

Getting the drop on 'giant' rain

You can get a world-class tan in Hawaii, but if you move a little off the island's eastern shore you can also get soaked by world-class rainfall. Each year, 300 inches of rain drop from a band of clouds near Hilo. Now these clouds have set a new kind of rain record. Atmospheric scientists report in the October *GEOPHYSICAL RESEARCH LETTERS* the discovery of the world's largest raindrops from warm clouds.

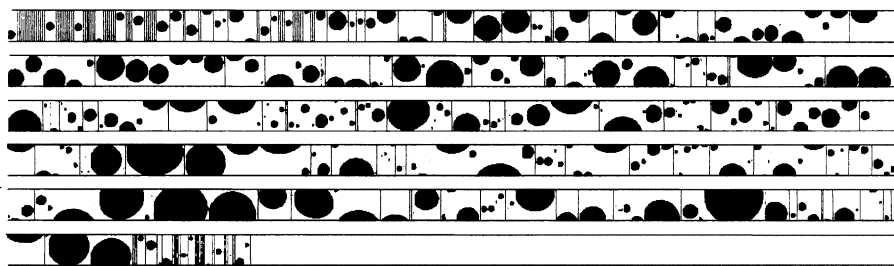
During the 1985 Joint Hawaiian Warm Rain Project, Kenneth V. Beard of the Illinois State Water Survey in Champaign and his colleagues found many drops measuring 4 and 5 millimeters in diameter, as well as one 8-mm drop. Drops up to 6 mm in size are known to form when cloud ice melts, but the conventional view of warm, tropical raindrops has held that they seldom get larger than 2.5 mm; earlier laboratory studies, modeling and field observations suggested that larger drops are routinely shattered when they collide with smaller drops.

Apart from showing that conventional thinking about the formation and survival of warm raindrops is all wet, the new finding is important to scientists who use radar to monitor rain clouds and estimate rainfall rates. To calculate these rates, meteorologists need an accurate account of the size distribution of drops in a cloud because the strength of radar signals reflected from a drop is strongly influenced by the drop's size. In addition, radar signals are affected by the shape of a drop, and the larger a drop, the more distorted it becomes (SN: 3/2/85, p.136).

Recent laboratory and modeling results have convinced Beard, David B. Johnson at the Bureau of Reclamation in Denver and Darrel Baumgardner at the National Center for Atmospheric Research (NCAR) in Boulder, Colo., that their finding of large drops in the Hawaiian clouds makes sense on a theoretical basis. Using a drop-size distribution commonly used in radar measurements, they calculate that 5-mm raindrops are destroyed once every 42 seconds. But using their actual observations, in which they found a much higher proportion of large drops than that standard model had predicted, the researchers obtain a destruction rate of only one 5-mm drop every 23 minutes.

"Because earlier observations suggested that these clouds don't have big drops, nobody was looking for them," says Beard. "And no one was doing any calculations to see if they were possible. Nature is often more interesting than what we theoreticians can invent."

Beard's group thinks the high water content of the cloud band near Hilo contributes to the unexpectedly high num-



Atmospheric scientists used an array of photodiodes aboard a research plane to record these shadows of falling raindrops in order to measure their sizes. This magnified record is a time sequence, with each vertical mark denoting the passage of 0.1 second.

ber of large drops. The clouds' large updrafts are also key because they suspend drops, enabling them to grow large before they fall. In addition, "relatively low numbers of small drops seem to be a necessary condition," says Beard, so that few collisions occur.

The researchers also suspect that the updraft may be tilted so that large drops fall out of the cloud, avoiding the cloud's rising small drops. Or, it may be that large drops are the first to fall from a cloud. "We certainly find large drops in the absence of significant numbers of small raindrops," says Beard. But, he adds, "we don't really understand how this part of it occurs."

In order to investigate the wind pat-

terns that give rise to these clouds, Roy Rasmussen at the Bureau of Reclamation in Denver and Piotr Smolarkiewicz at NCAR simulated the formation of the cloud band with a three-dimensional computer model. They found that the trade winds approaching the island are deflected back and down the slopes of two 13,000-foot-tall volcanoes. The deflected winds then run head-on with low-level trade winds, the converging air rises and clouds form. In other rainy areas, such as the island of Maui, clouds form because the air is pushed up by mountains. Having the winds turn back on themselves is "is fairly unusual," says Rasmussen. "No one's reported on this phenomenon before." —S. Weisburd

Molecular divorce gives strange vibes

Common sense says that the more vigorously you vibrate something, the more likely it will break into parts. But laser-wielding chemists pushing around weakly bound, identical molecular twins are finding that the effects of vibration on the molecular scale may not be as straightforward.

Researchers at the National Bureau of Standards in Gaithersburg, Md., observed that the harder they 'shake' coupled twins, or dimers, of nitric oxide (NO) molecules, the longer it takes to break the weak bond that holds together the two individual NO molecules. Such bonds are governed by what are called van der Waals forces, which are, in part, responsible for the shapes of proteins and enzymes, as well as for some chemical and physical properties of all materials. The scientists' findings, which will appear in the Nov. 15 *JOURNAL OF CHEMICAL PHYSICS*, run counter to both intuition and existing theories about how and why molecules break into pieces.

In usual earthly situations, molecules rock, rattle and roll in an energetic dance at a dizzying pace. A molecule's constituent atoms rotate around bonds a trillion times every second. With each tick of the clock, these bonds twist and bend about 10 trillion times. The atoms vibrate toward and away from each other at an even faster rate. Meanwhile entire molecules are slam-dancing with their neighbors,

making complex exchanges of energy. Twists become bends, which become vibrations that become rotations, or some other such choreography of transitions and motions. In those cases where all of this internal energy becomes too much — for instance, when solids melt into liquids or liquids change into vapors — molecules fragment until the smaller pieces are dancing at a pace that allows them to stick around.

When a molecule itself disintegrates or when it dissociates from another molecule to which it is bound, how are the complex internal energies redistributed throughout the fragments involved? Theories exist that fit well with observed patterns of molecular disintegration, but they are based on unexplained assumptions.

In the new research, a quartet of scientists, led by Michael Casassa, used ultrafast laser pulses to study how two identical and weakly bound NO molecules dissociate, a divorce that occurs in less than a billionth of a second. The researchers opted to study relatively simple NO dimers — two molecules, each composed of an oxygen atom and a nitrogen atom, which stick together due to van der Waals forces and form a trapezoidal molecule. Compared with more complex molecules, the four-atom NO dimer has a limited repertoire of dance moves. Yet even at room temperatures, motions