continuous and finite surfaces are the same, the boundary conditions are different, which results in substantially different solutions for the two types of surfaces. Continuous surfaces are primarily encountered in industrial processes—for example, in fiber spinning,[2] sheet casting,[3] and film coating[4]—where the production of such surfaces is technically feasible and economically desirable.

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4. S. J. Weinstein, K. J. Ruschak, *Annu. Rev. Fluid Mech.* **36**, 29 (2004).

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Anderson replies: The letters from Alan Faller, Barry Klinger, and Byron Sakiadis are a welcome addition to my article on the boundary-layer concept. Faller correctly points out the work of Vagn Ekman on three-dimensional boundary layers in rotating fluids. Ekman's discovery, and his subsequent experimental and analytical work, was contemporary with Ludwig Prandtl's and is an interesting example of an idea or concept whose time had come.

The history of science and technology is replete with such examples. The invention of the first successful heavier-than-air, pilot-controlled flying machine was an idea whose time had come at the beginning of the 20th century. The Wright brothers were simply the first to make it happen.

Both Faller and Klinger point out the role of the boundary-layer concept on the study of the motion of oceanic flows and circulation, a dimension of the concept not addressed in my article, written by an aerodynamicist from an aerodynamicist's point of view. Sakiadis discusses an even more general application to flows over continuous surfaces.

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Saving our view of the night skies

Of the many forms of pollution caused by humans, none is more obvious than the misuse of lighting. Unwanted and unwelcome light trespass began with the invention of the electric light and has expanded in proportion to the electrification of the planet (see PHYSICS TODAY, June 2005, page 24). The major sources of light pollution include street lighting, outdoor sports arenas, the promotional lighting of buildings and monuments, and car sales lots.

Simply put, light pollution is blinding ground-based astronomy. Extensive light pollution is gradually and inexorably reducing the quality and utility of astronomical observations made from major observatories all over the planet. To add insult to injury, more recently a number of medical researchers have discovered a correlation between extensive light pollution and an emerging number of serious human disorders.[1]

The International Dark-Sky Association (IDA) was founded by Kitt Peak astronomer David Crawford more than 18 years ago, and is made up of concerned astronomers and others who are accepting the challenge to slow down the continually advancing march toward brighter and brighter night skies. The IDA has taken the unusual stance of enlisting the major utilities, lighting manufacturers' associations, professional lighting engineering societies, and municipalities in finding better ways to achieve the objectives of lighting for safety and commerce without denigrating the natural dark sky environment. Organizations that have joined in supporting the IDA include the Illuminating Engineering Society of North America, the International Association of Lighting Designers, the Illuminating Engineering Society of Australia and New Zealand, and the Vienna-based International Commission on Illumination.

Although adopting coherent and effective lighting ordinances can provide immediate gains—including less energy consumption, improved security, and reductions in glare and light trespass—the improvement in preserving our dark skies for astronomical research is insufficient. The institution that has the responsibility to advance astronomical sciences in the US is the venerable American Astronomical Society. However, that organization is failing to address the problem. Although AAS has always agreed with the goals of the IDA and has written numerous papers and articles in support of the IDA's efforts to reduce light pollution, it has failed to aggressively encourage its members to join and support the IDA. Of all the members of the physics community, AAS has the most to lose by not directly supporting the IDA.

I call on the US physics community and all readers of PHYSICS TODAY to support the IDA, with your time and treasury, and to actively engage in any of the IDA's many sections throughout the world. Failure to act today will doom future generations from ever experiencing the wonder of seeing the stars from a dark and natural site and will ensure that the dark skies can only be experienced through planetariums and other artificial media. Astronomers of the future will only speculate on why this generation did not take the lead in protecting our dark skies when the opportunity was so clearly and readily available.

Reference

1. See, for example, B. Harder, *Science News* **169**, 8 (2006).

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[Editor's note: We invited a response from Craig Wheeler, president of the American Astronomical Association, and Kevin Marvel, AAS's executive officer.]

Wheeler and Marvel reply: The International Dark-Sky Association does valuable work to preserve precious dark skies. Through education, outreach, and consultation with lighting designers and policymakers, the association promotes more efficient use of nighttime lighting to reduce light pollution. We endorse the association's activities. The American Astronomical Society has been an affiliated organization of the IDA for years, one of us is a lifetime member, and many AAS members and astronomy institutions are active in the association as well. However, we believe that the IDA will draw members principally through its accomplishments and the value they provide.

The membership of the IDA is growing rapidly. The association currently has nearly twice as many members as the AAS. Even if all US AAS members joined, IDA membership would only increase by about 20%. Roberts correctly states that the IDA is composed of "astronomers and others." What he does not make clear is that the others far outnumber the astronomers who are members, and rightly so. Light pollution predominantly affects the general public. Poor nighttime lights threaten our health and safety, put migrating wildlife at risk, waste energy and money, and deprive countless millions of the beauty of the nighttime sky.

Light pollution, radio-frequency interference, and space debris are all issues of concern to the AAS. All of these detrimental aspects of human technology can potentially limit our ability to make astronomical observations. Light pollution certainly does negatively affect ground-based astronomy. Astronomers have either removed their telescopes to sites where the impact is minimal or worked with local communities—for example, in Tucson, Arizona, and in the West Texas counties surrounding McDonald Observatory—to reduce the growth of light pollution. Both efforts have been successful.

Light pollution will be controlled through the public's recognition of its detrimental effects on life in general, not through its impact on the small number of research observatories or the relatively small number of professional astronomers in the world. We applaud the IDA and its continued efforts, and we pledge to continue our support for its work.

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Safer vehicles by redesign

The technical discussion titled "Vehicle Design and the Physics of Traffic Safety" by Marc Ross, Deena Patel, and Tom Wenzel (PHYSICS TODAY, January 2006, page 49) is largely devoted to protecting the occupants of an automobile during an accident. Little is said about designing the car to help prevent the accident in the first place.

The article did mention poor road design and, briefly, driver error; it also referred to a vehicle's center of gravity as a potential problem, particularly if the driver needs to swerve to avoid a collision. However, one big factor not covered is poor car design—in particular that of sport-utility vehicles, which are extremely dangerous to oncoming drivers at night.

The headlights of SUVs and popular pickup trucks are at such a height that they shine directly into the eyes of oncoming drivers. The few seconds of blindness means loss of control by the oncoming driver, and the result may be to drive near or over the edge of the road. The SUV driver may continue on, never realizing that his lights caused the accident. When the police arrive and examine the overturned sedan and injured passengers, they check for alcohol and drugs. If no such evidence is found, they still blame the driver for being asleep at the wheel or suffering a lapse in judgment.

When an SUV and a sedan collide head on, the SUV's high bumper destroys the front end of the sedan and slams the engine into the driver's lap. The characteristic design of an SUV—with higher headlights and a higher bumper—makes it a dangerous vehicle that should be removed from the market.

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The good article on vehicle design and safety mentioned various innovations in the continuing effort to reduce traffic deaths. The best solution, of course, is one that prevents accidents rather than just reduces the severity of injuries. One contributing factor to the better Canadian statistics shown in the article's figure 2 is the mandatory use of daytime running lights in Canada. For 20 years or more, headlights that turn on with the ignition have been required on all new cars sold in Canada, wherever they were made. In daylight they operate at a low power; in twilight or darkness they switch to full power. They greatly improve the visibility of approaching cars in dim light or poor weather, and they were generally credited with a reduction of 10% to 15% in the frequency of collisions when they were introduced. My car is six years old and I have never turned the lights on or off and don't know how it could be done. I switch between high and low beams at night, but the automatic controls handle everything else. They even brighten the lights if I enter a tunnel for more than a few seconds.

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Ross, Patel, and Wenzel reply: These two thoughtful letters illustrate the importance of myriad details of vehicle design to dangers and safety in traffic. The height of the lights of most SUVs and trucks, which temporarily blind car drivers at night, is a significant risk (which has been crudely quantified in fatality statistics as around 100 per year). Ian Halliday's comments about daytime running lights are indirectly supported by the impressive fatality reductions that are being achieved in Canada (see figure 2 of our article). Those reductions should inspire Americans to question the less-than-impressive claims of success made for US traffic safety programs.

Vehicle design is critical to traffic safety. Specific design features, such as the heights of car seats versus the heights of "truck" fronts, where the trucks are merely serving as car substitutes, are among the most important issues for safety design. Differences in vehicle structures are important; but as we argued in our article, the laws of physics do not imply that vehicle mass, as such, is a safety feature. Observation suggests it is relatively unimportant in today's fleet.

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Early geodynamo work

Regarding the February cover article on the quest for a laboratory geodynamo (PHYSICS TODAY, February 2006, page 13), it is important, as Isaac Newton said, to "stand on the shoulders of giants" as we advance our understanding. Unfortunately, the present generation often fails to do so. Consider, for example, the Bullard–Rikitake dynamo theory, which explains not only the axial field but also its periodic spontaneous reversal, as observed in ocean-bottom cores. Here is the background:

In the early 1950s, Edward Bullard and a student of his named Rikitake built a geodynamo at the University of Newcastle upon Tyne in the UK. It consisted of two counter-rotating iron cylinders about two meters in diameter, connected electrically by an equatorial layer of mercury. It generated an axial magnetic field that spontaneously reversed its direction every 20 minutes, as Earth's field is known to do every 10 000 years or so.

The actual geodynamo has yet another peculiar and unexplained property: It is substantially off-center by about 10% of Earth's diameter. Earth's field is about 0.6 gauss in Siberia, and about 0.1 gauss in the diametrically opposite region in the southern Atlantic Ocean, as I pointed out in a paper presented in the 1950s at a symposium at Newcastle. This asymmetry is considerably harder to explain than the field generation itself or its periodic reversals.

I mention this for readers who may be interested in joining this fascinating field of experimental geophysics.

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The different research groups cited in Bertram Schwarzschild's story about experiments using a laboratory analogue of the geodynamo may have been