Lovely ‘snowfakes’ mimic nature, advance science

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(PhysOrg.com) -- Exquisitely detailed and beautifully symmetrical, the snowflakes that David Griffeath makes are icy jewels of art.

But don't be fooled; there is some serious science behind the UW-Madison mathematician's charming creations. Although they look as if they tumbled straight from the clouds, these "snowfakes" are actually the product of an elaborate computer model designed to replicate the wildly complex growth of snow crystals.

Four years in the making, the model that Griffeath built with University of California, Davis, mathematician Janko Gravner can generate all of nature's snowflake types in rich three-dimensional detail. In the January issue of *Physical Review E*, the pair published the model's underlying theory and computations, which are so intensive they are "right on the edge of feasibility," says Griffeath.

"Even though we've artfully stripped down the model over several years so that it's as simple and efficient as possible, it still takes us a day to grow one of these things," he says.

In nature, each snowflake begins as a bit of dust, a bacterium or a pollutant in the sky, around which water molecules start glomming together and freezing to form a tiny crystal of ice. Roughly a quintillion (one million million million) molecules make up every flake, with the shape dictated by temperature, humidity and other local conditions.

How such a seemingly random process produces crystals that are at once geometrically simple and incredibly intricate has captivated scientists since the 1600s, but no one has accurately simulated their growth until now. Griffeath and Gravner's model not only gets the basic shapes right, including fern-like stars, long needles and chunky prisms, but also fine elements such as tiny ridges that run along the arms and weird, circular surface markings.

Slide show:

Griffeath considers himself part of a long tradition of scientists, starting with famed mathematician and astronomer Johannes Kepler, who have marveled at snowflakes and simply wanted to understand them. But on the practical side, the model could help researchers better predict how various snowflake types in the clouds affect the amount of water reaching earth. Griffeath is now exploring that possibility with a UW-Madison meteorologist.

In the meantime, the project has given him a newfound appreciation for water, whose one-of-a-kind properties are what make snowflakes possible.

"Water is the most amazing molecule in the universe, pure and simple," he says. "It's just three little atoms, but its physics and chemistry are unbelievable."

Provided by University of Wisconsin