

Encyclopaedia Britannica, Micropaedia, Chicago, 1974

Zwicky, Fritz (b. Feb. 14, 1898, Varna, Bulg.), Swiss astronomer, physicist, and jet-propulsion pioneer who has made valuable contributions to the theory and understanding of supernovae - stars that for a short time are brighter than normal.

In 1925 Zwicky went to the U. S. as a research fellow at the California Institute of Technology. Pasadena, and there became assistant professor of theoretical physics in 1927 and professor of astrophysics in 1942. From 1948 he was an astronomer at Mount Wilson and Palomar observatories (now Hale Observatories) near Pasadena.

During the early 1930s Zwicky contributed substantially to the physics of solid-state, gaseous ionization, and thermodynamics but soon turned to the study of supernovae, novae, and cosmic rays. In 1934, in collaboration with the German astronomer Walter Baade, he published papers concluding that supernovae are a completely different class of stellar explosion than the ordinary novae and occur less often (two or three times every 1 000 years in our galaxy). In supernovae, most of the matter of the star is dissipated, leaving little or nothing behind, he said. Although his theories were greeted with skepticism, Zwicky began an extensive search of neighbouring galaxies for such supernovae; and from 1937 to 1941 he discovered 18 [korrekt:14] supernovae - only about 12 had been recorded previously in the history of man.

In 1943 Zwicky joined the Aerojet Engineering Corporation, Azusa, Calif., where he served as director of research (1943-49) and technical adviser and chief research consultant (1949-61). He developed some of the earliest jet engines, including the JATO (jet assisted take-off) units used to launch heavy-laden aircraft from short runways.

- galaxy clusters in Coma Berenices 7:829h

Kürzener, fast identischer Text auch in:

1975 Book of the Year, S. 537

1975 Yearbook of Science and the Future, S. 304.

Brockhaus Enzyklopädie, Band 20, 1974, S. 802

Zwicky, Fritz, Schweizer Astronom, *Varna (Bulgarien) 14. 2. 1898, † Pasadena (Calif.) 8. 2. 1974, war seit 1920 Forschungsassistent in Zürich, ging 1925 als Prof. für theoret. Physik nach Pasadena, wo er 1942-68 den Lehrstuhl für Astrophysik innehatte.

Daneben beobachtete er am Mount Palomar Observatory bes. aussergalakt. Nebel. Vor allem 1936-41 führte seine systemat. Suche nach den Supernovae in Spiralnebeln zu grossen Erfolgen.

Daneben befasste sich Z. mit den Problemen der Radioastronomie, der Flug- und Raketentechnik u. a.

Werk. Catalogue of galaxies and of clusters of galaxies (Zürich 1963).

Encyclopaedia Universalis, Paris; Universalis, 1975, S. 503

Mit Anmerkungen von Roland Müller []

Fritz ZWICKY
1898-1974

Astrophysicien suisse né à Varna en Bulgarie et mort à Pasadena (Californie) le 8 février 1974.

Zwicky est élève de l'École polytechnique fédérale de Zurich, où il sera assistant de recherche (1920-1925). C'est dans cet établissement qu'il connaît le théoricien de la physique W. Pauli [1] et le célèbre mathématicien H. Weyl. avec lesquels il se lie d'amitié; il les retrouvera plus tard tous deux à Princeton. Après ses premières recherches à Zurich, il part pour Caltech (1925) où il devient professeur assistant de physique théorique en 1927.

Il consacre au début, ses recherches à la cristallographie, puis il s'intéresse à la mécanique, à l'astronomie et à bien d'autres branches de la physique. En 1942, il est nommé professeur d'astronomie [2] à Caltech. Directeur de recherche de l'Aerojet Corporation (1943-1945 [3]), puis conseiller technique principal de cette société (1949-1961), Zwicky effectue de nombreux travaux sur les fusées et les engins propulsés en général: l'engin JATO (*jet assisted take-off*) est de sa propre invention [4]. Ces travaux lui valent la médaille de la liberté [5] de la part du gouvernement des États-Unis (1949).

En collaboration avec l'astronome allemand Walter Baade, Zwicky découvre vers 1932 [6] des étoiles devenant brusquement très lumineuses (d'un éclat plus de mille fois supérieur à celui des *novae* ordinaires), auxquelles ils donnent le nom de *supernovae*; par une recherche systématique poursuivie jusqu'en 1941, ils en découvrent dix-huit [7].

Peu conformiste et d'une imagination audacieuse, Zwicky, dès 1929, conteste l'interprétation du décalage vers le rouge du spectre des étoiles en termes d'effet Doppler, à laquelle il préfère l'hypothèse du *vieillessement des photons* durant leur propagation dans l'espace (plusieurs années-lumière). De même en 1934, avec Baade, il considère la possibilité de création dans l'univers de configurations «neutroniques», pouvant se produire par radioactivité bêta inverse (absorption d'un électron par le noyau), sous l'influence de très fortes pressions. La théorie de ce phénomène est donnée par L. Landau et par J. R. Oppenheimer et G. M. Volkoff (1938), qui ont montré que de telles configurations peuvent effectivement être stables, mais deviennent instables quand leur masse atteint 0,7 à 1,5 fois la masse du Soleil. La suggestion de Zwicky a trouvé sa confirmation par la découverte récente (1968) des *pulsars*: il s'agit d'objets aux dimensions réduites (d'un rayon d'une dizaine de kilomètres seulement), distants de plusieurs milliers d'années-lumière de notre galaxie (qui, semble-t-il, doit en contenir plusieurs) et en mouvement de rotation rapide (période de l'ordre de 0,25 à 1,3 s) tellement régulier qu'ils pourraient servir d'horloges d'une précision de 10^{-8} .

Zwicky a joué un grand rôle dans l'élaboration et la construction des grands télescopes rapides à grand champ (du type Schmidt) du mont Wilson et du mont Palomar (actuellement Hale) qui ont rendu des services inestimables pour l'exploration de l'univers.

Son travail le plus marquant est certainement celui de la classification des galaxies et amas de galaxies ainsi que celle des *étoiles bleues*, dont l'étude est en plein développement.

L'influence de Zwicky sur le développement des idées en astrophysique moderne a été considérable. Ses idées, d'une rare originalité, sur de nombreux problèmes, ont souvent été critiquées, mais cela n'a pas empêché qu'elles se soient révélées dans bien des cas justes et qu'elles aient toujours exercé une action stimulante.

Comme son élève Halton Arp (Hale) l'a écrit. Zwicky a découvert à lui seul autant de galaxies [8] que tous les autres observateurs réunis. Les nébuleuses spirales, photographiées par S. van den Bergh, avaient été signalées par Zwicky vingt ans auparavant.

Ayant souvent mis l'accent sur l'aspect morphologique des phénomènes du ciel, Zwicky a été élu président de la Morphological Society [9] en 1961.

Il est l'auteur du *Catalogue of Galaxies and Clusters of Galaxies* (Zurich, 1963) et d'un livre qu'il a traduit lui-même de l'allemand sous le titre *Every Man a Genius* [10], qui en dit long

G. K. (= G. Kayas, C. N. R. S.)

Anmerkungen von R. M.

Der Text basiert offenbar auf dem Nachruf auf F. Z. von Halton Arp, *Physics Today*, Vol. 27, June 1974, S. 70-71.

1. Wolfgang Pauli kam erst 1928 an die ETH
2. Professor für Astrophysik
3. 1943-1949
4. kaum
5. nein (siehe die Würdigung in der Zwicky-Biographie, S. 353)
6. 1933
7. Laut der F. Z.-Biographie, S. 214 [= EEF, 1966, 102]: **20**; gemäss Angaben in der Biographie, S. 605 (Anm. 42), S. 606f (Anm. 53) und S. 611 (Anm. 19) waren es von 1936-1942 insgesamt 20 Supernovae; dazu kommt noch eine von Edwin Hubble im Januar 1936 entdeckte (S. 151)
8. eher: Supernovae
9. F. Z. hatte sie im Dezember 1960 selber gegründet
10. „Everyone a Genius“

Who Was Who in America, Vol. VI, 1974-1976

ZWICKY, FRITZ, astrophysics; b. Varna, Bulgaria (citizen of Switzerland), Feb. 14, 1898; s. Fridolin and Franziska (Wreck) Z.;

B. S. in Physics, Federal Inst. of Tech., Zurich, Switzerland, 1920, Ph.D., 1922;

m. Margaritha Anna Zuercher, Oct. 15, 1947; children Margrit, Franziska, Barbara.

Came to the United States in 1925. Research assistant Fed. Inst. Tech., Zurich, 1920-25; internat. research fellow Calif. Inst. Tech., Rockefeller Foundation, 1925-27, asst. prof., theoretical physics, 1927-29, asso. prof., 1929-41, prof. of astrophysics, 1942-68, professor emeritus, 1968-74; dir. research Aerojet Engring. Corporation, Azusa, Calif., 1943-49, technical adviser, chief research cons., 1949-61; astronomer Mount Wilson and Palomar Observatories, from 1948.

Chmn. bd. trustees Pestalozzi Found. Am., 1958. Recipient Presidential Medal of Freedom, 1949. Mem. Am. and Swiss phys. socs., Am. Astron. Soc., Internat. Acad. Astronautics (v. p. 1967), Soc. for Morphological

Research (pres., founder 1961).

Clubs: Swiss Alpine (Glarus, Switzerland); French Alpine (Lyons, France).

Author: Morphological Astronomy, 1957; Morphology of Propulsive Power, 1962; Discovery, Invention, Research, 1969. Contbr. numerous articles to Am., Swiss and German sci. mags.

Inventor aeropulse, hydropulse, hydroturbojet, monopropellants, coruscatives. Patentee in field.

Home: Pasadena, Cal.

Died Feb. 8, 1974; interred Mollis, Switzerland.

Meyers Enzyklopädisches Lexikon, Band 25, 1979, S. 840-841

Zwicky. Fritz, *Varna 14. Febr. 1898, † Pasadena (Calif.) 8. Febr. 1974, schweizer. Physiker und Astronom.

Nach Forschungstätigkeit an der ETH Zürich ab 1927 Professor für theoret. Physik, ab 1942 für Astrophysik am California Institute of Technology in Pasadena; ab 1948 auch Hauptastronom an den Mount Wilson and Palomar Observatories.

Z. war einer der bedeutendsten Astrophysiker des 20. Jahrhunderts. Seine astronom. Arbeiten betrafen v. a. extragalakt. Sternsysteme und Supernovä, von denen er 20 durch systemat. Suche (1934-41) in Spiralnebeln entdeckte.

Er sagte die Existenz von Neutronensternen voraus, entdeckte Anfang der 60er Jahre die kompakten Galaxien und erstellte mit seinen Mitarbeitern einen sechsbändigen „Catalogue of galaxies and clusters of galaxies“ (1961-68).

Ausserdem lieferte Z. bed. Beiträge auf dem Gebiet des Strahlantriebs, wo er insbes. 1941-61 zahlreiche Entwicklungen vorantrieb.

Die von ihm entwickelte *morpholog. Methode* besteht v. a. darin, alle wesentl. Bestandteile, Prozesse, Parameter u. a. eines Problems möglichst vollständig aufzudecken, dann systemat. miteinander zu verknüpfen und auf diese Weise bei einem Minimum an Arbeits- und Zeitaufwand zu einem Optimum an Problemlösungen und neuen Möglichkeiten zu gelangen.

Weitere Werke: Morphological astronomy (1957), Morphology of propulsive power (1962), Entdecken, Erfinden. Forschen im morpholog. Weltbild (1966), New methods of thought and procedure (1967).

Encyclopedia universal ilustrada, Europeo-Americana, Madrid, Suplemento Anual, 1974-1975, 1980

Um die Sätze oder Satzteile in eckigen Klammern [] gekürzt, in:

Diccionario Encyclopédico Espasa, Madrid, tomo 11, 1996

ZWICKY (FRITZ). Astrónomo suizo de origen búlgaro, nació en Varna (Bulgaria) el 14 de febrero de 1898 y murió en Pasadena, California (Estados Unidos) el 8 de febrero de 1974.

Se doctoró en el Instituto Federal de Tecnología de Zurich. A principios de los años treinta hizo substanciales aportes a la termodinámica, a la ionización gaseosa y a la física del estado sólido. Pasó a Estados Unidos como físico teórico del Instituto de Tecnología de California, y allí fue profesor de Astronomía (1942-68). Con Walter Baade, estableció la distinción entre novae y supernovas, [sugiriendo que en la explosión de las últimas queda un núcleo de neutrones.

Con las cámaras Schmidt de 45 y 122 centímetros del observatorio de Monte Palomar realizó una búsqueda sistemática de supernovas,] descubriendo el 25 % de las que se conocen. [Otros 14 observatorios colaboraron en esta labor, siguiendo un programa internacional.]

Además, descubrió nuevos tipos de galaxias enanas, muchos conglomerados de galaxias y puentes de material intergaláctico uniendo galaxias separadas.

Fue director de investigaciones de la Aerojet Corporation (1943-49), siendo premiado con la Medalla de la Libertad, [que recibió de manos del presidente Truman].

[Astrónomo del Mount Wilson y de los observatorios de Palomar, trabajó luego en la American Pestalozzi Foundation.

En coherencia logró notables avances, objeto de patentes, la mayoría de las 50 que registró.]

Publicó algunas obras, resultado de sus investigaciones, entre ellas *Morphological astronomy* (1957), *Morphologische Forschung* (1959), *Morphology of propulsive Power* (1963) y *Entdecken, Erfinden, Forschen* (1966).

[Fue miembro de la Sociedad Americana de Astronomía, de la Sociedad de Investigaciones Morfológicas (que presidió y fundó en 1961) y de la Sociedad Suiza de Astronomía; en 1965 se le nombró vicepresidente de la Academia Internacional de Astronomía.]

Al cumplir 74 años fue galardonado con la medalla de oro de la Royal Astronomical Society británica. - A. P.

Fritz Zwicky in Chinas Fachlexikon

Eintrag im Band «Astronomie» der grossen Enzyklopädie (1981), mit Porträt

Der Staatsrat, also die Regierung der Volksrepublik China, gründete im Jahr 1978 einen Verlag für die Herausgabe der „Grossen Chinesischen Encyclopädie“ in 80 Bänden. Soeben erschien der erste Band „Tianwenxue“ (Astronomie“), 650 Seiten stark, mit etwa 1,5 Mio. chinesischen Schriftzeichen. Es werden darin Astronomen aus China und aus aller Welt wie Guo Shoujing (1231-1316), Shen Kuo (1031-1095) Nicolaus Copernicus (1473-1543), Galileo (1564-1642), Johannes Kepler (1571-16309 und andere gewürdigt.

Der einzige Schweizer, dem ein Stichwort mit Foto gewidmet wird, ist Fritz Zwicky (1898-1974), der bekannte Glarner Forscher und Wissenschaftler.

Im Steckbrief werden seine Lebensdaten und Leistungen aufgezählt, so der von ihm herausgegebene „Catalogue of Galaxies and Clusters of Galaxies“ (California Institute of Technology, Pasadena, 1961 und folgende Jahre). Beachtung verdient der Hinweis des Stichworttext-Verfassers Li Jing, Professor Zwicky habe sich sein Leben lang für die „morphologische Forschungsmethode“ (xingtaixue yanjiu fangfa) eingesetzt und das Buch „Morphological Astronomy“ (Springer Verlag, Berlin, 1957) verfasst.

Als Hauptverdienst des prominenten Glarner gelten seine Forschungsergebnisse über die Supernovae.

Unter dem Stichwort „Supernovae“ werden denn auch nur die beiden Abhandlungen Professor Zwicky's „Supernovae“ (Handbuch der Physik, Bd. LI, Springer Verlag, Berlin 1958) sowie „Supernovae, Stellar Structure“ (University of Chicago Press, 1965) als Referenzwerke erwähnt. Anerkennung findet auch Professor Zwicky's Voraussage der Existenz von Neutronensternen.

Harro von Senger in "Glerner Nachrichten", 12.2.1982, S. 1

The Biographical Dictionary of Scientists: Astronomers, 1984

identisch in: The Hutchinson Dictionary of Scientific Biography, 1994

identisch in: The Biographical Dictionary of Scientists, Third Edition, Vol. II, 2000

Zwicky, Fritz (1898-1974),

was a Swiss astronomer and astrophysicist who was distinguished for his discoveries of supernovae, dwarf galaxies and clusters of galaxies and also for his theory on the formation of neutron stars.

Zwicky was born in Varna, Bulgaria, but his parents were Swiss and he retained his Swiss nationality throughout his life. He was educated in Switzerland, gaining his BA and his PhD by 1922 from the Federal Institute of Technology at Zurich.

He was awarded a Fellowship from the International Education Board in 1925 and left Switzerland for the United States to join the California Institute of Technology. He was appointed Assistant Professor at Caltech in 1927 and continued to work there until his retirement in 1968, by which time he had been promoted to the position of Professor of Astronomy. After his retirement, Zwicky continued to live in the United States. He received the Royal Astronomical Society's Gold Medal in 1973 [1972]. He died on 8 February 1974.

Zwicky began his research by scouring our neighbouring galaxies for the appearance of a supernova explosion, hoping to discover one that was bright enough for its spectrum to be studied. But since the time when Johannes Kepler and Tycho Brahe observed their rare sightings of such events, no other supernovae have been seen to appear in our Galaxy.

Zwicky therefore calculated that only one supernova appears every three or four hundred years in any galaxy. He was among the first to suggest that there is a relationship between supernovae and neutron stars. He suggested that the outer layers of a star that explodes as a supernova leave a core that collapses upon itself as a result of gravitational forces. He put forward this theoretical model in the early 1930s, when there seemed to be no hope of actually observing such a phenomenon.

In 1936 Zwicky began a study of galaxy clusters. He used the 18-inch (46cm) Schmidt telescope at Mount Palomar Observatory to photograph large areas of the sky. This telescope was specially designed to provide a relatively wide field of view, so that a large portion of the sky could be viewed at one glance without sacrificing a high resolution of separate images.

Zwicky observed that most galaxies occur in clusters, each of which contains several thousand galaxies. The nearest is the Virgo cluster, which is also the most conspicuous of large clusters. It contains a number of spiral galaxies and Zwicky's spectroscopic studies of the Virgo and the Coma Berenices clusters showed that there is no evidence of any systematic expansion or rotation of clusters. Zwicky also calculated that the distribution of galaxies in the Coma Berenices cluster was similar, at least statistically, to the distribution of molecules in a gas when its temperature is at equilibrium.

He compiled a six-volume catalogue of galaxies and galaxy clusters in which he listed 10 000 clusters located north of declination -30 degrees. He completed the catalogue shortly before his death and it is still

generally regarded as the classic work in this field.

Zwicky's research interests were not limited to astronomy, but extended to the study of crystal structure, superconductivity, rocket fuels, propulsive systems and the philosophy of science. But his work on galaxies, galaxy clusters, interstellar matter and supernova stars outweighs these other interests in importance and has made a vital contribution to the field of astronomy.

Karl Hufbauer, Dept. of History; University of California Irvine, Irvine, CA

Grand Dictionnaire Encyclopédique Larousse, Tome 10, 1985

(Im Grand Larousse encyclopédique, Supplement 2, 1975, findet sich ein anderer, kürzerer Text)

ZWICKY (Fritz), astrophysicien suisse d'origine bulgare (Varna 1898 - Pasadena 1974).

Il s'est d'abord intéressé au stade ultime de l'évolution des étoiles. Après avoir établi définitivement, en 1934, avec W. Baade, la distinction entre novae et supernovae, il entreprit une recherche et une étude systématiques des supernovae; il s'attacha aussi à découvrir de nouvelles naines blanches; enfin, il fut le premier à envisager, en 1935, l'existence d'étoiles à neutrons, extrêmement denses, issues de l'explosion de supernovae.

Ses recherches ultérieures ont porté sur les galaxies et leur distribution dans l'Univers. On lui doit, outre un catalogue photographique de galaxies, la découverte des galaxies compactes, galaxies irrégulières dont la brillance par unité de surface est élevée, ainsi que celle de l'existence de ponts de matière entre certaines galaxies.

Il s'opposa à la théorie de l'expansion de l'Univers.

Grote Winkler Prins, Vol. 25, 1991

Zwicky, Fritz (Warna, Bulgarie, 14 febr. 1898 - Pasadena 8 febr. 1974), Amerikaans astronoom,

studeerde wis- en natuurkunde te Zürich, was sinds 1925 werkzaam in de Verenigde Staten, van 1927 tot 1972 verbonden aan het California Institute of Technology to Pasadena. Vanaf 1948 was hij tevens astronoom aan de Mount Wilson en Mount Palomar observatoria.

Van 1943 tot 1961 was hij bovendien verbonden aan de Aerojet Engineering Corporation, waar hij diverse soorten straalaandrijving ontwikkelde, o. a. voor gebruik onder water (hydropulse).

Op astronomisch terrein is zijn werk aan supernovae belangrijk. In 1934 was hij samen met W. Baade de eerste die een duidelijk onderscheid maakte tussen novae en supernovae, waarbij zij suggereerden dat een supernova-explosie kon leiden tot de vorming van een neutronenkern onder emissie van kosmische straling. Hij organiseerde een internationaal project tot opsporing van supernovae; een kwart van de bij zijn overlijden bekende supernovae is door hemzelf ontdekt. Verder heeft hij zich beziggehouden met o. a. nieuwe soorten extragalactische dwergstelsels, clusters en intergalactische materie (m .n. in de vorm van bruggen tussen stelsels).

*WRK. Multiple galaxies, in : *Ergebn. Ex. Naturwiss.*, 29 (1956) ; *Morphological astronomy* (1957); *Catalogue of galaxies and of clusters of galaxies* (6 dln., 1961-1968; m. E. Herzog en P. Wild) ; *Morphology of propulsive power* (1962) ; *New method of thought and procedure* (1968) ; *Catalogue of selected compact**

galaxies and of post-eruptive galaxies (1971; m. M. A. Zwicky).

Schweizer Lexikon, Band 6, 1993

Zwicky, Fritz, *Varna (Bulgarien) 14.2.1898, †Pasadena (Kalifornien) 8.2.1974, Astronom.

Nach dem Studium an der ETHZ war Z. 1925 als Rockefeller-Stipendiat, ab 1927 als Prof. für Astrophysik am California Institute of Technology in Pasadena. Er war an der Planung des Observatoriums auf dem Mount Palomar beteiligt. Mit einem auf seine Initiative dort aufgestellten Fernrohr entdeckte er in aussergalakt. Spiralnebeln etwa 20 Supernovae (explodierende Sterne).

Er entwickelte bahnbrechende Ideen über kompakte Sterne und Supernovae, die er als erster systematisch beobachtete, sowie über kompakte Galaxien und Galaxienhaufen. Z. leitete die Herausgabe eines grossen Galaxienkatalogs.

Während des 2. Weltkriegs arbeitete er an der Entwicklung von Raketentriebwerken und war wiss. Direktor der Aerojet Corporation. Er entwickelte einen neuen Raketentreibstoff und brachte 1957, kurz vor dem Start des ersten russ. Sputniks, eine kleine Metallkugel in eine Erdumlaufbahn.

Z. verfasste über 300 Arbeiten zur Astronomie und Morphologie. 1949 erhielt er von US-Präs. H. S. Truman die Freiheitsmedaille. Z. trat auf vielen Gebieten mit oft ungewöhl., häufig auch umstrittenen Ideen auf. Neben seinen wiss. Publikationen schrieb er „Entdecken, Erfinden, Forschen“ (1969), „Jeder ein Genie“ (1971).

Heinz Bächler, Uli W. Steinlin

[Leider enthält der kurze Text viele Fehler; Kommentar zum „Schuss in den Weltraum“ von Otto Walthert im Raumfahrt-Forum des Schweizerischen Förderkreises für Raumfahrt Hermann Oberth – Wernher von Braun (SFR), 6. Jg, Nr. 4, 1997, S. 109:

„... Überforderte schweizerische Hobby-Raumfahrthistoriker verbreiten ... noch heute ihren Unsinn und sichern damit dessen Weiterverbreitung an künftige Generationen: Es sei ein Körper auf eine *Erdumlaufbahn* gebracht worden, es habe sich um eine *kleine Metallkugel* gehandelt, dies sei noch *kurz vor dem Start von Sputnik 1* geschehen. ... Wer Spitzenleistungen anderer so salopp und falsch beschreibt, leistet einen Bärenienst und sollte besser schweigen.“]

Dictionary of American Biography, Supplement Nine 1971-1975, 1994

ZWICKY, FRITZ (Feb. 14, 1898 - Feb. 8, 1974), astrophysicist, was born in Varna, Bulgaria, the eldest of three children born to Fridolin Zwicky, a Swiss accountant and international merchant, and Franziska Wreck, a Czech national. At the time of Fritz's birth, his father was serving as the Norwegian consul to Bulgaria.

From 1914 to 1916, Zwicky attended the Oberrealischule secondary school in Zurich, Switzerland, and received a B. S. from the Eidgenössische Technische Hochschule (Federal Institute of Technology), Zurich, in 1920. He began graduate study in theoretical physics, and published his first scholarly work, "*The Second Virial Coefficient of the Rare Gases*," in 1921. He wrote a doctoral dissertation entitled "*On the Theory of Ionic Crystals*," and received his Ph. D. in 1922.

Zwicky remained at the institute as a research assistant until 1925, when he received a fellowship from the Rockefeller International Education Board to work with Robert A. Millikan and Paul Epstein at the California

Institute of Technology (Caltech) in Pasadena, Calif. Caltech appointed Zwicky assistant professor of theoretical physics in 1927, and he was promoted to associate professor in 1929.

On Mar. 25, 1932, Zwicky married his first wife, Dorothy Vernon Gates, the daughter of California State Senator Edgar J. Gates. The couple did not have any children, and their marriage ended in divorce in 1941.

In 1933, Zwicky changed his field of study from theoretical physics to astrophysics. He became interested in a special class of exceptionally bright, short-lived, nonperiodic novas (new stars). Zwicky renamed them supernovas and redefined them as the results of the transformation of ordinary stars into neutron stars, which resulted in the release of an extremely large amount of radiation. In late 1933, Zwicky, in collaboration with Dr. Walter Baade, who had emigrated from Germany to teach at Caltech in 1931, began a study of supernovas for use as measures of galaxies' distances.

Initial attempts to search for supernovas in a group of galaxies known as the Virgo Cluster were hampered by the limitations of the equipment in use at that time. Even though a two-hundred-inch Hale telescope was already being built for Caltech's Palomar Mountain Observatory, Zwicky was able to persuade Caltech's Observatory Council to also install an eighteen-inch Schmidt telescope at Palomar Mountain. Construction of the telescope began in 1933 and was completed in late 1936.

In early 1937, Zwicky began using the new telescope to conduct a systematic search for supernovas. He recorded his first supernova using this new telescope on Feb. 16, 1937. After the discovery of his second supernova on Aug. 26, 1937, Zwicky hypothesized that if nature could produce these types of nuclear explosions, then so could humans. This premise was proven nearly ten years later, with the development of the atomic bomb. During the next five years, Zwicky, along with Baade and Rudolph Minkowski (who was a long time associate of Baade's and an astronomer at the Mt. Wilson Observatory and Palomar Mountain), recorded a total of eighteen supernovas.

At the same time that he began to study supernovas, Zwicky also began measuring the motion of galaxies, focusing on the Virgo Cluster. When he compared the cluster's visible mass with its measured velocity, he was surprised to find that the mass was insufficient to keep the galaxies from flying apart. Zwicky concluded that there must be some type of invisible matter located between galaxies, as well as within them, which produced the additional gravitational forces necessary to keep the galaxies together.

It took the scientific community approximately forty years to acknowledge the importance of Zwicky's hypothesis, now known as the theory of dark matter.

In 1942, Caltech promoted Zwicky to professor of astronomy. That same year, Zwicky helped Theodore von Kármán and other scientists raise capital to form the Arojet Engineering Corporation, which was headquartered in Azusa, Calif. Zwicky became the corporation's director of research in 1943, and held this position until 1949. During this period, he helped pioneer the development of several different types of jet and propulsion engines, one of which, the hydropulse, operated under water.

By the end of his career, Zwicky held approximately fifty patents, most of them in the area of propulsion engine design.

In 1945 and 1946, Zwicky acted as technical representative of a U. S. Army Air Forces factfinding team sent to Germany and Japan to study those countries' wartime research on jet propulsion. From 1945 to 1949, Zwicky also served as a member of the U.S. Air Force Scientific Advisory Board. In 1946, he authored a book for the air force entitled *Certain Phases of War Research in Germany*, which discussed the information gathered during his trips to Germany.

Zwicky's interest in spaceflight led him to attempt to launch a number of artificial meteors in 1946. These

projectiles were designed to leave trails in the upper atmosphere similar to those left by meteorites. Zwicky used a V-2 rocket launched from White Sands, N. Mex., to send off these artificial meteors. The results of this air force-sponsored project were initially kept classified. It appears, however, that the launch was unsuccessful due to instrument failure.

On Oct. 15, 1947, Zwicky married his second wife, Anna Margarita Zürcher, the daughter of a Swiss hotelier, who was working as a cashier when they met. The couple had three children.

During that same year, Zwicky developed a system of morphological classification and nomenclature for jets. He published his conclusions as "Morphology and Nomenclature of Jet Engines" in *Aviation* (June 1947).

Often described as a very independent-minded person, Zwicky demonstrated this independence when he gave the Halley Lecture at Oxford University on May 12, 1948. Instead of discussing celestial phenomena, the traditional subject of the Halley lecturers, Zwicky chose instead to discuss the application of his morphological method to astronomy.

In 1949, Zwicky resigned his position as research director for the Aerojet Engineering Corp., but continued as technical advisor and chief research consultant until 1961. That same year, Zwicky received the Presidential Medal of Freedom from President Harry S. Truman.

In 1955, six years after Zwicky received the medal, the U. S. Defense Department rescinded Zwicky's security clearance, insisting that Zwicky either become a naturalized citizen or forever lose his security clearance. Despite Zwicky's fondness for the United States, he believed that naturalized citizens received only second-class treatment. He chose to retain his Swiss citizenship and refused to apply for United States citizenship.

Despite his lack of a security clearance, in October 1957, the air force invited Zwicky to participate in the launching into space of miniature artificial satellites. Zwicky had proposed this project several months prior to the launch, but the significance of the project was overshadowed by the launch of Sputnik twelve days earlier.

Also in the year 1957, one of his bestknown works, *Morphological Astronomy*, was published. In it, Zwicky expands upon his Halley Lecture, discussing the importance of knowing and understanding the structure of the universe through observation and experimentation.

Among his fellow scientists, Zwicky was known for being opinionated and combative, yet compassionate. Zwicky was actively involved in the work of the Pestalozzi Foundation of America, which provided financial support for orphanages. In 1958, Zwicky was named chairman of the foundation's board of trustees.

After the morphological approach to astronomy became popular, Zwicky established the Society for Morphological Research in 1961, and became its first president.

Between 1961 and 1968, Zwicky, along with a number of his colleagues, published the six-volume *Catalogue of Galaxies and of Clusters of Galaxies*. His second book on morphology, *Morphology of Propulsive Power* (1962), summed up much of his theoretical work on propulsive engines and rocketry. In 1965, Zwicky was elected vicepresident of the International Academy of Astronautics. In 1968, Zwicky retired from his academic position at Caltech, but he continued astrophysical research.

His final work, *Catalogue of Selected Compact Galaxies and of Post-Eruptive Galaxies* (1971), was coauthored by his oldest daughter, Margrit A. Zwicky [es war seine Frau; siehe Biographie S. 516]. In 1972, Zwicky traveled to Britain to receive the Royal Astronomical Society's Gold Medal, one of the most prestigious awards of its kind.

Fritz Zwicky died of a heart attack at the Huntington Memorial Hospital in Pasadena, Calif. He was buried in Glarus, Switzerland.

Fritz Zwicky will be remembered for his numerous contributions to science and technology. Included among his many achievements are his theories concerning neutron stars; his supervision of an international search effort for supernovas; his initiation of a sky survey at the Mt. Palomar and Mt. Wilson observatories, which resulted in the creation of the most comprehensive set of galactic catalogs ever produced; and his work in the areas of jet propulsion and rocketry.

[Zwicky's papers are located at the Landesbibliothek, 8750 Glarus, Switzerland.

The Rockefeller Archives Center, in North Tarrytown, N.Y., has papers concerning his Rockefeller Fellowship and early years at Caltech.

Caltech's Astrophysics Library, Pasadena, Calif., has a complete listing of Zwicky's 559 publications.

Several of his most important publications have been included in Kenneth R. Lang and Owen Gingerich, *A Source Book in Astronomy and Astrophysics, 1900-1975* (1979).

The only booklength biography of Zwicky is in German: Roland Müller, *Fritz Zwicky: Leben und Werk des grossen Schweizer Astrophysikers, Raketenforschers und Morphologen (1898-1974)* (1986).

Zwicky's work is placed in the context of contemporary astrophysics by Wallace Tucker and Karen Tucker, *The Dark Matter: Contemporary Science's Quest for the Mass Hidden in Our Universe* (1988).

An obituary is in the *New York Times*, Oct. 11 [11. Februar], 1974.]

TAMMY ANN SYREK

Biographical Encyclopedia of Scientists. Second Edition, Vol. 2, 1994

identisch in: Oxford Paperback Reference: A Dictionary of Scientist, 1999
(zuerst gebunden 1993)

Zwicky, Fritz (1898-1974) Swiss-American astronomer and physicist

Zwicky, who was born at Varna in Bulgaria, studied at the Federal Institute of Technology, Zurich, where he obtained his BS in 1920 and his PhD in 1922. He moved to America in 1925, working at the California Institute of Technology and the Mount Wilson and Palomar Observatories until his retirement in 1968. He was associate professor of theoretical physics from 1929 to 1942 and professor of astrophysics from 1942 to 1968.

Zwicky worked in various fields of physics, including jet propulsion and the physics of crystals, liquids, and gases.

He is, however, better known for his astronomical research. In 1936 he began an important search for supernovas. These are celestial bodies whose brightness suddenly increases by an immense amount as a result of a catastrophic explosion. They had been observed over several centuries in our Galaxy and one had been detected in the Andromeda galaxy as long ago as 1885. But when Edwin Hubble showed in 1923 that the Andromeda galaxy was about 900,000 lightyears away, the question arose as to how anything could

appear so bright over such a vast distance.

Zwicky worked out their frequency as about three per millennium per galaxy. Although many have passed unobserved in our Galaxy, five supernovas have been reported since AD 1000, including one in 1054 that produced the Crab nebula, Tycho's star in 1572, and Kepler's star in 1604. Zwicky also showed that supernovas characteristically have an absolute magnitude of -13 to -15, which makes them up to 100 million times brighter than the Sun.

In 1932 Lev Landau introduced the concept of a neutron star into astronomy and in 1934 Zwicky and Walter Baade suggested that these compact superdense objects might be produced in the cores of supernovas. This was later developed by Robert Oppenheimer, G. M. Volkoff, and others in 1939 into an important theory of stellar evolution.

In more recent years Zwicky and his colleagues carefully studied both galaxies and clusters of galaxies. One result of this work is the so-called *Zwicky catalog*, which gives the positions and magnitudes of over 30,000 galaxies and almost 10,000 clusters lying mainly in the northern-hemisphere sky.

Concise Dictionary of American Biography, Fifth Edition, Vol. 2, 1997

ZWICKY, FRITZ (b. *Varna, Bulgaria*, 1898; d. *Pasadena, Calif.*, 1974), astrophysicist.

Graduated Eidgenossische Technische Hochschule in Zurich, Switzerland (B.S., 1920; Ph.D., 1922). In 1925 he received a fellowship to work with scientists at the California Institute of Technology, where he was appointed assistant professor of theoretical physics in 1927 and professor of astronomy in 1942, having changed his field of study to astrophysics in 1933. He also became director of research for the Aerojet Engineering Corporation (1943-49), pioneering the development of several different types of jet and propulsion engines.

Among his many scientific and technological achievements are his theories concerning neutron stars; his supervision of an international search effort for supernovas; his initiation of a sky survey at the Mt. Palomar and Mt. Wilson observatories, which resulted in the creation of the most comprehensive set of galactic catalogs; and his work in the areas of jet propulsion and rocketry.

The Cambridge Biographical Encyclopedia, Second Edition, 1998

Zwicky, Fritz [**zvik**ee] (1898-1974) Physicist,

born in Varna, Bulgaria, of Swiss parents. He studied at the Swiss Federal Institute of Technology, Zürich, then took a position at the California Institute of Technology in 1925, becoming professor of astrophysics there (1942-68).

He remained a Swiss citizen all his life. He researched extensively into galaxies and interstellar matter, and produced the standard catalogue on compact galaxies. In 1934 he predicted the existence of neutron stars and black holes.

Dizionario Biografico degli Scienziati e dei Tecnici, 1999

Zwicky, Fritz (Vama, Bulgaria 14.2.1898 - Pasadena 8.2.1974) Astronomo e astrofisico statunitense di origine svizzera.

Si deve considerare Z. come uno scienziato statunitense in quanto la sua opera si è svolta negli Stati Uniti nella sua totalità; egli tuttavia non ottenne mai la cittadinanza, neppure quando svolse compiti per conto dell'amministrazione americana.

Z. nacque in Bulgaria da genitori svizzeri, e in Svizzera si formò, conseguendo il dottorato al Politecnico di Zurigo nel 1922. Tre anni dopo passò all'Istituto di tecnologia della California (Caltech), dove rimase fino al suo ritiro nel 1969.

Nell'opera di Z. si distinguono varie componenti, una delle quali è l'inclinazione all'analisi di complessi problemi teorici (Z. insegnò a Caltech fisica teorica dal 1927 al 1942): nel 1934, in collaborazione con W. Baade, suggerì che la materia neutronica potrebbe rappresentare la forma più stabile di materia nei nuclei stellari compatti (*stelle di neutroni*).

Z. suggerì anche che l'energia rilasciata nell'esplosione delle *supernovae* potrebbe aver origine dal collasso di materia ordinaria a materia neutronica. Egli diede anche importanti contributi all'astronomia extragalattica aggiornando la lista di W. Herschel ed estendendo le galassie catalogate dalla dodicesima alla quindicesima magnitudine.

Z. dedicò particolare attenzione al problema della distribuzione delle galassie su larga scala, agli ammassi e all'evidenza per i superammassi. Fino dal 1933, Z. aveva studiato la dispersione delle velocità negli ammassi, concludendo che essa non poteva essere spiegata in termini della massa concentrata nelle stelle, e che ad esempio in Coma «la materia oscura era presente in densità molto maggiore che la materia luminosa».

Lo studio di Z. si inseriva in un filone aperto da J. H. Jeans e J. C. Kapteyn (1922) e consolidato da J. H. Oort (1932). Z. ritornò reiteratamente sul problema della materia oscura, così importante nella cosmologia contemporanea, dal 1937 al 1961, ipotizzando che la materia oscura responsabile per la massa mancante potesse essere costituita da galassie nane e materia intergalattica.

Durante la seconda guerra mondiale Z. divenne direttore di ricerca alla Aerojet Engineering Corporation; alla fine del conflitto fu incaricato di interrogare il personale di Peenemunde che era caduto nelle mani degli alleati, e fece parte di una commissione incaricata di valutare i danni prodotti dalle bombe sganciate su Hiroshima e Nagasaki.

Z. ebbe marcati interessi epistemologici, e la sua opera scientifica ne è segnata in misura notevole.

Opere: *Morphological Astronomy*, Springer, 1957; F Zwicky et al., *Catalog of Galaxies and of Clusters of Galaxies*, volt. 1-6, Pasadena, Caltech, 1961-68;

A lire: Braccesi A., «Revisiting Fritz Zwicky», in *Modern Cosmology in Retrospect*, a cura di B. Bertotti, R. Balbinot, S. Bergia, A. Messina, Cambridge University Press, 1990; Trimble V., «History of Dark Matter in the Universe», *ibidem*.

American National Biography, Vol. 24, 1999

ZWICKY, Fritz (14 Feb. 1898-8 Feb. 1974), astrophysicist and space scientist,

was born in Varna, Bulgaria, the son of Fridolin Zwicky, a Swiss merchant, and Franziska Wrcek. Zwicky's early talent for science convinced his father to let him train for engineering rather than commerce. Accordingly, Zwicky moved to Zürich, Switzerland, where he attended the Eidgenössische Technische Hochschule. There Zwicky soon evinced a more abstract bent, switching from engineering to physics and mathematics in 1918. To obtain his teaching diploma in 1920, he wrote for the mathematician and mathematical physicist Hermann Weyl an essay on reflection in an inhomogeneous stratum. In 1922 he received his doctorate in theoretical physics, and his dissertation on the theory of ionic crystals was supervised by Peter Debye and Paul Scherrer. He stayed on until 1925 as a research assistant to Scherrer, working on X-ray crystallography, when he was offered a Rockefeller scholarship for research in the United States.

The two years Zwicky spent at the California Institute of Technology as a research fellow changed the course of his career. He had come for the mountains, fresh from climbing exploits in the Alps. When he asked about the closest peaks, he was shown Mount Wilson (elevation 1,700 meters) and reportedly replied "Ja, I see the foothills." He became assistant professor of theoretical physics at Caltech in 1927, and associate professor in 1929. Yet, his career in physics, in which he produced papers on thermodynamics, gaseous ionization, and solid state questions, was brief.

In 1928 the Rockefeller Foundation awarded Caltech the funds for a major new observatory. Zwicky willingly switched his allegiance to astronomy and helped to plan the new observatory on Palomar Mountain. In 1928-1929 he turned his attention to novae, producing a couple of papers on cosmology.

Between 1928 and 1939, Zwicky and Walter Baade, a Caltech colleague after 1931, laid the foundations for the modern understanding of novae, supernovae, and neutron stars in a series of speculative papers. They then used an eighteen-inch Schmidt camera - a new kind of telescope built for Palomar at Zwicky's urging - to collect data and place their speculations on a firmer footing.

During the first run, from 1936 to 1940, twelve supernovae were discovered, allowing for the study of their spectra and light-curves. The results of these observations would clearly demarcate ordinary novae from the much brighter supernovae, which were estimated to happen only once per 300 to 400 years in a given galaxy.

The survey of galaxies entailed by the supernova hunt yielded Zwicky's six-volume *Catalogue of Galaxies and of Clusters of Galaxies*, with E. Herzog, Paul Wild, and others (1961-1968) and the *Catalogue of Selected Compact Galaxies and of Post-Eruptive Galaxies*, with Margit A. Zwicky (1971).

In 1942 Zwicky became full professor of astrophysics. After his 1932 marriage to Dorothy Vernon Gates and their 1941 divorce, in 1947 he married Anna Margarita Zürcher; they had three daughters.

In recognition of his work, Zwicky was appointed astronomer at the Mount Wilson and Palomar Mountain observatories in 1947. Invited to give the 1948 Halley Lecture at Oxford University, he chose to speak more on the subject of morphology than on astronomy.

His morphological approach was concerned with the totality of all the possible aspects and solutions of any given problem. His 1957 monograph, *Morphological Astronomy*, reflected the same inclination in its discussion of galactic research.

Zwicky's astronomical interests also encompassed such subjects as the nature of the redshift (the shift toward longer wavelengths of light emitted by cosmic objects), the variability of fundamental "constants," intergalactic matter, "dark matter" (matter that may comprise most of the Universe's mass but that is undetectable except through gravitational effects), compact galaxies (galaxies of such concentrated brightness that they were almost indistinguishable from stars in normal photographs), and Humason-Zwicky objects (faint blue stars).

He retired from Caltech's faculty in 1968 and was awarded the Gold Medal of the Royal Astronomical Society in 1972. Zwicky was working on a catalogue of all known supernovae when he died of a heart attack in Pasadena, California.

Although as a Swiss citizen living abroad, Zwicky was not called to arms during World War II, he nevertheless worked for victory over the Axis. He served as director of research for the Aerojet Engineering Corporation in Azusa, California (1943-1949), which was engaged in jet and rocket propulsion research for the U. S. military; on the Scientific Advisory Board of the Army Air Forces; and as one of the board's technical representatives sent to evaluate wartime jet propulsion research in Japan and Germany (1945-1946).

His propulsion research led to plans for making "artificial meteors," for launching the same pellets into space, and for bombarding the Moon with them on the dark side of the terminator, the dividing line between the bright and dark sides of the Moon.

Over the course of fifteen years, Zwicky and Joseph F. Cuneo, former patent attorney at Aerojet Engineering, launched many "artificial meteors" from the ground or high-flying balloons, obtaining results outlined in *Morphology of Propulsive Power* (1962). However, they managed only two attempts at launching their coruscative pellets into interplanetary space. The first, off a captured V-2 rocket, in 1946, failed utterly. The second, from a U. S. Air Force Aerobee rocket, on 16 October 1957, apparently succeeded, marking the first time a humanmade object had escaped Earth's gravity, but, happening twelve days after Sputnik, the achievement was thoroughly eclipsed, especially as the Air Force embargoed news of their success for several months.

The Moon shot they had dreamed of was never tried due to a lack of confidence on the part of the requisite U. S. agencies, which stemmed from the failure in 1946 and from adverse reviews by other scientists. Nevertheless, from the 1948 Halley lecture on, Zwicky was an ardent advocate of space exploration and colonization, calling for the development of space law.

Zwicky's dedication to humanitarian causes dates back to his days in Zürich. He particularly admired the work of Fridtjof Nansen, a pioneer of refugee relief. From 1946 to 1962 he was a member of the Pestalozzi Foundation, which financed war orphan villages.

Locally, he denounced the smog that already plagued Los Angeles and proposed a tax on cars occupied by lone drivers. His most impressive initiative involved him in a decade-long effort when, realizing how World War II would ravage intellectual resources, he founded the Committee for Aid to War-Stricken Scientific Libraries. Starting in 1941, the committee gathered scientific publications and provided them free of charge to libraries abroad. Institutions in France, Germany, Japan, the Philippines, South Korea, and Taiwan were among its beneficiaries. For his many contributions, Zwicky received in 1949 the Presidential Medal of Freedom from President Harry S. Truman - in spite of Zwicky's criticism of the United States's bombings of Hiroshima and Nagasaki, Japan.

Zwicky sought to make his mark as a thinker by propounding a new heuristic methodology, which he termed the morphological approach. The fallibility of even his own trained mind often perplexed him, and he wished to understand the source of his insights. Still, however much he tended to credit his better ideas to the morphological approach, it is doubtful that it had any prescriptive value.

It is a measure of Zwicky's vision that it is still impossible in many cases to say with complete certainty whether he was right or wrong.

In the light of later research, Baade and Zwicky were essentially correct when they related cosmic rays and neutron stars to supernovae. Zwicky was also one of the first to take seriously the idea of black holes. His almost unanimously disbelieved suggestion, that the Hubble redshift could be due to gravitational drag, has

remained a subject of debate. Depending on the specialty considered, he will probably be remembered either as the discoverer of compact galaxies, the galactic surveyor, or the author of an enduring supernova paradigm.

- The papers of Zwicky, including 10,000 letters, are at the Landesbibliothek, 8750 Glarus, in Switzerland. Caltech's Astrophysics Library holds a complete listing of his 559 publications, and the Rockefeller Archive Center in North Tarrytown, N.Y., preserves materials bearing on Zwicky's International Education Board fellowship and his early years at Caltech.

Many of his most important scientific papers appeared in the *Proceedings of the National Academy of Sciences*; these include

- "On the Red Shift of Spectral Lines through Interstellar Space" 15 (1929): 773-79;
- with Baade, "On Super-Novae" 20 (1934): 254-59;
- and "Cosmic Rays from Super-Novae" 20 (1934): 259-63.

Other major papers include

"Photographic Light-Curves of the Two Supernovae in IC 4182 and NGC 1003," with Baade, *Astrophysical Journal* 88 (1938): 411-21;

„Types of Novae," *Reviews of Modern Physics* 12 (1940): 66-85;

the landmark "On the Frequency of Supernovae, II," *Astrophysical Journal* 96 (1942): 28-36; and

"On the Masses of Nebulae and Clusters of Nebulae," *Astrophysical Journal* 86 (1937): 217-46.

For Zwicky's views on aeronautics and space science, see his "Report on Certain Phases of War Research in Germany" (1 Oct. 1945) in the Caltech Archives, and "A Stone's Throw into the Universe: A Memoir," published by NASA in [R. Cargill Hall, ed.:] *Essays on the History of Rocketry and Astronautics*, 77 (1977). His books *Discovery, Invention, Research through the Morphological Approach* (1969) and *Jeder ein Genie* (1971) best illustrate his personal outlook.

For a thoughtful remembrance of the man, see Cecilia Payne-Gaposchkin, "A Special Kind of Astronomer," *Sky and Telescope* 47 (1974): 311-13.

JEAN-LOUIS TRUDEL

Concise Dictionary of Scientific Biography, Second Edition, 2000

ZWICKY, FRITZ (b. Varna, Bulgaria, 1898; d. Pasadena, California, 1974), physics, astrophysics, rocketry.

Zwicky came to the United States after receiving his doctorate at the Eidgenössische Technische Hochschule in Zurich (1920).

His most significant work was in astrophysics, where he initiated research on supernovas and coordinated the preparation of important catalogs of galaxies. He spent most of his professional career at the California Institute of Technology (1925-1968).

Zwicky coined the term "supernova" and hypothesized that they result in neutron stars. Although his interpretive work was viewed with skepticism by his colleagues, his research on supernovas and galaxies garnered him the Royal Astronomical Society's Gold Medal in 1972.

He also won the Presidential Medal of Freedom (1949) for his work on jet propulsion during World War II.

Chambers Biographical Dictionary, 2002

Zwicky, Fritz 1898-1974

US-Swiss astronomer and physicist

Born in Varna, Bulgaria, he was educated at the Federal Institute of Technology at Zurich, graduating with a PhD in physics in 1922. In 1925 he went on a fellowship to California Institute of Technology (Caltech), where he remained all his life, becoming successively Professor of Theoretical Physics (1927-42) and Professor of Astrophysics until his retirement in 1968.

His fruitful and wide-ranging research included work on cosmic rays and rocket design as well as many branches of astronomy. He was one of the first to recognize the power of the recently invented Schmidt telescope as a means of exploring the universe on a large scale, and from 1936 onwards used the 18in (45.7cm) Schmidt telescope on Mount Palomar to produce his catalogue of clusters of galaxies.

He was the author of an original book on that subject, *Morphological Cosmology* (1957) and the discoverer of compact galaxies (1963), objects of exceptionally high surface brightness which are hence intrinsically very luminous.

He was awarded the gold medal of the Royal Astronomical Society for his cosmological research in 1973.