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There's Something About China

By Gilbert Strang

Sometimes a particular conference just clicks. It might be the speakers, it might be the place. This is a quick report on a meeting held in March at Peking University (about computations in science and engineering) from a participant who enjoyed it all. As I write, the spy plane is held on Hainan Island, and its crew might feel a little differently about this, but I think China is fascinating and wonderful. Something unusual always happens on trips to China.

This time, for example, Henry Kissinger was a passenger on my flight home. He was extremely friendly (from Seat 1A) and even collected his own luggage from the carousel. Henry volunteered that it was the 30th anniversary of his historic secret trip to prepare for Nixon's visit. He didn't notice what I was bringing home, but I have to mention it here: a copper teapot whose spout is a yard long. Waiters use them at banquets, to pour tea at large distances. It was a gift from Yuesheng Xu of North Dakota State University. Everybody was smiling about it on the plane, and right now I can get 20% of the tea into the cup.

The lectures were excellent, and I would like to mention three—by Andy Majda, Ian Sloan, and Stan Osher. Andy has established a strong group at the Courant Institute to work on the application of mathematics to atmospheric and ocean science. A serious problem is the incompatibility of time scales—fast atmosphere and slow ocean. There are climate variables and unresolved short-time random variables. The techniques are quite remarkable, and I will jump to a fascinating one-dimensional model. It is a projection of the Burgers equation, in which the unknown function U has only N Fourier coefficients: $U_t + \text{Proj}\ UU_x = 0$.

Among the phenomena that Majda predicts (and sees numerically) is an eventual equipartition of energy. Readers will remember that this is what Fermi–Pasta–Ulam expected—but didn't find—for their nonlinear oscillators. (Solitons were discovered instead, giving exact solutions to very special nonlinear PDEs.) The new "Majda equation" has natural interest in chaotic dynamics, with a Gibbs measure and a scaling theory for the correlations (and still so simple!).*

Ian Sloan spoke about interpolation on a sphere. (Ian is chair of the scientific committee for ICIAM 2003.) The crucial question for spherical harmonics Y_{lk} is: Where to interpolate? Points that seem entirely reasonable can be (and were) disastrous. In desperation, Sloan's colleague Robert Womersley at the University of New South Wales was able to compute very successful points (apparently with positive weights) by maximizing the determinant from the interpolation equations. The matrix entries are $Y_{lk}(x_j)$.

I have no idea how Womersley maximizes the determinant of a full matrix of order 129^2 over all sets of points on the sphere. The group's Web site is www.maths.unsw.edu.au/~rsw/Sphere.

The third highlight for me was Stan Osher's lecture about new applications of level set methods. The central idea is to represent a curve or a surface as the set where a function equals zero, and then to work with the function instead of the set. A natural choice of function is distance from the set!

One key application is a fundamental problem in visualization—to create a shape from a collection of points and/or curves and/or surface patches. Osher formulates this as a variational problem, and the zero level set of the solution (with sign change from one side to the other) is the interpolating surface. Movement toward that optimum involves curvature and gradient descent. The level set ideas developed by Osher and Sethian and their co-workers have transformed computation of the motion of curves on manifolds. Stan is completing a book about these methods.

The Beijing conference was a small but inspiring sample of worldwide activity in computational mathematics.

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*See *Proceedings of the National Academy of Sciences*, Vol. 97, 2000, 12413; www.pnas.org/cgi/doi/10.173/pnas.230433997.