Colliding Clusters Hint at New Fusion Route

Slamming salvos of minuscule heavy-water cannonballs into a thumbnail-sized target containing heavy hydrogen produces micro-thermonuclear reactions in which some of the colliding atoms fuse, report scientists at the Brookhaven National Laboratory in Upton, N.Y. Though the fusing atoms release only a tiny fraction of the energy used to run the reaction, the scientists say their work opens "a possible new path to fusion power."

Fusion occurs readily in such places as the sun, stars and thermonuclear bombs, where high pressures and temperatures force hydrogen, deuterium (an isotope of hydrogen containing one proton and one neutron) or other nuclei to fuse with an accompanying release of energy, mostly in the form of fast-moving particles. Physicists have tried to duplicate these fusion-friendly conditions on Earth, largely by using magnetic fields to confine many nuclei in a small volume of space or powerful lasers to compress and heat a stationary fuel target.

Earlier this year, two independent research teams appeared to outshine those attempts by claiming they had achieved "cold fusion" at room temperature by forcing deuterium nuclei together between the atoms of palladium or titanium metal specimens. Though hundreds of others have tried to duplicate the results, the claims remain largely unconfirmed and controversial, especially those of B. Stanley Pons of the University of Utah in Salt Lake City and his British co-worker, Martin Fleischmann.

In the new approach, Brookhaven physical chemists Robert J. Beuhler and Lewis Friedman and nuclear chemist Gerhart Friedlander use electric fields to accelerate charged clusters of heavy water in a vacuum chamber. So far, clusters of up to 1,300 heavy-water molecules – each of which contains a pair of deuterium atoms instead of two hydrogen atoms as in regular water – have been sped up to several hundred thousand miles per hour. At the other end of the chamber rests a thin titanium target loaded with deuterium atoms.

As the clusters slam into the target's surface, the tiny underlying regions are compressed to a calculated 80 million atmospheres of pressure and heated to temperatures estimated in the range of hundreds of thousands of degrees. In the sub-trillionths of a second duration of each cluster impact, some deuterium nuclei are forced close enough to fuse, Friedman says. The chemists report their work in the Sept. 18 PHYSICAL REVIEW LETTERS.

"We really don't know the details of what is going on in the collisions," Friedman notes. But the researchers believe the evidence they have harvested points to deuterium-deuterium fusion. A sensor near the target has consistently detected the signature of such fusions – fast-moving hydrogen atoms and tritium, an isotope of hydrogen containing one proton and two neutrons – emerging with characteristic energies. Replacing the deuterium with hydrogen in either the clusters or the target results in collisions that do not produce fusion products. And the faster the clusters go, the more fusion they seem to cause. "I don't know what the limitations are, but there is no indication that the [upward] trend of energy is leveling off," Friedlander says.

Harold P. Furth, director of Princeton (N.J.) University's Plasma Physics Laboratory, says he is "astonished" that the clusters, which carry far less energy than most fusion researchers have become accustomed to thinking about, seem able to evoke fusion. "It's a real fascinating mystery to be looked at," he says. The next step, the Brookhaven researchers say, will be to use more powerful accelerators that should produce harder collisions and yield more data about the fusion mechanism. Furth suggests also substituting tritium for the deuterium in the target because this too would boost reaction output energy. *– I. Amato*

Warmer clouds could keep Earth cooler

Having refined the way computers simulate clouds, a team of British scientists reports that the greenhouse world of tomorrow may not produce temperatures as warm as predicted.

The new work, detailed in the Sept. 14 NATURE, illustrates one of the special problems that currently limit the credibility of long-term climate predictions (SN: 8/12/89, p. 106). "There is still major uncertainty about the magnitude of greenhouse warming, and a lot of the uncertainty comes from uncertainty about how to include the clouds," says David A. Randall, an atmospheric scientist at Colorado State University in Fort Collins.

Climate experts rely on complex computer models of the atmosphere and oceans, called global circulation models, to forecast how accumulating greenhouse gases such as carbon dioxide will affect the planet. Representing clouds in the standard way, the model at the British Meteorological Office in Bracknell predicts the world will warm 5.7°C by the time carbon dioxide concentrations double, which scientists expect in the middle of the next century. When J.F.B. Mitchell and his colleagues altered the cloud portion of this model, the predicted warming dropped to 2.7°C.

The difference stems from the ways in which the model predicts cloud properties. The revised cloud treatment requires the model to simulate the amount of liquid water inside a cloud. This technique is more detailed than the standard one, which bypasses a calculation of the cloud's liquid water.

The new simulations show that water in clouds – either ice or liquid water – could play an important role in limiting global warming because clouds reflect solar radiation that would otherwise warm Earth's surface. Ice particles fall out of clouds more quickly than do water droplets, which tend to be smaller, says Mitchell. When a cloud loses its water in either form, it thins and eventually disappears.

Many clouds in the world's mid-latitudes form at temperatures just below freezing, so even a slight global warming could change ice clouds into ones that contain liquid water. Because the water clouds last longer, a warmer world would reflect away more sunlight than today's planet – an effect that would check rising temperatures, according to the new forecast.

Though more sophisticated than the conventional cloud treatment, Mitchell's method does not necessarily yield a truer picture of the feedback clouds will exert on climate change, says Randall. A recent study of 14 different general circulation models shows wide variation in their predictions of future temperatures, precisely because they disagree on cloud feedback. In a commentary accompanying Mitchell's report, Anthony Slingo of the National Center for Atmospheric Research in Boulder, Colo., says that both the new simulations and the comparative study of models demonstrate the need to understand cloud feedback before models can make reliable predictions.

Earlier this month, the President's Office of Science and Technology Policy highlighted the importance of cloud studies when it offered its plan for U.S. research on global change for fiscal year 1990. The report lists understanding the role of clouds as the top scientific priority. *– R. Monastersky*