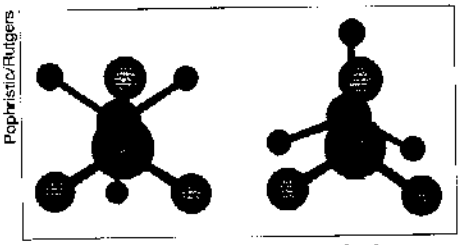
Molecular Chemistry Takes a New Twist

In a discovery that could have implications for biological research, new calculations show that a basic tenet of chemistry is wrong. At issue is why molecules twist into the shapes they do. The new finding indicates that in some molecules, quantum forces trump the traditional explanation.

The find focuses on ethane, or C_2H_6, which has two carbon atoms bonded to each other. Each also attaches to three hydrogen atoms. On the other end of the carbon-carbon bond, each hydrogen-adorned carbon atom, or methyl group, spins like a three-pronged turnstile, says chemist Frank Weinhold of the University of Wisconsin–Madison.

College instructors teach chemistry students to look at the molecule from one end, so that one carbon blocks the other from view. From this vantage point, students can distinguish the two ethane conformations. In the depiction of ethane's stable, or so-called staggered, conformation, all six hydrogens are visible and equally spaced. In diagrams of the less stable, or eclipsed, conformation, the rear three hydrogens are hidden because they line up directly behind the front three hydrogens.

Textbooks give students a seemingly straightforward reason for the greater stability of the staggered form, says Lionel Goodman of Rutgers University in New Brunswick, N.J. They pin it on so-called steric effects. In the eclipsed conformation, close carbon-hydrogen bonds crowd each other, thereby raising the molecule's overall energy.



Pophristic/Rutgers

In these nearly end-on views of ethane, C_2H_6, the front carbon atom (gray) partially blocks the rear one. The molecule's staggered (left) and eclipsed (right) conformations differ in the positions of the hydrogen atoms (blue).

But now, 50 years after this seductively simple explanation caught on, Goodman and his Rutgers colleague Vojislava Pophristic say that it's not so. "The implications are rather large because the cornerstone of our understanding of the structure of molecules is the steric effect," says Goodman. "And ethane is regarded as the benchmark for understanding the structure of molecules."

Pophristic spent 5 years crunching calculations with a supercomputer to figure out what underlies the stability of ethane's staggered conformation. First, she mathematically modeled ethane and removed the parts of the calculations that relate to the steric effect. To her surprise, the ethane molecule remained staggered. Something else must keep it in the staggered conformation.

Then, Pophristic looked at the other known influence on ethane's twisting—a quantum mechanical effect known as hyperconjugation. "The electrons of one methyl group jump over to the other methyl group," says Goodman.

When Pophristic blocked the electron jumping by placing a hypothetical screen between the two methyl groups, ethane's structure finally assumed the eclipsed form, she and Goodman report in the May 31 NATURE. Hyperconjugation, not steric effects, makes staggered ethane stable, they conclude. And what goes for ethane could go for many other organic compounds, says Goodman.

Researchers can no longer assume that steric effects play the major role in determining stable forms, comments Weinhold. They should give more attention to quantum mechanical effects when studying biological molecules and processes such as protein folding. "You eventually have to come to grips with this quantum mechanical aspect of everything," says Weinhold. —*J. Gorman*

Does breast-feeding accelerate AIDS?

In developing countries, a child born to a mother infected with HIV—the AIDS virus—faces long odds against survival. Some babies are born already infected, and the others run the risk of acquiring the virus through breast milk. Feeding a child formula avoids that hazard, but it's less healthy for the baby in other ways and more expensive for the family (see related story, p. 344).

A study in Kenya now suggests that mothers with HIV who nurse infants are themselves more likely than formula users to die within 2 years of a child's birth. This comes as chilling news because other research has shown that if a mother dies, her baby is up to four times as likely as others to die while still a child.

In 1992, a U.S.-Kenyan research team began designating groups of HIV-infected pregnant women to bottle- or breast-feed their infants. The women, who had all volunteered, were randomly assigned to a group. Of 200 women who fed their babies formula, 6 women died within 2 years. Of 197 who nursed their infants, 18 women died in that time, the team reports in the May 26 LANCET.

The researchers propose two scenarios to explain the correlation. When lactating, women produce the hormone prolactin, which stimulates breast-milk production. The hormone might suppress the immune system and somehow accelerate the course of AIDS, the researchers hypothesize.

On the other hand, women who breast-fed their babies lost more weight on average during the 9 months after giving birth than the mothers who bottle-fed their babies did. This suggests that breast-feeding steals nutrients from women and might make them more susceptible to AIDS, says study coauthor Joan K. Kreiss, an epidemiologist at the University of Washington in Seattle.

In a commentary accompanying the LANCET article, Marie-Louise Newell of the Institute of Child Health in London doubts the scenario theory because breast-feeding doesn't seem to increase the death rate of women in famines.

While it's tempting to discourage all breast-feeding among HIV-infected women in poor countries, the choice is not simple, says Robert J. Biggar, a pediatrician at the National Cancer Institute in Bethesda, Md. Water that spreads disease makes feeding with formula a dangerous option in some areas, he says.

Moreover, women in rural areas who bottle-feed a baby are sometimes suspected of having AIDS and then driven out of their village, says pediatrician Mary Glenn Fowler of the Centers for Disease Control and Prevention in Atlanta.

At present, the World Health Organization directs health workers to inform pregnant women of HIV-transmission risks and recommend formula where safe water is available.

The new findings "are certainly of interest and are provocative," Fowler says. But scientists need to look at other studies for evidence that breast-feeding is really at fault. Although the U.S.-Kenyan researchers assigned the women to groups randomly, the bottle-feeding group seemed to contain slightly healthier women, she says.

Kreiss says, however, that her team's findings might shift the balance further toward bottle-feeding when a mother carries HIV. —*N. Seppa*