Murray Hill, New Jersey, and colleagues have discovered a whole new cluster of galaxies and calculated its distance, without relying on its emitted light. Instead they inferred the unseen cluster's existence from the way its gravity rerouted light from more-distant galaxies beyond. Tyson's team is one of several racing to show that the technique, known as gravitational lensing, can be used to map matter in deep space (*Science*, 17 March 2000, p. 1899). But the new work, to be published in the 20 August issue of *Astrophysical Journal Letters*, "is the first convincing demonstration this goal will actually be realized by gravitational lensing," says University of Chicago astrophysicist Wayne Hu.

Astronomers believe that about 90% of mass in the universe is dark. Telescopes can't see it, but its gravitational pull blows its cover. "Gravity doesn't care whether matter is dark or luminous," says Tyson's Bell Labs colleague David Wittman, lead author on the paper describing the work. "All you need are background sources of light, which are all over the sky, and in principle you can find all the matter between us and the background sources."

The team, which also includes Vera Margoniner of Bell Labs, Judith Cohen of the California Institute of Technology in Pasadena, and Ian Dell'Antonio of Brown University in Providence, Rhode Island, used a special wide-field camera attached to the 4-meter Blanco telescope near La Serena, Chile. The astronomers studied a square of sky about twice as big as the full moon, containing tens of thousands of galaxies but no previously known galaxy clusters. They analyzed each individual galactic speck for telltale distortions that might be caused by massive but invisible objects closer to the telescope. Typically, images of distant galaxies appear to wrap around the lens core like the rim of a wheel (see figure). By scrutinizing the whole image a piece at a time and measuring the distortion in each region, the team created a "mass map" of the intervening space. A dense patch in one corner of the map revealed a cluster of galaxies, which the team subsequently confirmed using a conventional telescope.

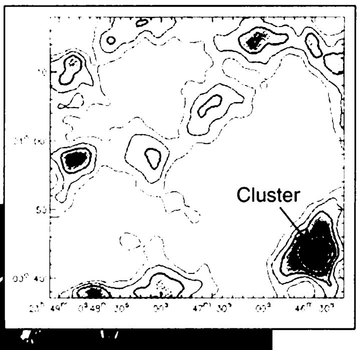
To gauge the distance to the lens, the astronomers exploited the fact that the more distant a light source is beyond a gravitational lens, the more the lens distorts the light in transit. So determining both how far the sources are from Earth and the amount that the images are distorted reveals the lens's location.

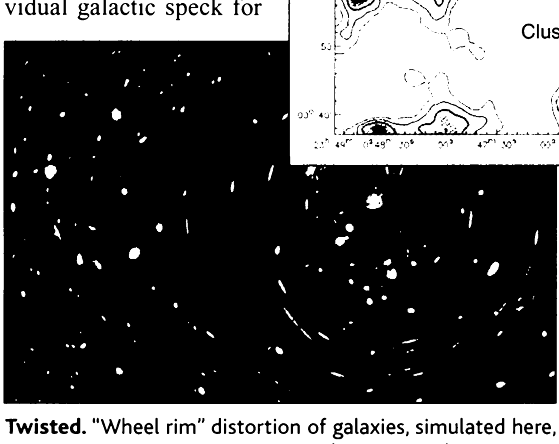
To measure very large cosmic distances, astronomers rely on redshift, the reddening of light that takes place as expanding space stretches the light's wavelength. The more distant the object, the redder the light. Tyson's team estimated the remoteness of the source galaxies by comparing their colors to those of other galaxies at known distances. Then, after studying how much the lens cluster distorted the light of thousands of sources, they calculated the distance to the cluster, again in terms of redshift. The team pegged the lens cluster's redshift at 0.3, corresponding to a distance of about 3.5 billion light-years. Double checking the spectra from some galaxies in the lens, the team confirmed the redshift value to within 10%. "I am still surprised at how well it works," Wittman says.

Mapping clusters by mass should help to close the gap between predicted and observed cluster abundances, says Peter Schneider of the Max Planck Institute for Astrophysics in Garching, Germany. "In that respect, this sort of work is very valuable." Hu goes further. "A catalog of clusters selected by their mass will be invaluable for the study of dark matter and dark energy in the universe," he says. "I expect great things."

—ANDREW WATSON

Andrew Watson writes from Norwich, U.K.





Twisted. "Wheel rim" distortion of galaxies, simulated here, revealed a massive galactic cluster *(inset, above)*.

CREDITS: (LEFT TO RIGHT) COURTESY J. A. TYSON/BELL LABS; ADAPTED FROM D. WITTMAN *ET AL.*, ARXIVE:ASTRO-PH/0104094 V3, 19 JULY 2001

ADVANCED COMPUTING

NSF Launches TeraGrid For Academic Research

Promising benefits to researchers working on everything from drug discovery to climate forecasting, the National Science Foundation (NSF) last week launched what will be the nation's most powerful network for scientific computing. NSF has pledged $53 million to four U.S. research institutions and their commercial partners to build and operate a system expected to be up and running by 2003. Its official name is the Distributed Terascale Facility, taken from its targeted capacity to perform trillions of floating-point operations per second (teraflops) and store hundreds of terabytes of data. But if it's a success, it may go down in history as Internet 3.

The institutions—the University of California, San Diego; the University of Illinois, Urbana-Champaign; the California Institute of Technology in Pasadena; and Argonne National Laboratory outside Chicago—are no strangers to supercomputing. San Diego and Illinois, for example, are home base for NSF's Partnership for Advanced Computational Infrastructure program. Last year NSF gave $45 million to the Pittsburgh Supercomputing Center for a 6-teraflops machine. But the TeraGrid, as it's been dubbed, is touted as a new breed of supercomputer, with software that will allow high-speed, high-bandwidth connections previously not possible.

"It's not just size or speed," says Fran Berman, head of the San Diego Supercomputer Center. "This will change how people use data and how they compute." Her counterpart at Illinois's National Center for Supercomputing Applications, Dan Reed, says the TeraGrid will "eliminate the tyranny of time and distance."

It's already changed the sociology of supercomputing, with its cutthroat competition to have the biggest and fastest machine on the block. The winning institutions were the only entrants in what was scheduled to be a competition. "We were under a lot of political pressure to get this out by September," says an NSF official, "and we only gave [applicants] 3 months to put together their bid. We knew that would be a tough deadline for people to meet." Despite being the only applicant, the winners put together a proposal "that passed [peer review] with flying colors," says Bob Borchers, NSF's head of advanced computing.

WHAT'S IN A TERAGRID?

- 13.6 teraflops (trillions of calculations per second) of computing power
- More than 450 terabytes (trillions of bytes) of data storage
- A 40-gigabit (40 billion bits per second) fiber-optic network
- Four main nodes: San Diego, Urbana-Champaign, Caltech, and Argonne National Lab

The TeraGrid will build on an existing 40-billion-bits-per-second fiber-optic network, the so-called Internet-2 created by Qwest, one of three key industrial partners in the facility. It will rely on clustered Linux servers from IBM powered by thousands of Itanium-family processors from Intel. Each of the four institutions will contribute elements to the TeraGrid; by April 2003, it is expected to deliver 13.6 teraflops of computing power and more than 450 terabytes of storage.

NSF officials are hoping that this fall Congress will give the agency enough money to connect the Pittsburgh center to the grid in a few years' time. That will be followed, says Borchers, by a "deepening" of the network to connect a steadily rising number of regional and local sites. That's the path NSF followed to help create its previous research backbone that became the Internet.

—JEFFREY MERVIS

PLANT SCIENCE

How Seedlings See the Light

Seedlings start to turn green the instant they pop out of the earth and receive sunlight. Exactly how light touches off the chain of events that converts a ghostly pale seedling into a green, photosynthesizing plant has long been a mystery. Now, a team of scientists has filled in one of the major gaps in understanding this photomorphogenesis, as it's called, by uncovering a surprisingly simple three-step pathway involving blue light.

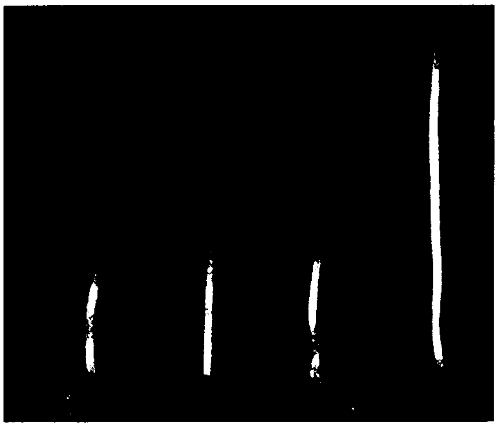
Plant scientists have known for roughly a decade that a plant protein called COP1 is a master regulator of photomorphogenesis. When seedlings germinate in the dark, COP1, which was discovered by Xing-Wang Deng's team at Yale University, keeps the genes that bring about the process in the "off" state by fostering the degradation of transcription factors needed for the genes' activity, including one well-characterized factor known as HY5. Then, when seedlings encounter light, COP1 levels in the nucleus fall, allowing the transcription factor levels to rise and switch on the photomorphogenesis genes.

Since COP1 was discovered, a number of laboratories have tried to identify what they assumed was a cascade of proteins connecting it to the photoreceptors that detect the light. But they could find no such proteins. Now Deng and colleagues have explained why this search has been futile. In a report published online this week by *Science* (www.sciencexpress.org), they show that in the plant *Arabidopsis thaliana*, blue photoreceptors known as cryptochromes interact with COP1 directly. Thus, they suggest that the light signal may be transmitted to COP1 without the intercession of other proteins.

Plant physiologist Roger Hangarter of Indiana University, Bloomington, says the study is "profound, because people have been struggling for a long time to see how the photoreceptor gets information into the nucleus." But plant geneticist Albrecht von Arnim of the University of Tennessee, Knoxville, cautions that the researchers have yet to show that a change in light conditions actually changes the interaction between cryptochromes and COP1.

The Deng team's current work was inspired by results published last year by Anthony Cashmore at the University of Pennsylvania in Philadelphia and his colleagues. They created *Arabidopsis* mutants in which cryptochrome structure was altered and that, consequently, experience photomorphogenesis even when reared in darkness. The observation that a change in cryptochrome shape blocks inhibition of the light response by COP1 suggested to Deng and his colleagues that there might be a direct interaction between COP1 and the cryptochromes.

A battery of tests performed by the team repeatedly caught the two sets of proteins in flagrante delicto: For example, antibodies against COP1 fished one of the two common classes of cryptochromes out of *Ara-*



From darkness into light. A newly discovered signaling pathway tells plants whether to grow tall in search of sunlight (far right) or to develop leaves (left).

CREDITS: (TOP TO BOTTOM) SOURCE: NATIONAL SCIENCE FOUNDATION; H. WANG ET AL.

ScienceScope

Cloning Around Just days after the U.S. House of Representatives voted to ban all forms of nuclear transfer in human cells (*Science*, 10 August, p. 1025), a panel of the National Academy of Sciences heard a case for allowing research on the technique to go forward. The workshop turned into a media circus, however, as dozens of reporters showed up to hear scientists who say they want to use cloning to create a human baby.

Although many panel members expressed grave doubts about the safety of reproductive cloning, most seemed in favor of allowing human nuclear transfer research to continue. Panel chair Irving Weissman, a cell biologist at Stanford University, said that nuclear transfer experiments with human cells could lead to better understanding of certain genetic diseases, insights into early human development, and potential therapies.

Panel member Robert Jaffe said he hoped the panel could draw a distinction between nuclear transfer research and reproductive cloning "clear enough for senators to understand."

Science Exemption Science and technology gets special treatment in new budget guidelines proposed by Japanese Prime Minister Junichiro Koizumi. Last week Koizumi announced that he plans to cut spending by 10% next year, the first overall reduction since 1999, in hopes of ending a prolonged economic slump. But science was spared: The guidelines recommend a 5% boost in funding for research, to $9.5 billion.

Stem Cell Suit In a preview of the tangled legal claims sure to arise over rights to embryonic stem (ES) cells (see p. 1242), the University of Wisconsin, Madison, has sued to block a California company from gaining additional rights to cells it controls.

The Wisconsin Alumni Research Foundation (WARF), a nonprofit corporation associated with the university, holds the patent on derivation and use of primate ES cells, including human cells. But Geron Corp. of Menlo Park, California, funded efforts by Wisconsin researcher James Thomson to derive the human ES cell lines and received commercial rights to six types of cells derived from ES cells.

The original agreement included an option to negotiate for rights to other kinds of cells, but "after good-faith negotiations we've decided not to provide additional cell types," says WARF spokesperson Andy Cohn. Geron says they hope to meet with WARF to resolve the dispute.