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The Periodic Table
One of the most important tools of chemistry

Dmitri Ivanovich Mendeleev

(1834-1907)

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... think scientifically, act scientifically... think scientifically, act scientifically... think scientifically, act...

Effective Technology Communication

Last month several experts deliberated on improving technology communication. The platform was provided by the Indian Institute of Technology, Delhi where a Centre for Rural Technology has been operational for many decades. Vigyan Prasar catalysed the deliberations and collected valuable insights into the process of reaching 'technology to the community.'

Setting the boundaries for the deliberations by the experts was challenging. Many rounds of pre-workshop discussion resulted in identifying areas of focus that included water and sanitation, disaster resilience, weather and climate, animal and soil health, challenges from coasts and oceans, and women's health.

Formal presentations served as case studies and these included largely successes – on different scales. The informal deliberations during 'break outs' yielded in admitting failures. The lessons were aplenty for serious scholars present.

Vigyan Prasar has used print, electronic, digital and interactive media for communicating science to different target groups. Partnering with other organisations, national campaigns have been mounted with far reaching effects. Year-long activities of Science, Astronomy, Bio diversity and currently Chemistry have resulted in developing communication material, training resource persons, and supporting field activities. Mobilising partners like National Council for Science and Technology Communication, networks of peoples' science movements and state agencies have been characteristic of such projects.

Technology communication, however, has not received adequate priority. In the field of agriculture and health the preferred formats have been exhibitions and demonstrations. Can demonstrations and visits be standardised and strengthened to become more effective? Considered investments of resources will yield sustainable changes in the level of understanding and perhaps change of behaviour.

Empowerment of the community will involve developing leadership capacities for problem solving and logical thinking. These can fortunately be taught and learnt. The approach needs to be pragmatic and laced with illustrative cases. Graduated efforts can be designed that build on existing levels of understanding and emphasise on democratic values and team work.

Live issues in the community that appear largely technical may have roots in sociology and sociological problems may yield best to technical solutions. Creativity has to be spotted and nurtured to find innovative and appropriate solutions for complex developmental problems. Technology communicators have to hone many skills to be successful besides a keen interest in science and development.

Women form an important and significant part of any community. Historically and sociologically they have been marginalised and require special communication strategies to be effective. Tribal populations present unique facets including their dialects, literacy levels and livelihood concerns. Small and marginal farmers, artisans and youth face challenges that require attention and an open mind. Success is unlikely if we present these groups a solution and look for problems where this would be effective. Many talented researchers have frustrating stories to recount when they venture in the farms and fields with brilliant technological options.

The technology developers need to team up with extension workers of the state governments or non government organisations. Monitoring groups must include representatives of user groups. Social entrepreneurs can prove very effective in such matters and be able to function with limited resources-money or manpower.

Vigyan Prasar would provide yeoman service to technology communication by documenting failures and analysing the factors responsible. The learning curve would be much shorter if adequate and authentic literature is available. Anonymity can be built into the cases to avoid embarrassment and other fall outs of reporting failures. Undertaken regularly, such documents would help accountability and provide feedback to technology developers. The reports for sponsoring organisation(s) need not be stark for obvious reasons.

Technology communication offers many unexplored pathways for new and existing institutions and resource persons to contribute to the task of accelerating the pace of development. The experts too were unanimous on this aspect.

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The Periodic Table

One of the most important tools of chemistry

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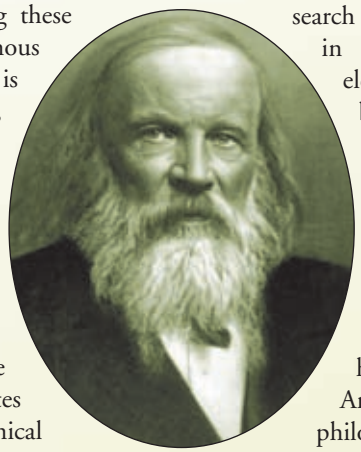
"The periodic table of elements greatly affected the subsequent development of chemistry. It was not only the first natural classification of the chemical elements showing that they form a harmonious system and are closely related to one another, but was also a powerful tool for further research."

N. L. Glinka in *General Chemistry*, Vol. I, Mir Publishers, Moscow, 1981

"The greatest table (the periodic table), that man has created. Its use will never cease!"

C. N. R. Rao in *Chemistry Today: A book to celebrate the International Year of Chemistry*, Sasta Sahitya Mandal, New Delhi, 2011

The modern periodic table is undoubtedly one of the major scientific achievements. It is widely regarded as the single most important reference available to chemists. The building blocks of the universe are elements. The periodic table provides the key to understanding these building blocks. Enormous amount of knowledge is hidden in the columns, rows, letters, and numbers in the periodic table. It may be said that the table is a condensed form of information about everything in chemistry. The table itself is a visual representation of the periodic law, which states that the physical and chemical properties of elements are a periodic function of their atomic number (proton number). The table arranges elements into groups (vertical columns) and periods (horizontal rows). The credit for the modern periodic table is usually given to the Russian scientist Dmitri Ivanovich Mendeleev. However, it should be remembered that scientists have been suggesting various ways and methods to arrange the elements in some form or the other and every small development ultimately led to formulation of the modern periodic table.



Dmitri Ivanovich Mendeleev

The periodic table is the result of the long search made by chemists in finding patterns in the properties of the chemical elements. Searching patterns is an important means in the process of learning about the world around us. A pattern once established not only helps to find how things fit together, but a pattern can be also used to make prediction about things as yet undiscovered. The search for finding patterns in the properties of elements began long before chemists had any idea about the structure of atoms.

Elements, at least some of them, which are found in nature in native form, have been known to humans since antiquity. It was Aristotle, the celebrated Greek philosopher, who first established the notion that the number of elements was limited from which everything was composed. Aristotle proposed around 330 BCE that everything is made up of mixture of one or more of the 'roots' namely earth, water, air and fire, as originally proposed by Empodocles. It was Plato, Aristotle's teacher, who called these 'roots' 'elements'. While Plato and Aristotle introduced the concept of elements, they did not contribute in any way in advancing the understanding the nature of matter.

Plato

Aristotle

Henning Brand, a German merchant, while trying to discover the Philosopher's Stone, a mythical object supposed to be capable of turning base metals into gold, first discovered a new element. In 1649, Brand discovered phosphorus by distilling human urine. He kept his discovery a secret. It became public when Robert Boyle rediscovered phosphorus. It was Boyle who first defined an element as a substance that cannot be broken down into simpler substances by a chemical reaction. Boyle's simple definition served for nearly 300 years (until the development of the notion of subatomic particles). Even today Boyle's definition of an element is taught in introductory chemistry classes.

Henning Brand

Antoine-Laurent Lavoisier's *Traite Elementaire de Chimie (Elementary Treatise of Chemistry)* published in 1779 formed the basis for the modern list of elements. Lavoisier's list included light and caloric, which he believed to be material substances. Lavoisier's description of elements only classified elements as metals and non-metals.

Chemists started classifying the compounds of elements as acids, alkalis, or salts. Some patterns were discovered fairly readily but then it became obvious that there had to be an underlying reason for the patterns. William Prout (1785-1850), British chemist and physiologist, proposed that the atomic weights of the elements should be exact multiples of the atomic weight of hydrogen; that is,

they should be integers. Prout's observation, which became known as Prout's hypothesis, drew considerable attention because it implied that elements were themselves 'compounds' of hydrogen. Prout termed hydrogen *prima materia* (basic substance) of the ancients. However, more accurate determinations of atomic weights, particularly by Belgian analytical chemist Jean Stas, showed that the atomic weights of many elements were not integers. Stas believed that the hypothesis was "only an illusion" but then he also remarked that there was "something at the bottom of it." Interest in Prout's hypothesis was again revived with the publication of Mendeleev's periodic table though Mendeleev himself described the idea of *prima materia* as "a torment of classical thought." The position was finally resolved after the discovery of isotopes in the 20th century.

William Prout

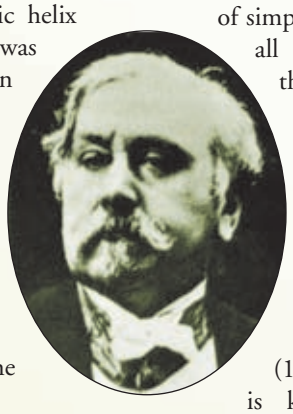
In 1817, the German chemist Johann Wolfgang Dobereiner (1780-1849) made one of the earliest attempts to classify elements. He found that some elements formed groups of three with related properties and called these groups 'triads'. In the triads the atomic weight of the second element was almost exactly the average of the atomic weights of the first and third element. For example, the atomic weight of strontium (at that time the accepted value was 88) was roughly the mean of calcium's (40) and barium's (137). Some of the triads classified by Dobereiner were:

Johann Wolfgang Dobereiner

1. chlorine, bromine and iodine
2. calcium, strontium and barium
3. sulphur, selenium and tellurium
4. lithium, sodium and potassium

By the beginning of the second half of the nineteenth century more than 60 elements had been discovered. With the increase in the number of known elements certain patterns in the way elements reacted became obvious to scientists. They began to devise better ways to classify them.

The French geologist Alexandre-emile Beguyer de Chancourtois (1820-1886) became the first scientist to notice the periodicity of the elements when he found that similar elements seem to occur at regular intervals when they are ordered by their atomic weights, Chancourtois found that when elements are arranged in a spiral on a cylinder by order of increasing atomic weight — elements with similar properties line up vertically. He called the graph *Vis Tellurique* or telluric helix because tellurium was the element in the middle of the graph. Chancourtois presented a paper on his findings to the French Academy of Sciences and it was published in the Academy's journal. Chancourtois' work attracted little attention from chemists working in different parts of the world.



Beguyer de Chancourtois

John Alexander Reina Newlands (1837-1898), a British industrial chemist, proposed that if the elements were listed in the order of their atomic weights a pattern emerged in which "the eighth element, starting from a given one, is a kind of repetition of the first, like the eighth note in an octave of music." He called this discovery the "law of octaves." He pointed out the analogy of his observation with the intervals of the musical scale. Newlands first presented his idea of a periodic table in a talk he gave to the Chemical Society of London on 9 March 1866. The talk was titled "The Law of Octaves and the Causes of Numerical Relations among the Atomic Weights." Newlands' claim to see a repeating pattern was savagely ridiculed. His classification of the elements, he was told, was as arbitrary as putting them in alphabetical order and his paper was rejected for publication by the Chemical Society. The significance of Newlands' idea was recognised only after Mendeleev's periodic table was announced.

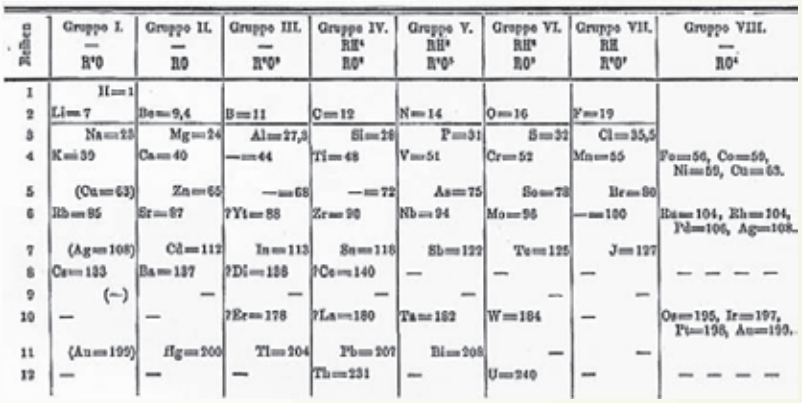
John Alexander Reina Newlands

Newlands published his paper 'On the Discovery of the Periodic Table' in 1884. He was not happy when the sole credit for discovering the periodic table was attributed to Mendeleev. He said: "Having been the first to publish the existence of the periodic law more than nineteen years ago, I feel under existing circumstances, compelled to assert my own priority in this matter….As a matter of simple justice, and in the interest of all true workers in science, both theoretical and practical, it is right that the originator of any proposal or discovery should have the credit of his labour." More than 20 years later, the Royal Society of London awarded Newlands the Davy medal for his work.

Julius Lothar Meyer (1830-1895), German chemist, is known for his contribution to the periodic classification of the elements. He prepared a chart by plotting atomic volumes against atomic weight. He measured the volume of one atomic weight's worth of each element; that is, one mole. He took these volumes as the relative volumes of the individual atoms. By plotting the volumes against the atomic weights, Meyer found a recurring pattern – something like waves with crests and troughs. Meyer noticed that elements with similar properties occur at comparable points on the different peaks. For example, metals such as lithium, sodium, potassium, rubidium, and caesium occur at the tops of the peaks. Meyer did not publish his table until 1870 and so he was pre-empted by Mendeleev who published his periodic table in 1869. Unlike Newlands, Meyer never disputed Mendeleev's priority. Meyer later admitted that he lacked sufficient courage to have gone on to predict the existence of undiscovered elements.

Julius Lothar Meyer

Dmitri Ivanovich Mendeleev (1834-1907), the Russian chemist, is generally given the sole credit for development of the periodic table. Mendeleev arranged the then known elements in a table, ordered by atomic weight, corresponding to the relative molar mass as defined today. Apparently Mendeleev thought of developing the concept of periodic table while preparing a new textbook of chemistry, *Principles of Chemistry*. While planning for the textbook he had prepared a series of cards, each listing the characteristic properties of one element. On arranging the cards in rows of suitably varying lengths, with the elements in order of increasing atomic weights, Mendeleev observed a certain pattern. He found that the elements with similar characteristics lie in the vertical groups. The pattern observed led him to the formulation of the periodic table.



Mendeleev's 1871 periodic table

Mendeleev presented a paper on his findings to the Russian Chemical Society on 6 March 1869. He demonstrated that if all the elements are arranged in order of increasing atomic weights (it may be noted that the term "atomic weight" was used before the term "relative atomic mass" was introduced), the elements with similar chemical properties occur at regular intervals, and that many properties of the elements arranged in this order repeat periodically. The remarkable relationship formulated by Mendeleev is known as the 'periodic law' which states: "The properties of simple bodies, as well as the forms and properties of the compounds of the elements are periodic function of the atomic weights of the elements." The vertical columns of elements with similar properties are called groups and the horizontal rows are called periods. The title of the paper was 'The Dependence between the Properties of the Atomic Weights of the Elements.' Mendeleev first published his periodic table in an obscure Russian journal but soon it was published in a German journal, *Zeitschrift fur Chemie* in 1869. Some of the important observations made by Mendeleev are:

1. When elements are arranged according to their atomic weights, they exhibit an apparent periodicity of properties.
2. Elements displaying similar chemical properties have atomic weights which are either of nearly same value (for example, Pt, Ir, Os) or which increase regularly (for example, K, Rb, Cs).
3. The magnitude of the atomic weight of an element determines its character.
4. The atomic weight of an element may be modified, based on the knowledge of the atomic weights of its contiguous elements. For example, based on the position of tellurium between antimony and iodine the atomic weight of tellurium must lie between 123 and 126, and cannot be 128.
5. There are many elements which are yet to be discovered; for example, two elements analogous to aluminium and silicon whose atomic weights would be 65 and 75.
6. Certain characteristic properties of elements can be predicted from their atomic weights.

Modern Periodic Table of the Elements

Mendeleev predicted 10 elements which he thought were yet to be discovered and he named eight of them. They were: *eka*-aluminium (gallium), *eka*-boron (scandium), *eka*-silicon (germanium), *eka*-manganese (technetium), *tri*-manganese (rhenium), *dvi*-tellurium (polonium), *dvi*-caesium (francium), and *eka*-tantulum). Mendeleev left space for these new elements so that there was no disturbance in the periodic table.

Ray Spangenburg and Diane K. Moser wrote: "But Mendeleyev's great daring was that, where elements wouldn't fit into his scheme for the table, he played the game as he would a game of solitaire, recognising that he might not have all the cards in his hand — some cards might still be in the deck. So if a slot called for an element with certain properties, and there was no such element as far as anyone knew, then he left gaps in his table for the elements still in the deck — those not yet discovered." It may be noted that Mendeleev liked playing a type of solitaire game called patience. For him the game was a means of relaxation.

Mendeleev pointed out that some of the then current atomic weights were incorrect. Mendeleev's periodic table did not include any of the noble gases which were discovered later. William Ramsay added these elements as Group 0, without altering the basic concept of the periodic table. In Mendeleev's periodic table there was no place for isotopes, which were discovered later. The theory of the atomic structure developed in the 20th century gave a new, deeper insight into the periodic law and the periodic table of elements.

In 1914, Henry Moseley, English physicist, established a relationship between an element's X-ray wavelength and its atomic

Continued on page 21

Bizarre exoplanets with retrograde orbits

Dr. P.K. Mukherjee
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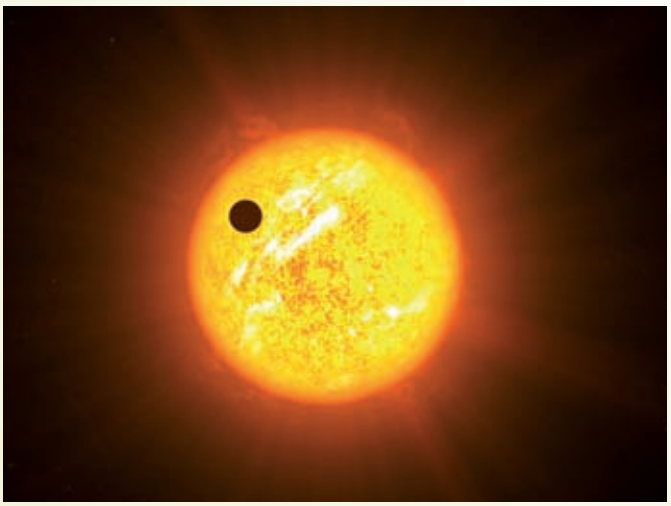
A planet orbits its parent star as well as spins about its axis. All planets move around their host star in the same direction in which the star spins. That is the thumb rule or norm. In our own solar system, all the eight planets orbit the Sun in the direction in which the Sun spins, which is counter-clockwise when viewed from the north of the solar system. In other words, none of the planets in our solar system orbits in a direction opposite to the Sun's spin, which is expressed by saying that they do not have retrograde orbits. This is due to the principle of conservation of angular momentum, flowing from Newtonian Mechanics, whereby the initial motion of the disk of gas (that condensed to form the Sun and afterwards the planets) is reflected in the current direction of orbital motions.

It may be noted that, barring Venus and Uranus, all the planets in our solar system spin about their axes in the same direction as their orbital motion around the Sun. The axial tilt of Venus is 177 degrees, which means it is spinning almost exactly in the opposite direction to its orbital motion. Planetary scientists say that Venus could have flipped its axis at some point of time so that it started spinning in a backward direction. They argue that the Sun's gravitational field on the very dense atmosphere of Venus could have caused strong atmospheric tides. Such tides, combined with the friction between the mantle and core of Venus, could have caused the flip in the first place. However, two planetary scientists Alexandre Correia and Jacques Laskar of CRNS Institute of Celestial Mechanics, by simulating the rotation of Venus over thousands of millions of years, concluded that Venus may not have flipped at all. They have instead proposed that the spin first slowed to a standstill and then reversed direction so that it became retrograde.

However, some satellites or moons of planets in our solar system do have retrograde orbits; i.e., these moons orbit in a direction opposite to the planets' spin. For instance, Triton, a moon of Neptune, has retrograde orbit around its planet. Most of the outer moons of Jupiter and Saturn also have retrograde orbits; and so have the outer moons of Uranus.

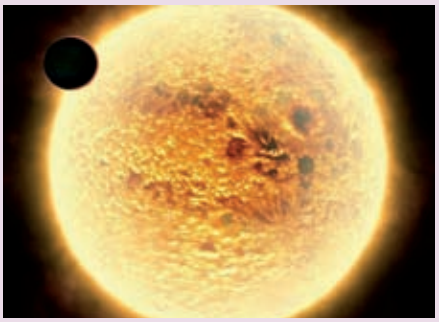


Exoplanets with retrograde orbits (artist's impression)

Astronomers have been able to discover planets, called extrasolar planets or exoplanets, outside our solar system. The tally of exoplanets (as on 9 June 2011) is 555. Their discovery has been confirmed and they have been included in the *Extrasolar Planets Encyclopedia*.

Although no planet in our solar system has retrograde orbit, the astronomers were surprised to find that the planet WASP-17b was orbiting its host star WASP-17 in a direction counter to its rotation. The astronomers say that WASP-17b appears to have been the victim of a game of planetary billiards, flinging into its unusual orbit by close encounter with a "big brother" planet. Professor Coel Hellier of Keele University remarked, "Shakespeare

Hot Jupiters



Hot Jupiters are a class of extrasolar planets whose mass is close to or exceeds that of Jupiter (1.9×10^{27} kg).They are also called roaster planets, epistellar jovians, pegasids or pegasean planets. While Jupiter orbits its parent star (the Sun) at 5.2 Astronomical Units (780×10^{7} km), the planets referred to as hot Jupiters orbit between approximately 0.015 and 0.5 Astronomical Units (2.2×10^{6} and 75×10^{6} km) of their parent stars.

Hot Jupiters are the earliest extrasolar planets to be detected via the radial velocity method because the oscillations they induce in the motion of their parent stars are relatively large and rapid compared to other known types of planets.

One of the most well-known hot Jupiter is 51 Pegasi b, nicknamed Bellerophon. Discovered in 1995,it was the first extrasolar planet orbiting a Sun-like star. Some other examples of hot Jupiters are HD 209458b and HAT-P-7b. The latter was discovered on 6 March 2008, in the constellation Cygnus, under the HAT Net Project. It was again observed later by the Kepler mission; that is why it is also named as Kepler-2b.

The Exoplanet HAT-P-7b (or Kepler-2b) orbits very close to its parent star GSC 03547-01402 and is both larger and more massive than Jupiter.

-Dr. P.K. Mukherjee

Puffy planets or hot Saturns

Gas giant planets with a large radius and very low density are sometimes called "puffy planets." They are also called "hot Saturns" due to their density being similar to that of Saturn.

Puffy planets may orbit close to their stars since the intense heat from the star and internal heating within the planet will help inflate the planet's atmosphere. Six large-radius and low-density planets have been detected by the transit method. In order of discovery they are: HAT-P-1b,Corot-1b,TrES-4,WASP-12b,WASP-17b and Kepler-7b.

-Dr. P.K. Mukherjee

said that two planets could no more occupy the same orbit than two kings could rule England; WASP-17b shows that he was right."

WASP-17b was discovered by a team of researchers led by David Anderson of Keele University, UK in collaboration of Amaury Triaud of Geneva Observatory in Switzerland. The likely explanation advanced for the retrograde orbit of WASP-17b is that it was involved in a near collision with another planet early in its history. Echoing this Anderson said, "Newly formed solar systems can be violent places. Our own Moon is thought to have been created when a Mars-sized planet collided with the recently formed Earth and threw up a cloud of debris that turned into the Moon. A near collision during the early, violent stage of this planetary system could have caused a gravitational slingshot, flinging WASP-17b into its backward orbit."

The discovery of retrograde orbit of WASP-17b has thrown planetary theories into doubt, for planets are formed from the same disk of rotating material that has given birth to the star around which they move.

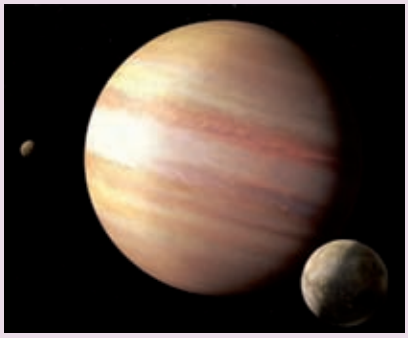
Quite recently (in June 2011) Daniel Bayliss, an astronomer from the Australian National University (ANU) and his team, using one of the world's largest telescopes, the HAT-South telescope at Las Campanas Observatory in northern Chile, stumbled upon the same planet WASP-17b. They confirmed this planet to have a retrograde orbit. As a possible explanation of this, Bayliss said, "It is possible that the planet underwent a close encounter with another giant planet billions of years ago, which altered its orbit so much that it began orbiting backwards."

Hardly a day after the announcement (in 2009) of the first planet WASP-17b having retrograde orbit came the announcement that the planet HAT-P-7b may also have a retrograde orbit. It belongs to a class of extrasolar planets called "hot Jupiters" in contrast to WASP-17b that belongs to an altogether distinct class of planets called "puffy planets."

Besides HAT-P-7b several other hot Jupiters discovered in 2010 have also been found to have retrograde orbits. A very strange explanation has been given by planetary scientists for the retrograde orbits of such hot Jupiters. They say that rather than a planet's orbit having been disturbed it may be that the star itself flipped over early during its system's formation due to the interaction between the star's magnetic field and the planet-forming disk. By combining new observations with the old data it was found by astronomers that more than half of all the hot Jupiters studied so far have orbits that are misaligned with the rotation axis of their parent stars. Moreover, six exoplanets in this study were found to have retrograde (spin) motion.

It is not known what fraction of extrasolar or exoplanets orbit their host stars in retrograde manner. However, astronomers are now actively trying to monitor other distant planets to see how common it is. If it were common, this would not bode well for the chances of life around other stars. The simple reason for this is that close encounter between giant planets would most probably destroy any small Earth-like planets in that system, and wipe out any chance of life arising in that planet. The retrograde orbit of exoplanets is, therefore, not merely an astronomical curiosity but can have a bearing of much deeper consequences. ■

The bizarre exoplanet WASP-17b



The Exoplanet WASP-17b was discovered on 11 August 2009 by the Wide Area Search for Planets (WASP) Project (also called Super WASP Project) of UK in collaboration with Geneva Observatory in Switzerland. The planet happened to be the seventeenth exoplanet found under this Project and hence was given its present name bearing the number 17.

WASP-17b is, incidentally, the first exoplanet discovered to have a retrograde orbit, meaning it orbits in a direction counter to the rotation of its host star.

A team of researchers led by David Anderson of Keele University, UK discovered the gas giant in the constellation Scorpius, which is about 1,000 light years (one light year is the distance travelled by light in one year and is approximately equal to ten trillion kilometres) from Earth, by observing its transit across its host star WASP-17. The discovery was made with the help of a telescope array at the South African Astronomical Observatory. Amaury Triaud and other members of his team at the Observatory of Geneva found that the radial velocity of WASP-17b varied over the course of its orbit around its host star. They, therefore, used characteristic red shifts and blue shifts in the spectrum of the host star to measure the planet's mass and obtained an indication of its orbital eccentricity.

The planet WASP-17b has a radius which is 1.5-2 times that of Jupiter and about half its mass. Its mean density is between 0.08×10^3 kg/m^3 compared with Jupiter's 1.326×10^3 kg/m^3 and Earth's density of 5.515×10^3 kg/m^3. The unusually low density of WASP-17b is thought to be a consequence of a combination of the planet's orbital eccentricity and its proximity to its parent star, leading to tidal flexing and heating of its interior.

-Dr. P.K. Mukherjee

Interview with Richard R. Ernst

Prof. Richard R. Ernst is a well known researcher in the field of Nuclear Magnetic Resonance (NMR) spectroscopy. Prof. Ernst was awarded the Nobel Prize in Chemistry in 1991 for his contributions towards the development of Fourier Transform nuclear magnetic resonance (FT NMR) spectroscopy and the subsequent development of multi-dimensional NMR techniques. These underpin applications of NMR both to chemistry (NMR spectroscopy) and to medicine (MRI). He also received Louisa Gross Horwitz Prize in 1991.

Prof. Ernst was born 1933 in Winterthur, Switzerland. His father, Robert Ernst, was teaching as an architect at the technical high school of the city. At the age of 13, He found in the attic a case filled with chemicals and the journey began. After a diploma as a "Diplomierter Ingenieur Chemiker" and some extensive military service, Ernst started working for a PhD thesis in the laboratory of Professor Günthard. Fortunately, he came in contact with a young and brilliant scientist Hans Primas, who never went through any formal studies but nevertheless acquired rapidly whatever he needed for his work that was then concerned with high-resolution nuclear magnetic resonance (NMR), a field in its infancy at that time. After some years of work, Ernst became interested in industry and joined Varian Associates in US. During last years at Varian (1966-68), he developed numerous computer applications in spectroscopy for automated experiments and improved data processing with his co-workers. He continued to work on methodological improvements of time-domain NMR with repetitive pulse experiments and Fourier double-resonance. In addition, he with his coworkers performed the first pulsed time-domain chemically-induced dynamic nuclear polarisation (CIDNP) experiments. In this way, he struggled with the NMR technique, which was about to die at that time and made it so profound, accurate and thus useful in medicine that now we using the application of NMR spectroscopy in medicine as Magnetic Resonance Imaging (MRI), which is a very important tool in imaging of internal parts of body.

Prof. Richard Ernst is now 78 years old, but very hopeful and energetic and careful towards new responsibilities. He has keen interest in Asian arts, music, and culture. He enjoys interactions with young researchers and motivating them for doing valuable work for the betterment of the society.

Recently Mr. Meher Wan got an opportunity to interact with Ernst on his life and research work. Here are excerpts from the interaction.

Meher Wan: First of all, I thank you Professor for accepting my request for your interview.

Your work was considered for the Nobel in 1991. After receiving Nobel Prize for Chemistry, how has your life changed? What kind of relaxation or responsibility do you feel after this award?

Richard R. Ernst: My life changed very little! You know that our shadow follows us irrespective of superficial successes. I was always my biggest own hurdle to overcome. Afterwards I had even less time to relax. But indeed, my responsibilities grew. I feel obliged to say what I think about our egomaniac course of doing business and structuring our personal lives. I try to teach as much as I can, being aware that after all it will not help too much except for providing me better sleep.

MW: Let me ask you about your days of childhood. How do you remember the childhood and boyhood days of Richard? How did you perform in your schools? Where did you study?

RRE: I went to school in our city Winterthur. I was not a good student. I was constantly thinking how I could annoy my teachers. I was almost thrown out of high school. I mostly learned by myself; for example, by doing chemical experiments in the basement of our house; and I survived and became a chemist!

MW: A very curious violinist moved towards chemistry? Do you remember those times?

RRE: I had two passions in my youth: chemistry and music. I played the cello and I was composing music besides doing chemistry experiments. But surely, I selected the proper profession!

MW: You have stated in your autobiography for website of Swedish Academy, "I was rapidly disappointed by the state of chemistry in the early fifties as it was taught." Do you think this is the trend of schooling of science in many countries even now? According to you, what should be the mechanism of education for best understanding of the subject by a student?

RRE: The best way of education is to evoke the curiosity of the students and then let them discover nature and the world themselves. Classroom teaching is absolutely useless, it just causes boredom.

MW: When you started your Ph.D., what was in your mind? Did you want to serve the nation, or industry, or something else?

RRE: I wanted to become a respectable person who contributes something of value for mankind and gains respect in this way.

MW: What quality of NMR spectroscopy impressed you to motivate you to invest your whole life for this field of science?

RRE: I was not primarily interested in NMR, but I was thrown into NMR and I started to like it. This happens so often in life. We are not born mathematicians or biologists. But our interests grow accidentally by doing. And then you have to stay in a field until you have achieved something.

MW: Tell us about your journey for making of Fourier transform NMR. What problems did you face for this work? Any interesting story related to this instrumentation? I read somewhere that the research paper related to this work was rejected twice.

RRE: NMR suffered from very low sensitivity and it was necessary to find

a way to improve sensitivity. Parallel data acquisition was the solution. It led to Fourier transformation.

MW: Which scientific goal do you still want to achieve?

RRE: At the moment I am working on pigment analysis in Central Asian paintings in order to understand their origin and dating and for finding means of conservation. NMR is useless for this purpose and I am using Raman spectroscopy.

MW: What phenomenon led your group to think about 2D Fourier transform NMR spectroscopy?

RRE: For determining molecular structures, one needs spatial relations between nuclei. A two-dimensional map may contain this type of information.

MW: Now multi-dimensional spectroscopy is available, what do you hope about future of this field?

RRE: I hope that it will find even more widespread application.

MW: Techniques developed by you and your group have very wide applications in different fields of science. How do you feel about it? Did you expect such wide range of applications of these techniques when you started your work?

RRE: What more could I ask for? There is nothing better in life than to experience the "usefulness" of your "children"!

MW: Which thing did you miss in your life and still want to do?

RRE: I hope to find more time to contemplate on the sense of our lives. I hope earnestly to be less disturbed by obnoxious journalists!!!

MW: You have interest in culture and art of different continents. How do the arts of Tibet impress you?

RRE: I like in particular the colourfulness and the visual beauty that allows an easy entrance across language barriers. It contains a wealth of immortal truths.

MW: You often talk about the responsibilities of researchers.

RRE: The responsibility is more with academic teachers than with the researchers. Anyway research is only a means of teaching and learning. Academic teachers are the only ones who can express what they think without the danger of losing the job, as politicians and merchants would. Thus they are obliged to take advantage of their privileged position.

MW: What do you want to convey to the young minds who want to opt for science as a career?

RRE: Whenever you try to honestly evaluate the surroundings and your responsibilities to improve them for the sake of future generations, you are in the midst of scientific reasoning and it is not far from becoming a professional scientist, researcher and in particular, a responsible teacher.

MW: I am very grateful to you that you invested your precious time for us. I have been reading your articles on science and society. Hope to have another conversation on society, science and cultures very soon. ■

Award for Original Writing of a Book in Hindi

Navneet Kumar Gupta, Project Officer (EduSat) awarded the first prize, which carries Rs.20,000 in cash and a citation for book writing in Hindi on Pollution control and management scheme by Central Pollution Control Board, Delhi. He was awarded for his manuscript "Pardushan aur badalti abohawa: Prathvi par mandrata santak".

Officer of, Central Pollution Control Board presenting the Medini Puraskar to Shri Navneet Kumar Gupta of VP

Letters to the editor

Partnership with CSCs

We were very happy to know your views expressed in the editorial of Dream 2047 (October 2011). We welcome your views on partnership with CSCs. for nurturing them into effective arms for science popularisation. Further the concept of exploratories should be effective and meaningful. Please take your thoughts further and guide CSCs. We are ready to become your partners.

Anil Kamdar
Saurashtra Education Foundation

*****

Enriching

As an elderly person with deep inclination to enrich my knowledge on Mother Nature, I was delighted to read the useful excerpts of the interaction with Prof. Pramod K. Verma, in your esteemed science magazine Dream 2047 (October 2011). The interview has widely travelled through the length and breadth of the universe, to enlighten all groups of readers, with the wonders of the universe, in which we live. The article on Nutrigenomics, will, I'm sure, help people to live a better life.

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*****

A treasure of knowledge

As a reader of Dream 2047, I thank you from the bottom of my heart for this valuable magazine. I feel excited to read about the scientists. I got lot of information about many scientists who were not familiar to me before. I got lot of information about many strange diseases. Dr Yatish Agarwal's column keeps us informed about preventive measures, and characters of many unfamiliar diseases. For students like me who live in village, your magazine is a treasure of knowledge.

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*****

Treatment Options for Polycystic Ovary Syndrome

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> "Outward beauty is not enough; to be attractive a woman must use words, wit, playfulness, sweet-talk, and laughter to transcend the gifts of Nature"
>
> —Gaius Petronius Arbiter Satyricon

A most common hormonal disorder among women, polycystic ovary syndrome (PCOS) is characterised by menstrual disturbances, excessive hair growth, severe acne and obesity. The condition may present itself in adolescence with infrequent scanty menstruation, or may become manifest some years later with abnormal weight gain, hirsutism and difficulty in getting pregnant.

Should you think you have this syndrome, you should consider seeing a doctor.

Going to the doctor

You are likely to start by first seeing your family doctor. However, in some cases when you call to set up an appointment you may be referred immediately to a doctor who specialises in conditions affecting the female reproductive tract (gynaecologist), one who specialises in hormonal disorders (endocrinologist) or one who specialises in both areas (reproductive endocrinologist).

Here's some information to help you prepare for your appointment, and what to expect from your doctor.

What you can do

Write down any symptoms that you may be experiencing. Take a note of all of your symptoms, even if you don't think they're related. At the same time, make a list of any medications, vitamins and other supplements you take. Write down doses and how often you take them.

Have a family member or close friend accompany you, if possible. You may be given a lot of information at your visit, and it can be difficult to remember everything. Take a notepad with you. Use it to write down important information during your visit.

Think about what questions you'll ask. Write them down; list the most important questions first. Some basic questions to ask may include: What kinds of tests might I need? How does this condition affect my ability to become pregnant? Are medications available that might improve my symptoms or my ability to conceive? What side effects can I expect from medication use? Under what circumstances do you usually recommend surgery? What treatment do you recommend for my situation? What are the long-term health implications of polycystic ovary syndrome?

Make sure that you understand everything that your doctor tells you.

What to expect from your doctor

Your doctor might ask you several questions to understand the nature of your illness.

Some potential questions include: What signs and symptoms do you have? How often do you experience these symptoms? How long have you been experiencing symptoms? How severe are your symptoms? When did you last have a period? Have you gained weight since you first started having periods? How much weight have you gained? Does anything improve your symptoms? Does anything make your symptoms worse? Are you trying to become pregnant, or do you wish to become pregnant in the future? Has your mother or sister ever been diagnosed with polycystic ovary syndrome?

Tests and diagnosis

There is no specific test which can confirm the diagnosis of polycystic ovary syndrome. The diagnosis is one of exclusion, which means your doctor considers all of your signs and symptoms and then rules out other possible disorders. During this process, your doctor takes many factors into account:

Medical history

Your doctor may ask questions about your menstrual periods, weight changes and other symptoms.

Physical examination

During your physical exam, your doctor will note several key pieces of information, including your height, weight and blood pressure.

Pelvic examination

During a pelvic exam, your doctor visually and manually inspects your reproductive organs for signs of masses, growths or other abnormalities.

Blood tests

Your blood may be drawn to measure the levels of several hormones to exclude possible causes of menstrual abnormalities or androgen excess that mimic PCOS.

Additional blood testing may include fasting cholesterol and triglyceride levels and a glucose tolerance test, in which glucose levels are measured while fasting and after drinking a glucose-containing beverage.

Pelvic ultrasound

A pelvic ultrasound can show the appearance of your ovaries and the thickness of the lining of your uterus. You must go prepared for the appointment with your urinary bladder full. During the test, you lie on a bed or examining table while a wand-like device, transducer, is placed on your lower abdomen. The transducer emits inaudible sound waves that are translated into images on a computer screen.

The radiologist may also consider carrying out a transvaginal ultrasound. During the test, you lie on an examining table while the transducer, covered with a condom-like rubber sheath, is placed in your vagina.

What You Can Do

Getting regular exercise and making healthy-eating choices is the first treatment approach your doctor might recommend, particularly if you're overweight. Obesity makes insulin resistance worse. Weight loss can reduce both insulin and androgen levels, and may restore ovulation. Ask your doctor to recommend a weight-control programme, and meet regularly with a dietician.

Go for exercise

Exercise helps lower your blood sugar levels. For women with polycystic ovary syndrome, an increase in daily physical activity and participation in a regular exercise regimen are essential for treating or preventing insulin resistance and for helping weight-control efforts.

Dietary measures

You may receive conflicting advice from dieticians and physicians on the role of diet in weight management. Much of the disagreement focusses on carbohydrates. The glycaemic index is a measure of the degree a carbohydrate will raise insulin levels after eating. Starches are high glycaemic index carbohydrates that tend to increase insulin levels to a greater degree compared with low glycaemic index carbohydrates such as green leafy vegetables.

Some health and nutrition advocates advise women with polycystic ovary syndrome to follow a low-carbohydrate diet without discriminating between carbohydrates on either end of the glycaemic index. In addition, a diet that calls for increased protein to compensate for decreased carbohydrates may spike your intake of saturated animal fats, elevating your blood cholesterol levels and increasing your risk of cardiovascular disease. Initial studies seem promising, but more research is needed to determine whether a diet that is low in animal fats and carries less of high glycaemic index carbohydrates is an appropriate alternative for people who are insulin resistant, including many women with polycystic ovary syndrome.

Choose complex carbohydrates

Choose carbohydrates that are high in fibre. The more fibre in a food, the more slowly it is digested and the more slowly your blood sugar levels rise. High-fibre carbohydrates include whole-grain breads and cereals, whole-wheat pasta, brown rice, and beans. Limit less healthy, simple carbohydrates such as *chat-pakori*, *namkeen*, *bhujiya*, excess fruit juice, cake, candy, ice cream, pies, cookies and *mithai*.

Additional research may determine which specific dietary approach is best, but it is clear that losing weight by reducing total calorie intake benefits the overall health of women with polycystic ovary syndrome.

How Your Doctor Can Help

Your doctor might recommend that you:

Schedule regular checkups

Long term, managing cardiovascular risks, such as obesity, high blood cholesterol, type 2 diabetes and high blood pressure, is important. To help guide ongoing treatment decisions, your doctor will likely want to see you for regular visits to perform a physical examination, measure your blood pressure, and obtain glucose and lipid levels.

Polycystic ovary syndrome treatment generally focusses on management of your individual main concerns, such as infertility, hirsutism, acne or obesity.

Regulate your menstrual cycle

Low-dose birth control pills. If you're not trying to become pregnant, your doctor may prescribe low-dose birth control pills that contain a combination of synthetic oestrogen and progesterone. They decrease androgen production and give your body a break from the effects of continuous oestrogen. This decreases your risk of endometrial cancer and corrects abnormal bleeding.

An alternative approach is taking progesterone for 10 to 14 days each month. This regulates your periods and offers protection against endometrial cancer, but it doesn't improve androgen levels.

Metformin. Your doctor also may prescribe metformin, an oral medication for type-2 diabetes that lowers insulin levels. This drug improves ovulation and leads to regular menstrual cycles. Metformin also slows the progression to type-2 diabetes if you already have pre-diabetes and aids in weight loss if you follow a diet and exercise programme.

Reduce excessive hair growth

Your doctor may recommend birth control pills to decrease androgen production, or another medication called spironolactone that blocks the effects of androgens on the skin. Since spironolactone can cause birth defects, effective contraception is required when using the drug, and it is not recommended if you're pregnant or planning to become pregnant. Eflornithine is another medication possibility; the cream slows facial hair growth in women.

Shaving, waxing and depilatory creams are non-prescription hair removal options. Results may last several weeks, and then you need to repeat treatment.

For longer lasting hair removal, your doctor might recommend a procedure that uses electric current (electrolysis) or laser energy to destroy hair follicles and control unwanted new hair growth.

Medication to induce egg release

If you're trying to become pregnant, you may need a medication to induce ovulation. Clomiphene citrate is an oral anti-oestrogen medication that you take in the first part of your menstrual cycle. If clomiphene citrate alone isn't effective, your doctor may add metformin to help induce ovulation.

If you don't become pregnant using clomiphene and metformin, your doctor may recommend using gonadotropins — follicle-stimulating hormone (FSH) and luteinizing hormone (LH) medications that are administered by injection.

Surgery

If medications don't help you become pregnant, an outpatient surgery called laparoscopic ovarian drilling is an option for some women with polycystic ovary syndrome. Your doctor can help you determine if you're a candidate for this type of surgery.

In this procedure, a surgeon makes a small incision in your lower abdomen and inserts a tube attached to a tiny camera, a device which carries the name of a laparoscope. The camera provides the surgeon with detailed images of your ovaries and neighbouring pelvic organs. The surgeon then inserts surgical instruments through other small incisions and uses electrical or laser energy to burn holes in follicles on the surface of the ovaries. The goal is to induce ovulation by reducing androgen levels. ■

Continued from page 28 (The Periodic Table : One of the most important tools of chemistry)

number (Z), which demonstrated that atomic numbers had an experimentally measurable basis. Before Mosley's discovery atomic numbers were simply sequential numbers based on an element's atomic weight. Mosley re-sequenced the elements in the periodic table by nuclear charge (proton number) rather than atomic weight. This necessitated the change of positions of some elements. Based on the wavelengths argon was placed before potassium, though argon has a greater atomic weight (39.9) than potassium (39.1). Mosley placed cobalt before nickel. He could explain why tellurium should be placed before iodine without revising the experimental atomic weight of tellurium (127.6) as proposed by Mendeleev. With Mosley's refinement changed the periodic law in the sense that the term "atomic weight" was replaced by the term "atomic number."

Henry Moseley

In 1945, the US physicist Glenn T. Seaborg proposed a significant change to Mendeleev's table to provide space for the actinide series. Seaborg predicted that actinides form a transition series analogous to the rare earth series of lanthanide elements. The actinide series form the second row of the f-block (5f series) and comprise the elements from actinium to lawrencium. Seaborg further elaborated the actinide concept by theorising a series of super-heavy elements in a trans-actinide series comprising elements 104 through 121, and a super-actinide series inclusive of elements 122 through 153.

Glenn T. Seaborg

Some distinct patterns found in the periodic table are:

- There is an increase in atomic size while going down a group, but the atomic size decreases across a period.
- In a group the metallic character increases as we go down a group but in a period the metallic character increases as go from right to left. The non-metallic elements are found at the right of the period.
- The reactivity of the elements in the metallic groups increases as we go down in a group.
- In the non-metallic groups the most reactive element is at the top of the group.

The periodic table is revised by the International Union of Pure and Applied Chemistry (IUPAC) whenever new data becomes available.

Though the periodic law has been refined, the basic concept of the periodic table proposed by Mendeleev has survived. Mendeleev had anticipated this development. He once said: "The periodic law is not in danger of destruction but only superstructure and development are promised." This was indeed a prophetic statement.

References

1. Mathews, Philip, *Advanced Chemistry* (Cambridge Low-Price Editions), Cambridge: Cambridge University Press, 1996.
2. Harwood, Richard, *Chemistry* (Cambridge Low-Price Editions), Cambridge: Cambridge University Press, 1999.
3. Glinka, N. L., *General Chemistry*, Vol. I, Mir Publishers, Moscow, 1981
4. Jones, Geoff, Mary Jones and David Acaster, *Cambridge Coordinated Science: Chemistry*, Cambridge: Cambridge University Press, 1994.
5. Jonas, Ann Rae, *Science Book of Answers & Questions*, Holbrook, Massachusetts: Adams Media Corporation, 1996.
6. Spangenburg, Ray and Diane K. Moser, *The History of Science in the Nineteenth Century*, Hyderabad: Universities Press (India) Limited, 1999.
7. *A Dictionary of Scientists*, Oxford: Oxford University Press, 1999.
8. *A Dictionary of Science*, Oxford: Oxford University Press, 1999.
9. Available sources on the Internet. ■

Recent developments in science and technology

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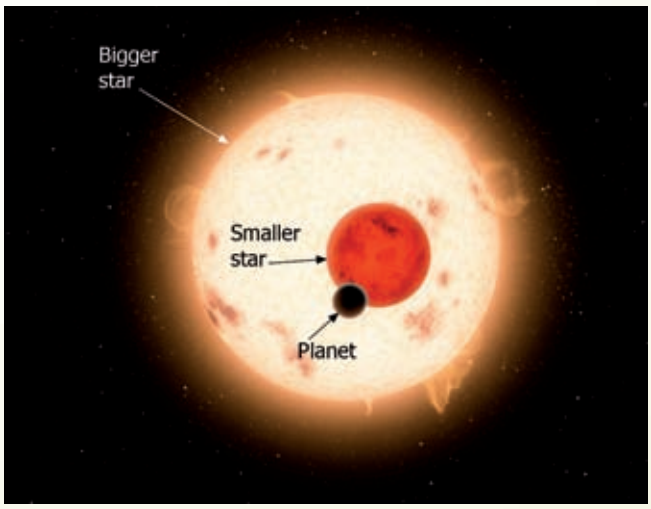
Planet around two suns discovered

Since the first planet orbiting a star outside our solar system was discovered in 1995, the total number of exoplanets discovered so far (till 15 September 2011) has gone up to 564.



The components of the double-sun planetary system Kepler-16 in transit. The large and orange star, the reddish and smaller dwarf star, and the exoplanet (dark) are shown to their relative size at the time of a transit. (Image credit: NASA/JPL-Caltech/R. Hurt)

The number of stars with planets around them totals 474, of which 61 have more than one planet in orbit. But the most recent discovery by NASA's *Kepler* spacecraft beats them all. For the first time, astronomers with the *Kepler* Mission have discovered a planet orbiting two stars. This is a fundamentally different kind of planetary system than has ever been discovered before. If there were inhabitants on the planet they would see two sunrises and sunsets every day!

The *Kepler* Mission has been "specifically designed to survey a portion of our region of the Milky Way galaxy to discover dozens of Earth-size planets in or near the habitable zone and determine how many of the billions of stars in our galaxy have such planets." Launched in 2009, the spacecraft has till date discovered more than a thousand planet candidates, including four possibly Earth-like planets around a star named Kepler-11, situated more than 1,990 light years from Earth.

The newly discovered system has been named 'Kepler-16' and consists of two stars, which circle each other every 41 days. The two stars are both smaller than the Sun. The bigger of the two, the primary, measures 69 percent of the Sun's mass and 65 percent of its radius. The smaller star, the secondary, is considerably smaller, with 20 percent of the Sun's mass and 23 percent of its radius. A planet with mass almost that of Saturn circles around both of these stars with a period of 229 days. The planet, made up of half rock and half gas, has been named Kepler-16b, because it is the 16th planetary system discovered by *Kepler*. The double star is located approximately 220 light years from our Sun, near the constellation Cygnus, in the Milky Way galaxy. Even though the planet has an orbital period of less than an Earth-year, it is still outside the habitable zone of the stars because the stars are much dimmer than our Sun. Such a planet orbiting two stars is called a 'circumbinary' planet (*Science*, 16 September 2011).

The two-star planetary system was discovered by a team of researchers, led by the SETI Institute's Laurence Doyle, who used data collected by *Kepler*, which tracks the brightness of over 150,000 stars. Specifically, they noticed four dips in brightness of the star system – two due to eclipses caused by the stellar pair going round one another, and the third and fourth eclipses caused by the planet as it moved in front of the two stars while orbiting them.

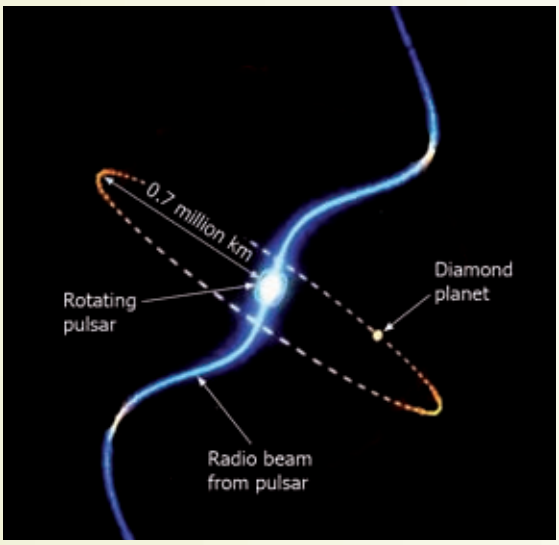
Circumbinary planets have been pursued by astronomers for decades. Although some scientists have claimed to detect such a planet in the past, none of those claims have been widely accepted by the scientific community. According to astrophysicists, the recent discovery increases the likelihood of success of the *Kepler* Mission, which is to detect the first habitable; i.e., Earth-like, planets around other stars. Incidentally, some scientists have nicknamed the planet 'Tatooine' after the name of the home planet of Luke Skywalker, the hero in the 1970s science fiction movie *Star Wars*. In the story – in a hypothetical galaxy far, far away – a circumbinary planet's double sunset was first brought to the screen.

And now, a diamond planet!

Pulsars are small spinning neutron stars only around 20 km in diameter that emit a beam of radio waves. As the star spins, the emitted radio waves sweep repeatedly over Earth where radio telescopes can detect them as a regular pattern of radio pulses or beeps. When the first pulsar was discovered in 1967, it created a commotion in the scientific community because the pulses were so precise they appeared to be sent by some extraterrestrial intelligent beings. But soon the mystery was cleared and today several dozen pulsars are known.

In 1990, the first planets orbiting a star other than the Sun were discovered around an old, rapidly spinning pulsar, PSR B1257+12. Since then many other pulsars having planets have been discovered, but none of them as exciting as the recent one, where the orbiting planet is no ordinary one – it is possibly made of diamonds! The unusual planet has been discovered around a millisecond pulsar known as PSR J1719-1438 located 4,000 light-years away in the constellation of Serpens in our Milky Way galaxy. The new planet is far denser than any other known so far and consists largely of carbon. A high density of 23 g cm^{-3} suggests that the carbon must be crystalline and a large part of this strange planet may be similar to a diamond.

The discovery was made by an international team of astronomers led by Matthew Bailes, an astronomer at the Swinburne Centre for Astrophysics &



The 'diamond planet' orbiting the radio wave-emitting pulsar J1719-1438 (Image: Swinburne Astronomy Productions)

Supercomputing in Melbourne, Australia, using the CSIRO Parkes radio telescope in Australia, Lovell radio telescope in the UK, and one of the Keck telescopes in Hawaii. According to the scientists, the newfound 'diamond' planet probably formed from a white dwarf star – the core of a dead Sun-like star – that was being stripped of matter by the pulsar. The leftover object likely represents just 0.1 percent of the white dwarf's original mass (*Science*, 25 August 2011 | doi: 10.1126/ science.1208890).

The astronomers noticed slight variations in the arrival times of the pulses from PSR J1719-1438 and concluded that it could be due to the gravitational pull of a small companion planet orbiting the pulsar in a binary system. From the variation they could calculate the distance and orbital period of the planet. They could also compute that the planet must be less than 60,000 km in diameter and have a mass slightly larger than that of Jupiter. This is what gave the scientist the first clue about nature of the new planet. If Jupiter with a diameter of almost 143,000 km has a mass less than the newly discovered planet, it meant that the new planet must be very dense, and that is what it turned out to be. The diamond planet orbits the pulsar at a distance of about 0.7 million kilometres; that is, about half the radius of the Sun.

Genetically engineered virus to fight cancer

Cancer is the uncontrolled growth of abnormal cells in the body, which can often kill. Normal cells multiply when the body needs them, and die when the body does not. Cancer appears to occur when the growth of cells in the body is out of control and cells divide too quickly. It can also occur when cells forget how to die.

There are many different kinds of cancers and many of them are fatal. Cancer can develop in almost any organ or tissue, such as the lung, colon, breast, skin, bones, or nerve tissue. Cancer treatment depends on many factors such as the type of cancer and its stage, which refers to how much it has grown, and whether the tumour has spread from its original location. Current cancer treatments include surgery, radiation therapy and chemotherapy, each of which has its potentials and limitations. Now another weapon is going to be added to the armoury – use of genetically modified virus. An international research team has recently completed a preliminary study demonstrating that a genetically engineered virus can be used to selectively kill cancer cells in humans without harming healthy tissue (*Nature*, 1 September 2011).

For decades, scientists have been toying with the idea of using viruses to alert the immune system to seek and destroy cancerous cells. But earlier studies had shown that viruses that had the ability to infect cancer cells also infected other healthy tissues. However, interest in the subject grown in recent years as advances in genetic engineering has made it possible to customise viruses that target tumours. In the latest study, scientists at institutions in the US, South Korea, and Canada and privately held biotech company Jennerex Inc used genetically modified poxvirus in a small, early-stage trial of experimental viral therapy and found that it consistently infected tumours with only minimal and temporary side effects.

In the first human trial, the researchers used an intravenous injection to spread the modified poxvirus – called JX-594 – throughout the bloodstream and target tumour cells anywhere in the body of 23 patients suffering from untreatable metastatic cancer that had spread. The patients participating in the trial received just one treatment. The results indicated that some tumours did indeed show evidence of shrinkage. The researchers say viral therapies like JX-954 stand apart from other cancer treatments because they can attack tumours in multiple ways, they can be customised easily for different types of cancer, and they cause minimal side effects.

According to Prof. John Bell of Ottawa Hospital Research Institute in Canada, who was co-leader of the trial, the patients may derive more benefit with additional treatments. It may also be possible to make the viruses more potent tumour-killers by equipping them with certain genes.

Dengue-resistant mosquitoes bred

Dengue fever, also known as break-bone fever, is an infectious tropical disease caused by the dengue virus. It can cause debilitating high fever, severe headaches, and pain in the muscles and joints. Although in most cases the fever is self-limiting and usually uncomplicated, in a small proportion of cases the disease develops into the life-threatening dengue hemorrhagic fever, resulting in bleeding, low levels of blood platelets and blood plasma leakage, or into dengue shock syndrome, where dangerously low blood pressure occurs. At present no vaccine or specific treatment is available against dengue.

Dengue is transmitted by several species of mosquito within the genus Aedes, mainly *A. aegypti*, and all current efforts centre around elimination of the mosquito vector, which preferentially breeds in clean water. Traditional control measures aimed at reducing populations of the main transmission vector, *A. aegypti*, have had little success in solving the global dengue

The Aedes aegypti mosquito, which is the main carrier of the dengue virus. (Photo credit: ALAMY)

problem, which affects more than 50 million people a year in 100 countries in tropical and subtropical areas, including India. Two recent reports of success with bacteria-infected *A. aegypti* mosquito to stop the transmission of the dengue virus bring a ray of hope.

Researchers have found that injecting bacteria into mosquitoes can block them from transmitting the dengue virus and help control the spread of a disease that kills 20,000 annually. Female mosquitoes infected with the *Wolbachia pipientis* bacteria passed the bug easily to their offspring, making them all dengue-free. Two papers published in a recent issue of *Nature* (25 August 2011) report an alternative approach to mosquito population control using the bacterium.

In the first paper, Scott O'Neill, a biologist at Monash University in Australia and colleagues describe a study which showed that *A. aegypti* mosquitoes, the chief carriers of the dengue virus, resist spreading that virus if they are infected with *W. pipientis*. The bacteria derived from fruit flies were found to significantly reduce the transmission of the dengue by the mosquito.

In the second paper, O'Neill and colleagues present the results of a controlled field trial that demonstrated that the release of infected mosquitoes leads to successful invasion of natural mosquito populations, which can effectively control the spread of the dengue virus. To test whether these resistant mosquitoes could displace their ordinary cousins in the wild, thus reducing the number of dengue-spreading mosquitoes, the researchers started setting the infected mosquitoes loose in two towns in northern Australia. They released between 10,000 and 20,000 mosquitoes a week in each location for about 10 weeks. The *Wolbachia* infection spread rapidly, exactly as the researchers had hoped, and it continued to expand even after they stopped releasing mosquitoes. Some six weeks after the last release, the infection rate was very close to 100% in both towns, the team reported.

According to the researchers, these results suggest a viable strategy to control dengue fever, although the present study was confined to Australia where dengue occurs only as sporadic outbreaks. Using infected mosquitoes could nonetheless provide a cheap and sustainable way to reduce transmission of dengue, which is important because many endemic regions are located in poor countries. To test the effectiveness of the technique in areas where dengue is endemic, the researchers next plan to test the technique in areas such as Indonesia and Vietnam, where dengue is more prevalent.

Bacterial suicide bombers

Pseudomonas aeruginosa is a dangerous, opportunistic bacterium that thrives wherever humans are weak. The bacterium infects the pulmonary tract, urinary tract, burns, wounds, and also causes other blood infections. It is the most common cause of infections of burn injuries and is the most frequent cause of infection through the use of medical devices including catheters, causing cross-infections in hospitals and clinics. One of the most worrisome characteristics of *P. aeruginosa* is its low antibiotic susceptibility. The bacterium is naturally resistant to a large range of antibiotics and often demonstrates additional resistance after unsuccessful treatment.

Scanning electron micrograph of Pseudomonas aeruginosa bacteria, which appear as light brown rod-shaped objects in the image. (Photo Credit: Janice Haney Carr)

Recently researchers at School of Chemical and Biomedical Engineering, Nanyang Technological University, Singapore have found a new way of killing this opportunistic bacterium by using 'suicide bombers' made by genetically modifying the common bacterium *Escherichia coli*. They used the tools of synthetic biology to create synthetically engineered *E. coli* that can infiltrate foreign bacteria such as pathogenic *P. aeruginosa* and explode, killing off the pathogen along with itself.

The researchers exploited the ability of *P. aeruginosa* to detect the number of microorganisms – either of their own species or others – in their environment. When pathogenic *P. aeruginosa* sense other species in their neighbourhood competing for nutrients and space, they communicate with members of their own species using chemical signals and collectively start releasing a bacterial toxin called pyocin that kills off the competition. Together, these communication and defense capabilities allow *P. aeruginosa* to form tightly packed layers called biofilms, which are like bacterial cities and are notoriously hard to destroy. Biofilms can cause respiratory tract infections in humans and are particularly dangerous to patients of diseases like cystic fibrosis. The new strategy uses *P. Aeurginosa*'s own weapons against it.

Researchers Nazanin Saeidi and Choon Kit Wong Nazanin focussed on a pyocin known as S5, which comes in two parts: one does the killing; the other makes the host cell immune to its own weapons. They engineered *E. coli* to produce a protein called LasR, which recognises molecules that *P. aeruginosa* cells use to communicate with one another. When LasR detects these chemical signals, it switches on two genes. The first one produces pyocin, a toxin that kills *P. aeruginosa* by drilling through its outer wall and causing its innards to leak out. The second gene produces a protein that causes the *E. coli* to burst apart, killing itself but also releasing a flood of deadly pyocin upon nearby *P. aeruginosa* (*Molecular Systems Biology*, 16 August 2011; doi:10.1038/msb.2011.55).

In preliminary lab tests, the *E. coli* bombers have proved to be remarkably effective against *P. aeruginosa*. When the two species were mixed together, the bombers killed around 99% of their targets. They even killed around 90% of cells in slimy communities of *P. aeruginosa* called biofilms. However, as of now, the method has not been tested in trials on humans or animals, but it could provide a new approach to tackling drug-resistant infections, where progress using current techniques has ground to a halt. ■

National Workshop on Innovative Physics Experiments

A national workshop on Innovative Physics Experiments for school teachers was organised at Digha, West Bengal. It was a 4-day workshop (15-18 September 2011) jointly organised by Vigyan Prasar, Indian Association of Physics Teachers (IAPT, West Bengal chapter), Digha Science Centre and National Science Camp. Bose Institute, Kolkata was also associated with the workshop. About 35 participants from West Bengal, Orissa, Uttar Pradesh and Haryana took part in the workshop. The main resource persons were Dr. Samar Bagchi and Dr. B. N. Das. Several other resource persons were also invited for the workshop. Some of the salient features of the workshop are given below.

1. It was an interactive workshop. Participant-teachers took part in the demonstrations of the experiments and they were also encouraged to suggest improvements and alternatives. In some cases participant-teachers did suggest improvements and alternatives.

Demonstratrion by a teacher-participant

2. The workshop was not simply confined to demonstration of experiments but due emphasis was also given on the concepts/principles associated with the experiments.
3. Each day there was a session of about 2-hour duration where teacher-participants demonstrated experiments devised by them or made presentation on how they are teaching certain topics with the help of demonstrations.
4. There were two sessions where school children participated. In these sessions particular lessons taught in their classes were demonstrated with experiments. The idea was to show how the concepts/principles taught in their classes could be demonstrated through real experiments.

Dr. Samar Bagchi observing a demonstratrion by a participant-teacher. Also seen (sitting from L to R) Dr. B. N. Das and Dr. Subodh Mahanti

In the inaugural session Dr. Subodh Mahanti, Scientist "F", Vigyan Prasar, made a brief presentation on the activities of Vigyan Prasar. He also noted that though Vigyan Prasar is not directly involved in the formal education sector, it has initiated a number of activities to make school science teaching more interactive and entertaining. Vigyan Prasar has been organising training programmes/workshops for school teachers and students in various parts of the country to show how the demonstration experiments and activity kits developed by Vigyan Prasar can make teaching-learning a fun and at the same time instructive. In the absence of experimental demonstration teaching becomes dull and boring and this is one of the reasons why students are not getting attracted to science. However, mere demonstration of experiments without explaining the concepts/principles is not very useful. He pointed out that in most schools students are not well exposed to experiments. Even in chemistry, which is an experimental science, the emphasis is not placed on experiments. He also made a few comments on the art of teaching. Dr. Mahanti briefly described the activities initiated by Vigyan Prasar on the occasion of the International Year of Chemistry-2011. At the end Dr. Mahanti observed that dedication and commitment of Dr. Bagchi and Dr. Das are worth emulating by others. ■

Dr. Mahanti addressing the participants

Dr. Samar Bagchi interacting with school students