present from Flagstaff and Phoenix in their figure 4. More stray light comes to the US Naval Observatory Flagstaff Station from Flagstaff, a close, small city with very stringent fixture requirements in place, than from Phoenix, a distant, large city with less stringent requirements.

The impact of fully shielded fixtures is rather small. The authors use 10% as the amount of light directed upward for "typical" community lighting fixtures, but a sample of commonly installed fixtures tested by the National Lighting Product Information Program[2] had uplight values averaging less than 0.3%. Counting only partially cut-off fixtures like the one illustrated in figure 3 of the article, the average uplight value was still less than 0.5%. Therefore, a value of 10% misrepresents what is actually being installed. Limiting the typical value of 0.3% uplight to 0% from fully shielded fixtures will have little incremental effect on reducing sky glow beyond current practice. Parenthetically, the statement attributed by the authors to members of the lighting profession that partially shielded fixtures permit wider spacing than fully shielded ones is incorrect; many fully shielded fixtures can be spaced farther apart than many unshielded ones.[3]

The direction of light leaving the property matters most in terms of light trespass and glare. Both are also measures of wasted light and to some communities can be just as important as sky glow is to astronomers. The outdoor site-lighting performance (OSP) system[1] has been used to develop methods to measure and limit light trespass onto adjacent windows from the lights illuminating, for example, a car dealer's lot. Similarly, glare into the eyes of automobile drivers from a fixture on a golf driving range can be measured, and limits can be established.

Our systematic review of current outdoor lighting practice and of the reasons people complain about light pollution[1] shows the state of outdoor lighting with regard to glow, trespass, and glare and suggests how to make improvements using the OSP system. Fully shielded fixtures are one way to limit wasted light, but they are not sufficient to reverse any of the three problems called light pollution. Luginbuhl and coauthors point out that unintentional use of vegetation and other structures reduces by 50–60% the impact of wasted light contributing to sky glow. Given that value, intentional use of vegetation and structures to prevent light from leaving a property could be more effective at controlling sky glow than the use of fully shielded fixtures advocated by the authors.

The OSP system is a practical computational tool to compare proposed and existing designs that limit wasted light with those used in current practice. It also gives owners and communities practical methods and effective criteria for minimizing glow, trespass, and glare not only to slow the growth of wasted light—including encroachment on the night sky—but to reverse it. We therefore applaud the authors for making the case to reduce wasted light as it affects astronomical observations, but many more issues associated with outdoor lighting need to be considered, including its benefits. With practical and effective tools, each community can best decide how to address the multifaceted issues of light pollution.

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Luginbuhl, Walker, and Wainscoat reply: We appreciate the concern of Mark Rea, John Bullough, and Jennifer Brons for aspects of light pollution other than sky glow, and we support increased awareness and reduction of all forms of light pollution and energy waste. Our article was explicitly about the impacts on astronomical observatories and science, though to a large extent the careless lighting practices that increase sky glow over observatories also cause light trespass, glare, and energy waste. Nevertheless, many techniques used to protect observatories, in particular the full shielding of fixtures to control direct uplight, have wide applicability for national parks, coastlines, and anywhere citizens want to preserve or restore their ability to see stars in the night sky.

Of course, distance and lighting amounts are critical factors. If direct uplight were a tiny fraction of total light output, approaches other than improving shielding might be more productive for reducing sky glow. But the observational evidence does not support the low uplight fraction Rea and coauthors suggest. Using measurements of how sky glow varies with distance and inventories of light fixtures, other researchers find uplight percentages of 8–15%.[1–3] So direct upward emission, whatever the distance or amount, dominates sky glow. Eliminating it in communities with typical shielding and near-ground blocking would reduce sky glow by 35–75% for observation distances of 50–200 km.

The writers' suggestion that vegetation could be intentionally used to decrease light pollution impacts may have some merit, though vegetation is not something on which astronomers or lighting designers have much influence. In any case, the modeling shows that the impact of direct upward emissions remains disproportionate even in the presence of substantial blocking by structures or vegetation.

Whatever uses the outdoor site-lighting performance metric may have for evaluating other aspects of light pollution, it is not a good metric for evaluating sky glow. It contains no information about the direction light is propagating away from a lighting installation, nor does it distinguish between upward- and downward-directed light. As our work and that of others[1,2,4] demonstrate, direction is critical in considering most aspects of light pollution.

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Hot topics in cold fusion

In his letter to PHYSICS TODAY (February 2010, page 10), Jacques Read raises an

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interesting question by suggesting that the cold-fusion results may be explained by cosmic-ray muons. I have investigated cold fusion for many years and find that the Fleischmann–Pons effect is strongly dependent on the palladium material. Palladium–boron alloys made by the US Naval Research Laboratory have worked especially well in my experiments (see US Patent 6,764,561, 20 July 2004, and US Patent 7,381,368, 3 June 2008). That seems to me to suggest the importance of impurities (boron is an oxygen getter) rather than cosmic-ray muons.

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In his letter about cold fusion involving muonic atoms, Jacques Read discussed the 1989 experiment by Stanley Pons and Martin Fleischmann that "has been repeated over and over." Like most nuclear physicists of my generation, I was very excited by the idea of cold fusion of hydrogen nuclei. I had accepted the prevailing conclusion that what was reported by Pons and Fleischmann was not fusion. In 2002, however, after a coincidental encounter, I started participating in research in condensed-matter nuclear science (CMNS)—the term practitioners now use instead of cold fusion. I was looking for at least one reproducible-on-demand demonstration of a strong nuclear reaction due to a chemical process. I have not been successful thus far. But I have met many CMNS scientists, read their reports, and participated in their international conferences.

The excess energy Read mentions is no longer the only claim made by CMNS researchers. Others are emission of nuclear particles, transmutation of elements, and changes in isotopic composition of elements. A recently published book by Edmund Storms,[1] a retired materials scientist from Los Alamos National Laboratory, summarizes what has been discovered since 1989. I believe that reports made by recognized scientists should be taken seriously, even when their results conflict with what is expected. According to CMNS researchers, a new kind of nuclear phenomenon in condensed matter has been discovered. But conditions under which the new phenomenon would be reproducible remain to be identified.

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Practical, near-term fusion power

The fusion–fission hybrids report (PHYSICS TODAY, July 2009, page 24) reflects the commonly accepted view that fusion power is a long way off. Not necessarily. Abundant clean energy can be generated from pure fusion power plants on a timeline consistent with the urgency of the world's energy, economic, and environmental problems. Heavy-ion fusion (HIF)—inertially confined fusion (ICF) ignited by beams of high-energy heavy ions—is the solution. In July 1976, 50 senior scientists, including Nobel laureates, from the major US ICF and accelerator laboratories assembled for an ad hoc two-week summer study.[1] Capturing the positive consensus of that meeting, the director of the Office of Inertial Fusion, now in the Department of Energy (DOE), stated at its conclusion that HIF's first step should be a $100 million facility (1976 dollars).

Multiple international design studies, annual workshops, and key experimental demonstrations rapidly confirmed that outlook. In May 1979 John Foster, chair of a DOE review of ICF, told the Energy Research Advisory Board that HIF would be the way to fusion power "if you wanted to make a conservative approach."[2] But the facility project that would have brought together a critical mass of talent was not funded. Yet, repeated assessment of the concept's prospects, propelled by the mountainous record of accomplishments of high-energy accelerators, has sustained HIF's progress worldwide.

In short, accelerator systems using technology established before 1976 can deposit tens of megajoules in fusion fuel pellets in nanoseconds via classical deposition physics. Also crucial, the repetition rate, efficiency, durability, and reliability needed for economical energy production are standard with high-energy accelerators. The road from achieving fusion burn to economic power production is clear, because