Darshana Jolts

The World Above – 1

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Preamble

Darshana is a Sanskrit word which means *seeing*, *knowing*, *worldview*, and *philosophy*. It also refers to the vision one has of the Divine or of a representation of it. *Darshana* expresses how the human mind perceives the world of experience. In this series I will be using the term to refer to the revolutionarily new perceptions of the physical world that have arisen as a result of the science of the past four centuries. It is important to recognize these in the current context of India's intellectual history. Because of the unhappy intrusions of the British into India and her political sovereignty for over two centuries, along with the understandable historical rancor against the West, there has also arisen the mistaken notion that modern science is Western in its essence, and needs to be challenged by ancient Indian science. Fortunately, this is ignored by and large by the growing body of Indian scientists.

Modern science emerged, evolved, and molded human civilization in unprecedented ways during the past four and odd centuries. By any fair, knowledgeable, and objective reckoning, the centuries from the seventeenth to the twentieth have been among the most significant ones in human history. Many people in the modern world do not realize the dramatic ways in which humanity's worldviews have been shaken and re-formulated. Those who have assimilated the newer worldviews are not always aware of when and how the extraordinary findings of modern science became part of humanity's collective consciousness. Much less is it realized how and when so much new knowledge came to our understanding in the course of these past few centuries. As a result, it is sometimes simplistically claimed that all the complex concepts and results of modern science were known to distant generations in ancient times.

In this series I will be presenting some of the major jolts in our *darshana* of perceived reality that have occurred as a result of the rise of modern science. Philosophical criticisms of science to the effect that scientific knowledge is limited, that science cannot create life, etc., and apologists for ancient worldviews notwithstanding, the fact remains that even the social, political, and ethical bases of human civilization have been drastically transformed, for the good and in some cases for the bad, by the rise of science. (From now on, by *science* I will mean *modern science*.)

I will recall such *darshana* jolts under ten broad headings, devoting two articles for each.

Introduction

Science started probably from the wonder that is the sky above. It is up there, distant from where we stand and move, providing us with a cosmic dome that brightens and darkens at regular intervals. At daybreak the effulgent Sun shows up with meticulous punctuality, splashing the world around with lavish light, enabling us to go about our daily chores. Then at night, it silently recedes, and the twinkling stars appear as if to say we are not left alone in deep darkness, along with the magical moon that waxes and wanes in regular rhythms.

Our ancestors of the remote past must have found all this to be fascinating, as we do too in our observant or reflective moments. Some of them in various cultures studied the celestial changes with care and keenness, and they discovered patterns and periodicities there. So the ancients discovered a 365 day cycle in seasonal changes and a 30 day one in lunar aspects. Some ancients also detected that among the hundreds of lighted dots sprinkled up on high, a few move somewhat differently. Thus were recognized the planets of ancient astronomy: Aside from the bright Sun and the huge moon, our ancestors spotted Mercury and Venus, Mars, Jupiter, and Saturn also[1]. All these, along with the countless stars, seem to be fixed and turning on a celestial sphere, gyrating around what seems to be our fixed abode: the Earth strikes us as being at the center of it all.

What a glorious worldview it was: a whole universe of unfathomable dimensions whirling around our terrestrial home which is located firmly smack at the center of it all. This picture resonates perfectly with our daily experiences in which each one of us is a center of the world as we see events and things come and go on the plane of our consciousness.

The ancients also pictured forms and shapes in the stellar splash of the nocturnal sky. They pictured in them images like a swan, a serpent, a horse, and more. They wove fascinating tales around the figures and created magnificent mythologies to describe the major constellations: a hunter here, a fish there, seven sages here, six sisters there, and so on[2].

Ancient Greek thinkers considered the depths of space in different ways. There was the infinity of Anaximander, the void of the Pythagoreans, the non-being of Parmenides, etc. Plato spoke of *chora*, a space which once emerged in the grand, and then gelled into *topos*, the space we

[1] The Babylonians are reckoned to be among the earliest to identify and name these five planets, consecrating a day to each of them as well as one each to the Sun and the moon: this is the origin of our seven-day week. We can recall this dedication in the names of the week in all languages, in Indian languages and in Sanskrit as well.

[2] There are fascinating mythological stories in different cultures associated with many of the major constellations. In the Hindu tradition, for example, the North Star (Polaris) is viewed as *Dhruva*, the Great Bear (Ursa major) was taken to be the *Saptarshi* (the Seven Ages), and the Pleiades was pictured as *Karrtikeya*.

experience today. Aristotle interpreted them as global and local spaces, comparing them to a country and a region in it[3].

In ancient Hindu thought there was something called *âkâsha* which was also taken to be one of the five primordial elements. It was the subtlest of them all, and endowed with the special property of sound which is manifest in the whole universe[4]. It was the vast expanse, limitless and all-pervading, yet distinct from space and time. On the physical plane, was the dark sky above, intangible and unattainable, but at the esoteric level it represented a mystical void whose apprehension is what spiritual enlightenment was all about[5].

Chinese thinkers spoke of *ch'i*, the all-pervading pristine principle from which everything arose. It is ever present as the life-giving entity for the entire universe. It is subtle, yet can be manifested as the material world, and it permeates the animate as well as the inanimate. It has pathways in the human body, and it keeps the body salubrious and in balance[6].

The efforts of ancient astronomers led to many interesting results, some valid, some not quite. Many of these were collected and presented in various texts of the classical world, like *Almagest* of Claudius Ptolameus of Alexandria[7] and *Sûrya Siddhanta* in India[8]. But in all these works, this was always the running perspective: that the Earth was at the center of a vast universe around which every celestial object revolves in perfectly circular orbits. For many long centuries, the world of astronomy rested on this fundamental principle which seems to be intuitively true from common sense experience.

That is what the game of science is all about: to go beyond the impressions created by our sensory perceptions and uncover how things really are. Science is an effort to get the views behind the veil of phenomena. Its successes emerged from the recognition that those views

[3] Aristotle said, "Place is what is motionless: it is the whole river that is place, because as a whole it is motionless."

[4] The belief was/is that the sacred *aum* is a cosmic vibration taking place here.

[5] In the *santum sanctorum* of the temple at Chidambaram, famous for its sublime icon of Nataraja (the Dancing Shiva), there is a sacred sector where naught is present: that is said to be *âkâsha*, the subtle symbol of spiritual vision.

[6] The notion of *ch'i* as a subtle energy principle continues to play a role in the framework of Chinese medicine to this day.

[7] The book, dating back roughly to the second century C E, was known respectfully as *Megale mathematike syntaxis* (Great mathematical composition). It was one of the first scientific treatises that exploited the power of mathematics in the description of the physical world: With it one could calculate with impressive precision when eclipses would occur, a knowledge which many ancient cultures had. There was a long span of European history when Ptolemy was all but forgotten until his work was recovered by Arab scholars who rendered it in the 9th century C E into their language, describing it as *Al-kitabu-l-mijisti: The Great Book*, by which name (modified) it came to be known by European scholars from the 12th century on: *Almagest*.

[8] This book is generally dated as belonging to the 6th century CE.

cannot be obtained from speculations, however ingenious and creative, but only through hard and systematic work, using tools, instruments, and measuring devices, as well as concepts and analyses. They can never be gathered from the lofty pronouncements of revered authorities whose role may be in guiding people on ethical matters, but whose solemn utterances on the how and why of natural phenomena are never assurances of their validity.

Non-Geocentricity: *We revolve about the Sun like the other planet*[9].

For whatever reason, the inner workings of the world are far from being clear to the normal human mind. Nature seems to be deceptive for she misleads us into believing just the opposite of what actually is the case. Thus, the Sun seems to *rise* and *set*, and to all appearances, it is the Earth that stands still at the center of the universe, the entire stellar heavens making grand circumambulatory dances around it. But some keen minds here and there in the ancient world had suspected otherwise[10].

In the year 1543 a book entitled *De revolutionibus orbium coelestium* (*On the Revolutions of the Heavenly Spheres*) was published, authored by Nicolas Copernicus, a Polish canon who had studied law in Bologna, and taught at the University of Cracow [11]. This work explained how all celestial motions could be understood in a much elegant manner than in the ancient system of Ptolemy, by imagining the Sun, rather than the Earth, to be at the center of it all. The Copernican system was based on extensive and careful observations and it gave due credit to at least some, if not all, its predecessors, including some eminent Arab astronomers. Its merit lay, not in being simpler than the Ptolemaic, but in its elegance. Planetary orbits did not have to be treated separately, but as being part of a single system. In the Copernican model, the Sun was placed, not in the center of the planets' orbits, but somewhat quite close to it.

The presentation of the key idea was in poetical as well as in scientific terms, for Copernicus wrote: "In the middle of all sits the Sun enthroned. In this most beautiful temple could we place this luminary in any better position from which he can illuminate the whole at once? He is rightly called the Lamp, the Mind, and the Ruler of the Universe."

This was a major *darshana* jolt, for it threw to the winds a worldview that is intuitively obvious to us all: a fixed Earth around which revolve the starry heavens. But it also contradicted some holy books. So it was not received with great enthusiasm by the religious establishment of the

[9] From now on every *darshana* jolt will be indicated in italics at the beginning of a section.

[10] For example, Aristarchus of Samos (4th century BCE) and Brahmagupta of Ujjain (6th century CE) are said to have suggested the geocentric view of the universe.

[11] For a fascinating history of this book see, Owen Gingerich, *The Book Nobody Read: Chasing the Revolutions of Nicolaus Copernicus*, Walker, New York, 2004.

day under whose auspices the work was published[12]. The book struck some thinkers of the age as the idea of an impertinent upstart who had the temerity to challenge the *Book of Job*.

Be that as it may, the Copernican insight finally won: *The crux of that insight was not that the Sun was at the center of the universe, but that the Earth was not*. This was a culture shock at the time. To be dethroned from the cosmic center was a major deflation of the human ego.

Today we know that the Earth is moving through space along its orbit around the Sun at the incredible speed of some 30 km/s, and we also know the orbital speeds of other planets, ranging from the dizzy speed of Mercury at almost 50 km/s to the slow pace of Pluto of barely 5 km/s. We have estimated, moreover, that the Sun itself is hurtling along a much larger orbit at more than 200 km/s!

Thus, as a result of the Copernican discovery, our worldview on the structure of the Universe has drastically changed. The starry sky is not a calm and cold dome of bright little heavenly lamps or mythic heroes routinely revolving around a static center that is our Earth, but a spray of stars scattered at random, of which our Sun is but one around which many planets whirl.

This was indeed the conceptual big bang. The very first discovery of this science was to dethrone the Earth and humanity from the pedestal of cosmic centrality to a modest point in what seemed like boundless space.

Planetary Orbits: *Planets move in orbs elliptic*.

In our own times, most people who have had even a slight acquaintance with science may know that the Earth is orbiting around the Sun. But they may be inclined to imagine that orbit to be circular. Since ancient times, celestial motions were regarded as perfectly circular, and Copernicus himself thought that it was so.

One of the earliest staunch supporters of the Copernican view was Johannes Kepler, a mystical-minded mathematically-inclined thinker who used to cast horoscopes aplenty and made broad astrological predictions that would embarrass any modern astronomer. Kepler had speculated on the reason for the number of planets on the basis of perfect geometrical patterns, and saw in

[12] Martin Luther, the founder of what became Protestantism declared, "This fool wishes to reverse the entire science of astronomy; but sacred Scripture tells us that Joshua commanded the Sun to stand still, and not the Earth." Copernicus might have been brought to the court of the Inquisition, but the man died on the very day his Earth-upsetting treatise came out of the publishing house. So the Catholic Church simply declared the notion to be heretical. Pope Paul V issued a decree by which "the doctrine of the double motion of the Earth about its axis and about the Sun is false, and entirely contrary to Holy Scripture."

them the music of the spheres [13], attributing specific notes to the various planets. He said that there was no audible sound there but that "the movements of the planets are modulated according to harmonic proportions."

By his painstaking analysis of the data on the orbit of Mars, which had been collected by the Danish astronomer Tycho Brahe with whom he had come in close contact fortuitously, Kepler was led to some fundamental conclusions regarding planetary motions. These have come to be known as *Kepler's Laws*. The first of these is that planets move in elliptical, not circular orbits, around the Sun. Ellipses are curves which are at the bottom of a right circular cone which is sliced (without cutting the base) along a plane not parallel to the base. With their sister figures, the parabola and the hyperbola, these had been studied since antiquity. An ellipse, has a major and a minor axis, as also two foci. Kepler discovered that planets move in elliptical orbits, with the Sun at one of the foci. No one before Kepler had any inkling that these were the curved paths along which planets move[14].

Kepler's second law states how the velocity of a planet varies with its position in the orbit. Kepler published these results in a book entitled *Astronomia nova*: *New Astronomy* which appeared in 1609 [15]. Kepler's third law of planetary motion gives the mathematical relationship between the distance and the period of revolution (planetary year) of a planet. This was published a decade later in another book that he wrote [16].

Kepler's first law was another *darshana* jolt in that it gave a death-blow to another ancient world view: that celestial motions are always perfectly circular, an idea that was the basis of practically all pre-Keplerian astronomy. The circular motion of celestial bodies was an important tenet in Aristotelian physics which was taught for centuries in Arab and European universities. Even Galileo accepted this to be true. After Kepler's discovery, there was nothing magical or mystical about circles in the heavens. But a new question now arose in the minds of investigators: Why do planets move in elliptical, rather than in circular orbits? Kepler himself tried to answer this question in terms of magnetic forces emanating from the Sun, but his attempt was not successful.

Kepler's laws were the first universal laws to be formulated in the context of modern science.

[13] The idea of the music of the spheres goes back to Pythagoras in the Western tradition. Hindus believe(d), likewise, that there are cosmic sounds which the spiritually enlightened heard and articulated as the Vedas.

[14] Ellipses had been studied by Greek geometers centuries before, especially by Apollonius (3rd century BCE).

[15] This massive work is of more than 650 pages; William H Donahue, *Johannes Kepler, New Astronomy*, Cambridge University Press, Cambridge, 1992.

[16] Kepler's third law, which states the relations between the orbital periods of planets and their distances from the Sun, has been used to determine the distance of the planets from the Sun.

Unlike the thesis of Copernicus, they did not create any commotion from the religious establishment. Indeed, very few people paid any attention to Kepler's laws which were too mathematical and abstruse.

Satellites: ***There are more moons in the heavens than we see with our naked eyes.***

Human beings have been seeing the moon since time immemorial. All ancient cultures noticed its changing phases, and wondered about its brightness and serenity. Some constructed calendars on the basis of these, and religious traditions continue to reckon festive days in terms of the lunar calendar[17]. Since remote times, the moon has been recognized as the closest celestial body circling the Earth. Moreover, in the ancient worldview, no other planet had other bodies circumambulating it. In this matter also the Earth was considered the only body of this kind in the entire universe.

When the Copernican picture was put forward, one had to imagine the Sun to be fixed, and it was difficult to understand how a body (the moon) could circle around a moving Earth. This was one of the problems in the Copernican model.

On the night of January 17th 1610, Galileo Galilei peered through his newly invented telescope and directed it towards the planet Jupiter. He thought he saw three faint stars in its vicinity and was intrigued by this observation. Then he made it a habit to see Jupiter and the 'stars nearby' night after night. Before a week was over, he spotted a fourth faint object in the region. Galileo watched them patiently and made a great discovery: What he was observing were minor bodies revolving around Jupiter!

Galileo's patron was the Grand Duke of Tuscany, known as Cosimo de Medici. Galileo named these tiny spots in his honor and called them Medicean planets. Though he used the word planets, they were not like Mercury, Mars or Venus, but more like our own moon, whirling around another planet. When Kepler heard about Galileo's discovery, he thought of the Latin word *satelles* which means an attendant or a guard. So he suggested that these Jovian companions be called *satellites*. The name stuck for a long time[18].

It may be noted in passing that Galileo made other interesting discoveries with his simple

[17] Divali and other festivals in the Hindu tradition, Easter in Christendom, Passover in the Judaic tradition, Ramadan in Islam, etc., are all reckoned on the basis of lunar calendars.

[18] Modern astronomers prefer the word moon to planetary satellites. According to a recent suspicion (David Jamieson, Science Daily, Oct. 24, 2009) Galileo may have also discovered what we call the planet Neptune, 234 years before it was actually recognized as such. He thought it was a star. Thus, unwittingly, he described a satellite as a planet and a planet as a star.

telescope, such as lunar craters and the granular structure of *Via Lactea* or the Milky Way [19]. He presented all his astronomical findings in a slim volume entitled, *Sidereus nuncius* (The *Sidereal or Starry Messenger*) [20]. In this book which was published in 1610 (four hundred years ago), in the same year as Kepler's *New Astronomy*, Galileo estimated some lunar mountains to be about four miles high: This was the first measurement, albeit indirect, of something high up in the heavens.

Unlike Kepler's book, The *Starry Messenger* was a great success right away. For one thing, it described matters which anyone could understand. Moreover, it did not have any mathematical symbols, which made it much more readable. And yet, it shocked some traditionalists: thinkers who find it difficult to adapt to new worldviews. So some called Galileo a fraud, or suspected that dust particles on the eye-piece of his telescope probably created the illusion of other planets. Others tried to prove theoretically that there could not be more than seven planets, given that the human face has only seven openings: two eyes, two nostrils, two ears, and a mouth. Galileo did not deign to rebut such logic which has not disappeared from human cultures to this day. In due course, one had to accept the existence of the four satellites that Galileo had reported; indeed, more such bodies were found encircling Jupiter and other planets also.

Indeed, since then, with more powerful instruments, observational astronomers have discovered some seventeen moons circling Jupiter and more than 330 satellites orbiting the various planets of the solar system. In addition, human beings have launched hundreds of satellites which circle our planet and serve us in many ways.

Revolutionary discoveries and insights that jolt the long-accepted *darshanas* seldom emerge without provoking angry reactions. The reason for this is that if it is difficult to adopt a new world picture, it is also painful and frustrating to have to abandon a long-cherished worldview, especially when it is affiliated to a religious tradition. People of all faiths experience psychological discomfort to let go of what they have been believing to be true because they been told so since early childhood by sanctified sources about the nature and properties of the world.

In this context it should be emphasized that a vast number of significant discoveries about the world were made because of instruments, of which the telescope is a prime example. The ancients were enormously limited by the fact that they did not have instruments to enhance the range and sensitivity of our faculties of perception.

[19] This name is derived from the Greek word *Galaxias*, meaning a path of milk. Indian astronomers referred to it as *Akâsh Ganga*, the Sacred River in the Heavens. Chinese observers also called it *Tien Ho*, The Celestial River, while for Arab astronomers it was simply *Al Nahr*, the River.

[20] This is a slim book, a science classic that every student of science should read. Several editions of it are available in English.

Other Planets: ***There are more planets than the days of the week.***

To the ancients and their faithful disciples such as modern day astrologers there are seven planets: the Sun, the Moon, Mercury, Venus, Mars, Jupiter, and Saturn[21]. This led to the mysticism associated with the number seven which persists in our own times[22].

The Copernican picture removed the Sun and the Moon from the planetary list, and added Earth to it. By the eighteenth century astronomers knew of only six planets, their satellites, and countless stars. Then something interesting happened. In 1781, William Herschel, a German émigré-astronomer in England, spotted through his telescope a faint disk-shaped object near the constellation of Gemini. First he interpreted this as a comet. The object had been recognized before by other astronomers, but they had mistaken it for a comet or a satellite of Venus. Anders Lexell, a Swedish mathematician-astronomer who was working in St. Petersburg, after carefully studying Herschel's "comet", declared that Herschel had actually discovered a new *planet*, not a comet [23]. Contrary to Herschel's first recommendation that it be called *Georgium Sidus* (in honor of King George III of England), the planet was named Uranus[24].

There was more to come. Meticulous observations of the positions and paths of the new-found planet revealed certain discrepancies. As per Kepler's laws and Newtonian planetary dynamics one expected Uranus to be moving along a certain course, but it seemed to be deviating from this mathematically calculated orbit. It was suspected that this might be due the perturbing (gravitational) influence of another massive planet not too far away. From the observed positions of Uranus celestial mechanists calculated where such a planet could be expected to be. In 1845, John Couch Adams announced that according to his calculations "the observed irregularities in the motion of Uranus may be accounted for by supposing the existence of an exterior planet, the mass and orbit of which are as follows..."[25]

In our own times, philosophers and nonscientific commentators glibly point to the limitations of science, and man-made constructs of mathematics, pleading equal validity and importance to

[21] Hindu astronomers added two more, *Rahu* and *Ketu*, which have astronomical significance (lunar nodes) as well as mythological. Thus, in the tradition, one offers prayer to the nine planets *nava-graha*. Hindu esoteric literature refers to the body as with nine gates: *navadvâra*, as in God's city.

[22] From the creation of the world in seven days in the Book of Genesis and the seven wise men of Greece and of India to Snow White and the Seven Dwarfs and the seven cardinal sins, we have countless examples of the special place that the number seven holds in human culture.

[23] For more on the fascinating story of Uranus see Ellis D Miner, *Uranus: The Planet, Rings and Satellites*, John Wiley and Sons, New York, 1998.

[24] The name was proposed by Urbain Le Verrier, another mathematical astronomer who too had accounted for the erratic behavior of Uranus in terms of a new planet.

[25] D Rines, Quoted in "The Discovery of the Planet Neptune," *Popular Astronomy*, Vol.20, p.483, 1912.

"other modes of apprehending reality". They would do well to pause and reflect on the scientific achievements of this kind: discovery of an invisible planet using mathematics based on physical theories.

Based on such results, Johanne Galle of Berlin Observatory, along with his young assistant Heinrich d'Arrest, spotted on the night of September 23, 1846, yet another new planet: It came to be named Neptune[26]. The same story was repeated when Percival Lowell noted some discrepancy in the motion of Uranus, and surmised the existence of yet another planet. His suspicion was confirmed in 1930 when such a planet was discovered by Clyde Tombaugh. This (thus far known) furthermost planetary body in our solar system is called Pluto[27].

Asteroids: *There are more things in the solar system than the moons and the planets*.

Comets had been seen since time immemorial. The name is derived from the Greek word *kometes* which means long-haired. In Sanskrit they are known as *dhûm-ketu*: a smoky bright object, and Tamil as *vâl-nakshatram*: a tailed star. But aside from comets, nothing else was known in the solar system besides planets and their satellites, and of course the moon, until January 1, 1800. On that date, a new faint object was detected in the sky by Giuseppe Piazzi, a monk-astronomer in Palermo in Sicily [28]. When news of this discovery spread, it was suspected to be a new star or perhaps a new planet. But detailed observations led to its location as somewhere between Mars and Jupiter. Because it had seemed star-like, it was called an *asteroid* which means just that. But the more correct description for it would be *planetoid*[29]. This first known planetoid was called *Cere*s after the mythic goddess of Sicily. Its dimension is of the order of a few hundred kilometers, and is among the largest planetoids known. More than two thousand planetoids have been spotted and named. They bear such names as *Pallas*, *Metis*, *Victoria*, and *Chiron*. The thousandth one, discovered in 1923, was named *Piazzia* in honor of the discoverer of the first one[30].

Today we know that the majority of the planetoids have orbits between those of Mars and Jupiter. There are several theories as to how they came to be. One of them is that they are the debris of a planet that once existed between Mars and Jupiter, but which somehow exploded.

[26] Dale P Cruikshank, *Neptune and Triton*. University of Arizona Press, 1996.

[27] Tombaugh, Clyde; Patrick Moore, *Out of the Darkness: The Planet Pluto*. Harrisburg, PA: Stackpole Books, 1980. We may mention here that in 2006 the International Astronomical Union voted to demote Pluto into a dwarf-planet of which there are more than 40 in our solar system.

[28] C J Cunningham, *The First Asteroid*. Star Lab Press, 2001.

[29] Technically, these bodies are referred to by the unromantic name of *Small Solar System Bodies* (SSSBs). There are also Trans-Neptunian Objects (TNOs) in our solar system.

[30] By convention one adds a number in front to indicate the order in which it was discovered. Thus, for example, we have 12 Victoria and 1000 Piazzia. See Lutz B Schmadel, *Dictionary of minor planet names* (online Edition). Springer Verlag, Berlin/Heidelberg, 2006.

Thus, now there is a huge collection of odd shaped rocky chunks of various sizes orbiting around the Sun, like the planets. If they come close enough to a planet they could be grabbed by the latter's gravitational pull and become its moon. It is believed that one of the moons of Mars was once a planetoid that got trapped this way. Another possibility is that they may collide with a planet and cause a massive catastrophe. However, astronomers have calculated that this is only a very, very remote possibility for the Earth: maybe once every 100,000 years. Some years ago there was a scare to the effect that a certain asteroid would hit the Earth in the year 2028. More careful studies have shown that this simply will not occur, though it could come close enough to the Earth: from twenty-five to seven hundred thousand km from the Earth. The consensus is that such an asteroid would be detected well ahead of any such intrusion into our lives and could be detracted from its collision course by Earth-bound scientists[31].

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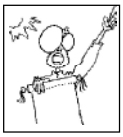
[31]CNN News report, September 2, 2003.



Information and Announcements

Crystallography School

22 November – 4 December, 2010

Networking Resource Centre (Funded by UGC), School of Chemistry, University of Hyderabad, Hyderabad.

The Centre is organising a Crystallography School (Theory and Practice of Structure Determination using Single Crystal X-ray Crystallography) for Research Students. The training school will consist of lectures, tutorials and practice sessions. Students pursuing a research program (M.Phil., Ph.D., Post-doctoral) are invited to apply. Participation is limited to 20 students. Travelling as well as a maintenance allowance will be paid by the Centre. There is no registration fee. Selection will be made based on academic record and research experience. Preference will be given to applicants from colleges and universities. The application form may be downloaded from the Centre's website http://chemistry.uohyd.ernet.in/~nwc . The completed form may be sent by post or by e-mail (nwcsc@uohyd.ernet.in), not later than **November 5, 2010.**

Science Academies Refresher Course on Modern Biotechnological Techniques

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Last date for receipt of applications**: 10 November 2010.**