About the cover
The cover graphic is courtesy of Edit Hepp and Peter Hamburger. Hamburger, a Professor at Indiana University – Purdue University at Fort Wayne, was at Illinois this past year on a visiting faculty appointment during his sabbatical year. Edit, his wife, is an artist who has turned a number of Hamburger’s Venn diagrams into color prints. Visit the website http://www.ipfw.edu/math/hamburger/ to see pictures of an exhibition they recently put on.

The cover graphic is a rotationally symmetric Venn diagram. Hamburger calls these diagrams doilies for the lacy crocheted pieces they resemble. He introduced his approach to the construction of rotationally symmetric Venn diagrams with n curves by giving an example in the n = 11 case in a paper “Doodles and Doilies, Non-Simple Symmetric Venn Diagrams” which he presented in 1999 at a conference and published in 2002 in Discrete Mathematics. His approach is based on (symmetric) chain decomposition of the Boolean lattice.

The diagram on the cover is the result of starting with the diagram at right and then a rotation of this curve 11 times over 360/11 degrees. For more information see http://www.siam.org/siamnews/01-04/venn.pdf.

This calendar was designed by Tori Corkery for the Department of Mathematics at the University of Illinois at Urbana-Champaign. Special thanks go to Sara Nelson, Lori Dick, Tess Larkin, and Professor Joseph Rosenblatt for their help and support on this project.

Department of Mathematics
University of Illinois at Urbana-Champaign
1409 West Green Street
Urbana, Illinois 61801
office@math.uiuc.edu
Tel.: 217-333-3350
Fax: 217-333-9576

www.math.uiuc.edu
tiny snow crystals are usually in the form of small hexagonal prisms which is how the six-fold symmetry of snowflakes gets its start. The intricate shape of a single arm is determined by the ever-changing conditions experienced by the crystal as it falls. Because each arm experiences the same conditions; however, the arms tend to look alike. The end result is a large-scale, complex, six-fold symmetric snow crystal. And since snow crystals all follow slightly different paths through the clouds, individual crystals all tend to look different. (Photos courtesy of snowcrystals.com)

The hexagonal symmetry of snowflakes originates with the underlying symmetry of the ice crystal lattice. Water molecules hook up in a hexagonal lattice and the molecular symmetry is imparted to the snow crystal form via faceting. In particular, the six-fold symmetry of snowflakes gets its start. The intricate shape of a single arm is determined by the ever-changing conditions experienced by the crystal as it falls. Because each arm experiences the same conditions; however, the arms tend to look alike. The end result is a large-scale, complex, six-fold symmetric snow crystal. And since snow crystals all follow slightly different paths through the clouds, individual crystals all tend to look different. (Photos courtesy of snowcrystals.com)
The number of visible spirals (parastichies) in spiral arrangements are most often Fibonacci numbers (1, 1, 2, 3, 5, 8, 13, 21 ...) and the angle between successive leaves is close to the Golden Angle—about 137.5 degrees. Some flowers, such as the rose, have petals that total a number in, or very close to, the Fibonacci series as shown in the above diagram. As well, many plants produce branches in quantities that are based on Fibonacci numbers. This frequent type of pattern in plants is called Fibonacci phyllotaxis.
Radial symmetry is a characteristic that is used to help classify multicellular organisms. Echinoderms have partial radial symmetry. They are only found in the sea.
The dodecaplex, or 120-cell, is a regular polytope in four dimensions. Its stereographic projection, shown here, has the geometry of a bubble cluster. From the article "Generating and Rendering Four-Dimensional Polytopes", by John Sullivan (The Mathematica Journal 1:3, 1991, pp. 76–85) which shows a nice way to generate coordinates for the regular polytopes in three and four dimensions, and describes how to picture some of the four-dimensional ones as bubble clusters, via stereographic projection.
Music of the Sphere (shown at far left) was made by sculptor Brent Collins who resides in Missouri. The sculpture is a ribbon deployed in an asymmetrically enriched trefoil pattern. The underlying geometry of the ribbon’s global circuit consists of three smaller spheres ensconced within a larger sphere. *Vox Solis* is a bronze cast also made by Brent Collins. It depicts a negative curvature ribbon deployed on a torus. The ribbon, which we see, loops back and forth on the surface of the unseen torus.
Keyboard instruments are not tuned today as in Bach’s day and before. Such music was composed to be played on specific tunings such as meantone or well temperament, not equal temperament, which is almost exclusively used today. Each tuning involves specific frequency ratios of intervals such as fifths, fourths, and major and minor thirds. These specific frequency ratios differ from one way of tuning to another. In equal temperament, it is possible to play in all keys without re-tuning, and an interval in one key has the same frequency ratio as the same interval in any other key. In well temperament, it is also possible to play in all keys without re-tuning, but each key has its own character, which can be utilized by the composer for creating an additional dimension to the music. To celebrate this new manner of tuning, Bach wrote twenty-four preludes and fugues, one in each major and minor key. He named this work *The Well-Tempered Clavier*.
Fractal, in mathematics, refers to a geometric shape that is complex and detailed in structure at any level of magnification. Mandelbrot has suggested that mountains, clouds, aggregates, galaxy clusters, and other natural phenomena are similarly fractal in nature. Fractal geometry's application in the sciences has become a rapidly expanding field, such as modeling soil erosion and analyzing seismic patterns. In addition, the beauty of fractals has made them a key element in computer graphics and multimedia applications. (Graphic at left is courtesy of Lars Clausen http://shasta.cs.uiuc.edu/~lrclause/fractals/)
Butterflies have reflection symmetry as do many plants and animals. The left side is a mirror image or “reflection” of the right side.
Origami, the ancient Japanese art of paper folding, has many mathematical connections, particularly in geometry and topology. Current research in origami helps physicists design an enormous telescope that will fold up to fit inside a rocket and fundamental mathematics helps determine what shapes can and cannot be created by folding. The photo here is a flower tower created by Chris Palmer—from http://www.paperfolding.com/.
"Music is a secret exercise in arithmetic of the soul, unaware of its act of counting." — Gottfried Leibniz, philosopher and mathematician.

Before the Renaissance, much of Western-based music relied on mathematics. Johann Sebastian Bach, who used a highly calculated approach to composition, sometimes treated the composition of canons and other types of music as exercises akin to solving mathematical puzzles and was famous for the numerical symbolism he used in his compositions. Frederic Chopin described the fugue as "pure logic in music." And twentieth century composers have applied sophisticated mathematical theory in their works.

---

**Department of Mathematics**

University of Illinois at U-C
1409 W. Green Street
Urbana, IL 61801
(217) 333-3350
office@math.uiuc.edu

www.math.uiuc.edu
A jellyfish is an example of an animal that is radially symmetrical. Radial symmetry means that the object can be cut in half along many different lines to obtain halves that are roughly mirror images. Radial symmetry is believed to have evolved in organisms before bilateral symmetry in which there is a single plane that divides it into two mirror images. Photo copyright 1996–2004 by Tristan Savatier—www.loupiote.com and used with permission.
The Rose Window in Notre Dame Cathedral is an example of radial balance. The axis is the center point and the design or pattern appears to "radiate" from that point. Nature contains many examples of radial designs as do manufactured objects that are usually round in shape, i.e. wheels, plates, and fans.