


WHERE DID ALL THE STARS GO?

**HOW LIGHT POLLUTION IS
STEALING THE NIGHT**

BY MARK BINELLI

The Milky Way,
seen from
Texas' Big
Bend National
Park, one of
the darkest
places in the
United States



THE LARGEST OPTICAL TELESCOPE in North America belongs to McDonald Observatory, which sits atop a mountain in West Texas. Astronomers have come here to peer into black holes millions of light-years away, massive enough to contain 17 billion of our suns. To arrive at the observatory, they've most likely made a three-hour drive east from El Paso, through an alien desert terrain of spiny yucca trees and severe, distant mesas. When McDonald was built in the late 1930s, the most famous observatory in the United States was still Mount Wilson in Pasadena, California, at the time possessor of the largest telescope in the world. But even back then, light pollution from Los Angeles was beginning to wash out the night sky. So when a wealthy bachelor from Paris, Texas, named William J. McDonald left his banking fortune to the University of Texas in 1926, saying he wanted the school to build a telescope big enough to peer into the very gates of heaven and see if anyone was there — in the paraphrasing of longtime McDonald Observatory employee Bill Wren — an initial site on the outskirts of Austin was wisely rejected.

Instead, the trustees turned to West Texas, which to this day remains one of the most isolated, indigenously eccentric parts of the United States. *No Country for Old Men* was filmed out here, and local wildlife includes the javelina, a furry, piglike creature that can be spotted scurrying into the tall grass off Dark Sky Drive, the road wending its way up to McDonald. Wren greets me in the parking lot. He's been working at the observatory



This 2012 image showing Africa, Asia, and Australia depicts the scope of the global light problem: With more than 50 percent of the world's population now living in cities and towns, the Earth can never truly go dark.

were dealing with,” Krupp told *The Los Angeles Times*. “The stars were in fact so unfamiliar, they called us wondering what happened.” Local police reported similar calls in which residents asked if the quake might have been caused by a curious “silver cloud” in the sky. This turned out to be the Milky Way — which, today, two-thirds of the U.S. population and one-fifth of the world’s cannot see.

How did our own solar system become so unfamiliar as to now seem like an alien menace? The short answer is light pollution: the fact that much outdoor lighting used at night is wildly inefficient, overly bright, poorly targeted, improperly shielded, and, in many cases, completely unnecessary. Dark-sky advocates don’t exactly love the “pollution” part of the term. “That’s the most accurate description of what’s going on, but people hear it and think I’m going to chain myself to the nearest streetlamp,” mutters

Wren, who has become one of the leading dark-sky evangelists in the country. Still, the net effects are undeniably environmental. Light pollution not only douses the night sky to the point of unrecognizability for much of the world, but also represents a feckless waste of energy, with the end result being more greenhouse gases released into the atmosphere.

The U.S. spends \$11 billion each year on unnecessary outdoor lighting, according to the International Dark-Sky Association,

which sounds like an organization that should be worried about keeping James Bond tied to a chair in a volcanic lair but is actually the leading advocacy group dedicated to combating light pollution. The behavior of nocturnal animals, the IDA points out, is also negatively affected by gratuitous outdoor lighting, and scientists have even linked serious human health risks (including breast cancer) to excessive nighttime exposure to bright, artificial light.

“It’s not like a species going extinct,” Wren says. “The sky isn’t going anywhere, and we aren’t harming the stars. But we are encapsulating ourselves in these bubbles of light around our major population centers that make it impossible to see the stars at night. And the consequences for that . . . well, I have no idea. But we’re losing something ineffable. Mystical. Would van Gogh have been able to paint *Starry Night* today? I’m not sure. Saint-Rémy, the town where he painted it, has some of the worst light pollution in France.”

Talk of “ineffable, mystical” loss might sound a tad nebulous and abstracted. I thought so — until I stood on that catwalk, as the twilight faded to pitch, and looked up. We were standing in one of the darkest places in the United States. The seven-county region surrounding McDonald Observatory has passed strict lighting

for more than 20 years. A bearded, white-haired 58-year-old, he walks with a wooden cane thanks to a teenage motorcycle accident. The hair and cane make him look older, though he has a lean, handsome face.

We make our way up to the metal catwalk circling one of the white observatory domes, which affords a spectacular view of the surrounding landscape. Two thousand feet below, there’s Fort Davis, an old garrison town where Buffalo Soldiers were stationed just after the Civil War. Closer to the mountain, a rustic development of approximately 100 houses stretches over the foothills. A good number of the residents, Wren tells me, are amateur astronomers, drawn to the area for its pristine night skies. Sure enough, a closer look reveals that many of the homes boast miniature observatory domes at the edges of their driveways, or else flat-topped sheds with sliding roofs.

At the moment, though, I can’t make out any of these particulars, because night has fallen, and the development, Limpia Crossing, is almost entirely unlit. There are no streetlights on the winding roads, just curbside reflectors that flash headlights back at drivers, warning them of turns. And none of the houses seem to have illuminated porches or driveway lights. The only dim glow leaks from the odd living room window. Otherwise, a development ranging over hundreds of acres remains al-

most completely camouflaged by the darkness. If Wren hadn’t pointed the place out, I would have never even noticed it.

LIKE THE professional astronomers working at McDonald Observatory, the amateurs at Limpia Crossing, and the hundreds of tourists drawn to weekly “star parties” in the observatory’s outdoor amphitheater, I’ve come to Texas to see the darkness. Across the country, as cities sprawl into suburbs and suburbs metastasize into exurbs, with the amount of artificial lighting exploding alongside every new McMansion, strip mall, and superhighway, the night sky, in its purest form, is increasingly becoming an endangered species. If you live in a decent-size metropolitan area, chances are you rarely glimpse any but a handful of the brightest stars and planets. A clear view of the solar system — and that awesome, unmooring, sublime, occasionally terrifying feeling that comes over us when we bear witness to the vastness of the universe and recognize our infinitesimal place in it — had been a routine nocturnal experience for the bulk of human history. Now it’s become rarefied and, for some, unimaginable.

Ed Krupp, the director of Los Angeles’ Griffith Observatory for the past four decades, has said that in 1994, after the Northridge earthquake knocked out much of the city’s power, the observatory began to receive panicked phone calls about “the strange sky.” “We finally realized what we

Contributing editor MARK BINELLI wrote about Buddhist scholar Robert Thurman in the August issue.

COURTESY OF NASA

ordinances that have helped to make the area “the dark-sky capital of Texas,” in the words of Wren, whose advocacy played a key role in getting those laws on the books: At 28,000 square miles, it’s the largest contiguous space in North America legislatively set aside to protect dark skies. The area includes the gargantuan Big Bend National Park, the darkest park in the continental U.S., which runs along the border with Mexico — big enough, at 800,000 acres, to hold nearly the entire state of Rhode Island.

I live in New York City; before that, Detroit and Atlanta. Still, I thought I’d seen plenty of starry night skies in my life — in northern Michigan and upstate New York, at a friend’s cabin in Maine, vacationing on a Greek island. But I’ve never caught a glimpse of the astral plane as dramatically unobstructed as this one. Initially, it’s overwhelming, like suddenly realizing you’ve swum too far out into the ocean. At the same time, being reduced to such a supplicant state of awe feels jarring and unfamiliar. Post-childhood, how often do you spend any significant amount of time with your head tilted back, gazing straight up?

Wren directs my eyes to the Northern Cross, Orion’s Belt, Polaris, the Summer Triangle. Occasionally, he uses a device that shoots light-saber beams straight

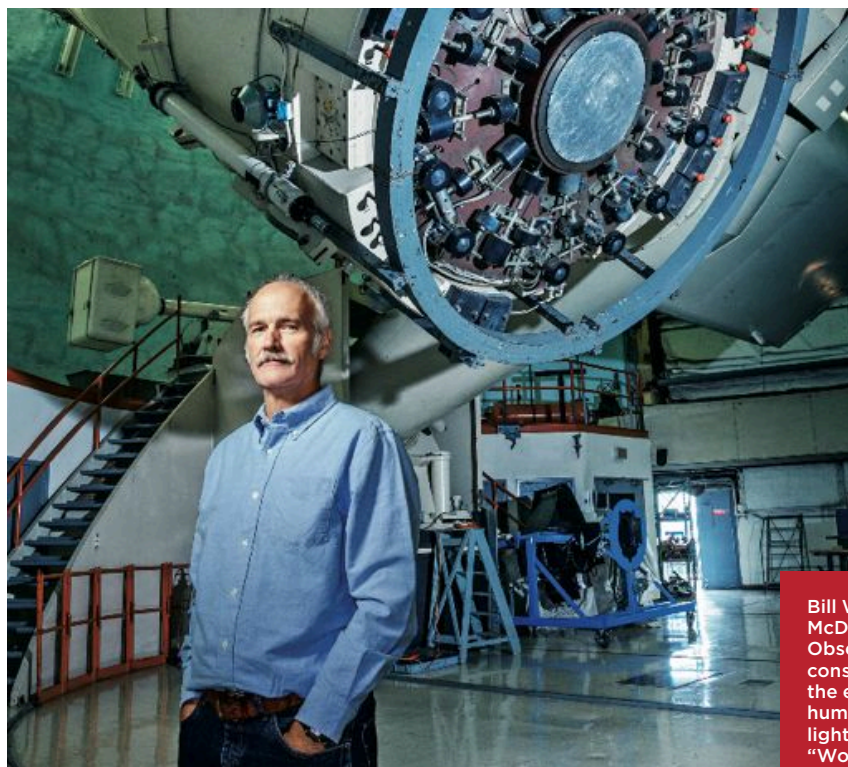
of the big domes. There are about 3,000 stars out tonight, versus the dozen or so you might see in downtown Austin. Those closest to the horizon shimmer like flecks of tinsel; farther up, they’re more fixed and intense, some as tiny as pinpricks, others thick as pearls. I see shooting stars and satellites. The white streak of the Milky Way looks like a gaseous bruise. I think about how I’m looking up at thousands of violent thermonuclear reactions, taking place trillions of miles away.

Down here, though, it’s very peaceful. The only sound is the shrill, chirrupy drone of invisible desert insects. I’m staying at the Astronomer’s Lodge, dorm-style accommodations for scientists visiting the observatory. The rooms have twin beds (with star patterns on the comforters) and

“**I**N THE CENTURIES preceding the Industrial Revolution, evening appeared fraught with menace,” the historian A. Roger Ekirch writes in his lively cultural history of the night, *At Day’s Close*. Darkness brought with it threats both real and imagined: murderers and bandits, witches and demons, pestilential night “fogges” and “vapours” thought to carry sickness and death. “All forms of artificial illumination — not just lamps but torches and candles — helped early on to alleviate nocturnal anxieties,” Ekirch notes.

The first streetlamps were lit with candles and, later, kerosene. With electricity came incredibly bright arc lights (which involved heating up vaporized carbon particles until they glowed), used in the late 19th century in cities like Paris. Incandes-

If you live in a decent-size metropolitan area, chances are you rarely glimpse any but a handful of the brightest stars and planets.



Bill Wren, at McDonald Observatory, considers the essential human cost of light pollution. “Would van Gogh have been able to paint *Starry Night* today? I’m not sure.”

up to the black firmament, tracing star patterns as casually as if it’s a speckled chalkboard. “The center of the galaxy is right . . . here,” he says, circling the brightest part of the Milky Way, then chuckling. “Pretty cool.”

Eventually, Wren goes off to bed. But I remain outside, lingering at the base of one

blackout curtains (because, of course, the astronomers work all night). Every time I begin to wander in the direction of my room, I notice something else up above and stop in my tracks. Occasionally, the dark shape of an astronomer glides past me, silent as a ghost.

cent lighting followed, and quickly spread. In 1891, Telluride, Colorado, became the first city in the world to use alternating current to power its streetlights, memorably described in Thomas Pynchon’s *Against the Day*: “The high-country darkness . . . soon gave way to an unholy radiance ahead, in the east. It was the wrong color for a fire, and daybreak was out of the question, though the end of the world remained a possibility.”

Bob Parks, the executive director of the IDA, says utility companies heartily embraced streetlights in order to avoid the costly and inefficient process of spinning down their generators at night, when home and business power usage dropped precipitously. By the 1950s, a new technology called high-intensity discharge (HID) lighting allowed streetlamps to burn 10 to 20 times brighter than incandescents. “And they didn’t cost much more,” Parks says. “So people were like, ‘Fine, give it to me.’”

Parks lives just outside Washington, D.C. When I visited him over the summer, I made time to swing by an exhibit at the Smithsonian dedicated to Thomas Edison, described by Parks as “the first great salesman of lighting.” Displays featured components from Edison’s first power plant

(on Pearl Street in downtown New York) and a photo of the first electric sign (spelling out the word EDISON in giant letters), but I couldn’t help squinting askance at the rows of antique bulbs, which,



THE WORST OFFENDER

Among American cities with significant light-pollution problems, like Los Angeles, New York, and Washington, D.C., Chicago stands out as perhaps the worst. In 2008, the city was named the single most light-polluted city in the country. Much of Chicago's problem stems from its profusion of billboards,

improperly aimed streetlights, and outdated Victorian-style streetlamps. In a positive development, as part of a recent effort to prevent birds from striking brightly illuminated buildings at night and dying, 100 Chicago-area skyscraper owners agreed to dim their lights during the evening.

after several weeks of my talking to people about light pollution, suddenly took on a sinister appearance, as if they were a collection of medieval torture instruments.

I met Parks for an early dinner at a chain chopped-salad restaurant. He was wearing round, rimless glasses, a green polo shirt, and khaki pants, with a tablet computer slung across his chest like a messenger's bag and his eyeglass case strapped onto a belt holster. A boyish 57-year-old, despite his white hair and beard, Parks possesses the soothing manner of someone who works in children's television, perhaps with puppets. He told me that he built his first telescope as a 12-year-old Boy Scout, from a kit. He loved the scope, but he had no further interest in

astronomy for the next three decades or so, until the day he began flipping through the stargazing magazines left around the office by one of his employees. (Parks owned a multimedia design company.) He hadn't realized you could pick up scopes so cheaply, and so he bought himself a nice little eight-inch SCT (Schmidt-Cassegrain, a popular, compact consumer design) and started taking it out into his yard in Alexandria, Virginia, where, on a good night, he was lucky to see 10 stars.

Later, this prompted him to buy 10 dark acres on top of Cave Mountain in West Virginia and set up a camper there. Around the same time, he joined a local astronomy club, where he learned about the IDA. Like

a hacker hired by a corporation to protect its servers from other hackers, Parks realized he could bring special skills to bear on this particular issue. Ironically, beginning in high school, he'd spent years working as a lighting designer, mostly for rock bands, his duties ranging from straight stage lighting to Hendrix-style psychedelic light shows. In college, Parks took upper-level physics courses on lighting, and continued in the business after graduation, working for A&M Records with touring artists like Tim Curry, of *The Rocky Horror Picture Show*, and a Japanese techno act called the Yellow Magic Orchestra. Parks is today a member of the Illuminating and Engineering Society of North America. Disappointingly, its members do not refer to themselves as the Illuminati.

Our indiscriminate overuse of outdoor lighting is the main cause of light pollution. We light our driveways, our porches, our parking lots, our billboards and storefronts, our streets and highways, our parks and public spaces — at times for the purpose of commerce, but often because, on a gut level, it just feels safer to have bright lights around at night. But much of our outdoor lighting is poorly designed, blasting light into the sky rather than onto the sidewalk or city street we're actually meaning to illuminate. Outsize spotlights used for architectural lighting — say, to highlight a flagpole or church steeple — could be replaced with seven-watt LED spots that would work just fine. Likewise, many safety concerns could be addressed with better targeted, lower-wattage lighting, in some cases activated solely by motion detectors; improperly aimed floodlights, perversely, wind up creating blinding glares that can make it easier for would-be criminals to lurk in the shadows.

In certain obvious, unfortunate ways, light pollution has simply evolved alongside our lighting technology. As Paul Bogard points out in the new book *The End of Night*, a single 75-watt incandescent bulb burns 100 times brighter than a candle. Satellite images of North America at night, with various intensities of light represented by glowing yellows and oranges, are startling, with just about everything east of the Mississippi looking like a graphic representation of a toxic spill. Sky glow has transformed the color of night, for many of us, into perpetually dizzying gradations of pink and blue. A 2001 study co-authored by scientists from Italy and the U.S. found that for 80 percent of the U.S. population and two-thirds of the European Union population, night-sky brightness equaled full-moon conditions all month long. "They therefore effectively live in perennial moonlight," the study concluded. "Night never really comes for them." (The authors also took note of the unusual amount of night visibility in Venice, the only Italian city with a population greater than 250,000 in which residents can typically see the Milky Way from the city center; they

attributed this fact “mainly to the unique low-intensity romantic lighting of this city, which deserves to be preserved.”)

Meanwhile, Richard Stevens, an epidemiologist at the University of Connecticut, has conducted research suggesting that lengthy exposure to bright, artificial lights at night (computer screen, television, streetlamps) causes circadian disruption in humans, resulting in the body producing lower amounts of melatonin, a hormone that fights cancer and suppresses tumor growth. Night-shift workers, according to Stevens’ study, are nearly twice as likely to develop breast cancer as day-shift workers. A 2012 report by the American Medical Association noted, “Biological adaptation to the sun has evolved over billions of years. The power to artificially override the natural cycle of light and dark is a recent event and represents a man-made self-experiment,” adding that “even low-intensity nighttime light has the capability of suppressing melatonin release.” Aside from “potential carcinogenic effects,” the AMA report states that circadian disruption could also exacerbate other health problems, including obesity, diabetes, mood disorders, depression, and reproductive issues, and calls for minimizing light pollution and further study of its potential effects.

University of Southern California professor Travis Longcore has written about the effects of light pollution on animals. Migrating birds become disoriented by lights and crash into tall, lighted buildings and broadcasting towers; newly hatched sea turtles crawl toward artificial lights (rather than the moonlight over the sea) and wind up crushed by cars or eaten by predators; nocturnal insects flock around city lights, dying in large numbers and disrupting the feeding of bats and other animals higher on the food chain (a study in Germany found that approximately 150 insects are killed by each German streetlight every night). “A pollutant is only a pollutant because we call it such,” Longcore told *Cabinet* magazine. “Carbon dioxide, of course, has been produced on Earth for billions of years, but we now consider it a pollutant because it’s more abundant than it would be naturally. In the same way, we can think of light as polluting when it’s more prevalent than it would be naturally.”

One of Parks’ first light-pollution campaigns, to help a local county adopt a strict lighting ordinance, became a teachable moment for him after one of the board members showed up at a public meeting dressed as Santa Claus, claiming the new laws would ban Christmas lights. “He was just a buffoon, playing on everybody’s fears,” Parks recalls. “He didn’t care about the lights. He was just against regulation. He was a Tea Party guy before there was a Tea Party.” The ordinance was never enacted, and Parks learned a crucial lesson about the importance of education: Bad lighting is something the average citizen rarely

notices unless it’s pointed out. “That’s the number one problem,” Parks says, sighing. “You never miss what you don’t know is there. I’d say 90 percent of the population now doesn’t miss dark skies. They’ve never seen them! And that’s really, really sad.”

OUTSIDE THE RESTAURANT’S plate-glass window, dusk has fallen, and the headlights of the cars gliding along K Street have turned themselves on. Stepping onto the sidewalk, Parks immediately scowls up at an ornamental streetlamp. “This city has probably the worst lighting in the country, and this is the worst streetlight ever invented,” he says. I have to admit (though I don’t, not aloud and in Parks’ presence), I rather like the design of the light: a slightly filigreed metal post rising up to an old-fashioned, mostly exposed acorn-shaped bulb known as a Washington globe. Unfortunately, because of the utter lack of shielding, more than 50 percent of the light shines up into the sky, serving no useful purpose, and about 20 percent radiates directly at eye level, creating glare. “You’re working against visibility by using a light like this one,” Parks says. “But people love the way they look during the day. I’d have no problem if they didn’t turn them on at night. Or if they just put candles in them, the way they were designed.”

Parks turns onto 16th Street, wandering in the direction of the Capitol Hilton. A series of small lights buried in the center of some shrubbery, designed to light up the landscaping from within, stops him in his tracks. “People like lights in bushes,” he

in reality, it’s probably 100. And it’s white light, which is the worst.”

Parks’ mood seems to be darkening with the night sky — which is not all that dark, Parks would surely point out — but still, the growing dimness allows the sheer amount of horrible lighting surrounding us to assume a much sharper focus. “That is just hellishly bright,” he says as we come across another Washington globe.

At the same time, Parks is not unsympathetic to the hardwired human yearning to vanquish the night. “We light because we are innately afraid of the dark,” he says. “Psychology ends up driving public policy: No politician will ever get fired for putting up outdoor lighting. The public feels safe during the day, and there’s a feeling that ultimately, the best thing would be for night to be like day.”

After Parks and I part ways, I head toward the National Mall. Others had warned me that once you start hanging around with light-pollution people, it’s impossible to unsee the matrix — in this case, an inescapable grid of harsh and aesthetically offensive lighting. And it’s true! A garish LED sign outside a bank, informing customers they can “Deposit in a Flash” with their smartphones, bathes a long stretch of sidewalk in a sickly irradiated glow. Staring into a park lit entirely by Washington globes actually makes my eyes hurt. It’s much darker on the Mall, where lighting is minimal along the major paths and nonexistent by the Reflecting Pool. Still, I can see only about a dozen stars, thanks to the sky glow from the rest of the city.

We light our streets and highways, our parks and public spaces, because on a gut level, it feels safer having bright lights around at night.

notes disapprovingly, adding, “Unshielded, but they’re hidden, so that’s OK.” The exterior of the hotel is highlighted by lights coming out of unshielded wall packs, but Parks says the pale paint job of the walls and the brightness of the surrounding streetlamps makes this choice unobjectionable.

At the sight of a restaurant’s brightly backlit sign, Parks pulls out his smartphone and opens a folder of apps labeled “Lighting Tools.” Photographing the sign, he uses one of the apps to map the amount of light being generated. The photo turns different neon colors, mostly green and yellow, with a tap of his finger displaying the number of lumens that section of the light source is emitting. “Fifty-five,” Parks says. “Though

The Lincoln Memorial looks beautiful in the distance, spotlighted in a way that seems to give the whiteness of the marble a living pulse, and with such a high-definition gleam on Abe himself, he could pass for a hologram. The flashes of dozens of tourist cameras sparkle like lightning bugs. A guy rides past on a bike with a kaleidoscopic array of glow sticks weaved into his spokes. I start back in the direction of my hotel and suddenly my newly light-sensitive eyes become slits: Near the Washington Monument, some kind of giant globe light has doused a cluster of trees and the surrounding sky.

I’m about to snap a photograph and fire off an angry email to Parks when I realize it’s the full moon.



LATE 1950S



1997



2025

BLINDED BY THE LIGHT

Researchers from the University of Padua, in Italy, working with the National Geophysical Data Center in Boulder, Colorado, have collaborated on the first World Atlas of artificial night-sky brightness, which measures global light pollution. The above images show light levels in the United States over the past five decades, along with a projection for 2025. Drawn from computer models based on upward light as measured by meteorological satellites, the images take into account other factors such

as altitude and the way light is scattered by smog. Black space represents the darkest areas, traditionally clustered in sparsely populated western states, while the colored areas depict different levels of light pollution. Yellow represents twice the amount of natural night-sky brightness. In orange zones, the Milky Way is no longer visible. Red zones mean fewer than 100 stars can be seen. Finally, in the white and pink zones, most prevalent in the 2025 map, the North Star and the Big Dipper have disappeared.

ON THE PLUS SIDE, light pollution is fundamentally a much simpler problem to tackle than most other kinds of pollution. It doesn't require the sort of life-pattern-altering tectonic shifts necessary for, say, weaning ourselves from oil or coal or factory-farmed meat. Our relationship to outdoor illumination remains a fairly passive one. If our towns decided to change the streetlamps, few of us, with the exception of the Santa-suit guy, would care, or even notice, until the night sky made its dramatic reappearance.

And as Bob Parks points out, solid-state LED lighting is coming online that could radically change the way we light cities. "You get this opportunity only about once a century," Parks says. "We're moving from a very mechanical way of lighting things — putting glowing elements inside glass, which is technology that was around a hundred years ago — to the sort of technology we've used to build computers. And we'll see that same rapid curve we got with computers, where efficiency will go up and up and up and at the exact same time cost will go down."

Jeffrey Cassis, the CEO of Philips' Color Kinetics division, who has spent years working on LED development, agrees: "The technology is there — now we're trying to get the cost down. And it's moving down very rapidly. Probably less than 1 percent of lighting in cities is now smart LED lighting. Think about how much of how we light our cities is being left to humans deciding to turn things on and off!" The alternative, Cassis and other experts say, will be smart grids allowing for automatic dimming of lights, either pegged to time of day — a particular neighborhood could, say, decide its streetlamps should be lowered significantly after midnight — or even more specific triggers. In San Jose, California, the comprehensive LED retrofit being installed will let streetlights become brighter when sporting events or concerts let out or when bars close. Nancy Clanton, an architectural engineer based in Boulder, Colorado, who has become one of the premier dark-sky lighting designers in the country, predicts future streetlights will have the ability to detect approaching cars (or pedestrians carrying mobile phones) and brighten automatically. "Unfortunately, everyone knows where we are at all times with GPS, so we might as well put it to good use," she notes cheerily.

Clanton has upgraded municipal lighting systems across the country, and says she initially approached the issue as a design challenge. She points out that streetlamps, for example, are typically set upon 30- or 40-foot poles — but what if a second, much lower tier of luminaires were built into the poles to light the sidewalks? Or how about curb-level lighting that would blast lights into crosswalks, so anyone in the street could be immediately seen by cars? "Now," Clanton says, "we can light the curbs themselves, or the stripes of crosswalks, or vertical strips on Jersey barriers" — the low concrete walls

on the sides of highways — “all of which is much more important than shining light down on everything. Do you ski? Go skiing one day when the light is flat. You can’t see bumps! That’s why we need layering in our lighting — which, by the way, we’ve been doing in interiors for years.”

Seattle has been using federal stimulus money to retrofit all 40,000 of its residential streetlights. Clanton points to a study conducted in that city in which nearly 450 participants responded to different outdoor lighting in various weather conditions. Stunningly, even when lighting was reduced to a mere 25 percent of its normal level, respondents continued to feel safe and secure — as long as the fixtures were targeted white lights with low glare. “Lighting level made no difference to people,” Clanton says. “In fact, they didn’t even know it was lower lighting!”

Research conducted by Virginia Tech’s Transportation Institute had passengers ride in vehicles on a mile and a half of test roadways. The vehicles traveled at 35 miles per hour, and passengers were instructed to press a button whenever they spotted an object in the road. Again, the tests took place in all sorts of conditions — wet, dry, various lighting levels — and the researchers found that lighting level made no difference on task detection if lights were properly designed. “So now we have both objective and subjective data,” Clanton says. All the data points to the fact that we’ve been designing lighting all wrong for years. “They were designing for one parameter: lighting level,” says Clanton. “Which we’ve found out is the worst predictor for visibility. What’s much more important is glare and contrast. It’s the quality of light — having really good optical design. And now with computers we can model everything, including contrast. Our tools

foot candle. The brightness of a full moon is one-100th of a foot candle.

At the same time, groups like the IDA have been pushing municipalities to adopt stricter lighting ordinances. Plymouth, Minnesota, a suburb of Minneapolis with a population of 70,000, became the first city in the U.S. to adopt the IDA’s comprehensive model lighting ordinance, which mandates specific amounts of shielding and caps brightness. The city council of Malibu, California, voted unanimously to adopt its own version of the ordinance in April as a direct response to the wild overlighting of a shopping center and football field. Arizona cities like Flagstaff and Tucson have long had strict lighting laws on the books that ban, for instance, searchlights and unshielded parking-lot lights. Both cities are surrounded by observatories, and some believe Flagstaff, a dry, high-elevation locale that has attracted stargazers since the 1890s, when it earned the nickname Skylight City, passed the first lighting restrictions in the country in 1958 in order to protect its skies.

THE IDA AND other light-pollution activists have also focused on creating dark-sky preserves, generally state or national parks, where visitors might glimpse what they’ve been missing. Along with Big Bend, the IDA’s highest-ranked — i.e., darkest — parks in the United States include Death Valley in California, National Bridges in Utah, Cherry Springs in Pennsylvania, and Clayton Lake in New Mexico. Part of the selling point of such ratings is the ability to market dark-sky tourism. Though one might assume Governor Rick Perry and the deeply conservative Austin legislature would balk at any lawmaking that smacked of environmentalism, the fact is, dark skies are good for business, and so the Texas Parks and Wildlife Department has agreed,

so can pull off saying things like “Get some grub” or “You’ll see all kinds of critters around here” with the unself-consciousness of a native speaker, has surely contributed to his success ratio. Thanks to Wren’s involvement, a Texas convenience-store chain called Stripes dimmed the lighting above the gas pumps at many of its 500-plus locations from 5,700 watts to 1,500 watts per canopy. “That’s still enough light to top off your car and perform brain surgery at the same time,” Wren notes drily. But he’s not complaining.

One night, under the dome of McDonald Observatory’s 36-inch telescope, built in 1956, Wren slides in front of a computer running an old DOS program and punches in some Messier catalog numbers from memory, whistling as he types. The Messier catalog compiles coordinates of various astronomical objects. Wren has just entered the coordinates for Saturn. The big telescope, shaded an institutional gray the color of a public school locker from the Fifties, swivels into alignment with an ugly grinding sound. Climbing onto a ladder, I peer into the finder scope and see what looks to be a cartoon drawing of the planet — a sailor’s tattoo of Saturn! — along with three tiny dots that Wren explains are moons.

“That’s not Saturn,” I say.

“People always say that,” Wren says. “They can’t believe it.”

Stepping out onto the catwalk, Wren continues, “Light pollution is a soft sell — it really is.” If he sees bad lighting, Wren will not hesitate to knock on someone’s door, often with a complimentary replacement fixture tucked under his arm. As might be expected, the initial response from Texans to a stranger telling them to change the way they’re lighting their private property is not necessarily to invite that stranger inside for a Shiner Bock. “Really, very few people have slammed the door in my face, though that does happen,” Wren acknowledges. “People will say, ‘What the hell are you talking about?’ or ‘You can’t tell me how to light my property!’ But then when you tell them, ‘Well, your neighbor across the street doesn’t appreciate your light shining in their bedroom window,’ they’re like, ‘Oh . . .’ It’s like noise pollution. Blasting music at 2 in the morning and keeping people awake, or having a bright barnyard light keeping people up — same difference. And once people see that, they get it.”

One of Wren’s earliest memories is watching the moon rise through a pair of binoculars pressed up against the plate-glass window of his childhood home. He thought about becoming an astronomer but realized he wasn’t wired for math and physics and so instead majored in philosophy, moving from the existentialists to Zen practitioners like Alan Watts. In Austin, he worked with runaway teens and their families, spending his free time playing poker and catching shows at Armadillo World Headquarters, the legendary Texas rock venue (where Wren proudly notes that he was *(continued on page 163)*)

“I’d say 90 percent of the population now doesn’t miss dark skies,” says Parks. “They’ve never seen them! And that’s really, really sad.”

are completely different. Back then, they could not analyze glare.”

Of course, had those same citizens been subjects of a telephone poll, many would have voted for more lighting, which intuitively feels safer, so education remains a key component of any future political fights. Clanton says she likes to ask people if they’ve ever taken a moonlit walk. “They’ll typically say, ‘Oh, yeah; it’s so great.’ And I’ll tell them, ‘You know, you can read 12-point print under full moonlight!’” Foot candles are units used to measure light intensity. A typical streetlamp, Clanton says, is one

with the blessing of the state, to assess all 93 Texas state parks for outdoor-lighting improvements and to send their park rangers to McDonald Observatory for night-sky training, in order to better teach visitors about constellations and telescopes.

Bill Wren has been a key player in advocating for such changes in West Texas and throughout the state, from shaping city and county ordinances to urging businesses and residents to change the ways in which they light their buildings. Wren’s courtly, nonthreatening manner, and the fact that he grew up in a small town in Missouri and

present for the taping of Frank Zappa's 1975 live album *Bongo Fury*). He also continued to pursue astronomy as a hobby, driving to the outskirts of town with carloads of friends and coolers filled with beer. He's since been told that a sports complex called the Field of Dreams has opened near his old viewing site, with lights "bright as televisions — out of compliance with everything." If he still lived in Austin, he'd have to find another stargazing spot.

Shortly after he started working at McDonald Observatory, Wren met David Crawford, the proselytizing co-founder of the IDA. Crawford, now retired, was an astronomer at Kitt Peak Observatory in Arizona; he started the IDA in 1988, converting a legion of missionaries such as Wren. Like Crawford, Wren sees himself as an educator, and spends much of his time traveling around the state making PowerPoint presentations about light pollution. He's also been working with a natural-gas drilling company to design a demonstration rig with dark-sky-friendly lighting. (There's been a sharp increase in fracking in Texas in recent years, and federal safety regulations require high levels of lighting on the big rigs, with operators generally employing monstrous floodlights.)

OUT ON THE CATWALK, Wren says he's grateful for the mountains ringing the observatory. Without them, he notes, we'd be staring at a sea of headlights from a hundred miles away. As we chat, a car makes a wrong turn as it exits the star-party parking lot and starts coming up the hill in our direction, its single pair of headlights washing over us like we're escaped convicts lambing it over a prison wall. Wren nods at a distant cluster of hills where a group of local survivalists has established an outpost. "Good lighting, though!" he murmurs. "They just have this one security light that bothers the hell out of me. . . ."

"Most people will say looking up at the Milky Way makes them feel so insignificant," Wren goes on. "You know, 'I feel so small and tiny.' Well, there's that. But there's also: Look at what you're connected to! I mean, we're part of something really grand, and for me, that kind of evens things out."

"One of the things I was interested in when I studied educational psychology is how we acquire different cognitive skills, like the ability to abstract — to imagine what it would be like to walk a mile in someone else's shoes, as opposed to just your own view," he continues. "To imagine a world beyond your horizon. And there are different theories of cognitive development, but most of them follow along the lines of Piaget, where you move from infancy into concrete operational thought, which is very black-and-white, letter-of-the-law, and then onto

formal operational thought, where you're able to abstract and imagine other points of view. And depending on who you believe, about half of the population never obtains any level of formal operational thought."

Why is that? I wonder.

"That's a good question," Wren says. "I'm wondering if losing touch with the sky has anything to do with it."

THE NEXT DAY, we drive over to Limpia Crossing, where I meet amateur astronomers like Allen Gilchrist, a retired research scientist who spent years working for oil-industry companies in Houston and carting around his telescope on vacations. He and his wife chose Fort Davis for their retirement in large part because of the darkness, and he bought a small observatory dome, which he's called Stonecrest, at the edge of his driveway. Leading me inside, where Prokofiev is playing softly in the background on an old boombox, he shows me some of the dazzling photographs he's made with his scope, one of the most impressive being the Lagoon Nebula, a colorful interstellar cloud that's part of Sagittarius. Amateur astronomers are like birdwatchers: Some focus on stars in our solar system, others on galaxies far beyond our own. You might be nerdily obsessed with the sun, or the moon, or seeking out supernovas or asteroids undiscovered by professional scientists. "There are only so many large telescopes in the world, so this is one of the few sciences left where amateurs can actually make contributions to the professional community," Wren says. "I mean, you don't hear about amateur particle physicists."

After my visit to McDonald, I spend the night in Big Bend National Park, in the newly retrofitted Chisos Basin. The main lodging area has dim, recessed lighting only where absolutely necessary: near doors and at foot level on walkways. It's very easy to get around, but any glow is muted and earthbound. A path from the main lodge leads to a series of stone cottages, built in the 1940s by the WPA, which is where I'm staying. While most of the park looks as austere as the landscape in a Road Runner cartoon, Chisos is a lush bubble of high desert ecosystem, notably cooler, with pine trees lining distant hills and animals you wouldn't expect to see in a normal desert: I spot a white-tailed deer with massive, goofy ears and a petite gray fox dragging an impressive tail.

As the sun sets, I sit on the back porch of my cottage and watch the stars come out. It's sublime in a way I'm not quite prepared for. I have a book I'm enjoying, and some work to do on my laptop. But I can't tear myself from this dizzying, unfamiliar view. At McDonald Observatory, my first glimpse of the night sky made me feel tiny and alone, just as Bill Wren described. Tonight, though, simply having been given the opportunity to witness these stars, the beauty of this entire yawning cosmic spectacle, even if it's just a fleeting

speck of a moment as we hurtle through space and time into an empty black void — it feels like a gift. Tonight I don't think of explosions. I think about how the stars must have looked to our ancestors, millennia ago: like tiny torches held out for us by invisible agents. The fact that we might be the only living beings in the universe bearing witness to this canopy of light can make everything feel pointless and random, sure, but, conversely, and maybe especially if you've spent the past few hours sipping from nip-size little airplane bottles of Dewar's (discreetly poured into a paper coffee cup you discovered back in your cottage), it can also make you feel special. Chosen, even — if only by natural selection, and by our own human craving for discovery and transcendence.

I pop the trunk of my rental car's hatchback and lie down in the bed like I'm at a drive-in. One of the neighbors wanders out to his own car to grab something, using a flashlight. The insect drone is one part squeaking mattress, one part teakettle whistle, and it blends with the sound of the wind, rolling in like a tide. I remember an art exhibit I saw once that included a work — well, "work" — by the playwright August Strindberg, who thought he could capture images of the cosmos by leaving exposed photo plates out all night. The images he produced were beautiful, and they could pass for frozen images of the night sky. Strindberg was disappointed to eventually discover that what he'd thought was the universe was likely no more than random scatterings of dust.

I'm starting to feel a dull ache in my neck, but I don't want to go inside. A car pulls out of the parking lot, briefly lighting up a tree and making it look plastic, overlit, part of a diorama at a natural-history museum. I wander back toward the cottage and suddenly, I'm startled by something huge moving toward me. It turns out to be a spider, transformed into a B-movie monster by one of the low-wattage IDA-approved lights, its legs rearing up in shadow against a wooden post.

I thought about my first night in Fort Davis, which happened to be July 5. Bill Wren had suggested we check out the town's fireworks display, and so I'd ended up at a party at his ex-brother-in-law's place, stretched out on the grass with a bunch of strangers, staring out at a fusillade of patriotic explosions — even then, tipping my head backward to peer at the stars, which struck me as far more compelling and exotic than any man-made pyrotechnics. The bursting of a new rocket would briefly force me to look straight ahead. And there, in front of me, a whole new galaxy of colored lights would be streaking the horizon, having appeared out of nothing. And then, just as quickly, it would be gone.

After a while, I lay back on the cool grass, giving up on the fireworks, and started looking for Arcturus, a bright star Wren had pointed out earlier. I knew it was up there somewhere. **M**