU, aphelion 5.95 AU, and inclination 10°.3.

achondrite A class of stony meteorite usually (though not always) lacking the tiny, rounded inclusions known as chondrules found in *chondrites. Achondrites make up about 9% of all meteorite falls. They consist principally of one or more of the minerals plagioclase, pyroxene, and olivine. The main distinction between achondrites and chondrites is that the achondrites have different abundances of calcium and similar elements, and almost no metal or sulphide. Achondrites are thought to have crystallized from a magma in the same way as terrestrial rocks. The achondrites are divided into five main classes. The two main calcium-rich classes (containing more than 5% calcium) are the *pigeonite–plagioclase achondrites* (*eucrites) and the *plagioclase–hypersthene achondrites* (*howardites). There are three main calcium-poor classes (usually less than 1% calcium): the *hypersthene achondrites* (*diogenites), the *olivine–pigeonite achondrites* (*ureilites), and the *enstatite achondrites* (*aubrites). The eucrites, howardites, and diogenites are often collectively referred to as the *basaltic achondrites. The *pigeonite–maskelynite achondrites* (*shergottites), *augite–olivine achondrites* (*nakhlites), and *olivine achondrites* (*chassignites) comprise the rare *SNC meteorites. There is also a very rare class of augite achondrite, the angrites, named after the Angra dos Reis meteorite, which fell in Brazil in 1869.

achromatic Describing a lens consisting of two or more optical components (*elements*), intended to correct for *chromatic aberration. Commonly used as the objective of small refractors, the achromatic lens (or *achromat*) was invented in 1729 by the English optician Chester Moor Hall (1703–71) and first manufactured commercially by J. *Dollond in 1758. It has one element of *crown glass and another of *flint glass. The *dispersion (1) of the crown glass compensates for the chromatic error of the flint glass, while still leaving some refractive power. The two-element design is termed an *achromatic doublet*. It is practically impossible to correct all wavelengths of light, however, and most lenses adopt a compromise, bringing two particular wavelengths to a common focus, thus reducing the false colour. A lens that corrects for more than two wavelengths is termed an *apochromatic lens.

achromatism Freedom from false colour (*chromatic aberration) in an optical system. In reality, no optical system containing lenses can ever be completely free

from false colour, but the aim is to reduce the amount of false colour to acceptable proportions. A mirror is completely achromatic.

A-class asteroid A rare class of asteroid that has both a moderately high albedo (0.13–0.35) and an extremely reddish spectrum at wavelengths shorter than 0.7 μm. Strong absorption in the near-infrared is interpreted as indicating the presence of the mineral olivine. Members of this class include (246) Asporina, diameter 70 km, and (446) Aeternitas, diameter 52 km.

acronical Referring to the rising or setting of a celestial object at or shortly after sunset. A planet's rising is acronical when it is at *opposition.

Acrux *See* ALPHA CRUCIS.

active galactic nucleus (AGN) The central region of a galaxy in which considerable energy is generated by processes other than those operating in normal stars. An active nucleus typically shows both continuum and emission-line spectra in the optical and ultraviolet, and may be an infrared, a radio, or an X-ray source. The energy may result from the accretion of material on to a black hole of up to 10^8 solar masses, situated within the central few light years of the galaxy. *See also* BLAZAR; LINER; SEYFERT GALAXY.

active optics A system that compensates for the deforming effects of gravity on a telescope's mirrors, maintaining their surface accuracy and alignment. The image of a guide star is examined as the telescope tracks it across the sky. Actuators behind the mirrors control movable supports to preserve the mirrors' shape and alignment. The first large telescope to employ active optics was the *New Technology Telescope at the European Southern Observatory.

active prominence A solar prominence with very rapid motion (up to 2000 km/s), often associated with a flare. Active prominences are located at low latitudes on the Sun, where sunspots and active regions are usually found. The main categories include *loop prominences, *coronal rain, *surge prominences, *sprays, and arch *filament systems.

active region An area on the Sun where magnetic fields emerge through the photosphere into the chromosphere and corona. Active regions on the photosphere include *sunspots and *faculae. Their counterparts higher in the chromosphere are *plages. Also in the chromosphere are dark *fibrilles and *filaments. Active regions in the corona are areas of enhanced density and temperature sometimes called *coronal condensations. Other examples of active regions are areas on the photosphere where sunspots have faded, and *X-ray bright points in the corona. *Flares occur in active regions.

Adams, John Couch (1819–92) English mathematical astronomer. In 1845 he calculated the orbit of a new planet whose gravitational effects would explain why Uranus did not follow its predicted path. A search from England was delayed, mainly because of the reluctance of the Astronomer Royal, G. B. *Airy. In 1846 J. G. *Galle sighted the new planet, subsequently named Neptune, from independent calculations by U. J. J. *Le Verrier. Adams and Le Verrier were eventually both credited with predicting Neptune's existence. Adams's later work included calculation of the Moon's *secular acceleration, and of the orbital elements of the Leonid meteor swarm.

Adams, Walter Sydney (1876–1956) American spectroscopist, born in Syria. He was the first to detect systematic differences in the spectra of giant and dwarf

stars. From 1914, with the German astronomer Arnold Kohlschütter (1883–1969), Adams developed methods of establishing the surface temperature, luminosity, and distance of stars from their spectra. In 1918 he showed that the density of the white dwarf Sirius B is 50 000 g/cm^3. Adams also carried out spectrographic studies of the atmospheres of Mars and Venus.

Adams Ring The outermost of Neptune's rings, named after J. C. *Adams. It lies 62 950 km from Neptune's centre, and is less than 50 km wide. It has three denser arcs, 4°, 4°, and 10° long, separated by 14° and 12°. One of these arcs has six moonlets within it, each 10–20 km across.

adaptive optics An optical design that can rapidly counteract the effects of atmospheric seeing on an image. This may be done by deforming a mirror in the light path of a telescope to keep a star's image as point-like as possible. The system may use as a reference a real star, or an artificial star produced by shining a laser up through the layers of air that are causing the bad seeing. Any extended objects in the field, such as galaxies, will also be sharpened. This technique can increase the resolution of a ground-based telescope by a factor of 40.

Adhara The star Epsilon Canis Majoris, magnitude 1.5. It is a bright giant of type B2, 570 l.y. away, with a companion of magnitude 7.4.

adiabatic process A change or process in which no heat enters or leaves a system, as occurs for example in an expanding or contracting gas cloud. An adiabatic change is usually accompanied by a rise or fall in the temperature of the system; ionization of atoms or dissociation of molecules may also occur. *See also* ISOTHERMAL PROCESS.

Adonis Asteroid 2101, the second of the *Apollo group to be discovered, by the Belgian astronomer Eugène Joseph Delporte (1882–1955) in 1936, when it passed within 0.015 AU (2.2 million km) of the Earth. It was not seen again until 1977. Adonis is about 1 km in diameter. Its orbit has a semimajor axis of 1.874 AU, period 2.57 years, perihelion 0.44 AU, aphelion 3.31 AU, and inclination 1°.4.

Adrastea The second-closest satellite of Jupiter, distance 129 000 km, orbital period 0.298 days; also known as Jupiter XV. Adrastea is 25 × 20 × 15 km in size. It was discovered in 1979 by the Voyager spacecraft. It lies less than one Jovian radius above Jupiter's cloud tops, and very close to the outer edge of Jupiter's ring. Adrastea's gravity probably keeps the ring particles within its orbit—it acts as a *shepherd moon.

ADS Abbr. for *Aitken Double Star Catalogue.

Advanced X-ray Astrophysics Facility (AXAF) A planned NASA X-ray astronomy satellite, one of the four *Great Observatories, scheduled for launch in 1998. It will use a mirror *grazing-incidence telescope with a collecting area equivalent to that of a conventional 0.4-m optical telescope to observe X-rays of 0.1–10 keV (0.12–12 nm). AXAF will provide sharper images (0".5) and more detailed X-ray spectra than any previous X-ray mission.

advance of perihelion A gradual turning of the major axis of an orbit in the same direction as the body moves along the orbit; also known as *apsidal motion*. An advance of perihelion means that the *longitude of perihelion of the orbit increases. In the Solar System, the effect is caused mostly by the gravitational attractions of the planets. A similar effect, the *advance of pericentre*, is seen in the orbits of binary stars, caused by the oblateness of the stars themselves. In the 19th

century, a small unexplained advance of Mercury's perihelion of some 43″ per century was attributed to an undiscovered planet within the orbit of Mercury (*see* VULCAN). This effect is now known to be caused by the curvature of space near the Sun, as predicted by the general theory of relativity.

advection Transfer by horizontal motion. The term is applied to both the shifting of planetary atmospheric gases by horizontal motion, and also to the resultant transfer of heat, for example from low to high latitudes. More recently, advection has also come to mean the transfer of heat vertically within a planetary body, for example by hot, molten material rising through the lithosphere of a planet.

aeon A period of 10^9 years (i.e. a billion years); US *eon*.

aerial Another name for an *antenna.

aerobraking The technique of using the atmospheric drag of a planet to modify the orbit of a spacecraft, thereby saving propellant. It was first used at another planet by the US Venus probe Magellan in 1993. Aerobraking lowered the high point of Magellan's orbit above Venus from 8500 to 600 km and shortened its orbital period from 195 to 94 min. Aerobraking can also be used to help space probes enter orbit around a planet, as with the Mars Global Surveyor craft in 1997.

aerolite An alternative name for a *stony meteorite, now largely obsolete.

aeronomy The study of processes and phenomena in the Earth's upper atmosphere, principally near its uppermost limit which, for most practical purposes, can be taken to lie at an altitude of around 300 km. Among the processes studied are *airglow, reactions in the *chemosphere, and the formation of *noctilucent clouds and the *ionosphere.

aerosol A layer of small particles, either solid or liquid, suspended in an atmosphere. Aerosols cause *atmospheric extinction.

Ae star A star of spectral type A which exhibits emission lines in its spectrum (hence the suffix 'e'). Usually these are sharp emission lines of hydrogen, and are superimposed on an otherwise normal spectrum. These lines arise in a surrounding expanding shell or disk of material. Ae stars are young stars still in the process of formation.

aether *See* ETHER.

afocal Describing an optical system in which an image is transferred without bringing it to a focus. Afocal photography, for example, involves pointing a camera, focused on infinity, into the eyepiece of a telescope whose image also appears at infinity. When an image is transferred as a beam of parallel light rays, the beam is termed an *afocal beam*.

AGB star Abbr. for *asymptotic giant branch star.

Agena Alternative name for the star *Hadar or Beta Centauri.

agglutinate A small object consisting of impact glass and fragments of minerals or rocks, all welded together into an *aggregate*. Agglutinates are produced by the impact of micrometeorites into the lunar regolith or other planetary surface.

AGK Abbr. for *Astronomischen Gesellschaft Katalog*, a series of catalogues of star positions. AGK1 covered most of the sky, observed by meridian circles around the world; it was published between 1890 and 1954. AGK2 (1951–8) was a repetition