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Contractor: Regents of the University of California

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C. Bradley Moore, Principal Investigator (415-642-3453)

Project Scientist: CBM

C. Bradley Moore

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Laser Studies of Energy Transfer

The work accomplished under this contract between July 1968 and June 1971 may be roughly divided into two areas; vibrational energy transfer in CO_2 systems and in hydrogen halide systems.

The experimental studies of energy transfer in CO_2 and mixtures containing CO_2 have been completed. Part of this work is described in the articles:

1. Donald F. Heller and C. Bradley Moore, The Journal of Chemical Physics 52, 1005 (1970), "Relaxation of the Asymmetric Stretching Vibration of CO_2 by Collisions with H_2O, D_2O, and HDO".
2. John C. Stephenson and C. Bradley Moore, The Journal of Chemical Physics 52, 2333 (1970), "Near-Resonant Vibration→Vibration Energy Transfer: $CO_2(v_3=1) + M \rightarrow CO_2(v_1=1) + M^* + \Delta E$".
3. John C. Stephenson, Robert E. Wood, and C. Bradley Moore, The Journal of Chemical Physics 54, 3097 (1971), "Temperature Dependence of Intramolecular Vibration→Vibration Energy Transfer in CO_2".

Three further articles, based on the Ph.D. thesis of John C. Stephenson are in progress. They will treat "Temperature Dependence of Near-Resonant Vibration→Vibration Energy Transfer in CO_2 Mixtures", "Vibrational Relaxation in Hydrogen Halide-CO_2 Mixtures", and a final paper presenting data on relaxation processes in mixtures with alkanes, deuterocarbons and other molecules. For simplicity in reporting these articles will be submitted under contract DAHC04 71 C 0047.

Studies of vibrational energy transfer in the hydrogen halides are still very much in progress. The completed work has been reported in articles published:

4. Hao-Lin Chen and C. Bradley Moore, The Journal of Chemical Physics 54, 4072 (1971), "Vibration→Rotation Energy Transfer in Hydrogen Chloride".
5. Hao-Lin Chen and C. Bradley Moore, The Journal of Chemical Physics 54, 4080 (1971), "Vibration→Vibration Energy Transfer in Hydrogen Chloride Mixtures".
6. Norman C. Craig and C. Bradley Moore, Journal of Physical Chemistry 75, 1622 (1971), "Vibrational Relaxation of Hydrogen Chloride by Chlorine Atoms and Chlorine Molecules".
7. Hao-Lin Chen, J. Chem. Phys. (in press). "Vibration-Vibration Energy Transfer in Hydrogen Bromide Mixtures".
8. Hao-Lin Chen, J. Chem. Phys. (in press). "Vibration-Rotation Energy Transfer in Hydrogen Bromide".

Work in vibration-vibration energy transfer in DCl mixtures is nearing completion. That combined with previously completed work may give a unifying overall look at vibration-vibration energy transfer processes involving in hydrogen halides. The study of relaxation of HCl by Cl atoms is of particular significance since it is likely that deactivation by reactive atoms is responsible for vibrational relaxation in chemical laser systems. It will be useful to operate lasers under conditions which optimize the ratio of chemical reaction rate to vibrational relaxation rate. This of course will be possible when the rates are known and the fundamental mechanisms of vibrational relaxation understood.

The substance of this final technical report is embodied in the reprints of publications which have been submitted separately as they were received.

Personnel

The following personnel were salaried from the contract for varying periods of time. These and others, e.g., the principal investigator, worked on the contract projects but were not salaried.

Dr. Hao-Lin Chen

Dr. Robert E. Wood (earned Ph.D.)

Dr. John C. Stephenson (earned Ph.D.)

Dr. Lawrence Hall

Mr. Donald F. Heller (earned B.A.)

Mr. Paul F. Zittel

Mr. James M. Scott

Mr. Robert V. Steele, Jr.

Mr. Jack Finzi