

Reviewing Harrison's Latest Work

In a paper to appear this month as a research announcement in the *Bulletin of the American Mathematical Society*, Jenny Harrison takes a theory known as Stokes' theorem and extends it to new domains. Because Harrison's recent work played a key part in the settlement of her sex discrimination suit against the University of California, Science asked its mathematics correspondent, Barry Cipra, to obtain expert judgments of Harrison's recent work. His report follows.

Stokes' theorem is a generalization of Newton and Leibniz's fundamental theorem of calculus. Loosely speaking, it equates integration on a geometric region such as a surface with integration on the region's boundary. Classically, Stokes' theorem requires that these boundaries be nice and smooth, but that's not always the case. That's where Harrison steps in.

Following work by the late Hassler Whitney at the Institute for Advanced Study in Princeton, Harrison developed a theory of integration for objects called chains that makes sense of Stokes' theorem in cases where the objects being integrated over are so wild that ordinary integration breaks down. Part of her purpose, Harrison told *Science*, is to provide techniques that will allow scientists to do rigorous mathematical work with some of the fractal models now in vogue.

The majority of the approximately 20 mathematicians contacted by *Science* declined to comment on Harrison's recent work, citing unfamiliarity or a desire not to get involved in the controversy at Berkeley. Four, however, were willing to speak, all specialists in dynamical systems, Harrison's subfield.

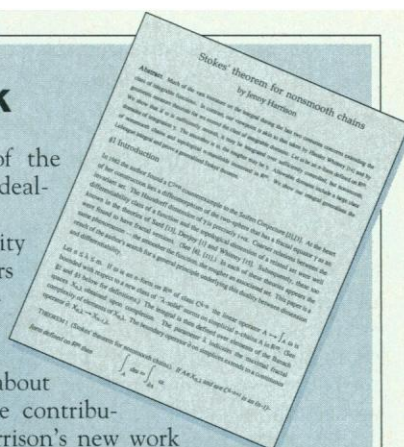
"What she's really doing is calculus on fractals," says Robert Devaney of Boston University. Devaney is unreservedly impressed with Harrison's recent work, calling it "a beautiful synthesis of classical ideas" that establishes "a deep relationship between the dimension of the space you're working in—the fractal dimension—and the smoothness of the map [i.e., function] that you're dealing with."

James Yorke of the University of Maryland, one of the founders of chaos theory, agrees. Because of its central role in the calculus of several variables, "anything new you can say about Stokes' theorem is a valuable contribution," he says. Not all of Harrison's new work involves difficult mathematics, Yorke notes, but "the parts that aren't that deep are quite pretty. And there are other parts that are quite deep."

Dennis Sullivan at the City University of New York, a leading expert in complex dynamics, was positive, though less effusive than Yorke or Devaney. "It's always important in math to extend the existing structures to their largest and most natural domain of definition," he says. A number of problems in mathematics are related to lack of smoothness, Sullivan says, and Harrison's geometric approach is one way of attacking those problems. "I can't really say [of Harrison's work] 'This is great' or 'This is not great,'" he says. "It's solid work, and it's a step that should be taken. It's just normal, solid mathematics. I would be happy to do it myself."

Morton Brown of the University of Michigan goes further: "I wish I had done it," he says. While noting that he hasn't closely read her most recent papers, Brown says he knows the problem she's working on and thinks it's significant. In Brown's opinion, Harrison's research will be the basis for future work on integration of nonsmooth curves. "I think it will make a mark in mathematics."

—Barry Cipra



in being promoted to full professor. Therefore they recommended that she be appointed full professor. The report's conclusion, provided to *Science* by Dan Siegel, Harrison's lawyer, states: "Our overall impression of Harrison is that she is an outstanding, creative mathematician whose research is of the caliber expected for tenure at Berkeley."

Chancellor Tien took the panel's advice and appointed Harrison a full professor. Criticism began immediately, starting with Ratner, a member of the National Academy of Sciences and a highly regarded researcher in the subdiscipline called ergodic theory. On 11 July, Ratner e-mailed the mathematics and statistics faculty that the settlement "certainly does not make [Harrison] qualified for the job, which she got through years of lying and a massive propaganda campaign which went unanswered." Ratner also wrote critical letters that were published in the *San Francisco Examiner and Chronicle* and in the newsletter of the Association for Women in Mathematics (AWM).

When Ratner was asked by *Science* what the "lies" were that she had mentioned in her e-mail, she said Harrison's claims of gender discrimination were false; in fact, Ratner says,

the department made an "exceptional effort to save Harrison's tenure." Ratner pointed out that Berkeley's Privilege and Tenure Committee, a faculty committee charged with monitoring grievances of faculty and allegations of misconduct at the university, spent 80 hours questioning 25 witnesses to review Harrison's claims. (The committee was not responsible for deciding whether Harrison should have received tenure; they were asked simply to decide whether the process was flawed.) In its September 1989 report, the committee concluded there was "no demonstrable evidence to the charge that gender discrimination existed in the department." Ratner also argues that the department has made "enormous" efforts to recruit women, including three offers to women in the past 8 years, two of whom accepted. (One has resigned; another is an assistant professor.)

Long-time Harrison opponent Rob Kirby calls Harrison's charges of sexism in the math department "like being accused of child molestation when you're completely innocent"—because both kinds of charges are so difficult to disprove. He says "people went out of their way" to treat Harrison "as nicely as one can." She was given a rare 3-

year leave, he said, to spend time at Oxford University. More generally, he says, the Berkeley math department has elected several pro-affirmative action chairmen. "Is it not curious," he says, "that the department, often by huge majorities, should elect pro-women chairs, and yet be called prejudiced?"

Although the settlement offered no conclusion on the issue of gender discrimination, university provost Carol Christ told *Science* that "the [math] department was judged not guilty of sex discrimination in 1986 [by the Privilege and Tenure Committee], and that's what the administration accepts."

For her part, Harrison argues that the process leading to the Privilege and Tenure Committee conclusion was flawed. For example, she says, she couldn't question witnesses about confidential matters. Nor could she gain access to confidential files she needed to make her case. That material came out, she says, only during pre-trial discovery in her suit, a process that included 110 hours of depositions, questioning of 17 witnesses under oath, and the release to her of more than 1000 pages of confidential documents. As a result, Harrison claims, if her suit had gone to a jury, she was prepared to document specific