STATISTICS DEPARTMENT  **SEMINAR**

TITLE: **MODELING SNOW CRYSTAL GROWTH**

SPEAKER: David Griffeath, UW-Madison Mathematics

TIME: 4:00 P.M.

DATE: Wednesday, March 22, 2006

ROOM: 140 BARDEEN

ABSTRACT:

Six-sided ice crystals that fall to earth in ideal winter conditions, commonly known as snowflakes, have fascinated scientists for centuries. To this day, snowflake growth from molecular scales, with its tension between disorder and pattern formation, remains mysterious in many respects. After a brief history of the scientific study of snowflakes, I will discuss two models for their dynamics: one purely mathematical, the other based on physical principles.

First I'll analyze cellular automata on the triangular lattice such that a vacant site with exactly one occupied neighbor always becomes occupied at the next update. These were introduced by Norman Packard in 1984 as prototypes for crystal solidification, and subsequently popularized by Stephen Wolfram in Scientific American, "A New Kind of Science," and elsewhere, to illustrate how simple mathematical algorithms can emulate complex natural phenomena. Wolfram argues that simulation by computer may be the only way to predict how systems such as this evolve, and that patterns grown from a single cell according to Packard's rules bear a close resemblance to real snowflakes. In fact, each such rule is amenable to traditional mathematical analysis, filling the lattice with an asymptotic density that is independent of the initial finite set. However their evolution has little in common with that of actual snow crystals.

A much more accurate lattice model combines diffusion limited growth with anisotropic attachment kinetics based on local geometry and an idealized semi-liquid layer. This is apparently the first approach that successfully captures the form of core and tip instabilities, branch faceting, and other aspects of real snow crystal growth. As parameters are varied, our nearest neighbor system reproduces the basic features of most of the observed varieties of planar snowflakes, and offers new insights into their genesis.

(This work is joint with Janko Gravner, UC-Davis Mathematics.)

Coffee and Cookies at 3:30 p.m. in Room 1210 MSC