1902 and all that

This year's offerings — calendars, kites and eruptions.

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Ours is a fortunate time indeed. For 1,000 years, folks could enjoy a palindromic year each decade. Then, with the turn of the first millennium, palindromic years came round only once a century. For the foreseeable future, only people alive around millennium turns will experience two palindromic years in one lifetime. *Fugit irreparabile tempus*!

In the suggestions that follow, we admit events occurring in preceding palindromic years as candidates for anniversarial celebration on an even footing with events that happened an integral number of 50 years ago. As usual, ¢ signifies 100 years, $ a Nobel prize. We also admit, as usual, quarter-century anniversaries in the twentieth century to take account of the feverish pace of recent science. An example of the power and propriety of our procedure appears at the years 1552 (Eustachius his tube) and 1881 (Edward Talbot Ely his pioneering operation of otoplasty). On what other anniversarial principles would these aural landmarks qualify for celebration at the same time? Also, our principles link humans and hominids more closely than does the theory of evolution; thus 1991 (iceman found in the Alps), 1952 ± 1 (Piltdown man suspected as a fraud), 1952 ± 25 (Peking man discovered), 1902 (Neanderthal man reconstructed).

Despite our cornucopia of deserving events, the choice of anniversary of the year was easy: the decision of the British government to enter into calendrical communion with Europe 250 years ago. The British wisely rejected the Gregorian reform of 1582 on the likely ground that the world would not last long enough to justify the expense of conversion, and on the more reliable ground that all changes are for the worse. When the world did not end and all the chancellor's tests were met, Britain dropped 11 days from the calendar in September 1752 and, for the first time in 170 years, agreed with Europe about the date. Some might find guarded comfort in this speedy precedent.

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The lost 11 days: Hogarth's *Election Entertainment* depicts the hostility at Britain's calendar reform.

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Moving on: Honold's 1902 magneto paved the way for the motor-car assembly line.

1902 (1.0 ¢)

To begin at the top, we note that 100 years ago Arthur Edwin Kennelly and Oliver Heaviside independently deduced that the atmosphere must contain an electrified layer capable of reflecting the signals then recently sent into the ether by Guglielmo Marconi ($1909). Léon-Philippe Teisserenc de Bort, proceeding upwards, thermometer in hand, observed that the atmosphere's temperature, after falling steadily for seven miles, remained constant to the greatest heights he could reach — which caused him to invent the words 'troposphere' for the lower region of change and 'stratosphere' for the upper region of layered consistency. The Kennelly–Heaviside layer lies above the stratosphere in the 'ionosphere'.

The great discovery of 1902 was the confirmation of the view, long held by Cassandras and cosmopolitans, that the world is falling apart. Ernest Rutherford and Frederick Soddy read from their data on the decline of activity of uranium X the news that the naturally occurring radioelements transform themselves by throwing off bits of

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Fighting anthrax in 1881: Pasteur performs his anthrax vaccination experiment at Pouilly-le-Fort.

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Going up in the world: Elisha Otis on his elevator.

matter. The revelation of the suicidal tendency of atoms upset normal people as well as chemists. Where would it end? Rutherford ($1908) and Soddy ($1921) guessed helium: radioactive heavy elements struggle to become or to eject a gas. By 1902, physicists had become so inured to novelties that they digested exploding atoms with scarcely an eructation.

Not far behind the instability of matter in interest and novelty was the discovery that the organs of the body can communicate without a direct electrical connection between them. William Maddock Bayliss and Ernest Henry Starling announced that the pancreas could secrete its digestive liquid with all nerves severed between it and the intestines. They reasoned that the blood must carry a chemical trigger, which they called 'secretin' after its product; Starling later named such substances hormones from the Greek for 'arouse' or 'put in quick motion'.

That brings motor cars to mind. Gottlieb Honold got them off to a good start with a high-tension magneto; Louis Renault and Frederick Lanchester concentrated on an effective stop, one with a drum brake, the other with a disk. To keep track of things in between, the British firm of Thorpe and Salter introduced the speedometer, optimistically graduated all the way to 35 miles per hour. James Edward Ransome's new motor-powered lawn mower did not need one. Nor did Hubert Cecil Booth's vacuum cleaner, the first of its kind — although it was drawn by swift horses, which made it inconvenient for indoor use. For a mess big enough, however, nothing could be more effective. England's Buckingham Palace and Windsor Castle each had one. The avant-garde could also have had an electric hair dryer, an electric typewriter and air-conditioning if they took in all the latest gadgets, and a teddy bear to console them if the power failed.

Among deaths in 1902 were those of Cato Maximillian Guldberg, Norwegian chemist and physicist, who worked out the law of mass action with his brother-in-law Peter Waage; Richard von Krafft-Ebing, Austrian psychiatrist, whose boring *Psychopathia sexualis* titillated generations of adolescents who could read its juicy bits in Latin; Johannes Wislicenus, German chemist, whose notion of geometrical isomerism inspired J. H. van't Hoff's ($1901) theory of the tetrahedral carbon atom; and Rudolf Virchow, a paragon of a pathologist. Among births, that of Fritz Strassmann, the collaborator of Otto Hahn and Lise Meitner on the work that led to the discovery of nuclear fission, provides an opportunity for rescue from undeserved neglect.

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Thomson: shown here in ordinary mass.

1881 (1.21 ¢)

In this palindromic year, Joseph John Thomson ($1906) calculated the electromagnetic mass associated with an electrified body in motion; Albert Abraham Michelson (born 1852, 1.5¢; $1907) began his quest to detect the Earth's motion through the ether by use of his newly invented interferometer; and, with all-too-much contemporary relevance, Louis Pasteur dramatically demonstrated his anthrax vaccine at Pouilly-le-Fort.

1852 (1.5 ¢)

Our pick for this drab successor to the year of the brilliant Crystal Palace is the safety elevator invented by the American Elisha Graves Otis, who demonstrated its effectiveness by cutting its cord while he rode in it. Only Henri Giffard's dirigible flight, the first ever, compares with Otis' short drop. Otherwise, the savant in search of a celebration must choose among Edward Franklin's proposal of something like valence; Hermann von Helmholtz's measurement of the velocity of nerve impulses; Rudolf Albert von Kölliker's elevation of sperm from a ferment to a cell; Henri-Victor Regnault's determination of absolute zero; and Edward Sabine's linkage of sunspot activity with disturbances in the Earth's magnetic field.

This is to omit the births of the American Society of Civil Engineers and of the brilliant Spanish neuroanatomist Santiago Ramón y Cajal ($1906); and the deaths of Johan Gadolin, the Finnish chemist, discoverer of

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Clean sweep: but not yet house-trained.

yttrium and the eponym of gadolinium (1886, the first element named after an individual), and Louis Braille, inventor of the tactile alphabet for the blind.

1802 (2.0 ¢)

Two centuries ago, Anders Gustav Ekeberg found a new metal in a new mineral from the prolific region around Ytterby in Sweden. He named it tantalum because its oxide refused to combine with acid even when fully immersed, just as the unfortunate Tantalus could not drink the water in which he stood. Jean-Baptiste Lamarck and Gottfried Treviranus independently coined another enduring neologism that year, 'biology'; and Gerardus Johannes Mulder, inventor of the word 'protein', was born.

In 1802 Humphry Davy, then beginning his brilliant career in chemistry at the Royal Institution, demonstrated that metal slips could be heated to incandescence by an electric current; Thomas Wedgwood, the son of the potter, and Davy presented the institution with the negative results of their efforts to render permanent images cast by sunlight on a paper coated with silver nitrate; and Thomas Young exposed the institution's audiences to his principle of superposition, whereby he endeavoured to explain the diffraction of light and the colours of thin plates. It would be premature, however, to celebrate Young's celebrated double-slit experiment, now regarded as a definitive confirmation of the wave motion of light and, suitably modified, of matter. We must wait until 2007.

It remains to announce the deaths of Franz Maria Ulrich Theodor Aepinus, who worked out a theory of electricity based on forces decreasing with the distance, independently of Henry Cavendish; Erasmus Darwin, physician, botanist, poet, inventor, friend of the Wedgwoods and grandfather of Charles; and Marie-François-Xavier Bichat (born in the palindromic year 1771), who made general anatomy the study of tissues.

1771 (2.31 ¢)

In 1771 Charles Messier published the first instalment of his catalogue of nebulae, undertaken to help distinguish them from comets, which he delighted to hunt. The last of his catalogues, for 1784, brought his nebular count to 103. Then William Herschel took up the game with his huge reflector, and by 1800 had found some 2,000. That gigantism in instrumentation can pay is not a discovery of the twentieth century.

1752 (2.5 ¢)

While Britain and its colonies, preparing to convert to the Gregorian calendar, worried about how to reckon rents and contracts, Benjamin Franklin was flying a kite. The sport was doubly successful: he showed the similarity of lightning and electrical discharges and survived to advertise the experiment. He had reason to underrate its danger. A few months previously, an old French dragoon, directed by the Comte du Buffon, had performed Franklin's test. The dragoon brought his knuckle close to an insulated iron rod projecting above the roof of a small guardhouse during a storm. A priest attended — to estimate the duration of the sparks by reciting the rosary and to render last rites if Franklin had miscalculated. Neither Franklin nor the dragoon received a lightning stroke.

Jumping over the disagreeable experiments on the digestive juices of hawks that René de Réaumur performed this year, we arrive at the pure theory of Leonhard Euler, who, 250 years ago, deduced the formula $V-E+F=2$ relating the number of vertices V, edges E, and faces F of a regular polyhedron. It follows from this innocent formula that five, and only five, such polyhedra — the number recognized by Plato — can exist. For this insight Euler received nothing special. Not so his fellow mathematician Johann Tobias Mayer, whose lunar tables, published in 1752 along with directions for finding the longitude at sea, won him a share of the great prize offered by the British Board of Longitude for a suitable solution to this problem of the age. Acting with the swiftness of English calendar reform, the board paid Mayer after his death. Incidentally, the method of lunars was taught in Nathaniel Bowditch's *New American Practical Navigator* of 1802 (2.0 ¢).

1752: mathematician Leonhard Euler.

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1702 (3.0 ¢)

David Gregory, a Scottish mathematician and pedagogue, achieved the notable feat of enlisting the support of both Newton's enemy John Flamsteed and Newton himself in his successful bid for the Savilian professorship of astronomy at Oxford. He comes to mind for his *Astronomiae physicae et geometricae elementa* (1702), which transmits Newton's belief that the ancients knew the inverse-square law of gravity. Thomas Savery's 'miner's friend' also looked backwards and forwards. It described Savery's application of seventeenth-century ideas of steam and atmospheric pressure to raising water and anticipated the more practical and powerful steam engine invented by Thomas Newcomen. The first recorded Newcomen engine dates from 1712 (2.9 ¢).

1661 (3.41 ¢)

There is only one choice, Robert Boyle's *Skeptical chymist*, which argued against the systems of Aristotle and Paracelsus, showed chemists how to use the mechanical philosophy to design experiments and express results, and exhibited some new and useful classes of substances.

1652 (3.5 ¢)

It was a Scandinavian lymph year. Thomas Bartholin of Copenhagen published his *De lacteis thoracicis*, demonstrating the lymphatic system in humans, and Olof Rudbeck of Uppsala showed the same to Queen Christina, using a dog. He (not the dog) died in 1702 (3.0 ¢). Our preference for a 3.5-¢ celebration is the birth of Wilhelm Homberg, chemist, alchemist and cosmopolitan, who published his *magnum opus*, beginning in 1702 (3.0 ¢), under the modest title *Essais de chimie*.

1602 (4.0 ¢)

We can offer Tycho Brahe's posthumous *Astronomiae instauratae progymnasmata*, which gives the positions of 777 stars and a description of the supernova of 1572 (4.3 ¢).

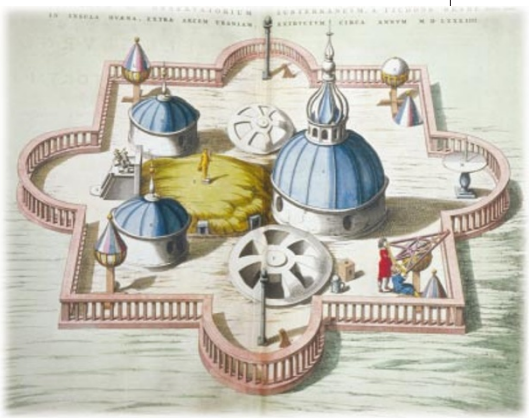
1551/2 (4.5/4.51 ¢)

Early products of the English Reformation include the author of the first book in English on melancholy (the English disease) (Timothy Bright, *b.*1551), and the publication of the first monographic description of the English malady, the sweat (1552, by John Caius).

On the European continent, Erasmus Reinhold, professor of higher mathematics at the protestant University of Wittenberg, and his colleague in the chair of lower mathematics, Georg Joachim Rheticus, were the leading early exponents of the heliocentric system of the Catholic Copernicus. Rheticus arranged for Copernicus' manuscript to be printed; Reinhold translated the theory into tables for astronomical observations. These *Tabulae prutenicae* (1551), named after their patron, Duke Albrecht of Prussia, replaced the Alfonsine Tables named after Alfonso X of Castile and Léon (acceded 1252, 7.5 ¢).

1502 (5.0 ¢)

This year marks the 500th anniversary of the return of that engaging liar Amerigo Vespucci



Stjerneborg: Tycho Brahe's observatory on the island of Hven.

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Mystery voyage: Vespucci seeking the New World.

(died 1512, 4.9 ¢) to Lisbon from Brazil. His racy descriptions of the sexual licence and cannibal cuisine of the Guaraní caused a sensation that no doubt encouraged him to concoct an account of his alleged voyage to the New World in 1497. This account, written in 1504, claimed priority over Columbus in the discovery of what is now known as South America. A German cartographer who accepted the fictional claim baptised the new world America. Columbus rated Vespucci the only honest ship chandler he knew.

1991 (0.11 ¢)

It was a murky year. Smoke from the oil wells in Kuwait ignited by Iraqi troops could be detected north of Turkey, west of the Sudan and as far as China. Mount Pinatubo erupted on the island of Luzon, the largest eruption of the twentieth century, massively polluting the atmosphere and damaging the ozone layer.

More worthy of celebration were the first imaging of buckyballs; the detection of volcanoes (perhaps active) on Venus; the orbiting of the 17-tonne Gamma-Ray Observatory; and the marketing of a new Cray supercomputer capable of 16 gigaflops.

1952 (0.5 ¢)

As a small dividend on the first explosion of a thermonuclear device, Glen Seaborg ($1951) and his group at Berkeley identified a new element among the products in the blast, which they named einsteinium in continuation of the practice begun with gadolinium (see 1852). Other nuclear events full of promise were the completion of the first breeder reactor in the United States, and the provocation (by human error) of the first reactor accident, in Chalk River, Canada. In purer physics, the Brookhaven Cosmotron came online at over 1 GeV, and Donald Glaser ($1960) observed the tracks of cosmic rays in his new bubble chamber.

Stanley Lloyd Miller and Harold Urey ($1934) exposed pure water, hydrogen, ammonia and methane to an electric spark, creating amino acids — which, had they been allowed another 10 billion years of lab time, might have formed sentient creatures.

New drugs and active therapeutic substances appeared with wonderful regularity, recognized sometimes by the Nobel institution, which awarded its medicine or physiology prize to Selman Waksman for streptomycin. The tuberculosis armamentarium was further enhanced by isoniazid, by Edward Heinrich Robitzek and his colleagues, leading many to assume that tuberculosis would soon be history. Other potent drugs of the year included erythromycin, reserpine, 6-mercaptopurine and chlorpromazine. Cortisone was synthesized and aldosterone isolated. When Charles Sherrington ($1932) died, aged 95, it seemed a safe bet that his would soon be an ordinary lifespan.

We note, too, the death of Chaim Weizmann, Russian-born president of Israel, the Zionist leader who obtained from Lord Balfour the famous declaration in favour of a Jewish homeland. Weizmann had access to high places through *Clostridium acetobutylicum* — a compliant bacterium whose properties he had investigated before the war — which breaks down starches into ethanol, acetone and butanol. During the First World War, Weizmann industrialized the process to make acetone in great quantities for the explosive cordite and created an obligation later translated into support of a Zionist state.

1952 ± 25 (0.5 ± 0.25 ¢)

Plus ça change. In 1927, Charles Lindberg made the first transatlantic solo flight, from New York to Paris, in 33.5 hours; in 1977, Bryan Allen flew the *Gossamer Condor*, a man-powered aircraft, 1.35 miles. In 1927, the first transatlantic telephone call came by electrical cable from London to New York; 1977 saw the first practical use of optical cables. In 1927, Georges Lemaître announced his hypothesis of the cosmic egg, a forerunner of the Big Bang; 50 years later, Alan Guth looked behind the egg to the inflationary Universe. Seventy-five years ago, H. J. Muller ($1946) grilled genes with X-rays; half a century later Phillip Sharp and Richard Roberts ($1993) independently split them and revealed a lot of useless information.

Charles Elton's *Animal Ecology* (1927) came at the beginning of a long career devoted to studying (among other things) animals adapted to hostile environments. The most notable may be the giant molluscs, tube worms and bacteria that share a sulphur-based metabolism in deep-sea vents off the Galapagos Islands, discovered by John Corliss and Robert Ballard in 1977. To finish, 1927 saw the foundation of the Verein für Raumschiffahrt (space travel club), which numbered Wernher von Braun (died 1977) among its members; and 1977, the launching of Voyagers 1 and 2 towards the outer planets.

Yin and yang. If we could be sure about the time and place, we would attend this year's big party for the principle of uncertainty, discovered or invented by Werner Heisenberg ($1932) 75 years ago. Heisenberg's formulation of the principle displeased Niels Bohr ($1922) for exaggerating particles over waves; and later in 1927 he tabled his own interpretation of quantum mechanics, which buys even-handedness at some cost in intelligibility. Bohr could point to experiments of 1927 which demonstrated the wave-like properties of electrons (Clinton Davisson and, independently, George Thomson; $1937). His 'complementarity', which places the task of physics in correct and communicable description of phenomena, has at least this in common with Percy Bridgman's ($1946) contemporary *The Logic of Modern Physics* (1927), that it allows into physical theory only entities for which a procedure of measurement can be stipulated.

The paradoxes and complementarities observable in 1977 include the last known case of smallpox, in Somalia, and the diagnosis of two cases of Kaposi's sarcoma, in New York City; the launch, by Stephen Wozniak and Steve Jobs, of their Apple II, the first personal computer for everyone, and the creation of Microsoft by Paul Allen and Bill Gates. ■

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1991: Mount Pinatubo erupts on Luzon.

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Apple's roots: Jobs (left) and Wozniak (right).