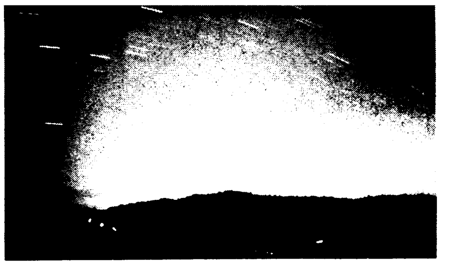
Quasars versus night colors in San Diego



Sky glow over San Diego.

If San Diego sticks with its latest decision to replace its mercury vapor (MV) street lamps with high pressure sodium (HPS) lamps, astronomers at nearby Palomar and Mount Laguna observatories will surely curse the light.

In November of 1982, on a 7-1 vote, the San Diego City Council decided to convert its 17,000 MV and 9,000 HPS street lights to low pressure sodium (LPS) to save energy and reduce light pollution (SN: 4/17/82, p. 269). On June 21, the council reversed two previous decisions and voted 5-4 to adopt the more aesthetically-pleasing HPS lamps; three of the five majority votes came from new members. In the next episode, scheduled for mid-August, the council will vote on seeking bids to purchase and install HPS lamps.

The yellow-orange LPS lamps emit light in a narrow yellow band that astronomers can ignore or filter, leaving the rest of the spectrum uncontaminated. The bluish-white MV lamps emit a number of discrete spectrum lines that astronomers can look between — less favorable but acceptable, were it not for their prohibitive operating costs. The amber-pink HPS lamps emit a broad fuzzy band that contaminates most of the visual spectrum.

"To an astronomer," says Robert Brucato, assistant director of California Institute of Technology's Palomar Observatory, "LPS emission is like a long picket fence with one picket. MV has five or six pickets, and HPS is like a brick wall." Brucato says that converting to HPS would threaten the future existence of the observatory, whereas switching to LPS would immediately reduce San Diego's unfilterable sky glow by 60 percent.

But the single yellow picket of light that does not obstruct star-gazing washes out colors on earth. "LPS lights are depressing and eerie," says council member William Mitchell, who also fears LPS lamps will hinder crime prevention. "The people of San Diego don't want those yellow things."

Two years ago, the city surveyed people in eight LPS test areas. According to Coleman Conrad, deputy city manager, "People generally found the lights acceptable, especially when informed of the energy savings." LPS bulbs use less energy per lumen, but burn out faster than HPS bulbs. "There's a lot of sentiment about the lighting systems concerning public acceptance, overall cost and crime prevention," says Conrad. "But we conclude that the objective evidence does not indicate a significant difference between them."

Astronomers assert that, to their instruments, the difference can be significant. Palomar houses the world's second largest telescope — the Hale 200-inch — which gathers enough light to detect objects 10 million times fainter than those the naked eye can see. Already, light pollution has reduced the capacity of the 200-inch to that of a 140-inch when the telescope is pointed southwest, towards the sky above San Diego. Sky glow also hinders Mount Laguna Observatory, run by San Diego State University.

"Exploring the outer reaches of the universe requires the darkest possible skies," says J. Beverley Oke, a Caltech astronomer who studies distant clusters of galaxies with the Hale 200-inch. If the city adopts HPS lights, Oke could theoretically do the same observations, "though it would take twice as long," he says. But Palomar is already booked solid.

Mitchell, who says he heard that space telescopes would make ground-based observations obsolete, maintains that the case is closed. Palomar officials assert that the two types of astronomy are complementary, not competitive. They hope the council will rescind its vote, opening up the HPS/LPS issue once again.

—S. Steinberg

New proof finally handles old math problem

The mathematics grapevine is buzzing with the news that a 60-year-old supposition in number theory, long thought to be true, has finally been proven. As a result, it is now known that a certain class of equations has only a finite number of rational solutions—solutions that consist of ratios of integers—not an infinite number. "What this suggests is that we may very well be able to someday find all the solutions of such equations," remarks Barry Mazur, mathematics professor at Harvard University in Cambridge, Mass. He has read and studied the proof, and says, "It's a very, very important result." Harold M. Stark, mathematician at both the Massachusetts Institute of Technology in Cambridge and the University of California at San Diego, agrees, saying, "It's been about 50 years since the last comparable advance."

The proof was derived by a young mathematician named Gerd Faltings from Wuppertal University in West Germany and copies of his work in the author's native German seem to be passing expert scrutiny as they just now circulate through the mathematics community. Faltings' proof of the long-standing number-theoretic conjecture originally presented by Louis J. Mordell in 1922 draws on ideas from a branch of mathematics known as algebraic geometry, and provides a more intimate link between the study of numbers and the study of spaces of high dimension.

Why was the confirmation so long in coming? "Many people expected any proof to be substantially more difficult than it turned out to be, and that may have discouraged their efforts," surmises Ronald L. Graham, a mathematician at Bell Laboratories in Murray Hill, N.J. A highly respected monograph in number theory by Paulo Ribenboim published in 1979 expressed pessimism by stating, "...a proof of Mordell's conjecture seems, with good reason, very remote." Yet, explains Mazur, Faltings' 40-page manuscript drew heavily from mathematical tools in algebraic geometry already developed over the past two decades by John Tate of Harvard and Russian mathematicians, adding to them one piece of "brilliant insight."

Rational polynomial equations contain sums and products, with rational coefficients, of variables raised to powers. Faltings' work bears on the subset of these containing only two variables. After applying a well-defined method to remove any singular (abnormally rough) points and to deal with points at infinity, the complete set of solutions for an equation in this subset can be thought of as the compact, smooth surface, or skin, of a three-dimensional shape.

These surfaces naturally fall into one of three categories according to their number of "handles" that could, literally, be grasped. The first category contains surfaces, like that of a sphere, which have no handles. The second category consists of surfaces, like that of a donut, which have just one handle. Equations that fall into either of these groups may have a finite number (even zero) or an infinite number of rational solutions, but in either case, existing procedures allow mathematicians to derive all the solutions from knowledge of just a few.

Faltings' proof addresses the largest and most troublesome third class which contains surfaces, like that of a pretzel, with more than one handle. For this last category, there is no known method for producing new solutions from old ones, but with the new proof, there is no pressing need for one; such many-handled surfaces have now been shown to contain only a finite number of rational solutions. Sixty years ago Mordell made the educated, perhaps hopeful, guess that this was the case, but the conjecture was not proven until Faltings' work. The proof is not what mathematicians would call an "effective" one since it does not include an exact upper limit for the number of solutions, but simply restricts the count to be less than infinite. Nonetheless, Faltings' proof represents a huge step forward. "This is a rare event," says Stark. "You don't see something like this every year."

—P. D. Sackett