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Flagstaff's Battle for Dark Skies

Dr. David S.F. Portree
Flagstaff, Arizona

SECOND PRIZE
BOEING *GRIFFITH OBSERVER* SCIENCE WRITING CONTEST

On 27 October, most of the United States returns to Standard Time and puts an hour of dark sky back into the first half of the night. Between the first Sunday in April and the last Sunday in October, most astronomers have to wait an hour for the sky to get dark enough to get started at the telescope, but Arizona's refusal to embrace Daylight Saving Time suggests that state makes cultivating astronomy an official policy. Arizona's approach to Daylight Time is not really an endorsement of astronomy, but Arizonans have protected dark skies with pioneering codes on outdoor lighting. Flagstaff, in northern Arizona, is the home of Lowell Observatory and the U.S. Naval Observatory, and its engagement with the "forces of darkness" and the "forces of light." Conventional symbolism associates the hero with light and the adversary with darkness, but in the confrontation over light pollution, astronomy is naturally allied with the "forces of darkness." In this prizewinning Boeing Writing Contest article, David S.F. Portree recounts how the conflict with encroaching light eventually enlisted the city of Flagstaff as a defender of the night.

David S.F. Portree is a freelance science writer specializing in spaceflight, astronomy, and the environment. His work has appeared widely in magazines, and he is a regular contributor to the syndicated "Earth & Sky" radio series. Several N.A.S.A. publications on the history of space exploration carry his byline, including *Humans to Mars: Fifty Years of Mission Planning* (February, 2001), *Walking to Olympus: An EVA Chronology* (April, 1997), and *Mir Hardware Heritage* (March, 1995).

Dr. Portree earned a Master's degree in history in 1987 and has also earned a Ph.D. in environmental history. He worked at planetaria for five years while developing his writing craft and subsequently was appointed Senior Technical Writer and Historian at N.A.S.A.'s Johnson Space Center, in Houston, Texas. He switched to full-time freelancing in 1995.

Since 1996, Dr. Portree has compiled "Romance to Reality" (http://members.aol.com /dsfportree/explore.htm), a website designed to ensure wide availability of the concepts developed since 1950 for exploration and settlement of the moon and Mars. He also teaches public astronomy at Lowell Observatory. As residents of Flagstaff, he and his wife Martha and his pug dog Marvin (the Martian) are soldiers in the army of the night.

For people the world over, city lights banish the stars from view. Millions of people have only heard of the Milky Way. In Flagstaff, Arizona, however, our home galaxy still spans a black sky pocked with stars. In 1958, Flagstaff pioneered the world's first lighting ordinance designed to preserve the night for astronomy. Since 1958, Flagstaff astronomers have mostly relied on quiet, friendly diplomacy to protect the night sky. In 1988-89, however, the astronomers and their allies waged open warfare on the side of darkness.

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Astronomy Comes to Flagstaff

Flagstaff's dry, clear skies and dark, cloudless nights drew Percival Lowell to town in 1894. In those days, Arizona was still a Territory and Flagstaff's population amounted to fewer than 1000 people. The townspeople deeded the eccentric, wealthy Bostoner a pine-clad knoll atop the mesa immediately west of town as an observatory site and built him a wagon road to reach it. The area became known as Mars Hill because of Lowell's famous passion for the red planet.

Fourteen years after Lowell's death, Lowell Observatory made its most famous discovery. Using a 13-inch refracting telescope configured as a camera and a search strategy based on Percival Lowell's calculations, observer Clyde Tombaugh discovered Pluto on February 18, 1930. It was the first planet discovered telescopically outside of Europe and the only sun-centered planet found in the twentieth century. Pluto helped put Flagstaff on the map.

Lowell Observatory became the toehold for astronomy's advance into northern Arizona. At mid-century, more astronomers arrived to take advantage of Flagstaff's prime astronomical conditions. In 1952, Arizona State College (present-day Northern Arizona University) established the Atmospheric Research Observatory on its south Flagstaff campus under Arthur Adel, formerly a Lowell astronomer. The U.S. Naval Observatory Flagstaff Station (NOFS) was established about five miles west of the city in 1955. By the time NOFS set up shop, Flagstaff's population was about 8000 people.

The Searchlight Law

Flagstaff adopted the first ordinance preserving the night sky with surprisingly little fanfare. In early 1957, Lowell Observatory prepared to take delivery on a 69-inch reflecting telescope from the Perkins Observatory in Ohio. Lowell staff realized that the instrument could not be used to its full potential on Mars Hill, which was increasingly light polluted. They sought a new site farther from town, enlisting aid from Dr. Harold Johnson, an astronomer who had measured sky brightness across northern Arizona as part of the NOFS site search.

Anderson Mesa, about 12 miles southeast of Flagstaff, emerged as the leading site candidate. Johnson was concerned, however, about Flagstaff's future growth. He worried in particular about advertising searchlights sweeping the sky. In March, 1958, Johnson voiced his concerns to U.S. Naval Observatory astronomer Dr. John Hall.

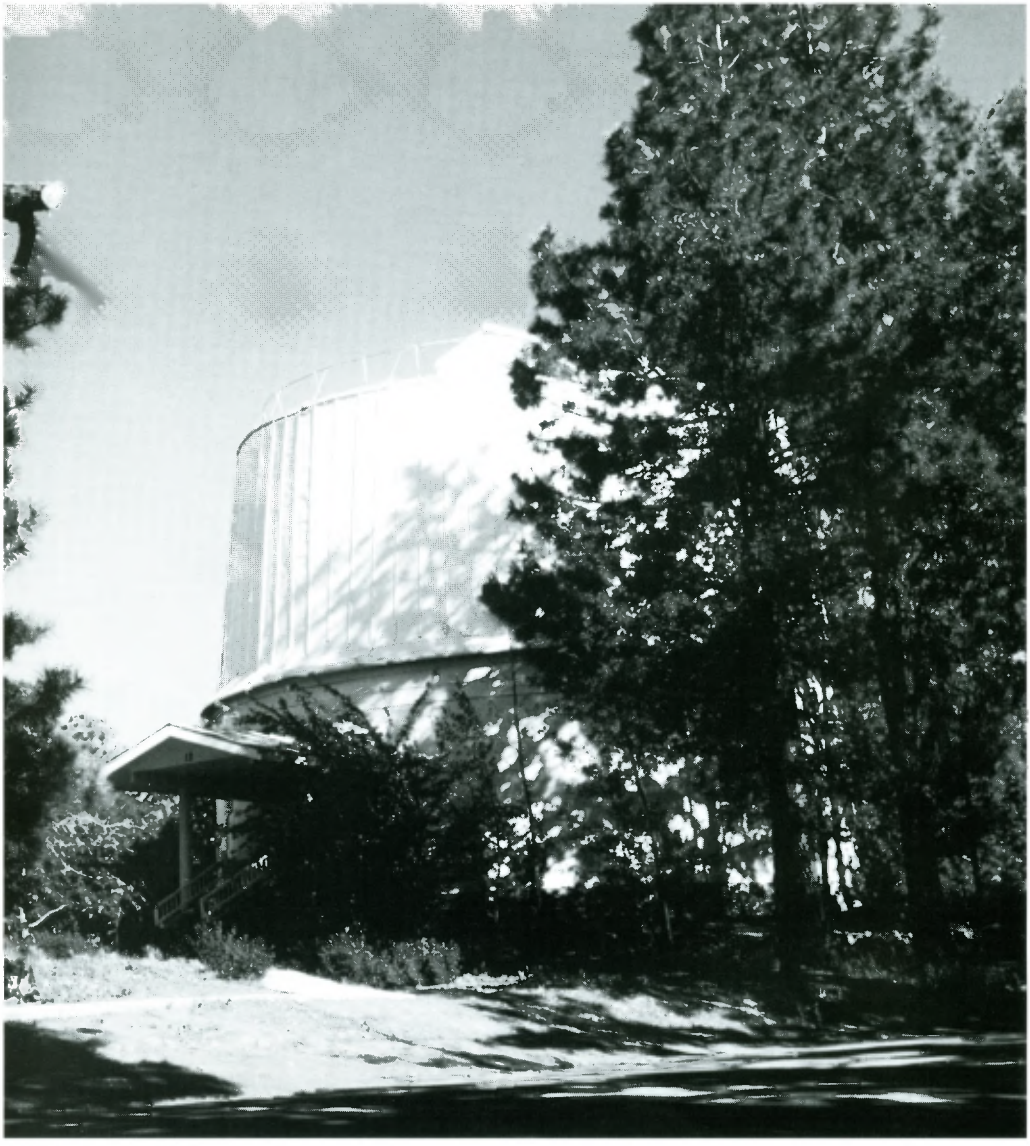
> **I can say from my own experience that one advertising {*sic*} searchlight can ruin the sky for...faint stars as much as 15 miles away. . .We had one such searchlight in Flagstaff a couple of years ago. We can say from experience that there is nothing you can do about them—the man with the searchlight has every legal right to ruin our sky with it.**

At this time, Lowell Observatory was courting Hall for the job of director (he accepted the post in July, 1958). After reading Johnson's letter, Hall urged a novel solution. Lowell Observatory should, he wrote, campaign for a city ordinance to protect Flagstaff astronomy from searchlights.

Johnson turned to Dr. E. C. Slipher, Lowell Observatory's acting director and a pillar in Flagstaff's business community. On April 4, 1958, Johnson told Hall that "EC did some talking to people. The entire [Flagstaff City] Council seems favorable and the ordinance will come up next Tuesday. EC says it will very likely pass." Less

FRONT COVER
Municipally Dark

Flagstaff and its observatories have grown up together. The town was founded in 1882, and Percival Lowell established his observatory 12 years later. In October, 2001, the International Dark-Sky Association made Flagstaff its first International Dark Sky City. That title was not earned easily. Dr. David S.F. Portree describes how Flagstaff edged into darkness in "Flagstaff's Battle for Dark Skies," a Boeing Science Writing Contest winner that begins on page 2. **(photograph Christian B. Luginbuhl, Flagstaff Dark Skies Coalition)**



Astronomy came to Flagstaff with a Massachusetts patrician, Percival Lowell, who built a personal observatory on high ground west of town. With the 24-inch refractor housed in this historic dome, Lowell mapped what he thought were the canals of Mars. **(photograph E.C. Krupp, 1994)**

than two weeks later, he could tell Hall that "the anti-searchlight law has passed and they are now illegal in Flagstaff. There is a $300 fine or 90 days imprisonment for operating one within the city limits." Johnson pointed out, however, that searchlights could still be operated legally in surrounding Coconino County.

Careful and Tactful Efforts

By June 5, 1972, the pioneering spirit in lighting control moved south from Flagstaff. On that date, Tucson adopted Arizona's second lighting ordinance. Designed to protect the National

This view of west Flagstaff from pine-clad Mt. Elden shows both good lighting and bad. Good lighting —low-pressure sodium lamps aimed down and shielded —highlights the property owners who value Flagstaff's unique astronomical setting and cost-saving, energy-efficient lighting plans. **(photograph Christian B. Luginbuhl, Flagstaff Dark Skies Coalition)**

Optical Astronomical Observatory on Kitt Peak, it required that lights be directed downward. Pima County, of which Tucson was seat, passed a similar ordinance a few months later. After lobbying by Flagstaff astronomers, Coconino County followed Tucson's precedent on October 1, 1973, and Flagstaff tagged along soon after.

Despite the new rules, the glow from a growing Flagstaff increased steadily in the 1970s and 1980s. By 1980, most of Lowell's research work and telescopes had moved to the dark skies of Anderson Mesa. Flagstaff's most significant contribution to planetary astronomy during the period occurred at NOFS in 1978, when Dr. James Christy discovered Pluto's moon Charon. The find enabled astronomers to calculate the distant ninth planet's mass and diameter for the first time accurately. Even as NOFS expanded the solar system, however, Adel's observatory at Northern Arizona University succumbed to light from the expanding city.

In 1986, Tucson and Pima County again led the way by jointly updating their 1973 ordinances. They banned mercury vapor streetlights and required low-pressure sodium (LPS) lights favored by Kitt Peak astronomers. LPS lights ruin only two small bands of the visible spectrum, leaving the rest available for astronomical research. Mercury vapor lights, on the other hand, obliterate a broad scattering of spectral bands.

That same year, Lowell director Dr. Arthur Hoag and Flagstaff city planners worked together with Arizona Public Service (APS), Flagstaff's electricity provider, to bring LPS lights to Santa Fe Avenue, at the base of Mars Hill. The trial aimed to gauge public reaction to the amber color. Hoag headed up the International Astronomical Union's Commission 50, which sought to identify and preserve astronomical sites and observing conditions around the world. He hoped that the Santa Fe Avenue trial would help make the citizens and government officials of Flagstaff and Coconino County aware of the impact light pollution had on the observatories.

An APS survey in October, 1987, showed the wisdom of Hoag's approach. After seeing the lights on Santa Fe Avenue, nine out of ten Flagstaff residents were ready to switch to LPS. One respondent found the amber light "softer, more romantic" than the old mercury vapor light. Flagstaff's newspaper, the *Daily Sun*, quoted a Santa Fe Avenue store owner as saying that "Lowell Observatory has history; it is part of Flagstaff. I think the Observatory was here before the streetlights, so it takes priority."

By the time the APS survey signaled Flagstaff's support for LPS and Lowell Observatory, Arthur Hoag had retired, and Dr. G. W. "Wes" Lockwood had taken charge of Lowell's lighting control efforts. Since he joined the observatory staff in 1972, Lockwood had used a telescope on Mars Hill to conduct long-term studies of the atmospheres of Uranus, Neptune, and Saturn's moon Titan. Lockwood outlined his approach to light pollution for Hoag and Jay Gallagher, Lowell's new director.

> **Thanks to Art's careful and tactful efforts over the years, city officials and many citizens recognize the importance of astronomy to Arizona and Flagstaff, and understand the danger that unrestricted lighting poses to our work...These efforts have been largely successful because we have avoided direct confrontation in an adversarial**

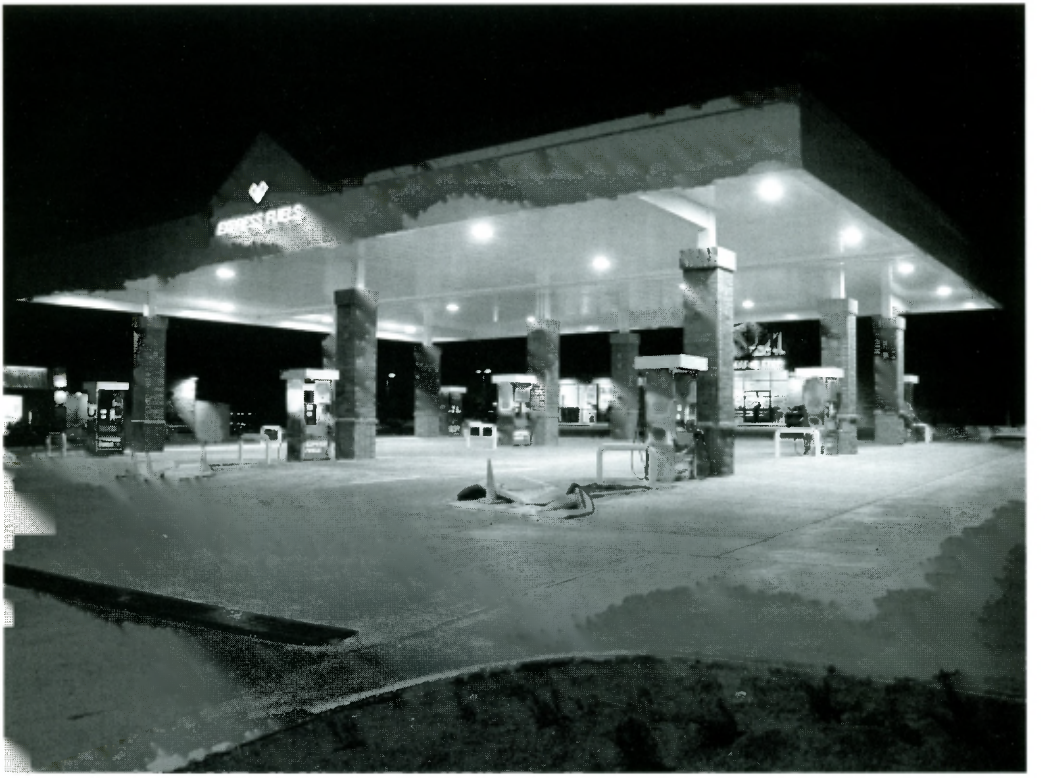
Many examples of bad gas station lighting survive in Flagstaff, despite revisions to the lighting code in 1999. Glaring canopies with light levels as high as 150 lumens per square foot dazzle the dark-adapted eye and create an ugly environment around the pumps. **(photograph David L. Crawford, International Dark-Sky Association)**

relationship. This should continue.

In spring, 1987, Lockwood and Christian Luginbuhl, who researched low-mass stars at NOFS, began non-confrontational efforts to update the 1973 lighting codes. They aimed to follow Tucson/Pima County's lead by banning mercury vapor lights in Flagstaff and mandating use of LPS. On May 13, 1987, Lockwood wrote to Coconino County Planning Director William Towler and Flagstaff Planning Director Jack Cunning to begin discussions. He suggested that the 1986 Tucson/Pima County joint ordinance could "serve as a good model statewide, and in particular for Flagstaff and Coconino County." Discussion proceeded slowly—not until the following March did Lockwood feel ready to advise his fellow Lowell staffers that he and Luginbuhl were "in the beginning stages of working with city staff in the drafting of a new light pollution ordinance."

A Good Neighbor with a Six-million-dollar Payroll

On May 13, 1988—one year to the day after the astronomers opened discussions with Towler and Cunning—the friendly, diplomatic approach to lighting control suddenly became inadequate. On that date, Coconino County planners wrote to NOFS to solicit inputs on an application for a Conditional Use Permit (CUP) by Yellow Freight Company, based in Overland, Kansas. The trucking firm sought to relocate its existing unlit, seven-acre trucking yard from east Flagstaff to a brightly lit, 11-acre site in the newly established Flagstaff Ranch Business Park. The west Flagstaff site was desirable for around-the-clock semi-truck cargo exchanges because it lay within



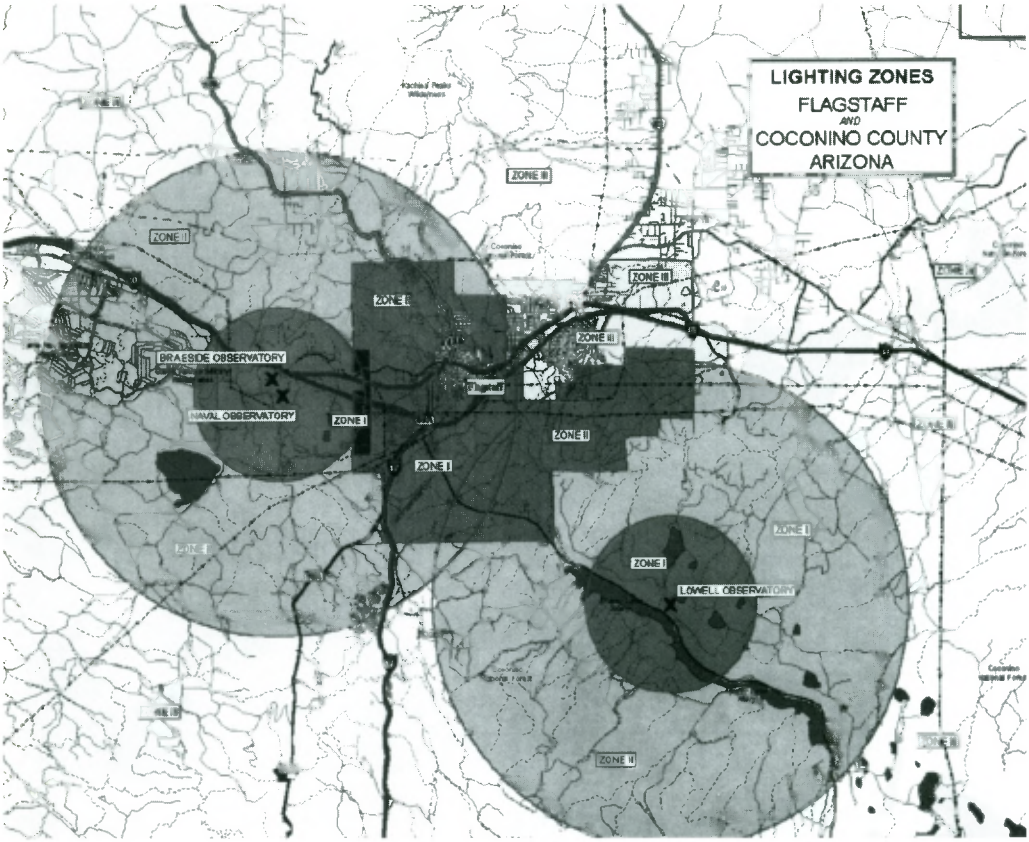
This service station complies with Flagstaff's 1999 lighting code. Fixtures embedded in the canopy direct light downward, reducing hazardous glare and light pollution. The average light level under this canopy is five lumens per square foot. (photograph by Christian B. Luginbuhl, Flagstaff Dark Skies Coalition)

two miles of the Interstate-17/Interstate-40 interchange. It was also within two miles of both NOFS and Mars Hill, however.

In his reply, NOFS director Dr. Harold Ables called the trucking yard "one of the worst kinds of development for this area so close to the observatory, both in terms of the amount of light that will be needed and the hours of operation." Lockwood responded on behalf of Lowell Observatory. "For Mars Hill," he wrote, "this facility would lie in the direction where our night sky is, for the moment, still quite dark." Citing "the certain detrimental effect of the proposed facility upon the research work of these two existing institutions," Lockwood urged that the CUP be denied.

Heeding the astronomers' advice, the Coconino County Planning & Zoning (P & Z) Commission rejected Yellow Freight's CUP application on May 31, 1988. Yellow Freight vowed to appeal the decision to the Coconino County Board of Supervisors. At the July 18 Supervisors meeting, nearby property owners—opposed to diesel fumes, noise, and potential reduction in property values—joined astronomers in speaking out against the trucking yard. The Board rejected the application by a vote of 3 to 2.

But Yellow Freight and Flagstaff Ranch developers refused to accept the Board's decision, and the astronomers quickly realized that Flagstaff's dark skies faced their greatest challenge ever. The company and the developers launched a publicity campaign to put pressure on the county government and the observatories. They had help from a sympathetic *Daily Sun*. In an editorial on July 27, the paper called upon the Board of Supervisors to reconsider its July 18 decision and "work a little harder to bring Yellow Freight management and local astronomers



In 1988, Arizona's Coconino County enacted the world's first outdoor light code to restrict both the type of light and the amount of light per acre. This code defined four zones for different levels lighting restrictions, with Zone 1 corresponding to territory with the greatest limits on lighting. This map of Flagstaff and adjacent Coconino County illustrates how the zones confined light near Flagstaff's observatories. The two sets of nested circles are centered on the Naval Observatory Flagstaff Station in one case and on Lowell Observatory's Anderson Mesa site in the other. The original Lowell Observatory is much closer to central Flagstaff, on Mars Hill, in a Zone II region. **(courtesy David S.F. Portree)**

together on a compromise." The editorial told readers that Yellow Freight ("a good employer and neighbor [with a] $6 million payroll") had offered to use LPS lights. It suggested that "when the observatories have critically important work to do, they could call Yellow Freight and ask officials to turn the lights out completely for the duration of the observation."

Flagstaff residents split over the issue. In letters to the *Daily Sun*, one declared that "no special-interest group as small as the observatories should be allowed to hamstring a city of 42,400 people," while another noted that many cities have truck stops - but very few could boast world-class observatories. One suggested that the observatories and the Supervisors move to the neighboring small town of Williams, "where they can all be in the dark together."

Particularly significant, however, was a long letter by Dr. Eugene Shoemaker, who had been instrumental in bringing the U.S. Geological Survey's Astrogeology Branch to Flagstaff in 1962. Shoemaker, a key player in Apollo program lunar science in the 1960s, was well liked around town. His August 4 letter rebutted the *Daily Sun*'s editorial. "It is not a question of asking people to

turn their lights off for an occasional critical experiment," he explained, adding that

> **The observing program goes on between evening and morning twilight, whenever the moon is down and whenever the nights are clear or partly clear...On a given night, there can be as many as eight independent observing programs under way at different telescopes all at once.**

Shoemaker pointed out that the U.S. Geological Survey had come to Flagstaff largely because of the observatories, and that the combined payrolls of Flagstaff's scientific institutions exceeded the six million dollars claimed by Yellow Freight. He reminded the *Daily Sun*'s readers that Flagstaff had "a rich scientific tradition. . .almost unique in a city of this size" and that it was world-famous as the place where Pluto was discovered. Shoemaker concluded by placing a clear choice before the community:

> **The question before the city and the county now is whether to continue to cherish and nurture this heritage...In order to retain its astronomical observatories in the long run, Flagstaff needs to cultivate industries...that incur minimum light pollution. The effort to contain light pollution must be continuous. It's a simple question of what kind of community we want this to be.**

Lumens Lead to Compromise

On August 10, Yellow Freight told the Coconino County Supervisors that it would submit a revised CUP application. Coconino County Deputy Attorney Terence Hance advised the Supervisors that they could not legally reconsider their July 18 decision because county law prohibited approval of a project within a year of its rejection. The developers chose to ignore the legalities; in their response, a Flagstaff Ranch spokesman told the *Daily Sun* that Yellow Freight's revised application deserved a hearing because the trucking yard was of "vital importance to the community."

The Board of Supervisors decided at a stormy August 14 meeting that Yellow Freight could submit a "substantially different" CUP application. The revised application, submitted on August 29, expanded Yellow Freight's Flagstaff Ranch parcel to 12.33 acres to create a bordering 20-foot-wide buffer around its yard in deference to local landowners, and included LPS lights to accommodate the observatories. Planning Director Towler advised that the application was too similar to that rejected on July 18. In a highly contentious meeting on August 30, however, the Coconino County P & Z Commission bowed to pressure from the developers and their allies and agreed to consider the revised application on September 14.

Now the Flagstaff light pollution war drew media attention beyond northern Arizona—and became more technical. Chris Luginbuhl told the Phoenix-based *Arizona Republic* newspaper that the observatories could accept a 30-percent increase in sky brightness. He explained that a 30-percent boost would increase by 30 percent the time needed to collect data on a dim object, with a corresponding cut in the time available for other observations.

Luginbuhl introduced a technical term into the battle—the lumen, the international unit of light quantity. A 60-watt incandescent bulb, for example, produces about 800 lumens. He told the paper that Yellow Freight's original CUP application called for 650,000 lumens of light over 11.25 acres, while its August 29 revised plan called for 309,000 lumens over 12.33 acres. Luginbuhl told the *Republic* that Yellow Freight could release no more than 200,000 lumens if a 30-percent light pollution increase were to be avoided.

On September 14, 1988, the date the Coconino County P & Z Commission was set to review Yellow Freight's revised CUP application, the light pollution war took an unexpected turn: the company and NOFS agreed to a novel compromise based on Luginbuhl's "lumens-per-acre" system. Yellow Freight would buy six additional acres in Flagstaff Ranch and leave them unlit to reduce the overall light produced in the area. In return, NOFS would cease raising lighting-related concerns. The company withdrew its August 29 application, announcing that it would soon submit a more "refined" application including the new compromise.

On January 3, 1989, the county P & Z Commission approved Yellow Freight's refined CUP application. The trucking yard could go

As part of the Flagstaff Dark Skies Coalition's 2001 "Stars Up! Lights Down!" campaign, the City of Flagstaff pledged to bring all old lighting into compliance with current rules. Before this fire station turned down the lights, the glare from its unshielded wallpack illumination spotlighted the problem. **(photograph by Christian B. Luginbuhl, Flagstaff Dark Skies Coalition)**

ahead at Flagstaff Ranch. Unlike his NOFS colleagues, Wes Lockwood was not bound to remain silent; after the vote, he told the *Daily Sun* that "the precedent of putting a major source of light...pollution near an existing astronomical observatory cannot be viewed as a positive development for astronomy in the Flagstaff area."

Victory for the Forces of Darkness

Luginbuhl's lumens-per-acre system, it was soon revealed, was a central tenet of the new Flagstaff lighting code proposed by the astronomers. While Yellow Freight and Flagstaff Ranch waged their publicity campaign, Luginbuhl, Lockwood, Flagstaff, and Coconino County quietly continued the work they began in May, 1987. Energized by battle, and drawing on the fund of goodwill built up through decades of light pollution diplomacy, the astronomers abandoned their plan to base the new code on the precedent established in the 1986 Tucson/Pima joint ordinance. Instead, they took up the mantle of Johnson, Hall, and Slipher and plunged into unexplored lighting control territory. On October 25, 1988, the Coconino County P & Z Commission unveiled the pioneering new code, the first in the world to restrict both type of light and amount of light per acre.

The new code established four zones, with the strictest lighting controls in Zone I. This encompassed all county land within 2.5 miles of NOFS and Anderson Mesa, including the Flagstaff Ranch Business Park. LPS lights were to be used in all zones, except where "color rendition" was required—for example, in a car dealer's lot. This recognized that, because they shine in only two spectral bands, LPS lights do not show color well. The code set a limit of 25,000 lumens per acre in Zone I, with 50,000 lumens per acre allowed in

Although the Flagstaff fire station had been burning with artificial light, it inexpensively reduced glare through installation of shields on the wallpacks. The shields now direct light downward, where it can do the most good. **(photograph by Christian B. Luginbuhl, Flagstaff Dark Skies Coalition)**

Zone II (2.5 to 7 miles from the observatories) and 100,000 lumens per acre in Zone III (7 to 35 miles from the observatories). Zone IV, taking in Coconino County beyond 35 miles from the observatories, had no lumens-per-acre restrictions, but had the same bans on searchlights and mercury vapor lights as the other zones. Planning Director Towler told the *Daily Sun* that the proposed code was "going to be controversial."

On November 22, the county Board of Supervisors appeared to yield to pressure from the developers by voting unanimously to postpone the P & Z Commission's consideration of the new

CENTER
America the Luminous

This image acquired from orbit by the U.S. Air Force Defense Meteorological Satellite Program shows how much of the night we have lost. City lights map the nation in wasted lumens and guarantee that only half of all American children see nothing more than the brightest celestial objects in their night skies. Astronomy's effort to take back the night is detailed in part in this issue's Boeing Science Writing Contest award-winning article, "Flagstaff's Battle for Dark Skies," by Dr. David S.F. Portree. **(image C. Elvidge, *et al*, National Oceanic and Atmospheric Administration)**

The Flagstaff/Coconino County Jail, completed in 2001, is recognized by the International Dark-Sky Association for its outstanding lighting. No unshielded fixtures illuminate the parking lots and walkways, and most lighting is astronomy-friendly low-pressure sodium, known for its warm yellow glow. **(photograph by Christian B. Luginbuhl, Flagstaff Dark Skies Coalition)**

code until late January. They did this, they said, to "allow more time for public input." The developers, it became clear, would use the time provided by the postponement to organize an assault on the new code. But on November 26, another, more hopeful reason for the postponement became apparent: Towler and his Flagstaff counterpart Jack Cunning announced that the city would join with Coconino County in developing the new lighting code.

Flagstaff Ranch developers fought back. They hired Ian Lewin, of Scottsdale-based Lighting Sciences, Inc., to hold a December 15 "public seminar" on light pollution. The astronomers demanded equal time. They called for Dr. David Crawford, co-founder of the newly established International Dark-Sky Association (IDA), to be included in the seminar. About fifty Flagstaff residents turned out at Flagstaff City Hall to witness Crawford and Lewin go head to head over the proposed lighting code. In its coverage, the *Daily Sun* emphasized Lewin's argument that the proposed new code's low light levels would leave the city and county vulnerable to costly lawsuits.

On January 31, 1989, the county P & Z Commission considered the new code. Lewin again raised the liability issue, calling it a "very serious problem." Deputy County Attorney Terence Hance, in no mood to be ignored this time, told the Commissioners that "I am not aware that [Lewin] is licensed to practice law in the state of Arizona, and I don't concur with him." The Commission then unanimously approved the new lighting code. After the vote, Commissioner Gary Gammons told the *Daily Sun* that "I wish we had done this before. I don't think the observatories asked for enough."

The tide of battle had turned, and victory was now swift. On March 6, the county Supervisors unanimously approved the new lighting code over strident objections from Flagstaff Ranch developers. In a story titled "Astronomers Win Their War Against Lights," the *Daily Sun* reported that the Supervisors had provided "immediate protection" for the observatories. On September 26, Flagstaff's P & Z Commission approved a lighting ordinance nearly identical to the Coconino County code. At the hearing, Luginbuhl asked that Flagstaff City Council join the county in giving the observatories immediate protection, because "many high-impact projects are now in the approval process, or are poised to enter it." The Council adopted the new ordinance on November 7, to take effect immediately.

The national newspaper *USA Today* trumpeted the victory for Flagstaff's dark skies. A week later, Wes Lockwood wrote to Flagstaff Mayor Chris Bavasi to thank him and city staff for their aid in passing the new city lighting code, the strictest in the world. "We recognize. . .that the test of implementation and public acceptance now lies ahead," Lockwood wrote. "We stand ready to assist. . .in communicating this new way of thinking about lighting to the community."

International Dark-Sky City

Yellow Freight announced on August 11, 1992, that, effective August 23, it would transfer 51

The International Dark-Sky Association may be based in Tucson, but it established Flagstaff as its first International Dark-Sky City on 24 October 2001. Participatiing in the ceremony, from left to right, are Flagstaff City Council member Penny Trovillion, Flagstaff City Manager Dave Wilcox, and International Dark-Sky Association Executive Director David L. Crawford. **(photographs by Christian B. Luginbuhl, Flagstaff Dark Skies Coalition)**

drivers from its Flagstaff Ranch operation to other cities because it had changed its routes. William Duffey, president of the Greater Flagstaff Economic Council, told the *Daily Sun* that the drivers' departure would mean a loss of two million dollars per year for Flagstaff's economy. He added that he had tried to persuade the company's officials to keep its drivers in Flagstaff, but that its routes were changing all over the United States. "It's a little like stopping a moving train," Duffey said. By 1996, Yellow Freight had withdrawn all its long-distance drivers from Flagstaff.

As Yellow Freight's tail lights faded into the distance, the old domes on Mars Hill saw new activity. In 1994, Percival Lowell's observatory commemorated its first century as part of Flagstaff by opening the new $2.5-million Steele Visitor Center. When comets Hale-Bopp and Hyakutake graced Flagstaff's dark skies in 1996-97, more than 140,000 visitors passed through the new center. Many also passed through Flagstaff's motels and restaurants.

The 1988-89 light pollution war heightened community interest in Flagstaff's unique astronomical resources. A new citizens' group called Dark Skies formally made its debut by marching in Flagstaff's 1998 Independence Day parade. The group soon changed its name to the Flagstaff Dark Skies Coalition and became a section of the IDA.

The struggle against light pollution in Flagstaff since 1958 reached a culmination on October 24, 2001, when the IDA declared Flagstaff its first International Dark-Sky City. According to IDA Executive Director David Crawford, "No other city or town has shown such an overall commitment to protecting the quality of its dark skies, not only for

the observatories, but for all the citizens of northern Arizona." A study using data from Defense Meteorological Satellite Program (DMSP) satellites in earth-orbit, found in 2000 that Flagstaff, with a population of 55,000 people, emitted only as much light as a typical city of 40,000.

What's a Dark Sky Worth?

A cynic might argue that astronomers battle light pollution to protect their jobs. Astronomers do not, however, become astronomers because astronomy is a lucrative industry. They become astronomers because the universe touches their souls. Battling light pollution is, deep down, an attempt to maintain contact with something bigger than humanity. Infinite space comes down to earth at night unless stray, trivial light banishes it beyond our awareness.

Many people reject such intangibles as having no value. New businesses, on the other hand, are tangible. And yet, for a city like Flagstaff, Arizona, the intangible glory a dark sky reveals has become an unconventional and enviable economic boon. The Yellow Freight Company left Flagstaff when changes in its business dictated, leaving only a cloud of diesel fumes. The observatories, on the other hand, are bound to the area by its dry, clear air and dark, cloudless nights. If Flagstaff skies remain dark, the observatories that explore them are likely to contribute steadily to the city's well-being for decades to come.

Eclipse Dining

Sylvia Sligar

Southern California experienced the trans-Pacific annular eclipse on Monday, 10 June 2002, as a deep partial eclipse. At maximum, about 72 percent of the area of the sun's disk was blackened by the moon in Los Angeles, and even though Griffith Observatory is closed to prepare for major renovation and expansion, at least 1200 people observed the eclipse from the Observatory grounds. The twin Zeiss refractor on the Observatory roof was operated for the public, and it was reinforced by 25 telescopes on the front lawn, supplied by the Los Angeles Astronomical Society and the Los Angeles Sidewalk Astronomers. Nine Los Angeles television stations, the two major newspapers, and several radio news reporters filed on-the-scene stories for the picture-perfect eclipse. In an upcoming issue, the *Griffith Observer* will provide a pictorial report of the event, but here, in the meantime, is the eclipse story from Orange County, where celestial alignment and refined dining were on the menu.

On Monday, 10 June 2002, we were treated to an incomplete view of an annular solar eclipse. An annular eclipse occurs when the moon's disk appears to be smaller than the sun in a central eclipse and so displays a dark disk centered on the sun. Because the sun is not completely obscured, a bright ring of sunlight remains around the black moon. Of course, you have to be in the path of the annularity to see the ring, or *annulus*. Outside of the path, you will see a partial eclipse or no eclipse at all.

Dick and I have traveled to see solar eclipses. In 1991, we traveled to Tahiti. In 1992, we traveled to Santa Catalina Island, 26 miles across the sea, according to the song by the Four Preps. In 1994, we were headed to Toledo, Ohio, but decided instead to stop in Marion, Ohio. It's a small town to the south of Toledo, and it was less congested.

Our travel distance for the 10 June 2002 eclipse was minimal. We were able to see first contact at 5:13 p.m., Pacific Daylight Time, from our roof in Orange County. The moon's disk began taking the edge off the bottom of the sun on the right (west) side. Because there is a hill to the west of our home, however, we had to travel to the other side of the hill to see the rest of the eclipse. But because Chapman Avenue has been widened, there is no place to pull off legally to the side the road on the other side of the hill. There are,