IT colonialism

The article 'The rise of the techno-baboo: IT is a brain-sink' by Rajesh Kochhar (*Curr. Sci.*, 1999, **76**, 1531–1533) is really an eye-opener. There has been a big hype about India's formidable strength in IT. But, it seems that now the Americans are repeating the same colonial history by employing our best brains to do routine IT jobs for them. At least in this field, since we neither require to invest too much money in infrastructure nor have we dearth of young talent, we should be on the cutting edge of IT research. As Kochhar has pointed out, this growth of software is being done at the cost of basic sciences. It will be a disaster in the long run. If globalization means, in the stunning words of Kochhar, 'a perpetual sunshine in the West and a perpetual sunset in India', it will really be a great tragedy.

I do hope that these warnings, so tellingly paraphrased by Kochhar, will be taken note of by the authorities and by the scientific community at large.

D. P. AGRAWAL

10, Jayanti Lal Park,
Bhopal Road,
Ahmedabad 380 058, India

NEWS

Chandra – The new telescope that views the universe through the X-ray window

Ever since man began wondering about the nature of the universe around him, he has been concerned about knowing the how and when of the origin, evolution and destiny of the universe. Experimental observations of astronomy would help decide on the most acceptable model from amongst the few that have been under study. In the 1920s, Edwin P. Hubble first identified galaxies outside our own Milky Way Galaxy and in 1929, he made an epoch-making observation that the distant galaxies appeared speeding away from the Milky Way, the more remote the galaxy the speedier it seemed to be. The so-called Hubble Law namely that the speed at which a galaxy moves away from us is proportional to its distance and the 'Hubble constant', the constant of proportionality was subsequent development. On this work is based the idea that the universe began with a 'big bang' and has been expanding since then. Although most scientists support this theory, it is still not confirmed if the universe will continue to expand or collapse back onto itself or remain unchanged. By observing the Doppler shift of light emitted by a star in the galaxy, one can estimate the speed with which a galaxy or star is receding. The distances of the galaxies/stars can be estimated by intercomparison of their brightness with the brightness of the so-called Cepheid stars and red giant stars. By combining this information, one can make a guess about the age of the universe. It has been believed that this age is somewhere in the range of 10 to 20 billion years. This range is too broad to pick on any one of the models as the correct one.

NASA has initiated its Great Observatories Programme based on the launch of four large telescopes to view the universe through different windows in the electromagnetic spectrum. The telescopes have been placed in various earth orbits by the space shuttle.

The Hubble Space Telescope (HST) was the first mission in this programme designed to complement the wavelength window ranges of other space observation telescopes (namely Compton Gamma Ray Observatory, CGRO; Advanced X-ray Astrophysics Facility, AXAF now called *Chandra*; and Space InfraRed Telescope Facility, SIRTF). HST, launched on 24 April 1990, named after Hubble, is capable of observation in the visible, near ultraviolet and near infrared region (1100 Å to 1 mm). Over a period of nearly two years, HST underwent three phases of operations referred to as orbital verification phase, science verification phase, and general observation phase. In the initial phase, HST was plagued by the fact that the primary mirror was spherically aberrated and also by solar panel problems. Thanks to the ingenuity and capabilities of the space missions, these flaws were rectified; the solar panels and some cameras were replaced and the aberrations on the mirror were corrected by suitable device replacements. The telescope has been providing the most remarkable images ever seen of various celestial features and objects, in the course of mapping the universe.

HST was followed by the launch of CGRO, weighing 17 tons, on 5 April 1991. The observatory is named after Arthur Holly Compton, who was awarded the Nobel Prize for his work on gamma ray scattering from electrons. CGRO can detect a broad range of gamma ray spectrum by employing four different instruments. The range of energy span is 20 keV to 30 GeV. The programme of CGRO involves studies of a variety of highly energetic celestial phenomena like solar flares, gamma ray bursts, supernovae explosions, quasar emissions, etc. CGRO has been able to help in the discovery of very new and exciting phenomena. One such discovery is that of gamma ray blazars – quasars that emit energy in the 30 MeV to 30 GeV range of the electromagnetic spectrum. Another astonishing discovery is the observation of high concentration of radioactive Al in the direction of the galactic centre. Nuclear deexcitations of carbon and oxygen nuclei and annihilation radiation due to positron–electron recombinations in the interstellar medium have been seen. One of the four instruments on board the telescope has provided an all-sky map of gamma ray bursts that points to the isotropy of such bursts from all directions.

While SIRTF is yet to be launched by NASA, the 4.6 ton, 14 m long *Chandra* X-ray telescope is the third, payload launched by the space shuttle in this series. It was launched on 23 July 1999 and has been installed in a highly elliptic orbit that will take it 200 times farther than HST to have an earth non-interfering view of the cosmos. The telescope is named after India-born Subrahmanyan Chandrasekhar, who was awarded the Nobel Prize in 1983 for his contributions to Astronomy, especially dealing with studies relating to physical processes underlying structure and evolution of stars. The telescope is designed to explore X-ray bursts from celestial objects like quasars, supernovae, etc. in the X-ray window with energy resolution of nearly 1 eV. It is stated that while the realization of HST which has an observing power about a billion times greater than Galileo's first telescope in the optical range took about four centuries, a leap of about the same order in the power of observation of X-ray telescopes via *Chandra* has taken a mere three decades.

Even in the present orbital check-out and calibration phase, the first images from *Chandra*, released on 26 August 1999, have been extraordinary in detail. One of the images traces the aftermath of a gigantic stellar explosion which can provide evidence of a neutron star or black hole near the centre, in the midst of shock waves rushing into space at millions of miles per hour. Another image shows a powerful X-ray jet blasting 200,000 light years into intergalactic space from a distant quasar.

Figures 1 to 5 show some of the spectacular images obtained by *Chandra*. These images, obtained within about two months after the launch of the telescope, have already provided 'new visions of cosmic explosions' and 'revealed previously unobserved features'. In addition to 'showing dramatic details of prodigious production of energetic particles from

Figure 1. Image of a pulsar PSR 0540-69 that emits pulses of X-radiation apart from radio and optical radiation at 50 Hz. The pulsar is in a satellite galaxy of the Milky Way that is at a distance of 180,000 light years from the Earth.

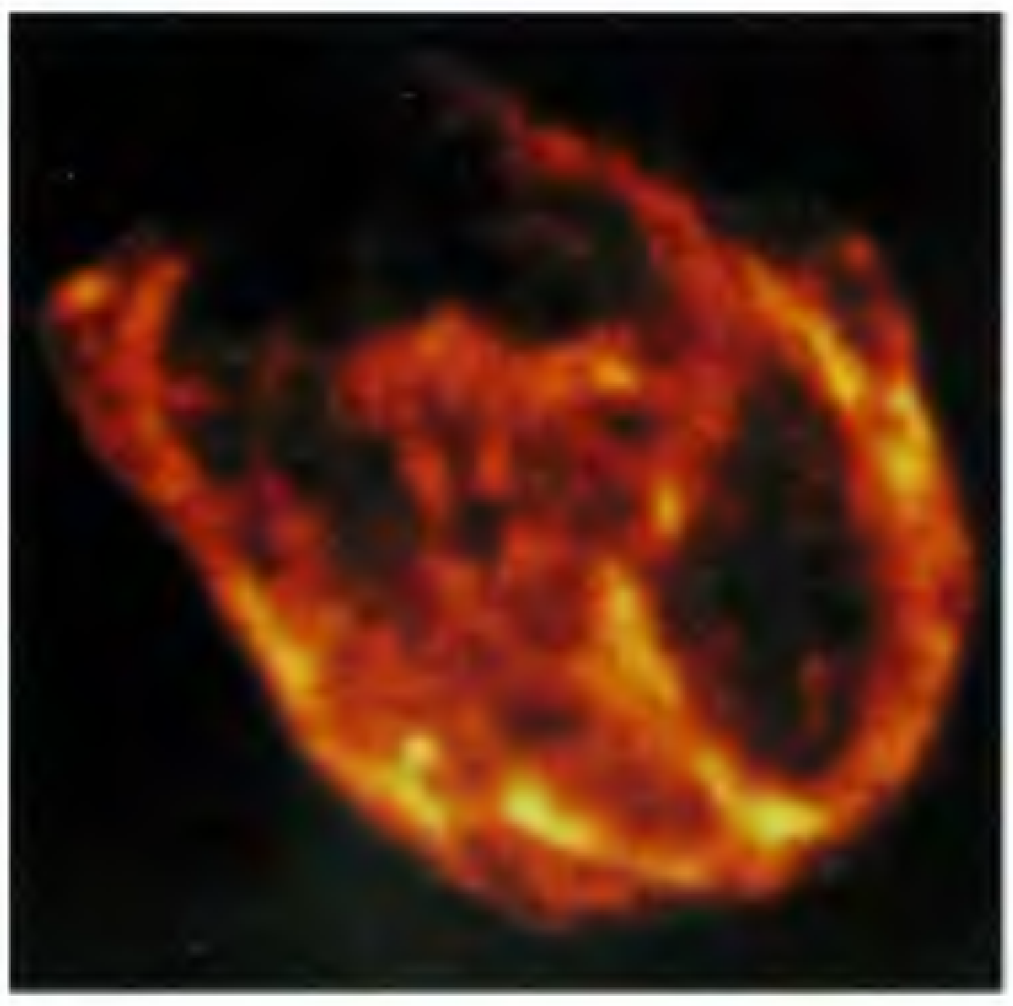

Figure 2. Image of N132D, the remnant of an exploded star in the Large Magellanic Cloud.

Figure 3. Image of a supernova remnant E0102-72 located in the Small Magellanic Cloud, a satellite galaxy of the Milky Way situated at 190,000 light years from the earth. The source resembles a 'flaming cosmic wheel at several million degrees of temperature stretched across 40 light years'.

Figure 4. Image of Crab Nebula, the remains of a stellar explosion that occurred in 1054 AD and the 'never-before-seen' image shows a ring around the nebula's heart, the Crab pulsar, a neutron star. A jet of highly energetic particles is seen to be flung away over a distance of nearly a light year from the neutron star that provides the energy. *Chandra*'s CCD imaging spectrometer and high energy transmission grating have enabled to receive this image.

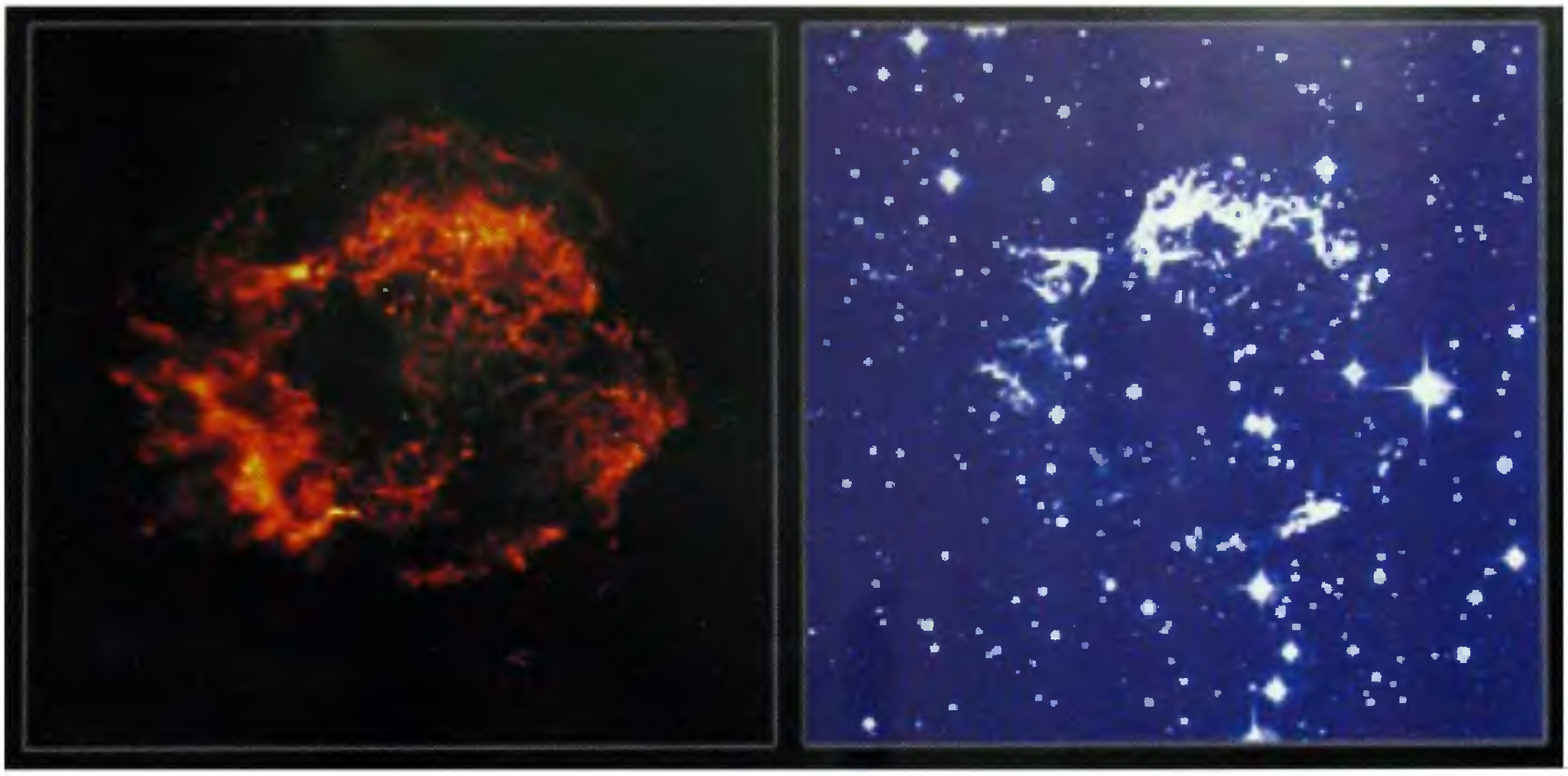

Figure 5. Composite image of X-ray and optical images of the shell-type remnant Cassiopeia A, a star that exploded about 300 years ago. The X-ray image on the left shows an expanding shell of hot gas at a temperature of about 50 million degrees, the shell diameter being about 10 light years. The image on the right is from an optical telescope.

rapidly rotating magnetized neutron stars', one also sees features like shells of hot gases produced by the explosions and puzzling structures. Gordon Garmire of Penn State University says, 'it is as though we have a set of Russian dolls, with structures embedded within structures'. These kinds of details 'namely the cores and the shells have never been seen before', according to Patrick Slane of Harvard–Smithsonian Center for Astrophysics.

HST, CGRO and now *Chandra* have been providing rich and new experimental findings. These may lead to an acceptable theoretical model of the universe.

Credits for these images are due to NASA (Marshall Space Flight Centre, Huntsville, Alabama), Smithsonian's Astrophysical Observatory (SAO) and Chandra X-ray Centre (CXC) at Harvard, Massachusetts. Kind permission from Education/Outreach Coordinator, CXC, for using these images is gratefully acknowledged.

K. R. Rao, 'Gokula', 29/2, 11th Cross, III Main, Malleswaram, Bangalore 560 003, India.

The Indian Astronomical Observatory*

The Indian Institute of Astrophysics (IIA) is developing a high-altitude field station, the Indian Astronomical Observatory (IAO), for optical and infrared astronomy. IAO is located on Mt. Saraswati, Hanle Ladakh, at 32°47′46″N lat., 78°57′51″E long., and 4517 m above mean sea level. The site was selected as a part of the Himalayan Infrared Optical Telescope (HIROT) Project which envisages building a large aperture telescope for the country. Based on a detailed study of meteorological data and satellite imagery, and site reconnaissance trips to six high-altitude sites in the Great Himalayan Ranges, the site at Hanle in the high-altitude cold desert of south-eastern Ladakh was chosen as the most prospective site. Figure 1 shows the Nilamkhul plain area with Mt. Saraswati. Site-characterization studies, being carried out since 1995 January, have proved that this site is among the best high-altitude sites in the world.

Considering that the site was remote and had minimal infrastructure facilities, it was decided to develop this site and, initially, install a smaller-sized telescope with remote operation facilities so as to gain experience before embarking on the project for installation of a large national telescope. It is proposed that by the

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