Winter Magic

The following is an excerpt of a paper written by **Dr. John A. Adam** of Old Dominion University as a review of the of "*The Snowflake: Winter's Secret Beauty*" by Kenneth Libbrecht.

Growing up as a child in southern England, my early memories of snow include trudging home from school with my father, gazing at the seemingly enormous snowdrifts that smoothed the hedgerows, fields and bushes, while listening to the soft "scrunch" of the snow under my Wellington boots. In the country, snow stretching as far as I could see was not a particularly uncommon sight. The quietness of the land under a foot of snow seemed eerie. I cannot remember the first time I looked at snowflakes per se; my interests as a small child were primarily in their spheroidally shaped aggregates as they flew through the air.

As might be expected, the study of snowflakes is not new; no doubt people have been fascinated by their beauty and symmetry since time immemorial. According to the Chinese awareness of this was recorded in 135 B.C., while in Europe the Dominican scientist, philosopher, and theologian, Albertus Magnus, studied them around 1260 A.D. Not surprisingly, the astronomer and mathematician Johannes Kepler was intrigued by snow crystals, writing a small treatise entitled *On the Six-Cornered Snowflake*. In 1611 he asked the fundamental question: *There must be some definite cause why, whenever snow begins to fall, its initial formation invariably displays the shape of a sixcornered starlet. For if it happens by chance, why do they not fall just as well with five corners or seven?* In his treatise he compared their symmetry with that of honeycombs and the seed arrangement inside pomegranates. However, nothing was known in Kepler's era of the molecular structure of water, which ultimately determines the hexagonal shape of ice crystals, so Kepler was unable to explain their shape in mechanical terms.

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A quote from D'Arcy Wentworth Thompson is particularly appropriate here: The beauty of a snow-crystal depends on its mathematical regularity and symmetry; but somehow the association of many variants of a single type, all related but no two the same, vastly increases our pleasure and admiration.…The snow-crystal is further complicated, and its beauty is notably enhanced, by minute occluded bubbles of air or drops of water, whose symmetrical form and arrangement are very curious and not always easy to explain. Lastly, we are apt to see our snow crystals after a slight thaw has rounded their edges, and has heightened their beauty by softening their contours.

One basic snow crystal shape is the hexagonal prism, which possesses two basal facets and six prism facets, and depending on which of the two types grows faster, the prism can become a long column or a thin plate. Basically, at low but fixed levels of supersaturation (degree of humidity), as the temperature decreases below 0◦C to about –35◦C, snow crystals are essentially plates, then solid prisms, and then plates again. At higher supersaturation levels, the evolution is from dendrites to needles, hollow columns, sectored plates and dendrites, and then columns again. Essentially, the overall crystal shape, whether it is plate-like or columnar, reveals something about the temperature at which the crystal grew, and the complexity of the structure indicates something about the humidity. However, each crystal falling on one's nose is a product of the cumulative history it has undergone as it has been wafted hither and yon by air currents through many different atmospheric conditions. In mathematical terms, we might think of its shape being defined by a line integral over its path through space and time. Generally, the length scale of variations of temperature and humidity will be much larger than the dimension of the crystal, so each vertex or arm of the crystal experiences the same conditions at each moment of time; their symmetry is evidently a reflection of their shared history.

A last word on the topic of snow crystals may be of interest: Thanks to the sharp eyes of a Minnesota man, it is possible that two identical snowflakes may finally have been observed. While out snowmobiling, he noticed a snowflake that looked familiar to him. Searching his memory, he realized it was identical to a snowflake he had seen as a child in Vermont. Weather experts, while excited, caution that this may be difficult to verify.

Questions & comments are encouraged! Email to: jadam@odu.edu. *John A. Adam is a professor of mathematics at Old Dominion University, Norfolk, VA. "The Snowflake: Winter's Secret Beauty" by Kenneth Libbrecht, with photographs by Patricia Rasmussen, Voyageur Press, Inc., 2003, hardcover, $20.00.*

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*(**Winter Magic** continued)*

For more information on the magic of Winter, visit the website of Kenneth G. Libbrecht at http://www.snowcrystals.com . This page is “...Your online guide to snowflakes, snow crystals, and other ice phenomena...” with subjects that include natural snowflakes and designer snowflakes, snowflake physics, snow activities and touring hotspots for snow enthusiasts. Snowcrystals.com is highly entertaining as well as educational. Learn about snow-related fun activities that sometimes do not even require going out in the cold!

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This amazingly detailed snowflake photo is from the NOAA Photo Library, Image 814 of "Studies among the Snow Crystals ... " by Wilson Bentley, "The Snowflake Man." From Annual Summary of the "Monthly Weather Review" for 1902. *Resource:* http://www.photolib.noaa.gov/

Fresh snowfall, Pembine, Wisoconsin 12/31/2005 by Peg Zenko