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OBSERVING INDIVIDUAL MOLECULAR REACTIONS

Molecular reactions happen fast: In a billionth of a second, two molecules can collide, intermingle, and merge, giving rise to a new chemical product. In tact, the trading of atoms or electrons between molecules takes place so quickly that scientists can only estimate the true reaction speed.

Now, Maryanne M. Collinson and R. Mark Wightman, chemists at Kansas State University in Manhattan and the University of North Carolina at Chapel Hill, respectively, have come up with a novel system enabling chemists to detect and monitor single molecular events.

By focusing on a small number of reactive molecules confined in a tiny place, the chemists can, in effect, observe reactions as they happen.

Their report appears in the June 30 SCIENCE.

The scientists placed a dilute solution of 9,10-diphenylanthracene (DPA) molecules, which fluoresce when chemically stimulated, into a minuscule, lightless reaction vessel only one-fiftieth the size of an average living cell. By applying a mild electric pulse across two tiny electrodes, each only a few micrometers in diameter, the researchers created positively and negatively charged DPA ions.

The ions float freely in solution, seeking out oppositely charged partners. When they meet, they react, emitting a single photon. By using an instrument capable of counting single photon emissions, the scientists can track each molecular coupling.

As expected, the rate of photon emissions corresponded to the rate predicted by theory. "The apparatus detected about four photons per microsecond, "Wightman says. "That's what we expected, according to the statistics. But what's interesting here is that, ordinarily, there's no way to observe each molecule react. Here you actually see it

happen."

Allen Bard, a chemist at the University of Texas, Austin, points out that this technique could lead to other methods for detecting small numbers of molecules in solution, an application that could prove useful to analytical chemists and molecular biologists.

To develop the new technique further, Wightman says, he will test it on other molecules to see how well it works for monitoring various types of chemical reactions.

"One of the virtues of this method is its simplicity," Wightman says. "I like low-tech experiments."

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By R. Lipkin

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