Polyacetylenes and doped polyacetylenes were also much discussed as they have attracted a great deal of interest in parallel with GICs. There are a number of similarities between graphite intercalation compounds and polyacetylene systems despite the two-dimensional character of GICs and the one-dimensional character of polyacetylene systems. Examples are the nature of the bonding between carbon atoms, the nature of dopant species and the charge transfer between dopant and host.

The above is just a sample of the many interesting topics that were discussed at the Conference. Full Proceedings will however be published shortly with the reference: "Physics of Intercalation Compounds", Eds. L. Pietronero and E. Tosatti, *Springer Series in Solid State Sciences*, vol. 38 (Springer, Berlin, Heidelberg and N.Y.) 1981.

H. Kamimura, Tokyo

Hollow Cathode Laser Research

M. Jánossy, K. Rózsa and L. Csillag, Budapest

(Central Research Institute for Physics)

Research on hollow cathode lasers carried out at the Central Research Institute of Physics in Budapest was a natural continuation of research performed earlier on positive column He-Ne and He-Cd gas lasers.

From the point of view of obtaining laser oscillation, both the negative glow region near the cathode surface and the positive column are interesting. However, if the cathode surface is concave a strong discharge can occur in the hollow of the curved cathode, which offers a good possibility of developing medium power gas lasers operating in the blue-green and ultraviolet region of the spectrum. While this kind of output is usually achieved using noble gas ion lasers, operating in the positive column part of the discharge, the advantage of a hollow cathode discharge (HCD) is that it contains more high energy electrons than are present in the positive column. The "beam-like" component of high energy electrons is very efficient in exciting high lying ionic and metastable energy levels, sufficiently populated to give the population inversion necessary for laser oscillation.

Research on hollow cathode lasers began around 1970 with an investigation of a He-Cd hollow cathode laser which consisted of a slotted hollow cathode 50 cm long and 4 mm inner diameter mounted over 21 anode pins. Cd was evaporated from two side-arms set between the anodes. Laser oscillation was obtained on visible transitions of the Cd ion (4416 Å blue, 5378 Å green 6360 Å red) but it was noticed that the Cd vapour distribution was not homogeneous along the tube, so that above a certain discharge current, the negative glow discharge contracted into an arc. Evidently the arrangement of many anode pins was not too effective in producing a stable discharge and moreover, the mW output power of the laser was rather low. Research therefore concentrated on two main problems:

1. Construction of a tube with good discharge stability;
2. Producing an appropriate metal vapour discharge.

Investigations on the structure of hollow cathode lasers were pursued in the light of a discovery made during measurements on a laser tube with a copper hollow cathode of small (1.65 mm) inner diameter (Fig. 1). Laser operation was being investigated in a He-Ne mixture at the well-known 6328 Å transition using for excitation 50 Hz half wave rectified a.c. when suddenly a strong laser signal appeared in the high current region as the laser mirrors were being adjusted. This was clearly in the infrared region as only the weak red light of the 6328 Å transition could be seen visually. Determination of the wavelength of the oscillation gave the unexpected value of

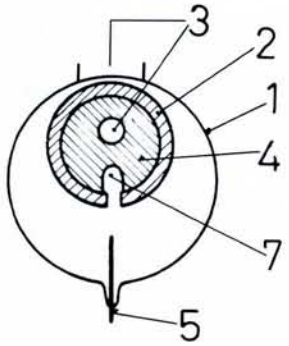


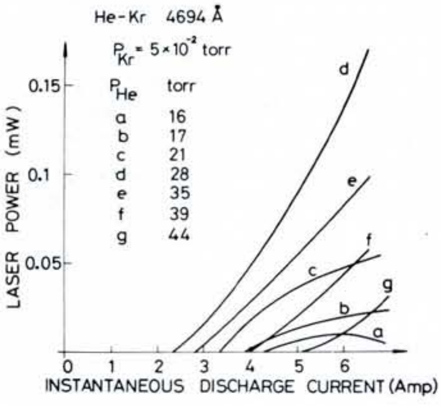
Fig. 1 — Scheme of Cu hollow cathode laser tube. 1 pyrex tube, 2 ceramic, 3 water cooling, 4 Cu hollow cathode, 5 anode, 7 region of hollow cathode discharge.

7808 Å which is the wavelength of a Cu ion transition. In the narrow confines of the Cu hollow cathode, sputtering was producing a sufficient amount of metal vapour for laser oscillation and charge transfer collisions between He ions and Cu atoms to produce population inversion.

This result was not entirely new as the use of cathode sputtering of Al to obtain laser oscillation was suggested already in 1965 by O. Heavens *et al.* and cathode sputtering was applied by E.K. Karabut *et al.* for He-Cd and He-Zn lasers. As these systems could be operated quite easily by heating further research had not been pursued. However, since our publication of the infrared He-Cu laser, continuous laser operation in the 2200 - 2800 Å ultraviolet range has been obtained by G.J. Collins *et al.* using Cu, Au and Ag cathode sputtering.

Contraction of the flow discharge into an arc turned out to be a serious problem. The arc localised at one point of the cathode causing laser oscillation to stop and often resulting in tube damage. On investigation it was found that the arcing threshold current did not depend on tube length over the 10 - 50 cm range involved in our experiments. Consequently the aggregate arcing threshold current for a given tube length could be increased by dividing the discharge into parts, for example, building the hollow cathode tube of segments 3 cm long to make up an overall active length of 54 cm. With this tube the arcing threshold current in a He-Kr mixture was increased from a few amps to over 15 A. Fig. 2 shows the results of measurements of laser output power at the 4694 Å transition of Kr II as a function of discharge current at different He pressures. It can be seen that the current threshold for laser operation increases at high He pressures, but then the output power increases very steeply with increasing discharge current.

Fig. 2 — Dependence of He-Kr laser power on discharge current.



Division of the discharge was applied also for construction of a He-Cd laser and in Fig. 3 the output power of this laser is plotted as a function of He pressure for the blue, green and red lines. The red lines are believed to be excited by charge transfer collisions between He ions and ground state Cd atoms, while the green lines are believed to be populated through the red cascade transitions. It can be seen that the dependence on the pressure is quite different for the two lines, indicating that in the high He pressure region the excitation

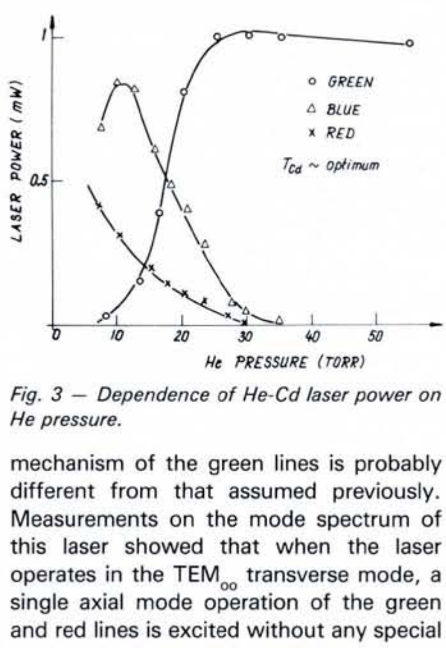


Fig. 3 — Dependence of He-Cd laser power on He pressure.

mechanism of the green lines is probably different from that assumed previously. Measurements on the mode spectrum of this laser showed that when the laser operates in the TEM_{00} transverse mode, a single axial mode operation of the green and red lines is excited without any special mode selection techniques being applied. The probable explanation of the single mode operation is the large homogeneous line width due to the high He pressure used.

To investigate the influence of voltage, independently of tube diameter, gas pressure and discharge current a number of anode rods were placed inside the cathode (Fig. 4) and named the hollow anode-cathode (HAC). Voltage — current characteristics of this and of an HCD are plotted in Fig. 5, from which it can be seen that voltages up to 2 kV can be reached in HAC tubes. For simplicity, the He-Kr noble gas mixture was chosen as active medium, although previous measurements of spectral line intensities indicated that the increased voltage of the HAC system should have greater effect on charge transfer collision excited lasers.

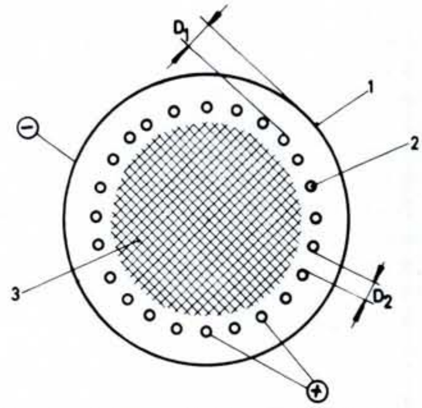
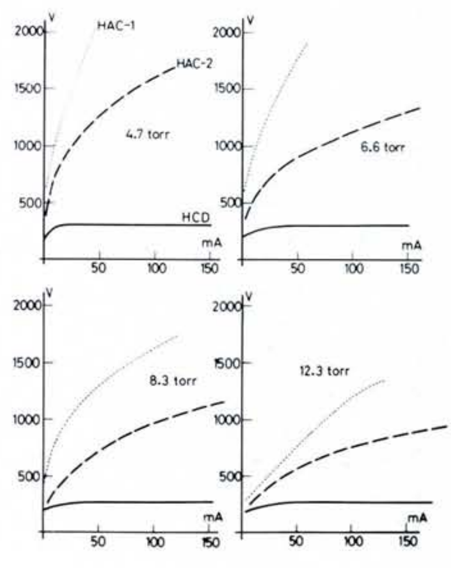


Fig. 4 — Scheme of hollow anode-cathode discharge. 1 cathode, 2 anodes, 3 bright part of the discharge.

In Fig. 6, output power is shown as a function of discharge current for HAC and HCD lasers. Exciting a 40 cm long HAC laser tube in a quasi-continuous manner by 100 μs half-width 20 A current pulses, 450 mW output power was measured on the 4694 Å Kr ion line, with a tube voltage of 1000 V. Using the HAC system for exciting noble gas mixture discharges, a number of new laser transitions were found. Continuous laser oscillation was observed for the first time at the 5314 Å and 4863 Å transition of Xe II in a He-Ne-Xe mixture.

Addition of He to the Ne-Xe mixtures used previously in positive column discharges, greatly enhanced the HAC laser output power. Several new continuous Kr ion and Ar ion laser lines were observed in He-Kr and He-Ar HAC discharges, the wavelengths falling between 4318 Å (Kr II) and 6861 Å (Ar II). All the new noble gas mixture laser lines have since been observed by R. Solanki *et al.* to oscillate in high current hollow cathode discharges. The lines are believed to be excited by second-kind collisions of He 2^3S metastable atoms with ground state ions. The ground state ions are excited mainly by electron impact.

Fig. 5 — Voltage — current characteristics in hollow anode-cathode discharge tubes.



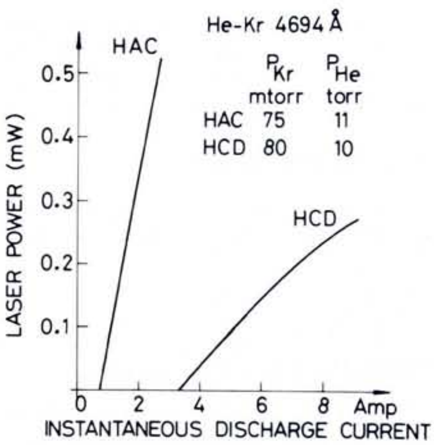


Fig. 6 — Dependence of laser power on discharge current in hollow cathode /HCD/ and hollow anode-cathode /HAC/ discharges.

The origin of laser oscillation in HAC discharges with a charge-transfer exited system remained unexplained and experiments have been carried out to determine whether in the relatively large internal diameter (7 mm) HAC discharge tube of a Ne-Al laser, a metal vapour density high enough for laser oscillation could build up inside the internal anode structure. Investigations have also been made of other cathode sputtering operated HAC metal vapour lasers, notably the He-Cu and He-Zn systems. In a He-Cu laser, 30 mW infrared laser power output was obtained whereas with a He-Zn HAC laser, a much higher output power is produced by heating than by sputtering.

To summarize, much progress has been made in clarifying hollow cathode tube construction principles and in finding new hollow cathode laser systems, but there are still basic problems waiting to be solved.

Physics Periodicals in Europe

In collaboration with the Publications Committee of the European Physical Society, a meeting was organized by UNESCO in Paris on 25 January 1982 which brought together a broad representation of editors and publishers of physics journals in Europe, with experts from organizations concerned with the publication of learned journals on a wider level. The object of the meeting was to encourage an exchange of views on some of the pertinent questions facing the various sectors of the publication system. Although special attention was given to physics, as was emphasized in the opening address prepared by A. Kaddoura (UNESCO Assistant Director-General for Science), most of the problems current in physics are common to all the disciplines. The subjects covered, were refereeing, the impact of modern technology, marketing and the role of international organizations in the publishing complex.

Within the Publications Committee, discussions had been held on the conflicts inherent in the refereeing system and the abuses that were alleged to exist. In the light of these a set of guide-lines on refereeing had been drawn up for presentation to the meeting by the Secretary, E.N. Shaw. These were aimed essentially at providing a better understanding between authors and publishers (including editors and referees) rather than laying down specific procedures. The key question was whether guide-lines of any sort would serve a useful purpose. It is easy to exaggerate the frequency of refereeing errors and the misuse of information while it is still confidential. In physics especially, the standard of publishing practices is generally high and for the most part a considerable effort is made by editors and referees to upgrade the level of submitted papers so that they can be published.

Whereas there was general approval of most of the "rules" proposed, opinions were divided on their utility and whether they would help in the most difficult cases, notably when the editor (referee) considered the submission to be "irrelevant". The discussion will be continued.

A special plea was made by F. Garcia-Moliner from Spain on behalf of the physicists in countries which were not publishers of core journals. One of their major problems was isolation and this was evident in the little representation of physicists from such countries on the Editorial Boards and refereeing lists of journals.

Whilst many publishers are anxious to have a wide geographical spread on their boards there are practical problems of communication. Even if contact can be maintained by mail, transmission is often slow, there is no guarantee in some countries that a document will be received, or that a document returned will not be subject to serious delay. The publisher was under great pressure to publish with maximum speed and this tended to be given priority. Even UNESCO was powerless to intervene in the internal communication practices of any country but this was clearly an area where the EPS and its Divisions could collaborate with publishers and the subject

Individual Members of the European Physical Society approved by Council at the end of 1981

Category 4A
M.A. Ahmed, Budapest, H
L. Struik, Delft, NL

Category 4C

Eötvös Lorand Physical Society
J. Bakos, Budapest
J. Gyulai, Budapest
L. Kertesz, Budapest
J. Kojnok, Budapest
D. Marton, Budapest

French Physical Society
R. Pick, Paris
J. Pirenne, Liège, B
J. Jacquinot, Chatenay-Malabry
J.-L. Leroy, Bagnères-de-Bigorre
F. Touchard, Orsay

German Physical Society
F.H. Effertz, Köln
R.J. Jelitto, Frankfurt/Main
G. Landwehr, Grenoble, F
W. Ohlendorf, Garching
W. Ruland, Marburg
H. Schmidt, Stuttgart

Finnish Physical Society
S.O. Bäckman, Pargas
P. Eskola, Helsinki
R.G. Gylling, Helsinki
B. Hedkrok, Rauma
R. Hämäläinen, Onttola
H. Ihalainen, Tampere
H. Ilomäki, Lohja
J. Joensuu, Helsinki
J. Kantele, Jyväskylä
M. Kara, Helsinki
A.E. Levanto, Oulu
P. Lounesto, Helsinki
J. Maalampi, Helsinki
H. Moilanen, Suolahti
M. Rosenblad, Helsinki
K. Salonen, Turku
R. Simonsson, Espoo
S.E. Stenij, Helsinki
H. Stenlünd, Espoo
J. Teinonen, Helsinki
R. Terho, Raisio
P. Tuomi, Espoo
T. Valkonen, Turku
I. Vallinoja, Helsinki
T. Vehanen, Espoo
J. Virtamo, Espoo

Hellenic Physical Society
E. Anastassakis, Athens

The Institute of Physics
M. Ebison, London
D.J. Munday, Geneva, CH

Italian Physical Society
M. Mazzoni, Florence
L.C. Pucci, Bologna

The Netherlands' Physical Society
E.P.J. van den Heuvel, Amsterdam
C. van Dijk, Bergen-NH

Norwegian Physical Society
J.M. Hansteen, Bergen
T. Jøssang, Oslo

Physical Section, Union of Yugoslav Societies of Mathematicians, Physicists and Astronomers
M. Dimitrijevic, Belgrade

Portuguese Physical Society
A. Elias, Lisbon

Spanish Royal Society of Physics
A.L. Garrido Simon, Madrid

Swiss Physical Society
W. Däppen, Sauverny
G. Pfister, Männedorf

Turkish Physical Society
H. Akçay, Ankara
Y.C. Akgoz, Ankara
E. Aksahin, Ankara
T. Armagan, Bornova-Izmir
Y. Bektore, Izmir
N. Büget, Ankara
D. Evin, Ankara
T. Firat, Ankara
Y. Güler, Ankara
C. Gumus, Trabzon
H. H. Güven, Istanbul
T. Incesu, Ankara
M.S. Kilickaya, Eskisehir
A. Kolat, Ankara
G. Öke, Ankara
N. Özalp, Trabzon
A.M. Özer, Ankara
M.E. Özsan, Ankara
R.G. Oraltay, Ankara
G. Tepehan, Istanbul
N. Türetken, Ankara
Y. Tulunay, Ankara
B. Yaramis, Istanbul