done research in East Germany before the wall came down. At the new Max Planck institutes, 40% of the directors were recruited from abroad (compared with 20% of foreign directors for Max Planck institutes in general), and only a few directors are eastern Germans. According to Werner Meske of Berlin's Center for Social Research, only a handful of eastern scientists moved to the top management positions at the new Leibniz institutes or other research centers, although more than half of the section leaders of some institutes are eastern Germans.

Rosenthal—an East Berlin scientist who was doing postdoc work in Cambridge when Germany reunified—argues, however, that the influx of talented researchers has helped revitalize science in the region. "We should feel privileged that so many good scientists came here," Rosenthal says. And Markl says Max Planck recruited many directors from abroad "because we wanted to create new institutes that would be on the cutting edge of certain fields of research. If we had sent 90% of the directors from West Germany, then perhaps it could have been viewed as a sort of 'colonial' takeover from the west."

But some eastern scientists also think that West Germany's leaders passed up a golden opportunity by imposing their own science system on the east without revamping that system at the same time. "Some aspects of West Germany's science system were also in need of reform," says Schipanski. Reich argues, for example, that the current system makes it difficult to "explore unexpected new lines of research" because it places too much emphasis on short-term results. Such criticisms make sense "only in hindsight," Markl counters. "If we had not imposed the west's system, then it would have taken much longer to revitalize science in the east," he says. "We could have spent 10 years just debating how to revamp Germany's entire science system." While he acknowledges that some aspects of science's transformation are debatable, Markl—who was DFG's president in 1989—thinks the transition was handled well overall. "Fifty years from now, I think we will look back and see German unification in science as a success story," he says. "The progress may be slower than we had hoped in 1989, but it is remarkable nonetheless."

–ROBERT KOENIG

ASTRONOMY

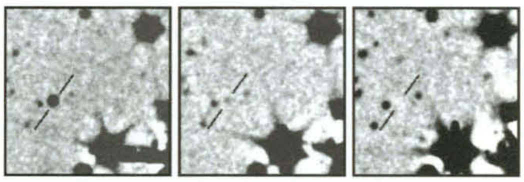
Links Between Supernovae and Gamma Ray Bursts Strengthen

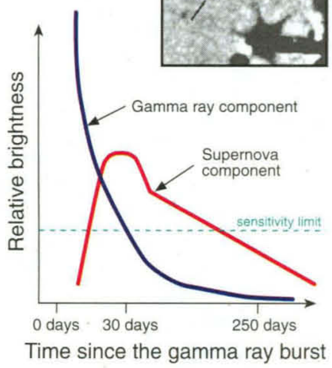
Two strong connections and three other possible links between supernovae and highly energetic "long" gamma ray bursts have recently been established

Want to make the ultimate bomb? Here's Stan Woosley's recipe: Take a supermassive star, strip away its outer mantle of hydrogen, and let its core collapse under its own weight. The result is a black hole with two extremely powerful jets of matter, producing a titanic flash of deadly gamma rays and blowing apart whatever's left of the star in a huge supernova explosion.

For several years, Woosley, a theorist at the University of California, Santa Cruz, and Bohdan Paczyński of Princeton University have been advocating such supernova models to explain some of the puzzling bursts of gamma rays that Earth-orbiting observatories have picked up from sources billions of light-years away. But their models have lacked direct observational support—until now. Astronomers have now linked as many as three "long" gamma ray bursts (lasting for more than 5 seconds) to supernova explosions, and two more possible cases have surfaced over the past few weeks.

"It's terrific," says Woosley. "The observations are much along the lines of our models. We're very gratified to see it happen." Establishing a possible connection between gamma ray bursts and supernovae is "really exciting," adds Craig Wheeler of the University of Texas, Austin, because it provides a new way of studying these stellar explosions. However, he cautions that "nobody knows how to take a physical event [like a supernova] and make a gamma ray burst out of it." And Paczyński and others have suggested that, because supernova models predict relatively long-lasting gamma ray–producing jets, bursts less than 5 seconds long may be caused by a different phenomenon, such as the collision of two neutron stars.





Going, going ... Spot associated with gamma ray burst fades then disappears in images taken on 27 March, 17 April, and 18 December 1998 (*top*). A Caltech group argues that a supernova explains the slow fade (*diagram*).

CREDIT: (GRAPH AND PHOTOS): S. BLOOM AND S. R. KULKARNI/CALIFORNIA INSTITUTE OF TECHNOLOGY

Gamma ray bursts have been observed since the 1970s, but it wasn't until early 1997 that astronomers, using the Italian-Dutch satellite BeppoSAX, were able to pinpoint their location precisely enough to look for counterparts at optical wavelengths. They linked several bursts to nothing more specific than fading spots of light in the sky. But the spectra of these inconsequential spots indicated that they lie at enormous distances, which implies that their true energy output must be tremendous. Indeed, gamma ray bursts are the most energetic explosions in the universe, second only to the big bang itself (*Science*, 26 March, p. 2003).

The first indication of a possible supernova connection came last year when a team led by Titus Galama of the University of Amsterdam linked a gamma ray burst, called GRB 980425, to a relatively nearby supernova, 1998bw (*Science*, 19 June 1998, p. 1836). The claim was controversial, however, because the supernova didn't coincide with a variable source of x-rays that appeared to be related to the gamma ray burst. Now, two more sightings and two additional coincidences have strengthened the supernova link.

The first came from a bright gamma ray burst, GRB 980326, that was spotted on 26 March 1998. Over the next 3 weeks, the burst's optical afterglow faded, and by mid-April all that was left was a faint glow, which astronomers assumed came from the distant galaxy in which the burst originated. On 18 December, a team of astronomers led by Joshua Bloom of the California Institute of Technology (Caltech) in Pasadena reobserved the location of GRB 980326 with the 10-meter Keck II telescope on Mauna Kea, Hawaii. To their surprise, the pictures showed nothing at all where the putative galaxy should have been. Because "galaxies do not just disappear," says Caltech team member Shrivinas Kulkarni, the astronomers realized that what they witnessed in April might have been the slow flare of a supernova. A thorough reanalysis of their original data backed up this view: The supernova must have continued to fade, and the host galaxy is apparently too faint to have been detected by the Keck telescope.

Bloom and his colleagues submitted their results to *Nature* on 23 March 1999 (the paper was published on 30 September). But despite *Nature*'s embargo policy, they also made the paper available on the Internet on 24 May. As they wrote in an accompanying note, they did this "given the rapid progress in the field of gamma ray bursts." Other teams quickly took a closer look at their own data.

Sure enough, within a month, a similar supernova signal was detected in the afterglow observations of GRB 970228, the very first gamma ray burst for which an optical counterpart had been found (*Science*, 21 March 1997, p. 1738). In a paper to appear in *Astrophysical Journal Letters*, Daniel Reichart of the University of Chicago claims that his analysis of GRB 970228 "is the strongest case yet for a GRB/supernova connection." A still more extensive analysis of the GRB 970228 data by a team led by Galama leads to the same conclusion. Galama and his colleagues have submitted their results to the *Astrophysical Journal*.

Both Woosley and Wheeler believe these new findings add credence to the claimed link between GRB 980425 and supernova 1998bw. "Three data points is enough to convince me," says Woosley, although he admits that he has a theoretical prejudice. Moreover, two more possible coincidences between gamma ray bursts and supernovae have been revealed over the past few weeks. Lisa Germany of Mount Stromlo and Siding Spring Observatories in Australia and her colleagues have submitted a paper to the *Astrophysical Journal* saying that GRB 970514 may have been related to the unusual supernova 1997cy. And last week, in a circular of the International Astronomical Union, a team led by Roberto Terlevich of the Institute of Astronomy in Cambridge, United Kingdom, noted a possible link between the very recent supernova 1999eb and a gamma ray burst that flared on 2 October. However, in both cases the evidence is circumstantial, because the positions of the bursts aren't known very accurately.

The stengthening supernova connection is likely to lead to a new burst of theorizing. Wheeler and his colleagues have also published theoretical models of massive supernova explosions that produce gamma ray bursts. But unlike Woosley, who believes the formation of a black hole is crucial, Wheeler thinks that even more modest supernovae that result in a collapsed neutron star are able to produce powerful flashes of gamma rays. Little is known about the precise mechanism, however. "We have to put some flesh on these bones," says Wheeler. "We need a lot more statistics." Woosley adds, "You have to look at the right time ... we now know when the right time is: 2 or 3 weeks after the burst. People are going to look harder."

–GOVERT SCHILLING

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

TECHNOLOGY TRANSFER

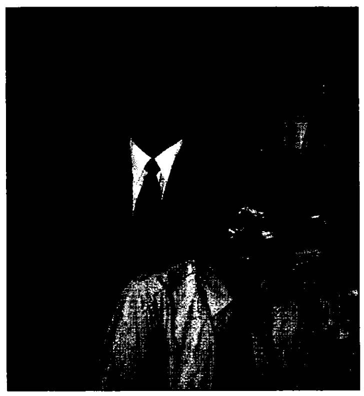
Japanese Faculty Show Signs Of Catching Start-Up Fever

New government policies and additional funding are helping scientists brave an environment that shuns risk-taking

TOKYO—When molecular biologist Fukashi Murai returned home after spending a year at the University of California, San Diego, in the mid-1990s, he was bitten so hard by the entrepreneurial bug that he did something highly unusual for a Japanese scientist: He quit his job at pharmaceutical maker Sankyo Co., nurtured ties with Japan's handful of venture capital firms, and scoured university labs for marketable ideas. "I found it just amazing" that U.S. academics were so eager to turn their discoveries into businesses, he says. "I couldn't understand why it didn't happen [in Japan]."

Murai eventually hooked up with University of Tokyo molecular biologist Shiro Kanegasaki, who in 1997 had discovered a human protein involved in regulating inflammatory reactions. The pair spent nearly a year crafting a business plan to develop the protein into an anti-inflammatory drug, followed by 6 months of intense negotiations with a venture capital firm that netted them $500,000 in start-up funds. They set up a small company, Effecter Cell Institute Ltd., rented lab space in a university-affiliated incubator, and opened a tiny office in a nearby apartment building. "I hadn't thought of starting a company," says Kanegasaki, who retired this spring after reaching the mandatory retirement age of 60. "But it's a good time to try."

Indeed, government officials, business leaders, and editorial writers are trying to boost the sluggish economy by exhorting scientists like Kanegasaki and Murai to take the plunge into the business world. Three agencies have requested $85 million in the fiscal year beginning 1 April for a package of subsidies, tax breaks, and loans to nurture new companies, particularly "bioventures," in the hope of expanding the country's minuscule presence in commercial biotechnology. This planned surge of money is the latest in a series of steps—from loosening regulations covering stock offerings to clarifying intellectual property rights—aimed at generating more start-ups, particularly from university and national institute labs. As a result, a few companies like Effecter are beginning to dot the landscape. But Japan's scientific community still has a long way to go to match the entrepreneurial vigor of U.S. researchers. Fostering a true venture business culture in Japan, says Yoshihiro Ohtaki, a molecular biologist who now heads Biofrontier Partners, "could take 10 years."



On their own. Shiro Kanegasaki (right) teamed up with Fukashi Murai to form a biotech company based on Murai's university research.

CREDIT: D. NORMILE

One sign of progress, in a country where the establishment still holds enormous sway, is the participation of some senior scientists in these start-ups. This spring, for example, Kenichi Matsubara, professor emeritus of molecular biology at Osaka University and a key figure in Japan's early human genome research efforts, joined a dozen colleagues to establish DNA Chip Research Inc. The company hopes to develop DNA chips for diagnostic purposes before tackling the technology needed to characterize the subtle genetic differences among individuals known as single-nucleotide polymorphisms. These differences are expected to help scientists trace disease genes and develop drugs tailored to those characteristics. Observers estimate that a dozen or more start-ups, covering everything from computer-based rational drug design to improvements in NMR techniques, have sprung from work at the Institute of Physical and Chemical Research (RIKEN) outside Tokyo, the Universi-