clear deterrent" of putting them out of business; hence, the interim standards compromise.

Ruckelshaus vehemently denied White House pressure in coming to his decision, saying rather that he was following the court's injunction to take social and economic risk factors into account. He also emphasized that by applying stricter standards first to California, where Japanese carmakers concentrate their sales, the battle between catalysts and the Japanese-produced stratified charge engines could be fought in an open, competitive marketplace.

Upon the outcome of that and other looming battles may depend not only the future of America's air, but millions of jobs and an industry whose activity constitutes roughly one-fifth the national economy. □

Illustrations: Richard Zare

Zare (r) and colleagues with their detector: "A powerful new analytical tool."

Where energy goes when chemicals react

For years chemists have yearned to know what really happens when chemical molecules react to form a new product. Molecular beam scattering techniques are bringing them closer to their ambition.

One of the first molecular beam scattering techniques projected beams of two kinds of chemical molecules so that the molecules interacted. But the compounds formed were scattered thinly into all angles, so the internal energy—vibrational or rotational levels—of the products could not be determined. For example, when potassium was made to interact with iodine, the salt formed could be distinguished from the potassium by the use of hot wire detectors. The detectors determined the angular distribution of the salt molecules, but did not show their vibrations and rotations. The detectors were also limited to reactions between atoms and molecules with extremely low potentials for ionization: alkalies like potassium and halogenated compounds like iodides.

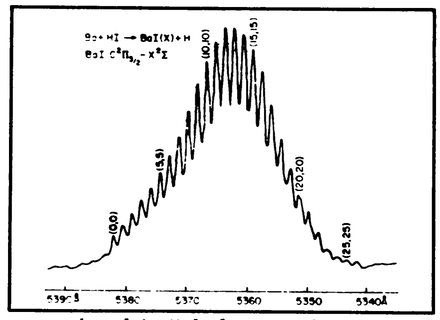
Then electron ionization and mass spectrometry arrived as an adjunct to molecular beam scattering. The angular distribution of all types of chemical products, including organic molecules, could be detected. But this technique was, and still is, handicapped by the low efficiency of the electron bombardment ionizer. This means that background gases as well as product molecules are ionized, and the gas ions can interfere with the detection of the angular distribution of the product molecules. What's more, the technique does not give the vibrations and rotations of the molecules.

Now, after two years of work, Richard Zare and his team of physical chemists at Columbia University have devised what appears to be the most sensitive and widely applicable molecular beam scattering technique yet for measuring energy output during chemical reactions. The technique gives not just angular distribution but also the internal energy of the reaction product following a reaction encounter, which takes no more than one-trillionth of a second.

In reporting the technique at the national meeting of the American Chemical Society in Dallas last week, Zare declared: "We have an immensely powerful new analytical tool which might be likened to an ultraselective analytical balance. As we can detect as few as 10,000 molecules in a given vibrational or rotational level, this corresponds to a weight of a billion billionth of a gram."

The chemists use a laser beam as a molecular beam detector. The laser's beam of sharp and intense light is focused on a chemical product right after it is formed. The energy in this high-powered beam induces the molecules in the product into an electronically excited state. Because the electrons in the molecules are excited, the molecules fluoresce, or "shine." The strength of the fluorescence of the excited product molecules is then measured as a function of laser wavelength. Patterns of fluorescence at different stages of excitation are printed out as a line of so many peaks and troughs. The peaks represent the concentration of the product molecules in a particular vibration or rotational level.

Zare and his colleagues have found how much energy goes into the vibrations and rotations—"shaking and quaking," as he puts it—of product molecules. "We can calculate directly," he says, "how the excess energy of reaction goes into vibration and rotation, and from this a picture emerges of



A molecule's "shaking and quaking."

how the reaction occurred. We learn whether reactants had to climb a hill to form a product, or whether they did not."

In an interview, Zare observed: "Laser-induced fluorescence is helping us realize the chemist's dream of understanding how energy flows to break old bonds and to form new ones. Such detailed knowledge should help us modify reaction conditions to make new products, or to increase the yield of products already of value to society. Laser-induced fluorescence may also clarify interactions among environmental pollutants, or among molecules in living organisms." □

NIH bans research on live fetuses

In a much-debated move last week the National Institutes of Health banned experimentation with live human fetuses. For almost two years NIH officials have been considering adopting guidelines that would have allowed such research only on nonviable fetuses, those that could not possibly develop into full-term babies. Standards for experimentation would have allowed the use of live fetuses aborted before the 20th week, less than 1.1 pounds in weight and shorter than 9.8 inches.

When it was publicly revealed that