

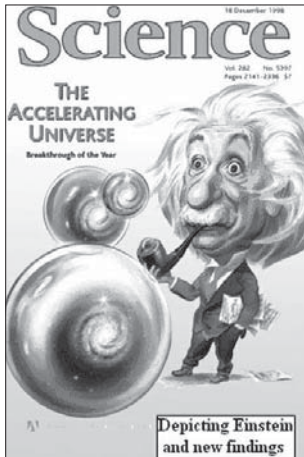
New light on dark energy

A survey of the sky supports the idea that the expansion of the universe is accelerating, says s ananthanarayanan

THEORIES

To explain the cosmos have been a seesaw ride during the last century. While Albert Einstein tried to give a theoretical base to the idea of a "static universe", facts showed that the universe, in fact, was expanding. And then the 2011 Nobel Prize for Physics went to a trio that showed that the expansion itself was getting faster. This last finding speaks strongly for a mysterious "dark energy" that pervades the universe and allows a repulsive gravity force. It is in this context that a confirmation of the observed acceleration of the expansion of the universe through a different and independent route has been reported by Masamune Oguri of the Kavli Institute of Physics and Mathematics of the Universe, at Tokyo, and Naohisa Inada of the Nara National College of Technology, Japan, in a study to soon appear in *The Astronomical Journal*.

Einstein reinterpreted the laws of motion to stay in keeping with the observation that the speed of light stayed unchanged when measured by observers in relative motion. The theory revolutionised the understanding of energy and mass, with the famous $E=mc^2$ formula, and then with the idea that gravity arises from a curvature that mass introduces in space itself, all of which has been accurately



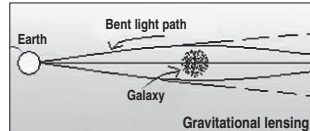
Depicting Einstein and new findings



Masamune Oguri and Naohisa Inada.

verified. But when the ideas were applied to the cosmos, they created a problem — how to keep the universe from collapsing into itself. Einstein found a way round by introducing a term called the *cosmological constant* in his equations, which balanced the gravitational attraction, to ensure a "steady universe". But facts soon showed that the universe, in fact, was not steady; that it was expanding.

In the 1920s, Edwin Hubble discovered that distant objects in the cosmos were receding and the more distant ones were receding faster! This finding has been verified with the help of the spectral lines of light from distant objects. It is known that waves from a receding object get shifted towards longer wavelengths. An example is the whistle of a speeding locomotive — the pitch of the whistle distinctly drops when the locomotive goes past and changes from an approaching object to a receding one. If the objects are receding, the frequency of the light they emit should be shifted, towards lower wavelengths. The light from cosmic objects is seen to have shifted towards longer, red wavelength, which shows that they are receding.



And the red shift, as the observation is called, becomes greater when the objects observed are further away. The effect is found to be so uniform that measurement of red shift has become a way to find out how far an object, like a star, is from earth.

Inflation

This observation that the universe was not steady but was expanding showed that the device that Einstein had introduced to counter to reality. In 1922, Alexander Friedmann, a Russian, showed that Einstein's equations, in fact, did not need the cosmological constant at all; they themselves led to a dynamical universe — an idea that was developed into the currently accepted expanding universe, a universe that came into being with the *Big Bang*. Einstein is reputed to have regretted having conceived the cosmological constant — but for the refuge it provided from a collapsing universe, he might have proposed the expanding universe before Hubble made the discovery!

In 1948, George Gamow, who invented the term "Big Bang", developed Friedman's work, with R Herman and RA Alpher, to show that the early universe must have been fiercely hot, and the radiation that was emitted should be present, as a microwave background to this day. This radiation was soon found, but there was a problem; the radiation was isotropic, or the same in all directions. Theoretically, this was not possible as there could not have been time for the radiation to diffuse and become uniform in this way. This difficulty was overcome by the idea of *inflation* — using Einstein's cosmological constant again, in a different manner. Alan Guth, in 1981, arrived at an *energy density* of empty space, with a *negative pressure*, which corresponds to *reverse gravity*. This is the force that drives the expansion of the universe and also allows a period of time when the universe was small and when different parts could communicate and grow uniform.

Speed of recession

While gravitational forces resulted in the formation of stars and galaxies, supernovae and the elements, Friedman's work says that the actual energy density of the universe would decide

whether the expansion would continue or would slow down and then reverse. It thus became a matter of interest to determine the rate of expansion of the universe — was it steady or was it slowing down? Two teams of researchers at the Universities of Michigan and Harvard took up the study with the help of supernova data. The reckoning of the distance of objects from earth has been done with the help of *variable stars* or stars that show periodic variation in brightness. It has been shown that the speed of variation is related to the actual brightness of the star, as opposed to its apparent brightness, when seen from a distance. If the real brightness of a variable star is worked out by observing its rate of brightening and dimming, the relationship of the real and apparent brightness helps make an estimate of the distance itself. The method has been refined by verification with formations at known distances and the method is now the standard method of distance estimation.

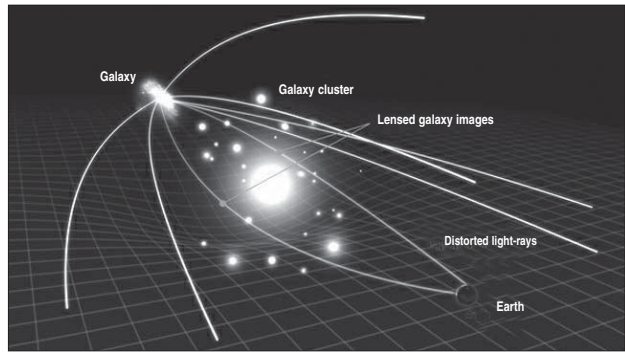
The same effect with a certain class of supernovae, which shine with consistent peak brightness, can similarly yield distance estimates at much greater distances — greater because supernovae are brighter than usual variable stars and can be seen from really distant places. The teams at Michigan and Harvard carried out a survey of supernovae that showed large red-shift and determined their distances. Displaying the red-shift, which indicates the speed of recession, against the distance would paint a picture of how the speed of recession behaves at different distances. The results of the study were eye-opening — the rate of recession was not slowing down at all, it was increasing! The conclusion then was that the expansion of the universe was accelerating and the universe was filled with invisible *dark energy*, and Guth's version of Einstein's equations was valid. Adam Riess, Brian Schmidt and Saul Perlmutter were awarded the Nobel Prize in Physics in 2011 for this discovery.

Verification
Masamune Oguri and Naohisa Inada have made use of statistical data, rather than direct measurements, to conclude that cosmic distances are indeed growing at an increasing pace, which is to say that they are accelerating. The method they used consists of analysis of the mass of

data collected in the Sloan Digital Sky Survey, a project in New Mexico, USA, which has collected spectral and huge red-shift data of the cosmos since 2000.

The team first scanned the data for very bright, distant objects called quasars. Quasars, or quasi stellar radio sources, are the glow of material crashing into massive black holes at the centres of galaxies, the *active galactic nuclei*. Such objects, at very great distances, arise from such high energy flows that they are exceedingly luminous. These distant, fiery beacons were used to trace galaxies that lay in the path from the quasar to earth. The presence of a massive galaxy results in the bending of light that comes from the quasar and displacing its position, as seen from earth. If the galaxy is right in the light path, light that would otherwise shine away from earth can be "lensed" in to allow multiple images of the quasar to be detected. Such images are called *cosmic mirages* and their detection indicates that there is a galaxy squarely in the path from the quasar.

While about 100 instances of mirage quasars have been reported so far, the study of some 100,000 quasars in the SDSS data revealed another 50 mirages. Now, given the mass of galaxies and the geometry of the quasar-earth path, the mirage formation is possible only if the distances separating the three objects are large indeed. The team of researchers estimated the probability of such occurrences given different cosmological models and found that the discoveries made were possible only with the distances of an accelerating universe. "The uniform expansion also increases the distance, but the accelerated expansion makes the distance even longer compared with non-accelerated case," says Professor



A diagram (not to scale) of how gravitational lensing works.

Masamune Oguri. The observed frequency of gravitational lensing was about 0.05 per cent, and theoretical calculations showed that this level of mirage detection, given the quasar catalog, was possible only if the universe were actually accelerating. The finding has bolstered the credibility of the work of Adam Riess and others, based on

supernova data, which involved some assumptions. "This result is important in that it confirms the presence of dark energy independently from the observation of supernovae," says Professor Masashi Chiba of Tohoku university.

The writer can be contacted at simplescience@gmail.com

TENDER

WEST BENGAL STATE ELECTRICITY TRANSMISSION COMPANY LIMITED
(A Govt. of West Bengal Enterprise)

NOTICE INVITING TENDER
WBSETCL invites sealed bids from eligible bidders for:

- NIT No. -CETR(O&M)/ACE/T-II/Tender/2012-13/Cvt/01, dt. 12/04/2012. WBSETCL, Dist. - Dakshin, Dinajpur. Construction of Boundary wall at vacant portion of Balurghat 132/33 KV S/Str.
- NIT No. -CETR(O&M)/ACE/T-II/Tender/2012-13/Cvt/02, dt. 12/04/2012. WBSETCL, Dist. - Malda. Laying and spreading of crushed stone over a layer of cement, sand and jama khaa mix and other allied works at switchyard of Samei 132/33 KV S/Str.

Bid documents shall be on sale from 20.04.2012 to 08.05.2012 on all working days (except Saturdays) between 11 am & 2 pm. Bids shall be received up to 3 pm on 11.05.2012 and shall be opened on 11.05.2012 at 4 pm. Interested bidders shall obtain detailed each NIT and bidding documents from Chief Engineer, Tr-(O&M), 10th fl. 'D' block, Vidyut Bhawan, Salt Lake, Kol-91 (Ph. No. 033-2359-1895) on payment of prescribed cost of each bidding documents. Detailed NIT and bidding documents are also available on the Company's website (www.wbsetcl.in) and can be downloaded for bidders' information. Bid submission should however be made on the bid documents purchased from WBSETCL and as amended from time to time. Chief Engineer, Tr.-(O&M)

HIDCO
West Bengal Housing Infrastructure Development Corporation Limited
(A Govt. of West Bengal Undertaking)
HIDCO BHABAN, Premises No. 35-1111, Mayor Avenue Road, 3rd Rotary, New Town, Kolkata-700 156
Telephone No. (033) 2324-9377 / 33; website: www.hidcotd.com

EXPRESSION OF INTEREST
Notice No.388/HIDCO/Ping/142/2/2012 Dated : 12.04.2012

Expression of Interest (EOI) is invited from reputed / experienced organizations for preparation / amendment of Land Use and Development Control Plans (LUDCP) by using satellite images/ field survey with Total Station where necessary for an area of 60.25 sq.km. (more or less) adjoining New Town, Rajarhat. The successful applicant shall have to complete the work within six months from the date of award of the work. The Expression of Interest (EOI) is to be submitted to the Chief Planner, Central Planning wing at HIDCO Bhawan, New Town, by 30.04.2012. For other details please visit the website : www.wbhidcotd.com or contact Central Planning wing, WBHIDCO.

GOVERNMENT OF MAHARASHTRA
Public Works Department (National Highways)
Tender Notification under e-Procurement
(1st Call)

Online tenders in form B-2 item rate basis are invited on behalf of Governor of Maharashtra from qualified bidders for the following works under e-procurement procedure.

System Tender No.	Package No.	Name of work	Approximate Value of work (Rs.)	Bid Security (Rs.)*	Cost of documents (Rs.)	Period of completion
1	2	3	4	5	6	7
		Improvement to riding quality from Km. 244/000 to Km. 258/000 Pune-Solapur-Hyderabad Road N.H. 9 in the State of Maharashtra,	9,69,83,902	19.40 lakh	25,000	15 (fifteen) calendar months including monsoon

TENDER SCHEDULE:

Period of download of bidding document : From 17-04-2012, Time: 10-00 hours To 14-05-2012, Time: 17-30 hours.

Pre-bid conference date, time and venue : On 07-05-2012@ 14-00 hrs. in the office of the Chief Engineer, National Highway (P.W.), Konkan Bhavan, Navi Mumbai. : Up to 30-04-2012, Time: 14-00 hours.

Last date and time for receipt of queries for pre-bid conference online : Up to 30-04-2012, Time: 14-00 hours.

Last date and time for online bid preparation and hash submission (technical and financial) : Date: 18-05-2012, Time: 17-30 hours.

Date and time for online bid data decryption and re-encryption (technical and financial) : From 18-05-2012, Time: 17-31 hours To 22-05-2012, Time: 15-00 hours.

Receipt of bid security, tender document fees and affidavits (in original one day before of the opening of the Technical Bid's date, time and place) : Up to 21-05-2012, Time: 17-30 hours in the office of the Executive Engineer, National Highway Division, Solapur.

Place, time and date of opening Technical Bids : Office of the Executive Engineer, National Highway Division, Solapur. Date: 22-05-2012, Time: 15-01 hours.

Place, time and date of opening Financial Bids : Office of the Chief Engineer, National Highway (P.W.), Room No. 527, 5th Floor, Konkan Bhavan, Navi Mumbai. Date: 25-05-2012, Time: 15-01 hrs. (if possible)

Note:

- All eligible/interested contractors are mandated to get enrolled on the e-Procurement portal (<http://maharashtra.etenders.in>) in order to download the tender documents and participate in the subsequent bidding process.
- For any other queries, regarding online enrollment on the abovementioned website and digital certificate, please contact to Sify Technologies Ltd., Nextender (India) Pvt. Ltd. on 020-25315555 / 25315556 (Pune) or 022-26611117 / 26611287 (Ext. 25 / 26).
- All documents related to tender are to be submitted by tenderer online only. In addition EMD, tender document fee and affidavit should be submitted in original one day before the submission date through Speed Post / Registered / in person, failing which online bid of the tenderer shall not be opened.
- Other details can be seen in the bidding documents. Right is reserved to reject any or all tenders without assigning any reason therefor.
- The electronic tendering system for national highway works of Govt. of Maharashtra will be available on a separate Sub Portal with URL <http://pwnh.maharashtra.etenders.in> as part of the Electronic Tendering system of Government of Maharashtra which is available on the Portal <http://maharashtra.etenders.in>

Executive Engineer
National Highway Division
Solapur

DGIPR/2012-2013/130

NEW TOWN ELECTRIC SUPPLY COMPANY LIMITED
(A Franchisee of WBSEDC)
Bidyt Bhawan, 5th Floor, D-Block, Bishanagar, Kolkata - 700016, No. 23591945

Tender Notice
N.I.T No. 78/MD/NTSC/OF/2012-13

Sealed tenders are invited from bonafide, experienced and resourceful Civil Contractors of Central Govt./State Govt./Semi Govt./Under taking for construction of Boundary Wall, Security Room, Internal RCC Road, Surface Drain & Sewerage Line, Switch yard fencing and Concrete Platform of 33/1KV GIS Sub-Station at Action Area-IA and IIG of New Town, Rajarhat with estimated amount of Rs. 54,17,945/- Cost of Bid Document Rs. 2000/- payable either in cash or through Bank Draft (or) Scheduled Bank drawn in favour of New Town Electric Supply Company Ltd. Date of submission of application with requisite Documents to eligible applicants : 30.04.2012 to 07.05.2012. Sale of Tender Document to eligible applicants : 09.05.2012 to 16.05.2012 (11 A.M. to 2 P.M) except Saturdays & Holidays. Last date for submission of Tender 21.05.2012 upto 2.30 P.M. Date of opening of Tender 21.05.2012 at 3.00 P.M. Earnest money @ 2% of the estimated amount.

OFFICE OF THE CMOH
DHFWs, KRISHNANAGAR
NADIA
TENDER NOTICE NO.-1
OF 2012-2013 (2ND CALL)

Sealed tenders in separate covers are invited by the Secretary, DHFWs & C.M.O.H. and Nadia from the bona fide, experienced contractors who have to abide by the condition stated in the following web-site. The details of the tender will be available in the Website of Nadia District i.e. www.nadia.nic.in or www.swaahyabihar.org

Secretary, DHFWs & CMOH
Nadia