

Publications

- "Chemiluminescent Reactions I. Nitrogen Afterglow," J. Chem. Phys. 48, 1302 (February 1968)
- "Chemiluminescent Reactions II. Nitric Oxide Afterglow," J. Chem. Phys. 48 (March 1968) (with N. Cohen)
- "The HF Chemical Laser Produced by Flash Photolysis of  $F_2O-H_2$  Mixtures," J. Chem. Phys. 48, (April 1968) (with N. Cohen & T. Jacobs)
- "Chemically Pumped  $CO_2$  Laser," J. Chem. Phys. 50, 1889 (1969)
- "Stimulated Emission Behind Overdriven Detonation Waves in  $F_2O-H_2$  Mixtures," J. Chem. Phys. 51, 1250 (1969) (with R. R. Giedt and T. A. Jacobs)
- "Mirror Mount for a Shock Tube Laser Cavity," Rev. Sci. Instr. 40, 1238 (1969) (with R. R. Giedt)
- "Continuous Wave Chemical Laser," Intl. J. Chem. Kint. 1, (5), 493 (September 1969) (with D. J. Spencer, T. A. Jacobs, and H. Mirels)
- "Comparison of HF and DF Continuous Chemical Lasers: II. Spectroscopy," Appl. Phys. Lett. 16 (10), 386 (May 1970) (with R. R. Giedt and M. A. Kwok)
- "Preliminary Performance of a C.W. Chemical Laser," Appl. Phys. Lett. 16 (6), 235 (March 1970) (with D. J. Spencer, H. Mirels, and T. A. Jacobs)
- "Isotope Separation with the CW Hydrogen Fluoride Laser," Appl. Phys. Lett. 17 (12) 516 (December 1970) (with S. W. Mayer, M. A. Kwok, and D. J. Spencer)
- "Time-Resolved Spectroscopy of a Flash Initiated  $H_2-F_2$  Laser," Appl. Phys. Lett. 19, 411 (1971) (with S. N. Suchard and J. Whittier)
- "HF Chemiluminescence from a Reacting Supersonic Jet," Bulletin of the Am. Phys. Soc. 1972 Annual Mtg., San Francisco (1972) (with M. A. Kwok and D. J. Spencer)"
- "An Electron Beam Initiated Chemical Laser in  $SF_6-H_2$  Mixtures," Appl. Phys. Lett. (with F. Wesner, Max-Planck-Institut fuer Plasmaphysik, Garching, Germany) 23, 559 (1973)
- "Chemiluminescence from the Supersonic Jet of a cw HF Chemical Laser" J. App. Phys., 45, 3500, (with M.A. Kwok, D.J. Spencer)
- "Laser Isotope Separation" Opt. Engineering 13, 506, 1974.
- "High Power Iodine Laser for Fusion Applications" in Laser Induced Fusion and X-Ray Laser Studies, Physics of Quantum Electronics, Vol. 3, S.F. Jacobs, M.O. Scully, M. Sargent III and C.D. Cantrell III editors, Addison-Wesley Pub. Comp. Reading, Mass 1976.

GROSS, R. W. F.

Publications (con't)

"Handbook of Chemical Lasers" R. W. F. Gross and J. F. Bott, editors, Wiley-Interscience, New York, 1976.

"Measurements of the Anomalous Dispersion of HF in Absorption" IEEE J. Quant. Electron. QE-16, 795, (1980) (with R. A. Chodzko, E. B. Turner and J. G. Coffey)

"Interference Patterns Produced by a Mach-Zehnder Interferometer and a Multiline HF Laser" The Aerospace Corporation Tech. Report SD-TR-80-17 (10 April 1980)



supersonic HF cw laser originated in discussions with him, Summer 1967

Morton Camac (then AVCO-Everett); in a classified presentation at Aerospace, 1969(?), on the gasdynamic laser, introduced the idea of fast, minimum length supersonic freezing nozzles to us. Conception of first multi-slit nozzles.

A.N. Draevsky (FIAN-Lebedev Institute, Moscow): showed me that  $F_2-H_2$  ~~mixtures~~ could be mixed ~~statically~~ and handled in the laboratory, Sept. 1969

D. Spencer, (Aerospace Corp.)

D. Durran, (Aerospace Corp.) without whose capabilities as a designer of gasdynamic equipment none of the work after 1969 could have been done.

#### Q.4.(c + d) Obstacles:

A: The greatest obstacles were in the early beginning the Laboratory management (R. Hartunian wanted a BLUE laser not one in the IR) and later bitter and jealous interdepartmental fights (H. Mirels vs. T.A. Jacobs and myself) over equipment for the cw laser experiments and the right to the original discovery (D. Spencer, who observed the actual first lasing, was in H. Mirels' department who "owned" the arc facility). Later the Airforce, who classified the initial cw experiments under Eighth Card (1968 for about 6 months). Still later the middle Aerospace management (G. King) who refused further funding if the Air Force was to reclassify the project! Finally a great loss was the leaving of T.A. Jacobs over personality conflicts with the new laboratory director (R.W. Warren jr.) in 1973 (?). The greatest help was, however, Maj. R. Oglukian's (AFWL) decision to fund the cw experiments out of the AFWL slush-funds then controlled by Col. Lambertson(?). (1969-70)

Because of the Eighth Card restrictions no one of our group had any access to AVCO's simultaneous work on GDLs (except for M. Camac's presentation mentioned above), which would have helped a good deal in solving some of our gasdynamic problems. We reinvented that wheel!

#### Q.4.(e) Collaborators:

A: Initially (1966-67) it was only myself and T.A. Jacobs (as department head and major driving force) thereafter the project mushroomed very fast:

R. Giedt and myself: shock-tube laser experiments (1969)

D. Spencer: arc-laser experiments (1969)

J. Bott, R. Giedt, and myself: unsuccessful MESA 1 experiments (1970)

G. Emanuel: theoretical modeling of reaction dynamics (1970)

R. Wilkens: trajectory calculations (1971)

H. Mirels: flame-sheet theory (1972)

M. Kwok: spectroscopy (1970)

R. Giedt and R. Gaskill: MESA 2 experiments at RPL in the desert (1971-74)

By 1972 nearly everybody in the laboratory was engaged in laser related work.

#### Q.4.(g) Publications:

A: Always threatened by classification we tried to publish whatever we could, - and fought for it, too.

The publication of the first cw lasing paper had a rather dramatic history: Phys.Rev.Lett. rejected the paper as not suitable for their journal after 5 weeks of deliberations! We believed that there was other work going on the same subject (United Technology Res. Labs, AVCO)- there was none, at these places - and were very upset. Finally Sidney Benson (SRI) offered to publish the letter unreviewed in the first issue of his new Journal of Chemical Kinetics. Benson was a consultant for the laboratory. At that moment T. Cool of Cornell University called to tell me that he had observed cw lasing from a chemically driven HF laser ( $\text{NO} + \text{F}_2 + \text{H}_2$ ). We agreed to publish back to back in Benson's journal.

A patent for the supersonic cw diffusion laser was applied for and granted in 1970. Coauthors were: T.A.Jacobs, H.Mirels, and D.Spencer.

Much of our early work was presented on the first Chemical Laser Conference in St.Louis (May(?) 1969). The entire first session was occupied by Aerospace papers. But some Air Force Major appeared in the wings and prevented the dramatic announcement of cw lasing in the very last minute. From the floor J.McCallum from ARPA was also watching the show and any violations of Eighth Card protocol. Here I met Oraevsky (sic!) who invited me to come to Moscow in September 1969.

In Moscow at the Chemical Laser Symposium I was allowed to only talk about our shocktube laser experiments not about the cw laser, which was by then in print (appeared October 1969). The visit was, however, the beginning of a number of close friendships with Soviet scientists and the first of six visits to the USSR (1969, 1972, 1976, 1977, 1980, 1984). In 1977 I worked 5 weeks at Basov's laboratory, 1980 I taught an 8-weeks course at Tbilisi University.

Thereafter we learned the ropes and except for the MESA 2 work which was going on at RPL in the Desert and which was clearly classified, we rarely had problems with publishing our results.

The last great hassel took place between 1972 and 1974 when I tried to collect all relevant chemical laser work in one volume: "Handbook of Chemical Lasers" (edit. J.F.Bott and myself, Wiley, 1976). Every paper contributed had to be declassified. The Air Force sat on mine for 2 years before an expurgated version was finally released. The book appeared 1976. Despite that by that time it was technically really out of date, it became the bible for every effort in building HF lasers from Los Angeles to Dalian in the PRC. A Russian translation appeared in 1980 in Moscow, translated and edited by Oraevsky.

#### Q.4. (h) Funding?

A: All my work has been funded by the Air Force, DARPA, internal Aerospace funds (ASRs), and very occasionally by ERDA-DoE. There have been no or few changes over the years.

#### Q.5. (i) Commercialization?

A: The "commercialization" of this product (field) has consisted of military government contracts to profit making corporations (in contrast to Aerospace Corp. which is non-profit). I have occasionally been involved in the R&D evaluation, analysis, and direction of these contracts for the Air Force. However, I consider the "Handbook of Chemical Lasers" as my most prominent contribution of the "commercialization" of this field.