This month Andrews and others will begin to wrestle with a slew of organizational issues, including whether to establish the fund as a new entity led by a seasoned executive (like In-Q-Tel) or to ask an existing outfit to manage the $25 million pot. Officials appear to favor the In-Q-Tel model but not its estimated 15% administrative costs. "I'm looking to hold down the overhead," Andrews says.

Whatever model is chosen, some analysts question whether the Army's venture into high-tech investing can pay off. Last year, for instance, an Army Science Board panel concluded that existing research funding mechanisms could meet the Army's needs. It also warned that creating a venture fund could embroil the Army in "tumultuous" debates over how to spend any potential income. But it questioned whether products made for the military will also be attractive to other consumers; the Army now earns less than $500,000 a year in royalties from products it helped develop, the panel noted.

Such concerns, however, don't worry the fund's backers. Although Dahlberg says he doesn't expect the fund "to change the world, it will help get [the Army] closer to the creative smaller organizations." House appropriators, he adds, are ready to boost its annual budget, to up to $50 million, if things go well over the next few years. Success could also mean spreading the concept to the other armed services. –DAVID MALAKOFF

ASTRONOMY

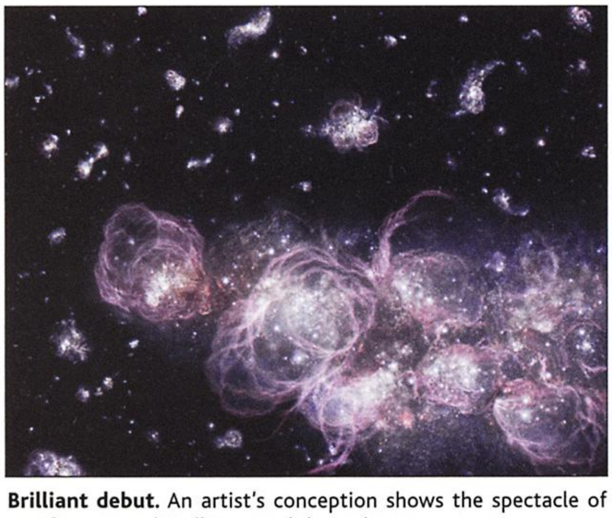
Star-Spangled Universe Dawned in Early Light

Hollywood directors would have filmed it differently, but Mother Nature started her performance with the grand finale. A few hundred million years after the big bang, long before anyone was around to appreciate the spectacle, the universe blazed with the most violent burst of star formation it has ever experienced. Since then, the rate of star formation has decreased, and the current activity is just a fizzle compared with the natal fireworks.

That new screenplay contradicts earlier scripts, which suggested that star formation gradually increased until a "baby boom" took place some 4 billion years after the big bang before dropping off again. "All analyses so far have missed a substantial part of the starlight in the very early universe," says Ken Lanzetta of the State University of New York, Stony Brook, who presented his results at a press meeting at NASA headquarters on 8 January 2002. A paper describing the new theory will soon be published in *The Astrophysical Journal*.

To learn about the early universe, astronomers examine very distant galaxies, whose light took billions of years to reach Earth. Three tiny patches of sky, known as the Hubble Deep Fields, have been studied in exquisite detail, both by the Hubble Space Telescope and by other instruments in space and on the ground. But according to Lanzetta, "even the deepest images made by Hubble are not sensitive enough to detect most of the light in the very distant universe." As a result, astronomers can glimpse only a small fraction of the amount of star formation in distant galaxies. "At these large distances, our telescopes see only the brightest parts of the galaxies," Lanzetta says. "The faint and intermediate-bright parts are below the observational threshold. But it's the intermediate-bright parts of galaxies where most of the starlight is being produced."

To calculate how much of that light had dropped below the range of visibility, Lanzetta and his collaborators analyzed all available observations of the Hubble Deep Fields. For some 5000 faint galaxies, they first determined their distances by studying their colors. More-distant galaxies appear redder because their light has been stretched more by the expansion of the universe. Then the astronomers calculated how much energy was produced in each pixel of the images. By comparing these results with data from nearby galaxies, the team was able to estimate how much starlight earlier analyses of the Hubble Deep Fields had missed—like a listener reconstructing the repertoire of a distant marching band by comparing recorded music with the booming of the bass drum. Lanzetta's technique "is really very



Brilliant debut. An artist's conception shows the spectacle of star formation that illuminated the early cosmos.

CREDITS: (TOP TO BOTTOM) DON FIGER/STSCI/NASA; ADOLF SCHALLER FOR STSCI

ScienceScope

FAME Flames NASA last week abruptly canceled a mission to obtain precise measurements of 50 million stars. The Full-sky Astrometric Mapping Explorer (FAME) was slated for a 2004 launch, but burgeoning costs prompted the space agency to abandon the project.

FAME's price tag had grown from $160 million to $220 million, primarily because of design and delivery problems with two dozen digital imaging cameras. And the final cost was likely to go higher, according to NASA officials and Kenneth Johnston, principal investigator and an astronomer at the U.S. Naval Observatory in Washington, D.C. "It's a great disappointment," says Johnston, who had hoped to convince the Department of Defense to cover the additional costs. The mission, selected in a tough 1999 competition, would have helped astronomers understand stellar evolution and the distance scale of the universe.

Accidental Death Tennessee authorities say that Harvard biochemist Don Wiley died in an accident. Wiley mysteriously disappeared on 15 November 2001 from a Memphis bridge over the Mississippi River; his body was found on 20 December 2001 some 480 kilometers downstream (*Science*, 4 January, p. 31). This week, Shelby County Medical Examiner O. C. Smith ruled out both foul play and suicide. Instead, Smith believes Wiley fell from the 35-meter-high bridge after leaving his rental car to check it for minor damage. Alcohol consumption, a seizure disorder, and a gust of wind caused by a passing truck all may have caused Wiley to lose his balance and fall over a thigh-high guardrail. He died from the impact on the water.

High Eye on the Sky Champagne flowed atop a remote mountaintop this week as astronomers dedicated the new 8.1-meter Gemini South telescope at Cerro Páchon in the Chilean Andes. The new $184 million telescope joins its identical twin, Gemini North, at Mauna Kea, Hawaii. Together, they give astronomers from the seven nations footing the bill—the United States, United Kingdom, Canada, Chile, Australia, Argentina, and Brazil—access to the entire sky.

Contributors: Katie Greene, Richard Stone, David Malakoff, Andrew Lawler, Constance Holden, Govert Schilling

nifty," says Bruce Margon of the Space Telescope Science Institute in Baltimore, Maryland, although he adds that the result will probably be controversial, because the measurements are extremely difficult.

If Lanzetta is right, the new findings have far-reaching implications for ideas about the formation of galaxies, among other things. Many galaxies may have formed early and rapidly instead of gradually, as most cosmologists have assumed. Such a fast-start scenario also would make it easier to explain why the early universe appears to have already been "polluted" with relatively heavy elements, which are produced in stars and then dispersed through space by supernova explosions.

Some astronomers are skeptical. Barry Madore of NASA's Infrared Processing and Analysis Center in Pasadena, California, who hasn't read Lanzetta's paper yet, says the results might be easier to swallow if there were independent confirmation. In fact, one unrelated study comes up with a somewhat different conclusion. Rodger Thompson of the University of Arizona's Steward Observatory in Tucson carried out a similar analysis using data from the Hubble Space Telescope's infrared NICMOS camera. His results point to a less violent beginning for the universe, with a star formation rate that stayed relatively constant for a couple of billion years before gradually tapering off. Thompson says the discrepancy might be due to subtle differences in the way the two teams corrected for the missing light.

Although Lanzetta says studies of distant quasars support his conclusions, he concedes that his analysis doesn't constitute definitive proof. But he hopes that future instruments such as the Next Generation Space Telescope and the Atacama Large Millimeter Array might see part of the missing light. –GOVERT SCHILLING

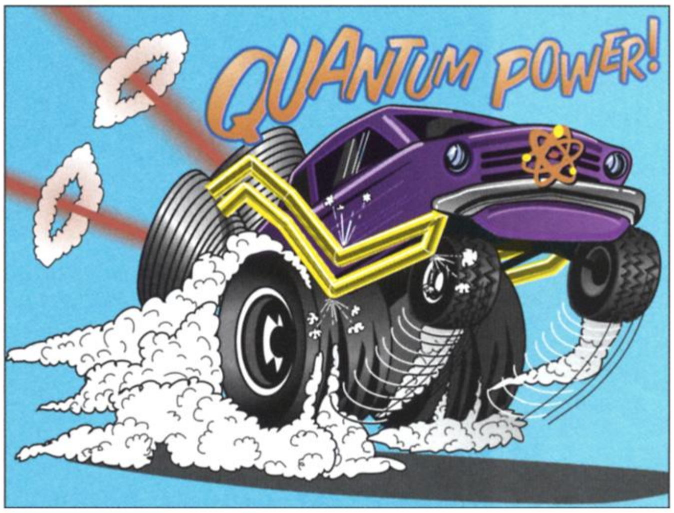
Govert Schilling is an astronomy writer in Utrecht, the Netherlands.

THERMODYNAMICS

Quantum Engine Blasts Past High Gear

All engines, whether the colossal thrusters on the space shuttle or the gasoline-fired power plant under the hood of your car, have to obey the laws of thermodynamics. Among other things, the laws set clear limits on the engines' efficiency: how much work they can squeeze from a given energy input. But take those classical axioms and add quantum mechanics, and unusual things can happen. Recently, Marlan Scully, a physicist at Texas A&M University, College Station, has discovered that in the quantum world, you can sometimes reap more horsepower than you'd expect.

Scully found that in theory he could take the hot exhaust from one kind of heat engine and drive a laser with it. Lasers work by storing energy in the internal quantum energy states of atoms or molecules and then releasing the energy in the form of photons. But heat engines generally ignore the internal states and instead harness the thermal motions of atoms and molecules in the "working fluid" (for example, the hot gas made by burning gasoline) as it expands and moves pistons to turn a crankshaft. The twist in Scully's scheme is to trade energy between the external and internal states of the atoms in a carefully choreographed way so as to squeeze a few more drops of work out of the engine.



Overdrive. In theory, a quantum afterburner could supercharge a heat engine by turning exhaust energy into laser light.

CREDIT: ALAN "HOT-RODDIN' DADDY" STONEBRAKER

In a paper accepted for publication in *Physical Review Letters*, Scully applies the concept to a type of heat engine called the Otto cycle, a cousin to the common car engine. Scully considers an idealized version of this engine without the exploding gasoline, instead just considering what happens as gas is compressed, is heated, does work, and is cooled again.

In his scheme, Scully takes the still-hot gas in the expanded piston chamber and routes it into a laser cavity, where the internal quantum states of the gas molecules come into play. The hot exhaust that would normally just be shoved out the door gets used to create more useful work by means of the laser emission. As a result, the total energy out is more than you'd expect from classical thermodynamic analysis of an "ideal" Otto cycle engine.

"I think it's a nice paper, very fun, and it's potentially useful," says Seth Lloyd, a physicist at the Massachusetts Institute of Technology. After hearing Scully give a talk about the concept, Lloyd dubbed the theoretical gadget a "quantum afterburner" by analogy to the devices that squeeze extra thrust out of the exhaust from a jet engine. "It takes advantage of a source of energy that hasn't been taken advantage of before," Lloyd says. After all, "the steam engine wasn't very useful until James Watt came along and made it more efficient. He didn't invent the steam engine, but he figured out how to control it."

Scully acknowledges that his analysis is controversial. But he says that doubters who once attacked him for flirting with perpetual motion have come around. "In thermodynamics, the devil is in the details, but so are the angels," he says. "You have to look at a specific physical system [such as the engine] and not just abstract thermodynamic calculations." Ronnie Kosloff, a theoretical chemist at Hebrew University in Jerusalem, agrees that Scully's concept is on solid ground: "It is consistent with all the laws of thermodynamics."

To check that his equations were on the up-and-up, Scully recently put his quantum afterburner to the ultimate theoretical test: hooking it up to an engine running at maximal efficiency. Until then, he had applied it only to the Otto cycle engine, which runs less efficiently than thermodynamics allows. But when Scully probed how well such a device would work with the ideal Carnot cycle, the gold standard of thermodynamic machines, the quantum afterburner couldn't squeeze out any extra energy—proof, Scully says, that his theoretical device is playing by the rules. –DAVID VOSS

GEOBACTERIA

Microbes Use Mud to Make Electricity

Self-recharging bacterial batteries that clean up organic pollution as they generate electricity? Sounds more like science fiction than science. But on page 483, microbiologists report coming one step closer to making microbial fuel cells a reality: They harnessed bacteria to generate electricity from underwater sediments. The microbes make excess electrons that they stick directly to graphite wires, which in turn send current to a second wire much like a car battery does. For fuel, the