Army. Succeeding Hubert as station manager was Chiara Montanari, an Italian engineer with extensive Antarctica experience.

Hubert fought back in court and scored a dramatic turnaround in 2016. In September, Belgium's Council of State suspended the decree that had pushed the foundation out of the Polar Secretariat. And in October, a court stopped the government from sending a military maintenance team—already in Cape Town, South Africa, en route to Antarctica—to the station. Instead, Hubert returned to Antarctica in November and remains at the base with a dozen staff. They found the station "in poor shape," says Hubert's wife, Nighat Amin, who is IPF's vice president of international affairs. (Hubert was not available to speak with *Science* from Antarctica.)

The crevasse between the parties has only widened since then. The Polar Secretariat is no longer functional, and the Belgian government has instructed researchers not to travel to Antarctica, says glaciologist and ice-sheet modeler Frank Pattyn of the Free University of Brussels. The only scientists to pay a visit so far this year are two from WSL, the Swiss institute, and two private grantees who traveled to the station last weekend with Amin.

At the station, IPF staffers are keeping some experiments going, Amin says. Van Lipzig says her cloud observatory is not among them because it would be very difficult for nonspecialists to operate. She adds that the standoff puts her in a difficult position with foreign colleagues: "You spend a year planning projects, and then you have to tell them it won't happen."

Meanwhile, the government has refused to give Hubert the codes to the base's satellite phone system, which has reduced communication to a minimum. There was no internet at the station over the past month, says WSL's Michael Lehning, who just returned to Switzerland. In December 2016, the government claimed IPF was offering tourist visits to the station as part of a pricey trip organized by a South African firm. IPF denies the allegation.

Researchers hope a thaw will soon set in. "We need long-term stability," Van Lipzig says. The government is mulling how to proceed. Although Hubert's accomplishments are undisputed, says the state secretary's spokesperson, "You're dealing with taxpayers' money. If you can't keep your books in order, you shouldn't be running a polar station." Amin denies that IPF is to blame for the fiasco and says the government's audits were biased against the foundation.

IPF, she says, is waiting for the government to offer an equitable proposal on station management. "This has been our work for the last 14 years," Amin says. "There's no way on Earth that we're going to walk away from it." ■

ASTRONOMY

Your self-driving car could kill radio astronomy

Emerging technologies pose challenges to observatories

By **Daniel Clery**, *in Grapevine, Texas*

Add energy-saving streetlights, self-driving cars, and balloon-borne internet services to the threats facing astronomers needing dark skies free of electromagnetic smog. The rise of all three technologies is posing new challenges to ground-based researchers who use the optical and radio spectrum to observe the universe, speakers warned earlier this month here at the annual meeting of the American Astronomical Society (AAS).

If the radar on a single self-driving car is pointed at a sensitive radio telescope, for instance, it "can cause interference … even at 100 kilometers away," notes astronomer Harvey Liszt of the National Radio Astronomy Observatory in Charlottesville, Virginia. And "cities will have millions of them. You don't know the impact [of such technologies] until they are released into the wild."

Optical astronomers face their own nightmare. They have long battled the increasing brightness of city lights, sometimes abandoning observatories near cities in favor of darker, more remote locations. But over the past decade even veteran researchers were blindsided by the rapid spread of energy-saving light-emitting diodes (LEDs), which can produce a problematic glow.

LEDs are irresistible to municipal authorities because of their long lives and low energy consumption. Roughly half of U.S. municipalities, and a slightly higher share of European communities, have switched to LEDs, spurred in part by attractive financing offered by lightmakers.

The main problem with LEDs is not that they are brighter; it's that they are the wrong color. Before LEDs, most public lighting used high-pressure sodium (HPS) lamps, which emit light mostly at

Most LED streetlights produce a harsh, bluish light (top), which can cause major problems for optical astronomers. Softer, more telescope-friendly LED lights (bottom) are now becoming available.

PHOTOS: REMI BOUCHER/MONT-MEGANTIC INTERNATIONAL DARK SKY RESERVE

the red end of the visible spectrum. In contrast, the first generation of commercial LEDs emitted strongly in blue, at a so-called light temperature of about 5000 K. And because the atmosphere preferentially scatters blue light—that's why the sky is blue—these LEDs help create more of a light "haze" that obscures the view of telescopes. "We were surprised by the blue LED phenomenon and how fast it caught on," says John Barentine of the International Dark-Sky Association, a campaign group in Tucson, Arizona.

Newer LEDs are typically less blue, with a light temperature of 4000 K, but an entire city converted from HPS to such lamps can still do considerable harm, says physicist Martin Aubé of the Cégep de Sherbrooke in Quebec province in Canada. A city can increase its light haze fourfold by switching to 4000-K LEDs, he's found, brightening skies "for hundreds of kilometers." And LED use keeps expanding. Prior to their introduction, public illumination was growing by about 6% per year in the United States, he says. Now, with the availability of cheaper, more efficient LEDs, the growth is closer to 15% annually.

> ***"We were surprised by the blue LED phenomenon and how fast it caught on."***
>
> **John Barentine**, International Dark-Sky Association

Relief could come from new LEDs with lower, less harsh light temperatures (some below 3000 K). Models developed by Aubé show that a city could actually reduce the light haze produced by traditional HPS lamps by switching to 2700-K LEDs and making other changes, such as installing fixtures that point downward and planting trees that grow taller than streetlamps.

Although low-temperature LEDs are not yet common, astronomers have successfully helped lobby cities to adopt them. This past November, the city of Phoenix agreed to replace streetlamps with 2700-K LEDs. Although Phoenix is more than 100 kilometers from major observatories, "Its sky glow is evident now and astronomers worried it could get much worse," Barentine says.

For the radio astronomers, the battle is fought not in town halls, but in the conference rooms of the International Telecommunication Union (ITU) in Geneva, Switzerland. That's where nations meet every 4 years to divvy up the radio spectrum (from 10 megahertz to 3 terahertz) among a huge range of users, including radio and television broadcasters, military services, and high-tech industries. Since the advent of radio astronomy in the 1960s, regulators have reserved about 2% of the spectrum for the sole use of astronomy and Earth observation, and designated another 4% for sharing with other users. For example, the frequency at which neutral hydrogen emits, known as the 21-centimeter band, is strongly protected "because it is really, really important to astronomers," says astronomer Liese van Zee of Indiana University in Bloomington, vice-chair of the Committee on Radio Frequencies of the U.S. National Academies of Sciences, Engineering, and Medicine.

Yet broadcasts at nearby frequencies can fill protected bands with an electromagnetic fog that mars observations. As a result, astronomers seeking ever-fainter signals are in the position of someone trying to listen to an insect's footsteps while a pneumatic drill operates nearby.

In 2015, astronomers lost a long fight with the automobile industry when ITU gave companies the right to use frequencies close to some that are important to astronomers for the radars key to automated collision-avoidance systems. Despite the industry's earlier assurances that it would work with astronomers to protect radio observatories—perhaps by enabling drivers to switch off car radars close to radio telescopes—researchers failed to win such commitments in the latest round of frequency allocations. "The [commercial] pressure was too great," Liszt says.

Now, astronomers are studying as many as 20 new allocation requests for the 2019 ITU meeting. One that has already raised concerns involves high-altitude platforms (HAPs): high-flying balloons or low-orbiting satellites that would beam internet access to remote communities using frequencies directly adjacent to the protected astronomy spectrum. Companies including Iridium Communications, Google, SpaceX, and Boeing are investigating HAPs, which Liszt says could be "extremely damaging" if not properly deployed.

Other potential threats to the clear, dark skies astronomers need are on the horizon. Proposals to shoot particles into the atmosphere to block sunlight and curb global warming, for instance, are no longer as farfetched as they once seemed, and at the AAS meeting astronomers discussed how the humanmade haze would cloud their views of the cosmos. Should such geoengineering need to move ahead, AAS Vice President James Lowenthal of Smith College in Northampton, Massachusetts, says astronomers "have to know what the risks are." ■