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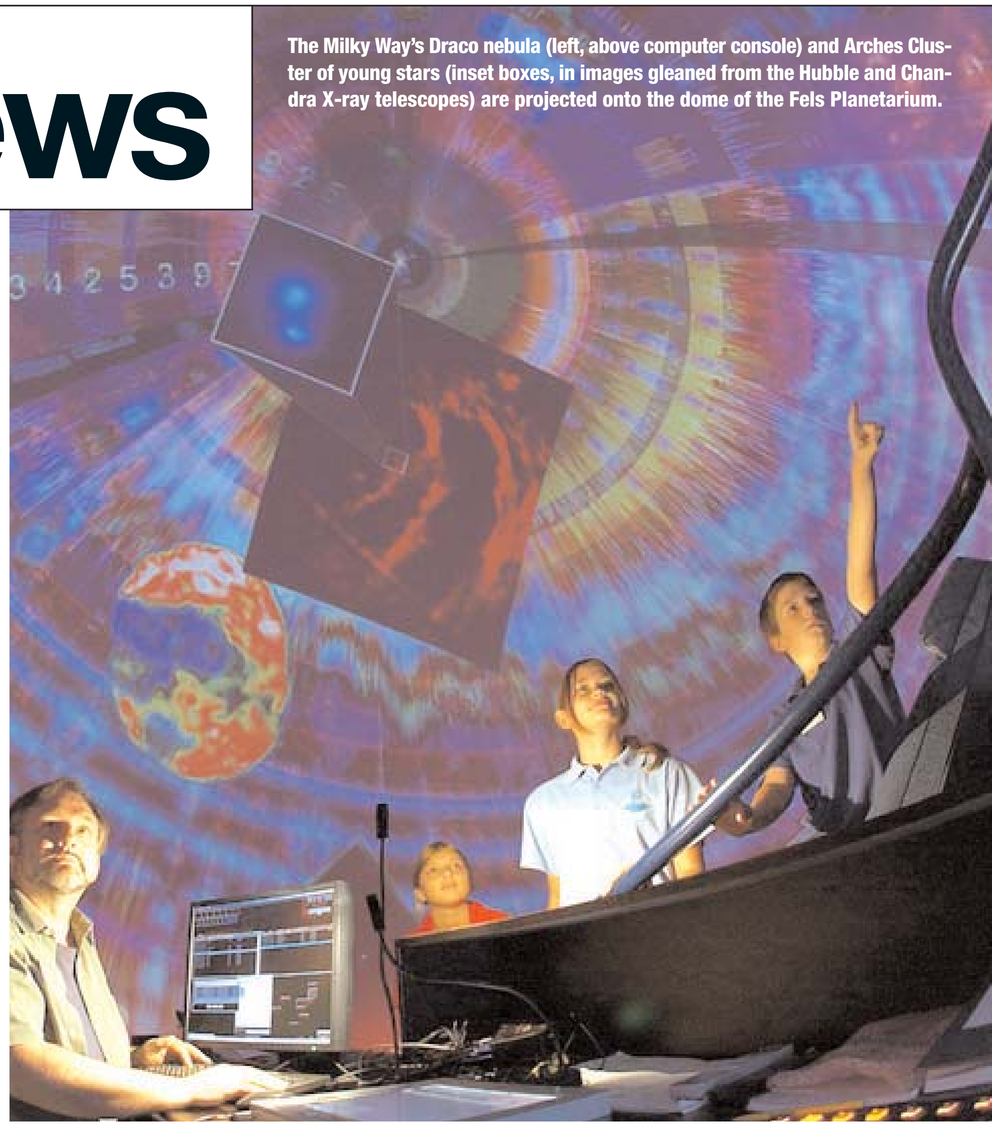
The Milky Way's Draco nebula (left, above computer console) and Arches Cluster of young stars (inset boxes, in images gleaned from the Hubble and Chandra X-ray telescopes) are projected onto the dome of the Fels Planetarium.

Clear Eye on the Great Sky

A prestigious planetarium gets rid of the old gewgaws and upgrades to an all-digital vision of the cosmos

By Brad Lemley

Fels Planetarium
Franklin Institute Science Museum
222 North 20th St., Philadelphia, PA
www.fi.edu/visitF.html; Telephone 215-448-1200

The empty Pepsi bottle on a back room shelf at Philadelphia's Fels Planetarium is not a remnant of some janitor's lunch. As recently as 2001, it created one of the facility's snazziest special effects. "It would spin around on this little motorized platform, and we would shine a light through it," says Derrick Pitts, the Fels program director. The bottle's rippled sides, he explains, "made this great shimmering effect on the dome" that simulated the view from a spacecraft descending through Venus's thick atmosphere. "We had hundreds of these goofy little devices that we would build and use to put on shows."

Lately, however, planetariums are rocketing into the digital age, and the Fels is leading the way. Revamped in a six-year effort that was largely finished by late 2004, its venerable Zeiss star projector has given way to six razor-sharp video projectors. A typical show now depicts a dawn sky with clouds scudding across it, a full-motion rendering of Jupiter's storms, or even a dome-filling peek up into the space shuttle's thrusters during liftoff. Viewers can fly through a virtual Valles Marineris, a 2,480-mile-long series of yawning canyons on Mars or gaze as galaxies collide in a complex, swirling star dance (as will happen with the Milky Way and Andromeda galaxies in a few billion years). For those who remember when a radical planetarium special effect was a single shooting star, and the major challenge for audience members was staying awake, the new versatility is a revelation.

The high-tech transformation seems all the more surprising considering the Fels's historic gravitas. Housed within the stately limestone walls of the Franklin Institute Science Museum, it opened in 1933 and is the nation's second-oldest planetarium. For most of its 72 years, the Fels generated its images with a star projector, the distinctive barbell-shaped apparatus in the center of the floor that shoots light through pinprick holes. By contrast, the planetarium's new all-digital show resides on eight servers packing almost a terabyte of storage. The control board has shrunk from a dial-studded console resembling an airplane cockpit to three sleek flat-panel screens, and the resolution generated by the video projectors on each square inch of dome is 1,600 by 1,200 pixels—the same as a good computer monitor.

Not that such a dazzling redesign comes cheap. Producing a program heavy on digital graphics can now cost more than $400,000, in contrast to the $10,000 price tag for each old in-house show. Yet the new system, most of it made by Sky Skan of Nashua, New Hampshire, "allows maximum flexibility, and is easy to upgrade," says Pitts. He envisions projecting live broadcasts from the International Space Station or the Mars rovers or even creating dome-filling games that use wireless controllers. Nor does he believe that planetariums should confine themselves to the heavens: "I'd like to take people to the inner core of the earth, or into the deep oceans, or go deep inside something and show how nanotechnology works."

Still, he maintains a sneaking affection for the old star projectors. "They project absolutely beautiful stars: crisp circles of the proper spacing and brightness with a rich, velvety black background," he says. That clarity, though, was offset by a serious lack of flexibility; anything other than a star field, such as a trip through the sun's corona or Saturn's rings, had to be crudely approximated with other equipment. "It was a complicated hand task," says Pitts. "We had artists draw and paint, then we would take photos, make slides, put them in slide projectors all around the room, and hope we had the edges blended properly."

Does he ever miss the analog days? "Absolutely," he says, a little wistfully. "There was something about those old shows that was really special. I might still make a show that uses stuff like that." So the Pepsi bottle, though a bit dusty, will not be recycled anytime soon.

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Big Bang: The Origin of the Universe

By Simon Singh; Fourth Estate, $27.95

Though it happened nearly 14 billion years ago, the birth cry of the universe still rumbles through space. It is broadcast continuously on the radio, emanating uniformly from all directions in the heavens. To hear it, simply tune to a spot between stations. About one half of 1 percent of the shushing sound you hear is cosmic background radiation, a fading echo of that mother-of-all-explosions known as the Big Bang.

How astronomers came to recognize this and other pieces of the puzzle of creation is one of the great stories of modern science, told in amiable prose by physicist Simon Singh. Until recently, no one other than religious literalists could claim any knowledge of the day of creation. Was it only a few thousand years in the past? Was it billions? Without any sort of hard data, scientists were stymied.

In the 1920s, however, astronomer Edwin Hubble discovered that almost all galaxies were moving away from Earth, with the furthest galaxies receding the fastest. The universe was expanding, and two competing schools of thought soon sought to explain why. One viewed the expansion as the result of a great explosion billions of years in the past; the other, as a perpetually occurring steady state. Ironically, it was British astronomer Fred Hoyle, the chief proponent of the steady-state theory, who coined the term Big Bang. Intended as a joking dismissal of the primordial explosion, Hoyle's name stuck, though his theory did not.

Today, astronomers cite multiple lines of evidence that bolster the Big Bang theory: the abundances of the elements formed in the explosion (an average of 10 hydrogen atoms to every 1 helium atom everywhere in the universe); observations of galaxies in their earliest stages of formation; experiments in particle accelerators that mimic the first moments of the explosion; and, of course, that cosmic background radiation you hear on the radio, first observed by two Bell Labs scientists in 1964, and now extensively mapped by sophisticated satellites.

For someone who is already an astronomy or cosmology buff, Singh's history reads like a comfortable recounting of well-worn family anecdotes with tales of pioneering ancestors and even a few drunken uncles. For others, this book provides an entertaining, if occasionally inaccurate, account of how science learned to solve the biggest puzzle of all time. You can't know the universe, these days, without knowing the Big Bang. Singh's book is a fine place to make its acquaintance. —*Laurence Marschall*

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Now playing on a bandwidth near you: cosmic background radiation, a remnant of the 14-billion-year-old Big Bang.

BOOKS


Calculus just comes naturally to this frisbee-catching pooch.

The Math Instinct: Why You're a Mathematical Genius (Along With Lobsters, Birds, Cats, and Dogs)

By Keith Devlin; Thunder's Mouth Press, $25

If the book of nature is written in the language of mathematics, as Galileo put it, then nature should be the greatest mathematician of all. Indeed, natural selection has endowed animals with built-in math skills. Birds, butterflies, and salmon migrate thousands of miles using the polarization of sunlight, the movement of stars, and Earth's magnetic field as a guide. The peregrine falcon dives to intercept its prey with an accuracy that would challenge NASA scientists. Among humans, professional athletes like outfielders and soccer goalies perform similar automatic calculations that, on paper, would require the equations of differential calculus. Why is it then that a chimp—our closest relative—can't count past 10?

The answer, says Stanford mathematician Keith Devlin, is that there are two types of math: natural and abstract. The former involves specialized tricks that evolution has hardwired into the bodies and brains of organisms; the latter is what we're taught in school and is characterized by a formal language consisting of numerals and other symbols. We don't learn this language until age 4, but 2-day-old infants—and many nonhuman animals—possess an innate sense of addition and subtraction. It's the symbolic language of math that separates us from other animals and allows humans to do calculus and build spaceships. Nevertheless, Devlin writes, "the mathematical principles involved in cockroach locomotion are very similar to those used to design and control the latest high-performance jet fighters." —*Alex Stone*

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