

practical applications; the metal carbonyl ionization produces copious quantities of cold metal ions, which may, Smalley suspects, be useful in technologies such as ion implantation.

At the University of Illinois at Urbana-Champaign, McDonald and his group use an apparatus similar to that of Smalley. They have detected quantum beats in fluorescence of the molecules methyl glyoxyl and biacetyl—the first quantum beats due to vibrational structure to be observed, McDonald pointed out to us. The beats occur by mixing of states of the first excited singlet and vibrationally ex-

cited levels of the first excited triplet. The Illinois group chose these two molecules because they have the right density of states in the triplet, and sufficiently long radiative lifetimes to show beats.

—JTS

References

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New assessments of ozone depletion

A National Academy of Sciences-National Research Council panel has doubled its earlier estimate of stratospheric ozone depletion by halocarbons, though a British government report says that our present understanding of ozone depletion is limited and makes such estimates of doubtful significance. The NRC panel on stratospheric chemistry and transport, headed by Harold Schiff of York University, Toronto, concluded that continued world-wide use of halocarbons will result in ozone depletion that is calculated to reach 16.5%, half of which will occur in the next 30 years. A 1976 NRC report estimated the eventual ozone reduction at 7.5% (*PHYSICS TODAY*, November 1976, page 101).

The small amount of ozone in the stratosphere acts as an ultraviolet shield for the Earth and plays a role in determining the climate of the planet. Chlorofluoromethanes (CFM's), the primary focus of this and past studies, rise to the stratosphere and are dissociated by ultraviolet radiation into ClO_x fragments that enter into catalytic chain reactions in which one molecule can destroy many ozone molecules.

The increased predicted ozone depletion resulted from new values for some of the rate constants for the chemical reactions that govern ozone levels. Recent improvements in the computer models used to simulate the chemical reactions going on in the atmosphere and the air currents and more and better laboratory and atmospheric measurements that can be used to check the validity of the models have reduced the uncertainty range of the estimates as well.

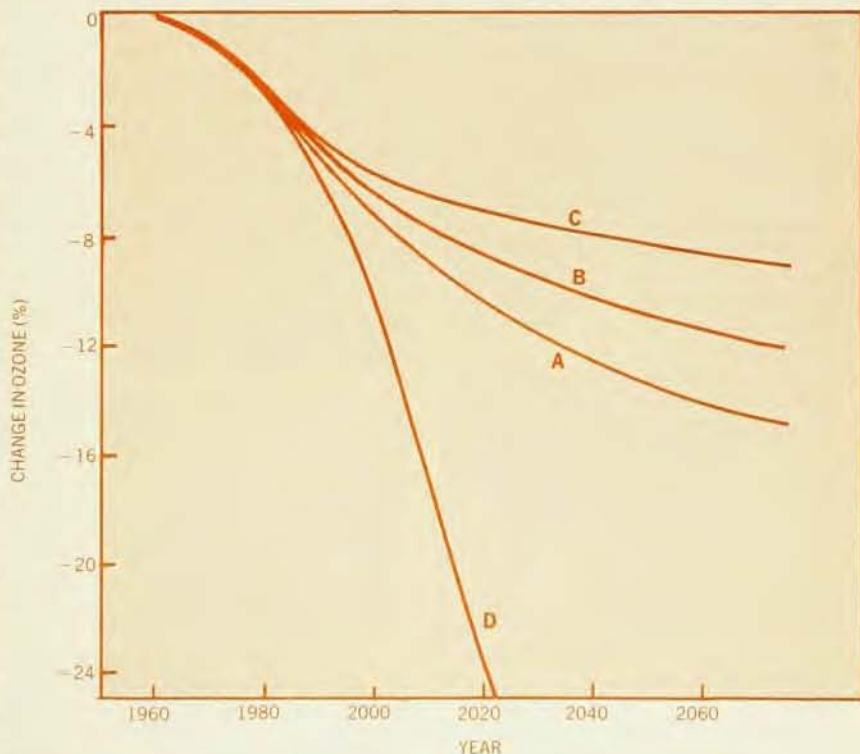
The primary conclusion of the report, *Stratospheric ozone depletion by halocarbons: chemistry and transport*, is that "continued release of halocarbons into the atmosphere will result in a significant decrease in the amount of stratospheric ozone." The NRC group chose to consider only the effects of two halogens, F-11 (CFCl_3) and F-12 (CF_2Cl_2), because they are produced and released in large quantity and, to the best of our

knowledge, are not removed in the troposphere (the region between the surface and the stratosphere). "The present study estimates an eventual decrease of 18.6% in the total amount of ozone for continued release of F-11 and F-12 at the 1977 rates . . ." The group reduced this "best estimate" for the eventual ozone decrease to 16.5%, however, taking into account the possibility of tropospheric "sinks" that can remove some CFM's below the stratosphere and the effects of thermal feedback mechanisms. The

temperature changes in the stratosphere and the troposphere resulting from ozone destruction can alter the rate at which ozone is created and destroyed.

Uncertainties. The NRC group isolated two potential sources of error in their calculations: uncertainties in the rate constants used, and uncertainties as to the validity of the one-dimensional model used. They worked with a model that considers only the vertical motions of chemical substances because they believe that when all the motions of the atmosphere are summed over all latitudes and longitudes, the effects of horizontal motions of substances largely cancel and the vertical movements dominate. "Combination of all these sources of error amounts to a range of a factor of 6. Thus our best estimate is that for continued CFM values at 1977 levels there is one chance in 40 that ozone depletion will be less than 5% and 1 chance in 40 that it will be greater than 28%."

The panel also pointed out that there are two possible sources of error that cannot be quantified. One is that some important chemical reaction has been overlooked; the other is that some systematic error exists in the chemistry, such as the assumption that the reaction rate is independent of pressure. They placed rough uncertainty estimates on these



Ozone reduction estimated for four different scenarios of CFM release: continued release of F-11 and F-12 at the 1977 rates (case A); continued release at the 1977 rate until 1983, followed by a 25% reduction at that time, then continuation at the reduced level (case B); the same reduction assumed in case B plus an additional 25% reduction in 1988, with constant release thereafter at half the 1977 level (case C); constant release rate at the 1977 level until 1980, a 7% per annum growth rate until 2000, and a constant release rate at the year 2000 level beyond that date (case D). (From the National Research Council report on stratospheric ozone depletion.)

unknowns and concluded that even given these unknowns, "there is a 3 out of 4 chance that continued release of CFM's at the 1977 level will result in an ozone depletion that lies in the range of 9% to 24%."

The panel realized that the scope of their study was limited. They considered only two halocarbons, F-11 and F-12, because all others that are released into the atmosphere are removed, to some extent, in the troposphere by HO radicals, with the exception of methyl chloride, methyl chloroform and F-22 (CHClF₂). Appreciable fractions of these three substances do reach the stratosphere and contribute to ozone destruction. They were not considered, however, because the fraction of these chemicals that reaches the stratosphere depends on the HO concentrations in the troposphere, which are only poorly known. "If the rapidly increasing use of F-22 and methyl chloroform continues unabated," the panel said, "the release rates and atmospheric behavior of these compounds will require careful attention. However, since chemical reactions remove appreciable fractions of these compounds before they reach the stratosphere, substitution of F-22 for F-11 and F-12 would be beneficial."

The group also admitted that "it is difficult to project accurately the effect of increased halocarbon release when the release of other man-made pollutants may also be increasing in an undetermined way. A moderate increase in stratospheric NO_x resulting, for example, from increased use of nitrogen fertilizers, would reduce the effect of halocarbons on ozone because of the coupling between ClO_x and NO_x chemistry and would increase the ozone amount at lower altitudes." Carbon dioxide, they said, could also offset the decrease caused by halocarbon release to a small degree by cooling the stratosphere and thereby increasing stratospheric ozone.

The UK Department of the Environment released a parallel report on ozone depletion almost simultaneously with the NRC's. *Chlorofluorocarbons and their effect on stratospheric ozone*, the report put out by the UK, took essentially the same data as did the NRC group but drew from it significantly different conclusions. Although they agreed with the NRC that, if the projected ozone depletion is calculated from available data a 16.5% depletion is derived, the British argued that such calculations are really not reliable at this point, because "basic scientific understanding, although progressing rapidly, is still inadequate in many respects."

The UK group also placed less importance on the role of ozone levels in determining climate than did the NRC group.

The reliability of the available models was another source of conflict: "...dis-

crepancies between model calculations and measurements bring into question the validity of the models presently used to predict ozone perturbations," the UK group said.

Finally, the two groups reached different conclusions about the uncertainties associated with the estimates. The British assert that the uncertainty range may have actually increased, not decreased as the NRC claims, since 1976. "It is not possible to assign numerical values to the associated uncertainties and this limits the reliance that can be placed on current models for predictive purposes."

Schiff, head of the NRC panel, told PHYSICS TODAY that the discrepancies between the NRC conclusions and those of the British report can be partly attributed to the fact that his panel had access to some more recent data than did the group in the UK. Also, the British group, he said, tended to focus its attention on the relatively few shortcomings of the models, rather than their successes.

The United Nations Environment Program committee on the ozone layer last November lent tacit support to the NRC's document by recommending additional action to reduce chlorofluoromethane emissions significantly.

A second NRC report, *Protection Against Depletion of Stratospheric Ozone by Chlorofluorocarbons*, estimated that a 16.5% reduction in ozone would eventually result in several hundred thousand additional cases of non-melanoma skin cancer each year and several thousand additional cases of melanoma in the US alone. The report stresses the need for international cooperation in controlling ozone depletions and highlights the rapidly growing nonpropellant uses of CFC's.

—MEJ

NSF to support eight new regional facilities

The National Science Foundation has awarded a total of \$11.39 million to eight universities for the establishment of regional instrumentation facilities. This brings the number of such facilities established under the two-year old program to 14. The program makes sophisticated instruments broadly available, taking advantage of the economies that result from sharing such instruments.

Arizona State University was awarded \$1.5 million for a high-resolution electron microscopy facility that will include capabilities for scanning transmission and analytical microscopy with a resolution of around 3 Å and a computer-based theoretical approach for image interpretation. John Cowley, Peter Buseck, LeRoy Eyring and John Spence will direct the facility.

Sunney Chan will direct a \$1.2-million very high-field (11.7–12.9 tesla) nmr

spectroscopy facility at Caltech. This facility will allow studies on organometallic compounds, membranes, molecular recognition of DNA and other biological systems.

The University of California, Berkeley, and Stanford University will get \$1.8 million to establish the San Francisco Laser Center. It will include a laser lending library to provide state-of-the-art lasers for use in an investigator's own laboratory. Research to be conducted at the facility includes metal combustion processes and multiphoton dissociation of molecules. The laser center will be directed by Yuan Lee and Bradley Moore of Berkeley and John Brauman and Richard Zare of Stanford.

The University of Illinois, Urbana, received a \$1.4-million grant for a high-resolution nmr spectroscopy facility to be directed by Herbert Gutowsky and Eric Oldfield. It will include capabilities for three spectrometers, solid-state "magic-angle" experiments, large sample multinuclear operation, cooled-coil and cooled pre-amp high-sensitivity probe and ¹H, ²H and ¹³C operation.

Michael Feld will direct the Northern Regional Center for Laser Spectroscopy and Dynamics at MI. Costing \$1.5 million, it will include capabilities for state-of-the-art pulsed and continuous sources of laser radiation from the far infrared to the near ultraviolet.

Montana State University received \$1.4 million for a facility for surface science and submicron analysis. It will allow x-ray and ultraviolet photoelectron spectroscopy and scanning Auger microprobe and many ancillary measurements. Gerald Lapeyre will direct the laboratory.

The University of Minnesota will establish an Upper Midwest facility for surface analysis with a \$1.4-million grant. Lanny Schmidt and Robert Hexter will direct the facility, which will emphasize epitaxial film growth as well as scanning Auger microscopy and x-ray and uv photoelectron spectroscopy.

Yale University will establish a facility for high-field (11.7–12.9 tesla) nmr spectroscopy with its \$1.2-million grant. Biochemistry and biophysics research will be conducted there, including metabolite transport, DNA-protein binding and properties and structure of steroids and macromolecules. A. Lyons, D. Crothers, J. Faller, J. Prestegard, M. Saunders and I. Armitage will direct the facility.

in brief

The 107-ton, 18-kG superconducting magnet that operated at Argonne's 12-foot bubble chamber will become part of the high-resolution spectrometer at PEP, saving an estimated \$5 million and three years construction time. □