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## Numerical Cubature from Geometry and Coding Theory

### Abstract for the Combinatorics Seminar 2005 June 8

The numerical cubature problem is the generalization to higher dimensions of integration methods such as Simpson's rule. Given a measure  $\mu$  on  $\mathbb{R}^n$ , a  $t$ -cubature formula is a finite set  $C$  such that the integral of any polynomial  $P$  of degree  $t$  with respect to  $\mu$  equals a weighted sum over values on  $C$ . The main interest is in cubature formulas with few points, with positive weights, and without points outside of the domain of  $\mu$ . Gaussian quadrature satisfies all three conditions in one dimension, but the problem is already open-ended in two dimensions and increasingly non-trivial in higher dimensions.

I will discuss new methods for the cubature problem coming from error-correcting codes, symplectic moment maps, and lattice packings of discretized convex bodies. The methods yield many new explicit, efficient, positive, interior, cubature formulas for the most standard choices of  $\mu$ . In one context, they also lead to an interesting local lower bound on the number of points needed for cubature.

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