

MICHAEL S. YAMASHITA/NATIONAL GEOGRAPHIC CREATIVE

Snowflakes can be tricky to photograph

**W**HEN Bing Crosby dreamed of a white Christmas, chances are he imagined one fashioned by flurries of perfect, six-sided snowflakes. This image of what a snowflake looks like has become ubiquitous. It is found on everything from cards and woolly jumpers to shop windows during the festive season. So you may be surprised to discover that the vast majority of snowflakes look nothing like this.

The classic image of a snowflake can be traced back to home-schooled farmer Wilson “Snowflake” Bentley of Vermont. When he was 15, he started peering down his mother’s microscope. “Always, from the very beginning, it was snowflakes that fascinated me most,” he later said. Bentley eventually persuaded his parents to get a camera and hooked it up to the microscope. In 1885, after much trial and error, he finally managed to take a decent photograph of a snowflake. His hobby was to become a lifelong obsession, and he went on to take thousands of photos.

Bentley was the first to claim that no two snowflakes are alike. Yet while his images show great diversity in shapes, they are dominated by symmetrical, six-sided star-like beauties. This was in keeping with the Victorian ethos of divinely created perfection, and when Bentley’s photos appeared in magazines, they caught the public imagination.

Bentley’s star-like images have continued to shape the popular idea of a snowflake ever since, but do they really show the real thing? In 1892, German meteorologist Gustav Hellmann asked his associate Richard Neuhaus to photograph snowflakes. His images showed imperfect, irregular specimens. Hellmann later accused Bentley of fraud, and the argument went on for decades.

What is clear is that Bentley gave his white-on-white images a black background by scraping the emulsion off the negatives around the outline of each snowflake. But did he sometimes scrape away asymmetries too? Hellmann claimed he had “mutilated the outlines”, and Bentley’s defence of his methods is not entirely reassuring. “A true scientist wishes above all to have his photographs as true to nature as possible, and if retouching will help in this respect, then it is fully justified.”

# No great flakes

Six-sided? Perfectly symmetrical? Think again about snow crystals, says [Helen Pilcher](#)

# “Every snowflake that falls to Earth has its own unique history”

Bentley continued to create images in the same way and to defend his methods until he died from pneumonia, aged 66, in 1931. Since then, of course, we have learned much more about snowflakes. We now know they usually form when a super-cooled water droplet in a cloud freezes around a speck of dust to form a basic six-sided crystal. This crystal grows and becomes more complicated as it steals water vapour from the air and starts to fall.

At  $-2^{\circ}\text{C}$ , simple hexagons and star shapes form. Between  $-5$  and  $-10^{\circ}\text{C}$ , it's columns. Then below  $-15^{\circ}\text{C}$ , the six-siders appear again. What's more, each tiny snow crystal experiences a gamut of temperatures and humidities as it falls, and often collides with other crystals. A snowflake can consist of a single crystal, or it can be many thousands of these crystals joined together. “Every snowflake that falls to earth has its own unique history,” says ice physicist John Hallett of the Desert Research Institute in Reno, Nevada.

The complexity of the snowflakes that reach the ground has been revealed by a high-speed camera designed by atmospheric scientist Tim Garrett of the University of Utah and his colleagues. It can snap shots at shutter speeds of up to  $1/40,000$  of a second – fast enough to capture snowflakes in mid-air (below).

Over the past two winters, the camera

has captured more than a million pictures of falling flakes at Utah's Alta Ski Area in the Wasatch Range mountains. The aim is to improve weather forecasting but it is also revealing what “normal” snowflakes look like. “The complexity of nature almost seems to defy categorisation,” Garrett says. More often than not, his pictures reveal flakes that are complicated, twisted conglomerations of many thousands of snow crystals. “The chances of a snowflake falling without colliding with other snowflakes or water droplets is a near impossibility,” he says.

Some flakes, known as graupels, collect millions of tiny water droplets that freeze as they fall. They look like mini-snowballs and feel like ball bearings under your skis. Others are snow crystals that have bumped into other snow crystals to make

## GROW YOUR OWN

Snowflakes have been grown in the lab for more than 70 years, but Ken Libbrecht is a grand master of the art. By tweaking conditions, he can create designer snowflakes that do not occur in nature, including snow-crystal chandeliers, snowflake bouquets and a 2.4-centimetre-wide snow star. He uses state-of-the-art equipment, but his website ([www.its.caltech.edu/~atomic/snowcrystals](http://www.its.caltech.edu/~atomic/snowcrystals)) has a guide to growing snowflakes at home.

the fluffy, air-packed aggregates that make Utah's ski slopes so fantastic. Then there's everything in-between.

But the camera does also occasionally capture snowflakes like those Bentley photographed. Perfect six-sided snowflakes do exist, says Bentley's modern-day successor, Ken Libbrecht of the California Institute of Technology in Pasadena. They are, however, extremely rare and only form when conditions are perfect. “I have to go to great lengths to ignore the ugly stuff,” says Libbrecht, a physicist by trade and also a keen photographer of snowflakes.

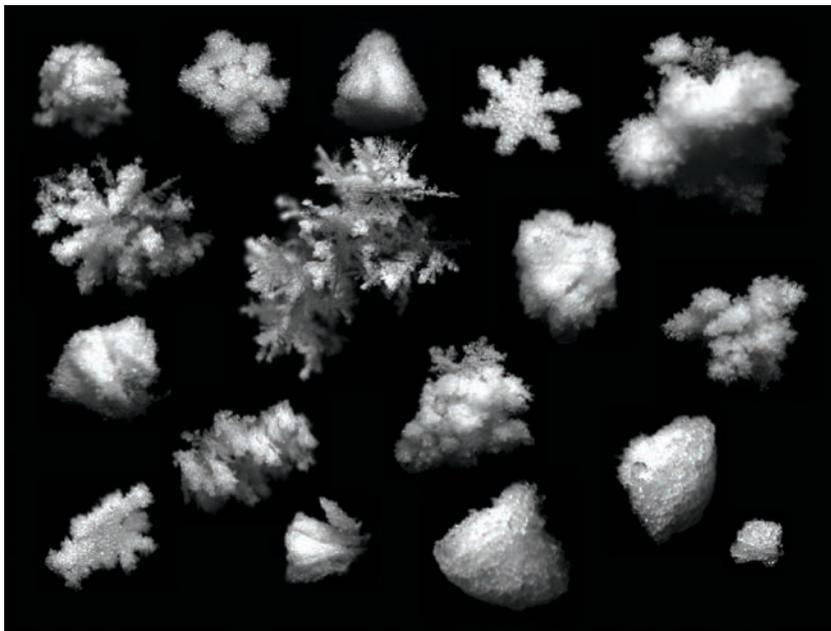
His photos reveal an extraordinary array of shapes, from spiky needles to stumpy hollow columns. Sometimes, if the conditions are right, he finds triangular crystals, 12-sided snowflakes or icy cufflinks – columns with hexagonal stars on either end. “I find the real gemstones,” he says.

For perfect six-siders, it needs to be around  $-15^{\circ}\text{C}$ , with low cloud and no wind. Caught in the halo of urban street lamps, symmetrical snow crystals twinkle as they fall to earth. So Libbrecht can sometimes be found staring skyward in the parking lots of Northern Ontario, trying to catch the ephemeral sparkles on a piece of card. He uses a tiny brush to transfer them under the microscope, but even after all this effort only 1 in 1000 are perfect six-siders.

Did Bentley also find these rare flakes? Or did he tidy up less than perfect ones? Libbrecht, for one, does not think that Bentley did anything dubious. “All he did was the old-school version of Photoshop,” he says. Others suspect Bentley did go further, but not to deceive. “Bentley produced the paragon,” says history of science researcher Latif Nasser of Harvard University. “He created images he believed were true to nature, whilst Hellman photographed snowflakes exactly as they were, warts and all.”

So, in keeping with the spirit of the season, it seems that Bentley and Hellmann were both right. If Bentley and Libbrecht's snowflakes are the supermodels of the skies, then Hellmann and Garrett's are the paparazzi-free *jolie laides*. Their beauty is unconventional and quirky, and perhaps it's time we gave them their own photo shoot. ■

Imperfect: snowflakes snapped in mid-air



TIM GARRETT/UNIVERSITY OF UTAH

Helen Pilcher is a special snowflake