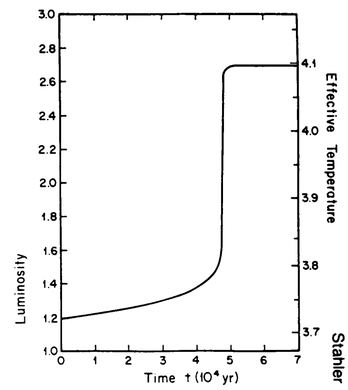
Young stars that jump the light fantastic

Stellar evolution follows a balancing act: Gravity pulls a star's matter inward while hot gases inside push their way outward. Standard theory states that young stars continually radiate light. But new research and preliminary observations suggest that some budding stars don't emit much light. Instead, these youngsters may remain dim for long periods, keeping energy locked inside while pressure builds. Finally, over a period equivalent to an astronomical eyeblink, light as bright as 500 suns bursts forth from the star's surface.

MIT astrophysicist Steven W. Stahler made his illuminating finding while computer-modeling protostars, clumps of hot gas that give birth to stars. He calculated that some of these star progenitors are much smaller than researchers had theorized. As a consequence, some young, intermediate-mass stars – in the range of 2.5 to 6 solar masses – would have only about one-tenth the previously assumed radius before they begin burning hydrogen, he says. And therein lies the rub.

A star in this mass range with a large surface area efficiently reduces gas pressure before its hydrogen ignites, by transporting hot gas outward from its center and converting it into a steady stream of light at the surface. But smaller stars in the same mass range do not. These stars rid themselves of thermal pressure by emitting photons – particles of light – deep within their hot interior, Stahler says. Photons, however, take much longer than hot gas to reach the stellar surface because they must penetrate the star's opaque core. Continually absorbed and reemitted by successive stellar layers, the photons may not escape for 100,000 to 10 million years, Stahler's model suggests. But when they finally emerge, the previously dim star erupts in a brilliant glow,



Graph shows proposed luminosity jump in hypothetical young star of 5 solar masses.

jumping 30 times in luminosity. Stahler says his "crude calculation" indicates the brightness jump occurs over a mere century.

Observations have yet to verify Stahler's theoretical work, but a hint of the long, dim epoch that precedes the predicted luminosity jump may lie in infrared observations of the nearest region known to harbor newly formed stars, says astronomer Mary Barsony of the University of California, Berkeley. She and her colleagues used a sensitive infrared detector and the 2.1-meter telescope at Kitt Peak National Observatory near Tucson, Ariz., to record the luminosity of young stars hidden in the dark clouds of the constellation Ophiuchus, some 400 light-years from Earth.

Barsony found a puzzling deficit in the number of stars whose infrared brightness corresponds to that of young, intermediate-mass stars. She thinks the relative scarcity of such stars in the infrared may be the telltale signature of the dim period described by Stahler. While Barsony emphasizes that her data are preliminary and restricted to a single wavelength, she notes that other astronomers observed a similar dip in Ophiuchus several years before, using a detector that was less sensitive but that recorded luminosity over many wavelengths. Both Stahler and Barsony reported their findings last week at the annual meeting of the American Astronomical Society in Arlington, Va.

A more tantalizing, though perhaps less supportive, set of observations comes from stellar outbursts detected in the Orion constellation. Astronomers in the 1930s saw an unexplained light burst in a star known as FU Orionis, and since then researchers have observed a sudden and dramatic brightening in five more stars in other constellations. While Stahler hopes the outbursts correlate with his predicted luminosity jumps, he says his theory, which currently rules out such jumps in all but 4 percent of newly formed stars, cannot explain that many events over such a short time. "I feel strongly that the physics [of bursting] is related, but each star would have to have multiple jumps for the [proposed] theory to match the frequency of observations," Stahler says. *– R. Cowen*

Antibodies enhance spinal nerve regrowth

With the help of novel antibodies that block nerve-growth inhibitors, scientists have stimulated unprecedented nerve regeneration in the severed spinal cords of rats. New fibers grew as much as 11 millimeters in three weeks – about 10 times the regrowth achieved without the antibodies.

Although biochemical hurdles preclude immediate application in humans, the experiments provide evidence that scientists have overcome one of the major roadblocks to central nervous system (CNS) repair.

Indeed, the results effectively banish the already-crumbling notion that the vertebrate central nervous system is incapable of significant regrowth. Moreover, they strengthen the concept – until now unproved in animals – that the fate of damaged CNS nerves rests not on growth factors alone but on the delicate balance between growth-enhancing and growth-inhibiting substances.

Martin E. Schwab and Lisa Schnell of the University of Zurich, Switzerland, severed the cortico-spinal tract – a bundle of nerve fibers in the spinal cord – in 41 rats. Control rats given no antibodies or antibodies unrelated to nerve regrowth made feeble attempts at nerve regeneration, with new nerve sprouts rarely extending beyond 1 mm.

But rats receiving doses of an antibody that inactivates naturally occurring nerve-growth inhibitors showed "massive sprouting" of new nerve fibers at the injury site, the researchers report in the Jan. 18 NATURE.

Schwab and his colleagues discovered several years ago that growth-inhibiting proteins reside in the myelin sheath surrounding CNS cells. In 1988, the group used mice to produce antibodies against these proteins. Experiments on cultured nerve cells showed then that the antibodies enhanced nerve growth by inactivating the inhibiting substances.

The new experiments are the first to achieve this effect in live animals, says neuroscientist Albert Aguayo at McGill University in Montreal, who calls the research "very promising, very exciting." He notes that nerve regrowth must extend beyond 11 mm to reach very distant targets in humans. "But for rats," he says, "distances such as these are quite substantial."

The results illustrate the "very prominent role" of inhibiting substances in the control of CNS development, Schwab told SCIENCE NEWS. He says researchers know little about the potent proteins, which appear late in fetal development and apparently engage in a "subtle, antagonistic interplay" with several naturally occurring nerve-growth-promoting proteins identified in recent years. By suppressing sprouting, the inhibiting factors may serve as "guardrails," he adds, keeping new nerve endings from straying outside their proper paths.

Having originated in mice, the experimental antibodies would trigger a dangerous immune response if injected into humans, Schwab says. But once scientists gain a better understanding of their structure and mode of action, it should be possible to synthesize human-compatible versions, he adds. He theorizes that scientists will someday accomplish significant CNS regeneration in humans through the combined use of growth inhibitors and promoters. *– R. Weiss*