AURORAS: HEAVENLY LIGHTS

By Kenny Taylor, republished from the pages of National Geographic magazine

The whole dome of night sky was awash with color: cascades of yellow-green and blushes of crimson fanning from a darker point high overhead. As they fell in broad rays, they shifted and changed in brightness, sometimes intense in one place, then cool, then hot. It was like looking up into the heart of a flower of glorious light whose petals rippled in a breeze that could not be felt—a breath from beyond this planet.

That aurora (Latin for "dawn") lit up the night at my home in the Scottish Highlands more than a decade ago, but to this day I can picture its colors, shapes, and movements. The show peaked for less than an hour, but its tonal themes lingered longer. It seemed an act of magic, but I knew that science had unveiled this magic act: Electrically charged particles from the sun were making gases glow in the upper atmosphere.

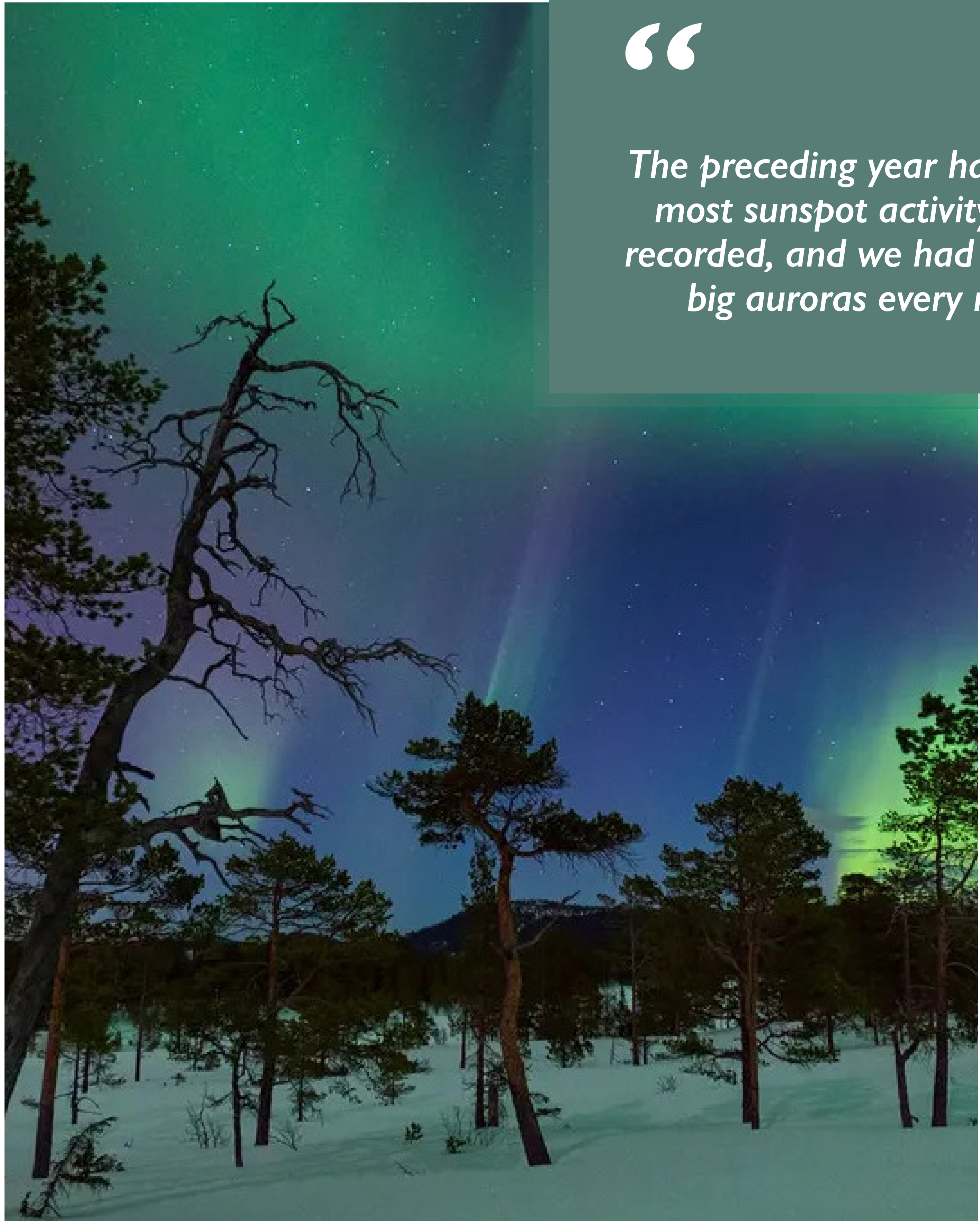
Thousands of miles away, in Alaska, the aurora also caught the attention of Charles Deehr, a physicist at the Geophysical Institute of the University of Alaska Fairbanks.

I visited Deehr in March 2001 during the current phase of intense auroral activity. Deehr is a wiry man who retains, in his sixties, a youthful zest for new research ventures. His work in auroral forecasting mixes science and divination as he searches for patterns in the latest information sent from near-Earth satellites in hopes of predicting auroral activity a day or so in advance. Such forewarning makes it possible to prepare electrical systems on Earth and in space for disturbances.
Scientists use satellites to gauge an aurora's power, but it was the 1989 aurora's extreme reach that demonstrated to most of us how unusual it was.

Most auroras are visible only in the higher latitudes (above 60 degrees), but that one showed up as far south as Key West in Florida and the Yucatán Peninsula in Mexico. People unnerved by the fiery tint in the sky phoned the police; others watched in awe.
Within 90 seconds of the aurora's reaching the skies above Quebec, magnetic storms associated with it caused a province-wide collapse of the power grid, leaving six million Canadians without electricity for hours. At the same time, compass readings became unreliable, and there were reports of automatic garage doors opening and closing on their own.

Radio transmissions and coastal navigation systems were disrupted, and information feeds from some satellites were temporarily lost.
These troubles were a clear illustration of the need to predict auroras. In the Middle Ages a glowing red aurora over middle latitudes was seen by some Europeans as an omen of bloody battle or other impending doom. The superstition may have faded, but in a time of increasing reliance on high-tech links, discovering what auroras might actually signify has taken on practical relevance and a new urgency.
Charles Deehr arrived in Fairbanks with several other graduate students in physics in 1958.

"That display on March 13-14, 1989, was one of the best in the last 50 years."



"The preceding year had the most sunspot activity ever recorded, and we had fancy big auroras every night"

Wild pine trees stand firm under an aurora-filled sky in Gjenvollhytta, Norway.
PHOTOGRAPH BY
Orsolya Haarberg, National Geographic Creative

They were participating in the International Geophysical Year (IGY), which brought together scientists from 67 countries to study Earth's surface, interior, and atmosphere. The great red aurora of February 1958—perhaps the most extraordinary of the century—had just occurred. This indicated explosive activity on the sun, ideal conditions for auroral research. Since the mid-1800s it has been known that the number of sunspots—dark, cooler patches of intense magnetic activity that are often accompanied by major eruptions on the solar disc—peaks roughly every 11 years. Sunspot numbers are usually high for a couple of years or so before and after the crest of this wave, known as the solar maximum.

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Auroras are hooked in to that roller coaster. So when the sun is restless, as it was in the late 1950s, Earth's night skies may dance.

Deehr's group contributed to the discovery that there are two great ovals of auroral activity encircling the geomagnetic poles—one for the aurora borealis in the Northern Hemisphere, one for the mirroring aurora australis in the Southern. These typically bulge farther toward the Equator on Earth's night side and change shape a bit in the course of a single day. During a big aurora they may move even farther, giving people beyond the normal limits a glimpse of the lights.

Our understanding of auroras comes in huge measure from linking insights gained through manned space missions to data and images from satellites, rockets, and observatories on the ground. The current research armory includes various craft in the International Solar-Terrestrial Physics (ISTP) program. Largely under the command of NASA, the European Space Agency, and Japan's Institute of Space and Astronautical Science, this international endeavor uses spacecraft to study the sun-including sunspot activity-and its effects on the Earth.

There is always auroral activity somewhere over the But its strength and extent vary hugely, according to what the sun has been hurling at us in preceding days. Flares that release energy bursts as powerful as millions of volcanic eruptions and coronal mass ejections that send hurricane blasts of ten billion tons of plasma into space figure more often during active parts of the solar cycle.

The sun, like the Earth and most of the planets, is a huge magnet, with its own force field stretching far beyond it. This gets twisted into a spiral by the sun's rotation, and within it the solar wind particles course along magnetic field lines that channel their movements. The eye-catching computer graphics Deehr showed me were an attempt to model the path of that energy from the sun to beyond the Earth.

As they zoom toward near-Earth space, the particle streams hit the edge of our planet's own magnetic sheath-the magnetosphere. Deflected by the magnetosphere, like water meeting a rock, the solar wind swirls past Earth and then pushes in again on the night side, squeezing the magnetosphere and elongating it into a comet-shaped tail. On the day side, the magnetosphere grows when the solar breeze is light and shrinks in a solar gale.

Charged particles that get trapped in the "magnetotail," which may stretch millions of miles, can be sent hurtling back toward Earth.

Then, in a variety of possible ways not yet fully understood, some eventually rain down into the upper atmosphere over the polar regions—the places where our protective magnetic envelope is most open to space.

"Here's where we're seeing a piling up of fast and slow particles. When we plot out what we think is going to happen, our model says we could get some increase in auroral activity later today."

Auroral light comes largely from electrons hitting oxygen and nitrogen atoms and molecules in the upper atmosphere, the same phenomenon that produces the glow in a neon lighting tube. But in the aurora the illumination can be 600 miles (965.6 kilometers) high, stretch for thousands of miles, and be linked to a magnetospheric power generator churning out three million megawatts or more—about four times the electricity the United States uses at peak summer demand.

I asked Deehr what my chances were for an aurora that night, my last in Fairbanks. He clicked a couple of keys.

But my departure was not to be graced by an aurora. I was reminded of what he had said about forecasting them. "There are no guarantees. We're still about a hundred years behind the meteorologists—it's that bad, or good."

In the past few years the term space weather has become a catchall to include eruptions from the sun, variations in the solar wind, and changes in the magnetosphere, which can in turn affect the Earth's atmosphere, producing auroras. Part of the uncertainty in making space-weather predictions is the difficulty of relating an event in one part of this vast system—such as in the sun—to a later event on Earth, such as an auroral display. "A lot can happen in 93 million miles (149.7 million kilometers);" was how one space physicist put it. Scientists at NASA's Goddard Space Flight Center in Greenbelt, Maryland, are part of an international team at the forefront of research into auroras and connections between the sun and the Earth.

A supermoon rises over the Sierra Nevada mountain range in California.
PHOTOGRAPH BY Jossen Todorov

"One of the most important aspects of auroras is that the polar regions are where the magnetic field lines concentrate."

Acuna, who was born in Argentina and still speaks in a warm, accented baritone, is a veteran of NASA science missions from the early satellite days. "So over a small region you can observe what is happening over a gigantic volume in space. The complexity lies in how we can relate this auroral picture to phenomena that are happening elsewhere in the magnetosphere." To make sense of the system, he explained, we need, as in weather forecasting, to have enough instruments in key places to understand cause and effect—where the energy comes from, how it gets transformed, and where it ends up.

The moon shines through an aurora borealis in Laksefjorden, Norway.
PHOTOGRAPH BY Erland Haarberg, National Geographic Creative

> *"When you pass on again, you end up in the dancing spirit-that's the aurora spirit. When we were kids, we were told that you have to be quiet when the aurora comes out. You don't want to upset the spirits in the sky by calling them closer."*

That's the big picture. But what shapes the finer detail of the classic auroral patterns-the curtains, folds, and rays-still awaits explanation.

Head reeling with ideas from space physics, I needed to reconnect with the visible aurora and the feelings it can stir. Yellowknife is the capital of Canada's Northwest Territories and the top global destination for aurora tourism. Last year some 12,000 people came here to see auroras-a pursuit of the truly dedicated in this frost-bitten location.

This urban myth may have started in April 1992 with an episode of Northern Exposure, a TV series set in small-town Alaska and filmed in Washington State. In it an aurora begins while a group of Japanese visitors are in a guesthouse, and they all run upstairs to try their luck under the northern lights.

"How can they say that about us?" asked Yukiko Suzuki. Yukiko, who is from Tokuyama in western Japan, had found aurora work in Yellowknife for the winter. "In Japan we cannot watch the northern lights, but we know how it's beautiful and great," she said. "That's why they're coming."

Don Morin, part Chipewyan, part Cree, and a former Northwest Territories premier, gave me another perspective on the aurora.

"Many of the original peoples of North America have medicine animals," he told me one night as we sat in a huge tepee at Aurora Village, established by his family to give tourists a flavor of tribal life in addition to aurora-viewing opportunities.

"So when you pass on, you're going to go into an animal spirit. That's the next stop." For Morin's people, spirit life after death is a two-stage process.

Raven Tours, the oldest of the aurora enterprises, was founded by Bill Tait in 1981. Tait was away in Japan drumming up business, but Jared Minty, an eager young co-director, gave me the essential information.

"In our current aurora tour season, which runs from mid-November through mid-April, we'll have more than 9,000 clients," he said happily. "The other main operators will also have a few thousand. Almost all these clients are Japanese."

I observed the Japanese enthusiasm for auroras that night at Prelude Lake, some miles from town. With each burst of celestial choreography, groups of people cheered and clapped, some of the women ululating in high-pitched tones. Japanese passion for auroras intensified during the 1990s. Ask the average Yellowknife resident, as I did over a beer in the Raven Bar, and many will say that the Japanese believe that conceiving a child under a good aurora increases the chances of having a gifted offspring.

The authors seem to hover over a house in Nordland, Norway.
PHOTOGRAPH BY
Sérgio Pitamitz, National Geographic Creative

Northern Lights productions
PHOTOGRAPH BY Sérgio Pitamitz

"They've always been sacred to us," said Suzan Marie, a Déné-Chipewyan and Cree woman from the South Slave region. "But of course with elders telling us as children not to whistle at the lights, we had to test to see if it was really true. We knew we shouldn't be doing it, and if they really started to move, we'd get frightened and not stay out too long." Which, as in many tales, was the down-to-earth practicality that complements the elders' spiritual spin on the world.

In Norway I met a man at Tromsø's Auroral Observatory who bridges the contrasting responses to auroras. Asgeir Brekke is an expert on auroral lore and legend. The walls of his office are hung with an intriguing mix of images, from radar stations to figures from northern mythology. Brekke is a soft-spoken man with a sweep of graying hair, and as we talked, he probed the images of death and life that recur in stories of aurora in different cultures-the links to spirits and battles between supernatural forces in the sky.

"I think for many people the phenomenon was scary, but some brave souls had their own thoughts about it." He mentioned the Norwegian who in about 1250 proposed rational-sounding explanations for the northern lights. One was that Greenland's ice drew in so much power that it could light the beams of the aurora. Along similar lines, other Scandinavians had wondered if the lights were reflections from the sea or even from the glinting scales of huge shoals of herring.

In collaboration with Dagfinn Bakke, an artist in Lofoten, Brekke has produced a book of watercolor paintings, scientific accounts, folktales, and poetry to show how people in Norway have related to auroras over the centuries. As I'd now come to understand, Brekke's enthusiasm for the lights represents a common bond between people who live beneath them and those who study them from afar. When he ended our meeting by reading poems about auroras, it seemed only fitting.