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RESEARCH GROUP

Report

AN ANNOTATED BIBLIOGRAPHY OF ARTICLES ON PLASMA PHYSICS AND CONTROLLED THERMONUCLEAR RESEARCH BY U.K.A.E.A. STAFF, 1958 to 1962

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AN ANNOTATED BIBLIOGRAPHY OF ARTICLES ON PLASMA PHYSICS AND CONTROLLED THERMONUCLEAR RESEARCH BY U.K.A.E.A. STAFF, 1958 to 1962

Compiled by

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Berks.

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Introduction

The bibliography contains references to journal articles and conference papers published or presented between January 1958 and December 1962.

The entries are arranged in chronological order by month of publication and, within each month, alphabetically by author. An author index will be found at the end of the bibliography.

1958

1. Thonemann, P.C., and others.
Production of high temperatures and nuclear reactions in a gas discharge.
Nature, vol.181, no.4604, January 25th, 1958. pp.217-220.

"First public announcement of Zeta experiments. Preliminary results reported in the article show that relatively long-time stability can be achieved in a toroidal metal-walled tube. Neutron yield and kinetic ion temperatures were measured over a limited range of conditions. The neutron flux obtained was insufficient to attain the accuracy of measurement required to identify a thermonuclear process."

2. Hubbard, J.
The description of collective motions in terms of many-body perturbations. Part 2. The correlation energy of a free electron gas.
Proc. Roy. Soc. A, vol.243, no.1234, January 14th, 1958. pp.336-352.
(AERE T/P 29).

"The theory developed in a previous paper is applied to calculate the correlation energy of a free-electron gas. The theory involves no cut-off and gives a uniform description of collective motion effects in the long-range limit and of particle motion effects in the short-range limit. It is shown that in the lowest order the theory agrees with Bohm and Pines's plasma oscillation theory in the long-range limit, but is inadequate in the short-range limit. The theory is approximately evaluated to the next order and is applied to calculate the correlation energy at several gas densities."

3. Hubbard, J.
The description of collective motions in terms of many-body perturbation theory. Part 3. The extension of the theory to the non-uniform gas.
Proc. Roy. Soc. A, vol.244, no.1237, March 11th, 1958. pp.199-211.
(AERE T/P 30).

"The theory previously developed is extended to calculate the energy of an electron gas in a potential field. Two new features arise: (i) the introduction of a self-consistent field which is a generalization of the ordinary Hartree field; (ii) the occurrence of 'local field correction' effects. The theory is applied to crystals and an approximate expression for the correlation energy of a metal is derived neglecting Lorentz-Lorenz corrections effects."

4. Butt, E.P.
Zeta (the control room monitoring and recording instruments).
Electronic Engineering, vol.20, no.361, March, 1958. pp.110-114.

"Description of measurements carried out in Zeta experiments and the way in which they are taken and recorded."

5. Dolder, K. and Hide, R.
An experiment on the interaction between a plane shock and a magnetic field.
Nature, vol.181, no.4616, April 19th, 1958. pp.1116-1118.

"Preliminary report of an experimental investigation of the hydromagnetic interaction between rapidly moving, hot, ionised gas and an intense magnetic field."

6. Adlam, J.H. and Allen, J.E.
The structure of strong collision-free hydromagnetic waves.
Phil. Mag., vol.3, no.29, May, 1958. pp.448-455.

"A theoretical study has been made of the structure of strong 'hydromagnetic' waves which are propagated, across a magnetic field, in a low density plasma where collisions can be neglected. Under these conditions the ions are accelerated in the direction of propagation and then brought to rest again. The thickness of the wave is determined by the characteristic distance $\sqrt{(mc^2/4\pi ne^2)}$ and the wave velocity lies between the Alfven speed and twice the Alfven speed."

7. Rose, B., Taylor, A.E. and Wood, E.
Measurement of the neutron spectrum from Zeta.
Nature, vol.181, no.4624, June 14th, 1958. pp.1630-1632.

"The energy spectrum of neutrons emitted from Zeta has been studied using a high-pressure diffusion cloud chamber to obtain information on the mean velocity in the laboratory reference system of the centre of mass of the interacting D-D system. It is concluded that the neutron spectra observed may be interpreted in terms of an acceleration process, for which a mechanism is proposed, and suggested that the majority of the neutrons from Zeta are not produced by a thermonuclear process."

8. Allen, J.E.
Thermonuclear power and the pinch effect.
Endeavour, vol.17, no.67, July, 1958. pp.117-126.

"A review of the fusion process and possible methods of attaining it under controlled conditions. Contains coloured photograph of Zeta and brief description of Zeta experiments."

9. Bickerton, R.J. and London, H.
The scaling laws for the stabilised pinch.
Proc. Phys. Soc., vol.72, pt.1, no.463, July 1st, 1958. pp.116-120.
(Published version of paper included in TID-7558).

"The scaling laws for the stabilised pinch are derived. The recent results obtained with such discharges are considered in the light of these relations."

10. Harrison, E.R. and Dawton, R.H.
Apparatus for producing plasma beams.
Jnl. Electronics and Control, vol.5, no.1, July, 1958. pp.29-32.

"Apparatus for producing a constricted discharge is described; this is followed by a brief account of one or two elementary experiments with discharges of this kind. The apparatus has a number of useful applications, e.g. it can readily be adapted to serve as an ion source."

11. Robson, A.E.
Alternative roads to thermonuclear power.
New Scientist, August 21st, 1958. pp.657-659.

"A semi-popular account of the various geometries being investigated in Britain and America."

12. Adlam, J.H. and Allen, J.E.
Hydromagnetic disturbances of large amplitude in a plasma.
Second Int. Conf. on the Peaceful Uses of Atomic Energy, Geneva, September, 1958. Proceedings, vol.31. pp.221-224. (Paper P/1).

"Calculations have been made pertaining to the rapid compression of a plasma containing a magnetic field, under conditions where collisions can be neglected."

13. Butt, E.P., and others.
The design and performance of Zeta.
Second Int. Conf. on the Peaceful Uses of Atomic Energy, Geneva, September, 1958. Proceedings, vol.32. pp.42-64. (Paper P/1519).

"Description of design and operational characteristics of Zeta which reports the principal mechanical and electrical parameters, the performance as an electrical circuit, and present knowledge of the physical characteristics of the plasma."

14. Craston, J.L. and others.
Materials in thermonuclear research.
Second Int. Conf. on the Peaceful Uses of Atomic Energy, Geneva, September, 1958. Proceedings, vol.32. pp.414-426. (Paper P/34).

"Examines the processes occurring at the walls of the discharge tube and discusses their importance in the choice of materials both for present equipment and future designs. The emphasis is primarily on plasma contamination as a result of erosion of the wall, but other effects are considered, such as thermal stress fatigue and radiation damage of the wall."

15. Curran, S.C. and others.
Studies of high-current gas discharges at high rates of build up.
Second Int. Conf. on the Peaceful Uses of Atomic Energy, Geneva, September, 1958. Proceedings, vol.31. pp.365-373. (Paper P/1460).

"A description of the work carried out at A.W.R.E. on the shock-heated pinch. Results refer mainly to experiments with the 6000 joule bank, but include some preliminary results with the 45 kilojoule bank."

16. Harding, G.N. and others.
Diagnostic techniques used in controlled thermonuclear research at Harwell.
Second Int. Conf. on the Peaceful Uses of Atomic Energy, Geneva, September, 1958. Proceedings, vol.32. pp.365-378. (Paper P/1520).

"General survey of the lines along which diagnostic methods are developing at Harwell. Indicates results obtained so far. The techniques may be divided broadly into three groups; spectroscopy, electrical measurements and study of high energy radiations."

17. Thonemann, P.C.
Controlled thermonuclear research in the U.K.
Second Int. Conf. on the Peaceful Uses of Atomic Energy, Geneva, September, 1958. Proceedings, vol.31. pp.34-40. (Paper P/78).

"Brief survey of British work up to the time of the Conference."

18. Thompson, W.B. and others.
Theoretical problems suggested by Zeta.
Second Int. Conf. on the Peaceful Uses of Atomic Energy, Geneva, September, 1958. Proceedings, vol.32. pp.65-71. (Paper P/2).

"Discussion of stability problems in Zeta. The first section explores the consequences of the hypothesis that a stabilized pinched discharge has been produced in ZETA; the second section considers what happens if the stability condition is violated; the third section discusses the transport coefficients and develops a method of analysis in which the role of the fluctuating field is exhibited."

19. Tayler, R.J.
The stability of a constructed gas discharge.
Second Int. Conf. on the Peaceful Uses of Atomic Energy, Geneva, September, 1958. Proceedings, vol.31. pp.160-170. (Paper P/33).

"A general survey of stability problems in the wriggling discharge and stabilised pinch."

20. Bickerton, R.J.
The amplification of a magnetic field by a high current discharge.
Proc. Phys. Soc., vol.72, 1st October, 1958. pp.618-624.

"A discharge in a longitudinal magnetic field in which the plasma pressure is balanced by electrodynamic forces is considered. It is shown that the resulting current flow is helical about the axis of the discharge. The direction of the helix is such that the initial longitudinal field is amplified inside the discharge channel. Some experimental evidence supporting the theory is presented."

21. Pease, R.S.
Controlled nuclear fusion reactions.
Nature, vol.182, no.4642, October 18th, 1958. pp.1051-1053.

"A review of the information on controlled thermonuclear reactions presented at the 2nd Geneva Conference, 1958."

22. Harrison, E.R.
Spherical plasmoids in low pressure electrodeless discharges.
J. Electronics and Control, vol.5, no.4, October, 1958. pp.319-328.

"Experiments with spherical plasmoids in argon at a pressure of 10^{-4} mm Hg show that the electron temperatures are in the region of 10^5 to 1.5×10^5 °C and the electron number density is of the order of 10^8 cm^{-3}. The plasma equation of Tonks and Langmuir, for spherical symmetry and for ion generation proportional to the electron density, is solved and an approximate theory is advanced to explain some of the effects observed."

23. Robson, A.E.
Controlled thermonuclear fusion - many machines but answer still elusive.
Nucl. Power, vol.3, no.30, October, 1958. pp.486-489.

"A brief review of the fusion devices described during the Geneva Conference, September, 1958."

24. Harrison, E.R.
The runaway effect in a fully ionized plasma.
Phil. Mag., vol.3, no.35, November, 1958. pp.1318-1325.

"The conditions for producing runaway electrons in a fully ionized gas are considered, using Chandrasekhar's coefficient of dynamic friction. The runaway currents emitted continuously from linear plasmas are then estimated and are shown to be in agreement within an order of magnitude with the results from some preliminary experimental work. From some recently published results with toroidal plasmas it is shown that the runaway current, provided it is contained and not drastically affected by the magnetic fields, can rapidly become comparable in value with the conduction current."

25. Bickerton, R.J.
Controlled thermonuclear reactions. (Report on the 1958 Geneva Conference).
Engineering, vol.186, no.4842, December 26th, 1958. pp.824-828.

"Review of Geneva papers on fusion devices other than pinch devices. A table showing the principal parameters of all the devices described at Geneva is included."

1959

26. Bickerton, R.J. and Jukes, J.D.
The direct conversion of thermonuclear energy to electrical power in the stabilized pinch.
J. Nucl. Energy, vol.8, no.4, January, 1959. pp.206-214.

"A method is suggested whereby the energy liberated by the thermonuclear reactions in a stabilized, pinched discharge may be converted directly into electrical power. Physical criteria are derived which must be satisfied by the discharge. A comparison is made between the direct conversion method and one in which an external heat cycle is used."

27. Gibson, A.
Possibility of ion runaway in Zeta. (Letter).
Nature, vol.183, no.4654, January 10th, 1959. pp.101-102.

"It is shown that, under the conditions which apply in Zeta, runaway ions cannot occur, except, perhaps, in restricted regions of the discharge where conditions are abnormal. There is as yet insufficient evidence to show whether or not such regions exist."

28. Robson, A.E. and Thonemann, P.C.
An arc maintained on an isolated metal plate exposed to a plasma.
Proc. Phys. Soc., vol.73, pt.3, no.471, March, 1959. pp.508-512.

"It is shown theoretically that a cathode spot may be maintained on an isolated metal surface immersed in the plasma of a gas discharge. Two experiments are described in which arcs of this kind were produced on a mercury surface."

29. Fry, D.W.
Thermonuclear processes.
J. Brit. Nucl. Energy Conf., vol.4, no.2, April, 1959. pp.145-156.

"A review of current thermonuclear studies including a description of the fusion devices discussed at the second Geneva conference."

30. Bickerton, R.J.
A brief review of the toroidal stabilised pinch.
Proc. I.E.E., vol.106, pt.A, Suppl. no.2, April, 1959. pp.148-151.

"The state of research into the toroidal pinch approach to fusion is reviewed and a qualitative summary is given of the theory of the stability and heating of such discharges. The experimental results to date are discussed in the light of similarity laws and some of the remaining problems and questions are listed."

31. Butt, E.P. and others.
The design and performance of Zeta.
Proc. I.E.E., vol.106, pt.A, Suppl. no.2, April, 1959. pp.12-29.

"Describes the main design parameters of Zeta, the principal observations made with it during the period up to April 1958, and the deductions on the physical phenomena occurring in the hot gas."

32. Carruthers, R.
Transformer design for toroidal discharge systems.
Proc. I.E.E., vol.106, Pt.A, Suppl. no.2, April, 1959. pp.138-141.

"The design of ion-cored and air-cored transformers is discussed, and it is shown that the transformer problem is not one which can be considered apart from the associated equipment. Such factors as the effect of the transformer design on energy storage requirements and torus dimensions must be taken into account."

33. Carruthers, R.
Energy storage for thermonuclear research.
Proc. I.E.E., vol.106, Pt.A, Suppl. no.2, April, 1959. pp.166-172.

"Energy may be stored as electric charge, magnetic flux, mechanical energy or chemical energy and these various methods are considered. It is shown that storage as electric charge in a capacitor is most suitable where a rapid discharge is required. Magnetic storage as current in an inductance has its greatest usefulness where energy is required for periods of milliseconds, whilst machines and batteries are more appropriate to the longer pulses."

34. Fitch, R.A.
Rapid heating for controlled fusion research.
Proc. I.E.E., vol.106, Pt.A, Suppl. no.2, April, 1959. pp.177-182.

"The reasons for seeking a means of rapidly heating a plasma to thermonuclear temperatures are discussed, and it is suggested that shock compression by a rapidly increased magnetic field is a possible method. The problems of producing and maintaining such fields are considered and it is concluded that capacitor discharge banks with the minimum inductance are required for both phases. Finally the design of low-inductance condenser banks is discussed and it is suggested that the maximum rate of current rise attainable with available materials is about 10^{14} amp/sec."

35. Fitch, R.A. and McCormick, N.R.
Low-inductance switching using parallel spark-gaps.
Proc. I.E.E., vol.106, Pt.A, Suppl. no.2, April, 1959. pp.117-130.
(Published version of A.W.R.E. - NR/P-4/59)

"It is suggested that the requirement of a capacitor discharge bank for a fast low-impedance switch can be met by using many spark-gaps in parallel. Three types of triggered spark-gap are described and their operation in a parallel system is analysed. Some results of experiments on these gaps are given. Finally a report is given of the construction and performance of the 45 Kilojoule 200-spark-gap bank currently in use at A.W.R.E."

36. Jukes, J.D.
Possibilities of direct energy conversion from fusion reactors.
Proc. I.E.E., Pt.A, vol.106, Suppl. no.2, April, 1959. pp.173-176.

"A method is suggested for extracting electrical energy directly from fusion reactors, and it is shown that about one-third of the available energy may be so extracted. In a power reactor, modulated currents of at least 8 MA are required with optimum fuel, purity and other conditions."

37. Mitchell, J.T.D. and others.
The modification of Zeta in 1958.
Proc. I.E.E., vol.106, Pt.A, Suppl. no.2, April, 1959. pp.74-81.

"Modifications have been carried out on Zeta to improve performance of the equipment in scientific and engineering aspects. These comprise installation of a stainless steel bellows liner in the torus, ignitron switching and simplification of the pulse circuit, and improved vacuum pumping, stabilizing field and diagnostic facilities."

38. Niblett, G.B.F.
Rapid compression of a plasma with azimuthal currents.
Proc. I.E.E., vol.106, Pt.A, Suppl. no.2, April, 1959. pp.152-157.

"Discusses a rapid pinch process in which azimuthal currents and their associated axial magnetic fields are used to heat and confine a plasma. Previous work is reviewed and an account is given of preliminary experiments at A.W.R.E. The principal features of a toroidal system using azimuthal currents and axial fields to heat and subsequently confine a plasma are presented and the advantages and consequences of this configuration are examined, particularly as compared with a torus using axial currents."

39. Robson, A.E. and Hancox, R.
Choice of materials and problems of design of heavy current toroidal discharge tubes.
Proc. I.E.E., vol.106, Pt.A, Suppl. no.2, April, 1959. pp.47-55.

"Three processes of erosion from the walls of the discharge tube are examined in detail. These are thermal evaporation, sputtering and the formation of arcs. Metals are superior to insulators in thermal properties and ease of fabrication but tend to form 'unipolar' arcs when exposed to plasma. The mechanism of these arcs is discussed and some experiments on the arcing properties of different materials are described."

40. Smart, D.L.
Some switching problems in thermonuclear research.
Proc. I.E.E., vol.106, Pt.A, Suppl. no.2, April, 1959. pp.107-116.

"The most typical switching problem in thermonuclear research is that of transferring a large amount of energy quickly from an energy store to an inductive load and then maintain the load current at or near its peak value for a comparatively long period. The requirements of the simple LC circuit with 'clamping' switch can be met by various combinations of spark gap, vacuum arc and mechanical making switches: some of these arrangements and their limitations are discussed."

41. Tosswill, C.H. and Hope, E.L.V.
The calculation of discharge currents in a torus with a continuous conducting liner.
Proc. I.E.E., vol.106, Pt.A, Suppl. no.2, April, 1959. pp.101-106.

"A continuous metallic liner has been introduced into the Zeta torus. The parasitic current flowing in this liner will limit the permissible rate of current increase in the discharge. An analysis is made which shows how far Zeta now approaches this limit, and makes it possible to weigh an increase in liner resistance against an increase in the capacitor bank in terms of cost, engineering difficulty, etc."

42. Allen, T.K. and others.
Experimental generation of plasma Alfven waves.
Phys. Rev. Letters, vol.2, no.9, May 1st, 1959. pp.383-384.

"Describes an experiment in which an attempt is made to generate a hydromagnetic wave at one end of a cylindrical plasma and detect the transmitted wave at the other end."

43. Jephcott, D.F.
Alfven waves in a gas discharge.
Nature, vol.183, no.4676, June 13th, 1959, pp.1652-1654.

"Describes a method of exciting oscillations in a toroidal gas discharge and it is shown that these were due to the passage of Alfven waves."

44. Robson, A.E.
Status report on thermonuclear research.
Nuclear Power, vol.4, no.38, June, 1959. pp.98-101.

"Report on the papers presented at the I.E.E. Convention on Thermonuclear Processes, April, 1959. (See Proc. I.E.E., vol.106, Pt.A, Suppl.no.2, 1959)."

45. Wright, J.K. and others.
Some experiments with an electrodeless discharge. (Letter)
Nature, vol.183, no.4676, June 13th, 1959. pp.1665-1666.

"Describes an investigation of electromagnetically driven shock waves generated by an electrodeless discharge in deuterium."

46. Thonemann, P.C.
High temperature plasmas.
Proc. Conf. on Plasma Physics and related Astrophysical Questions, Varenna, June - July, 1958.
Nuovo Cimento, series 10, Suppl. to vol.13, 1959. pp.111-131.

"Describes the experimental methods used in studying plasmas at high temperatures. The methods illustrated by describing some of the results obtained with Zeta."

47. Bickerton, R.J.
Thermonuclear processes.
Nature, vol.184, no.4682, July 25th, 1959. pp.240-241.

"Review of the papers presented at the I.E.E. Convention on Thermonuclear Processes, April, 1959. (See papers from Proc. I.E.E., vol.106, Pt.A, Suppl. no.2, 1959.)"

48. Harrison, E.R.
Emission of relatively high-energy ions from low-voltage arcs.
Nature, vol.184, no.4682, July 25th, 1959. pp.245-246.

"Describes experiments on low-voltage arcs in which the principal effect observed was the emission of luminous rays consisting of ions of the cathode material at energies much greater than the total potential difference across the arc. A completely satisfactory explanation has not been found for all the effects described."

49. Adlam, J.H. and Pyle, I.C.
Collision-free compression of a plasma.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.1077-1080. (Published version of AERE - R 3002.)

50. Aitken, K.L., Burcham, J.M. and Reynolds, P.
Experiments with linear pinch and inverse pinch systems.
Fourth Conf. on Ionization Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.896-900.

"Thin current sheaths have been produced with pinch and inverse pinch discharges in straight quartz tubes of length 70 cm and inside diameter 30 cm. The formation and subsequent stability of the sheaths has been studied by means of magnetic probes. A comparison of the two systems under similar operating conditions has shown the inverse pinch to be the more stable."

51. Ashby, D.E.T.F. and Paul, J.W.M.
A toroidal fast pinch experiment.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.961-966.

"An experiment is described in which an axial skin current is produced in a toroidal plasma containing an axial magnetic field. This current sheath collapses at a high velocity producing a hydromagnetic shock. After reflection from the axis of the tube the shock meets the current sheath and causes adiabatic radial oscillations of the discharge. These are described by a simple hydromagnetic theory and information about the discharge derived."

52. Bodin, H.A.B. and others.
An experimental investigation of the rapid compression of a plasma using azimuthal currents (Thetatron).
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.1061-1064.

"An experimental study of phenomena accompanying the compression of a plasma by a rapidly rising axial magnetic field is described. The field is produced by the discharge of a low inductance condenser bank through a single turn coil and peak currents of 1.8×10^6 amps and fields of 1.1. x 10^5 gauss are recorded."

53. Bodin, H.A.B. and others.
The formation and implosion of a cylindrical current sheath in Thetatron.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.1065-1072.

"During investigations of pinched discharges using azimuthal currents, it has been observed that magnetic field diffuses into and is trapped within the imploding sheath. In this paper it is shown that the field diffuses in during the sheath formation time and values for this time at different pressures in deuterium are deduced. Measurements are also reported of the pinch times in oxygen, deuterium and air as a function of pressure. The scaling of the time with the discharge parameters is found to agree with theoretical predictions."

54. Fitch, R.A. and McCormick, N.R.
The modes of operation of a cascade spark gap for precision switching.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.463-467.

"The modes of operation of a 3-electrode triggered spark gap are discussed, in particular the "swinging cascade mode" in which the first gap breaks down on a fast-rising pulse, and the second on the subsequent voltage overswing across the stray capacitance of the common electrode. A theoretical analysis of this mode is described and compared with experimental performance. Measurements are given of the precision in firing of a pressurised 3-electrode gap.

55. Francis, G.
Thermonuclear work at Harwell - a brief review.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.929-930.

56. Fry, D.W.
A review of work towards nuclear energy from controlled thermonuclear reactions.
Proc. I.E.E., vol.106, Pt.A, August, 1959. pp.290-298.

"A review of information contained in the papers presented at the second Geneva Conference."

57. Gabriel, A.H.
The spectroscopic study of electron energy in a linear pinched discharge.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.829-832.

"Using a 2500 joule low inductance condenser bank, two types of discharge are investigated; one in pure deuterium, the other in deuterium containing 5% of oxygen, which is believed to have only a small effect on the nature of the discharge. These are studied by streak and Kerr cell methods and time-resolved spectroscopy. The variation of the spectra in space and time is investigated and absolute measurements made on line and continuum intensities during the first pinch."

58. Hardcastle, R.A. and Jephcott, D.F.
The velocity and damping of Alfven waves in a gas discharge.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.786-789. (AERE - R 3109).

"Describes the excitation of magnetic field oscillations in a toroidal gas discharge and gives details of measurements of the phase velocity of propagation and the damping of the waves. The results are consistent with the assumption that the oscillations observed were Alfven waves damped by collisions between ions and neutral gas atoms, and by resistivity effects."

59. Harrison, E.R.
Experiments with plasma beams.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.1160-1163.

"Experiments are described in which a continuous discharge is used as a source of charged particles. With increased pressure the discharge acts as a source of small diameter plasma beams of up to several amperes. On increasing the applied electric field the plasma beams are found to contain a large fraction of energetic or runaway electrons. With further increases in source pressure a thermally constricted arc and finally a plasma jet are formed."

60. Harrison, E.R. and Thompson, W.B.
The low pressure plane symmetric discharge.
Proc. Phys. Soc., vol.74, pt. 2, no.476, August, 1959. pp.145-152.

"It is shown that the low pressure plane symmetric plasma equation, using the collision-free model of Tonks and Langmuir, can be solved analytically. The conditions for the formation of a stable plasma-sheath boundary are briefly examined and a general criterion is obtained without considering any specific mechanism of ion transport. With the aid of the criterion developed in the present treatment, conclusions are drawn in the case of the collision-free model regarding conditions applying at the plasma boundary. The experimental results are found to be consistent with these theoretical conditions."

61. Lees, D.J. and Rusbridge, M.G.
Magnetic field configurations in toroidal discharges.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.954-960.

"Magnetic field configurations have been measured in the discharge in Zeta and in a 12" bore torus of generally similar design known as the Mark IV. In the present paper a method is described by which useful information may be obtained from measurements of fields near the magnetic centre of the discharge only, i.e. the point defined by $B_\theta = 0$, with simultaneous measurements of gas current. Results are presented of the application of the method to discharges in Zeta and the Mark IV."

62. Little, P.F.
The imprisonment of resonance radiation.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.202-205.

"Early treatments of the movement of resonance radiation as diffusion in its own gas gave a quadratic dependence of decay time on pressure, where experimentally a linear relation was found. Direct calculations of the transport rate have yielded the correct dependence and one explanation of the failure of the first attempts was that no mean free path existed for photons of a broadened line in thermodynamic equilibrium. This paper shows that a mean free path may be defined and that a correct diffusion treatment gives the linear relation desired. The results are in good quantitative agreement with experiment."

63. McWhirter, R.W.P., Griffin, W.G. and Jones, T.J.L.
The interpretation in terms of atomic collision processes of a measurement of the absolute intensities of some of the Balmer spectral lines as emitted by a deuterium discharge in Zeta.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.833-838.

"The observed absolute intensities of the first six members of the Balmer series as emitted by a deuterium discharge in Zeta are interpreted in terms of a model for excitation and the effect of the imprisonment of resonance radiation."

64. Niblett, G.B.F.
On C.T.R. research at A.W.R.E., Aldermaston.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.1057-1060.

"Brief survey of the experimental research at A.W.R.E. covering
(1) the study of the rapid compression of relatively dense plasmas,
(2) the study of dilute plasma in devices of the mirror machine type, and
(3) the study of the structure and properties of strong shock waves.
This paper deals only with (1) and (2)."

65. Robson, A.E.
The motion of an arc in a magnetic field.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.346-349.

"Motion of an arc in a uniform magnetic field has been investigated when the magnetic field was inclined to the plane of the cathode. In addition to the retrograde motion which occurs at low pressure, the track of the cathode spot has a drift component towards the acute angle between the field and the cathode. This drift is explained on the basis of the theory of retrograde motion proposed by Robson and von Engel."

66. Temperley, H.N.V.
Estimating the lifetime of ions in a mirror machine.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.1015-1016.

"Describes a model of a mirror machine consisting of two or more portions connected stepwise, in each of which the trajectory of an ion can be computed analytically, the object being to reduce the pile-up of errors that occurs if a long trajectory is computed step-by-step. In addition, the model can be handled by wave-mechanics and lifetimes estimated in a manner analogous to that of the Gamow theory of radioactive decay."

67. Thompson, W.B.
Linearized plasma dynamics.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.555-565.

"An introduction to the study of small oscillations and the growth of instabilities in a plasma. Describes some of the physical models and mathematical techniques that have been used to represent the motion of a plasma in situations in which the departures from equilibrium are small."

68. Wright, J.K. and Black, M.C.
A theory of electromagnetically driven shock waves.
J. Fluid Mechs., vol.6, Pt.2, August, 1959. pp.289-301.

"During the last few years, many experimental devices have been built in which strong shock waves are generated in gases by electromagnetic forces on current-carrying gas particles. The general theory of these devices is discussed, taking external circuit inductance into account. It is shown that a shock wave of constant speed is finally attained. This shock wave is travelling at 90% of its final speed when the circuit inductance has increased to 3 times its initial value."

69. Wright, J.K.
An apparatus for the production of intense shock waves.
Fourth Conf. on Ionisation Phenomena in Gases, Uppsala, August, 1959.
Proceedings, pp.1105-1109.

"A simple apparatus is described for the production of two oppositely facing intense shock waves. Temperatures of the order of 10^6 °K are attained in 1 mm of deuterium when the two shocks collide. The use of such an apparatus in the study of shock structure and in measurement of the rate of attainment of equilibrium intensity of spectral lines is discussed."

70. Bickerton, R.J.
Coulomb collision and plasma conductivity.
Int. School of Physics "Enrico Fermi", Course 13, Varenna, September, 1959.
Proceedings, pp.107-118.

"Theoretical review of collision and diffusion processes in a plasma."

71. Bickerton, R.J.
Stability experiments.
Int. School of Physics "Enrico Fermi", Course 13, Varenna, September, 1959.
Proceedings, pp.145-150.

"Describes the experiments carried out at Harwell by Reynolds, Aitken and Burcham, to study the relative importance of hydromagnetic and electrostatic instabilities."

72. Bickerton, R.J.
Experiments with waves in a plasma.
Int. School of Physics "Enrico Fermi", Course 13, Varenna, September, 1959.
Proceedings, pp.119-125.

"Describes two experiments, one by Jephcott at Harwell and one by Wilcox and Baker at Berkeley, in which hydromagnetic waves are excited in a plasma and measurements are made on their propagation and damping. These appear to be the first experiments in which quantitative measurements have been made on hydromagnetic waves in plasmas."

73. Bickerton, R.J.
Pinch effect.
Int. School of Physics "Enrico Fermi", Course 13, Varenna, September, 1959. Proceedings, pp.126-144.

"Description of the pinch effect, its characteristics and instabilities, with some remarks on joule heating and heating by rapid compression."

74. Hamberger, S.M.
Microwave diagnostics in plasma research.
Nucl. Power, vol.4, no.41, September, 1959. pp.106-107.

"A very brief review of the microwave instrumentation in use for studying plasma properties, particularly plasma density and electron temperature."

75. Pease, R.S.
Phenomena at plasma-solid boundaries.
Int. School of Physics "Enrico Fermi", Course 13, Varenna, September, 1959. Proceedings, pp.151-157.

"Brief review of processes which occur when plasma is in contact with a solid surface."

76. Pease, R.S.
Sputtering of solids by penetrating ions.
Int. School of Physics "Enrico Fermi", Course 13, Varenna, September, 1959. Proceedings, pp.158-165.

"Review of current knowledge of sputtering phenomena and its application to thermonuclear research."

77. Laing, E.W., Roberts, S.J. and Whipple, R.T.P.
Equilibrium configurations of a toroidal plasma.
J. Nucl. Energy, Part C, vol.1, nos. 1-2, October, 1959. pp.49-54.
(Published version of AERE - R 2895.)

78. Thompson, W.B.
The physical basis of magnetohydrodynamics.
Advances in Aeronautical Sciences, vol.2, 1959. pp.1098-1110.

"It is shown that the most interesting magnetohydrodynamic phenomena occur in plasmas and that, on a laboratory scale, the mean free path is often long. However, it is shown how strictly two-dimensional linearized magnetohydrodynamics can be obtained from the motion of non-colliding particles. The derivation is not complete, since it is not capable of producing local hydrodynamic equations for non-symmetric flow, or even in the symmetric case for non-adiabatic flow."

79. Phillips, N.J.
Ionization by ion impact in a collapsing current sheet. (Letter)
Proc. Phys. Soc., vol.75, Pt.2, no.482, February 1, 1960. pp.316-317.

"In a previous paper, a theory of the trapping of gas inside a collapsing current sheet in a gas discharge was described in which the mechanism by which neutral gas is trapped was supposed to be ionization by electron impact assuming values of electron temperature of about 50 eV. This note comments on recent Russian results in which much lower electron temperatures are reported and from which it is suggested that charge-exchange processes may be a more dominant mechanism than electron impact ionization. The note draws attention to the effect of charge-exchange processes in modifying the efficiency of trapping."

80. Harrison, E.R.
Runaway and suprathermal particles.
J. Nucl. Energy, Pt.C, vol.1, no.3, March, 1960. pp.105-115.

"The subject of runaway electrons and ions is treated, first in a uniform ionized gas in which the particles have Maxwellian velocity distributions and, secondly, in a current conducting plasma. The conditions for decoupling and accelerating particles from their thermal state are discussed and, in particular, it is shown that in the case of a weak electric field ions are unlikely to achieve speeds very much in excess of the drift speed of the electrons, except in restricted regions where runaway electrons are continually forming and escaping. When the ratio of the thermal and magnetic energy densities, given approximately by β, is small, the runaway electron current grows rapidly at the expense of the conducting current. A number of ways are considered in which the runaway current may grow and become predominant."

81. Wright, J.K.
Shock waves and controlled thermonuclear fusion.
Proc. Phys. Soc., vol.75, Pt.3, no.483, March, 1960. pp.412-420.

"An assessment is given of the various types of thermonuclear device based on shock heating. The classical shock heating process in which the mean free path in the shocked gas is much smaller than the dimensions of the apparatus is analysed and it is shown that shock heating alone is unlikely to yield temperatures in excess of the order of 3×10^6 deg. K with present techniques. The temperature may be increased in principle to a value required for power production by isentropic compression after the shock heating phase. The so-called Z pinch types of apparatus are limited by the growth of instabilities whereas the θ pinch devices are limited by the difficulty of recovering energy without undue ohmic losses."

82. McWhirter, R.W.P.
Ionization times of impurities in hydrogen plasmas.
Proc. Phys. Soc., vol.75, no.484, April 1, 1960. pp.520-525.

"The problem discussed is the calculation of the time it takes for impurity atoms and ions to become ionized in the hydrogen plasma produced in pulsed thermonuclear machines. Classical ionization cross-sections are used to calculate ionization rates and the effect of radiative recombination is included. The time for impurity ions to reach the steady state is compared with the duration of the discharge for a number of operating thermonuclear machines and it is found that the latter times are too short for the steady state to be established. The assumption of the steady state is shown to be acceptable for a power producing D-D reactor."

83. Gallet, R.M., etc. and Harding, G.N.
Microwave whistler mode propagation in a dense laboratory plasma.
Phys. Rev. Letters, vol.4, no.7, April 1, 1960. pp.347-349.

"Propagation in the whistler mode near 3000 Mc/sec. for $\omega_H/\omega \simeq 2$ was observed between cross-polarised short electric dipole antennae over paths up to 24 cm along the Zeta torus axis."

84. Allen, T.K. and others.
Apparent enhanced diffusion in plasma in a magnetic field. (Abstract only.)
Bull. Amer. Phys. Soc., series II, vol.5, no.4, April 25, 1960. pp.314.

"The behaviour of the glow-discharge positive column in a longitudinal magnetic field agrees well with theory up to a critical value. At higher values of magnetic field the longitudinal electric field is appreciably higher than expected and the associated increase in electrical noise has led to the suggestion of enhanced charged particle losses by the mechanism of "drain diffusion". Extension of these experiments shows a relation between the enhanced losses and a marked unstable constriction of the luminous plasma column. Further information on this constricted column, its helical nature and rotation, and associated properties will be reported."

85. Adlam, J.H. and Allen, J.E.
Collision-free hydromagnetic disturbances of large amplitude in a plasma.
Proc. Phys. Soc., vol.75, no.485, May, 1960. pp.640-648.

"Calculations are given of certain collision-free hydromagnetic disturbances produced by the rapid compression of a plasma containing a magnetic field."

86. Medford, R.D. and others.
'Prize' : a pre-ionized 'Theta' pinch. (Letter)
Nature, vol.186, no.4726, May 28, 1960. pp.706-707.

"Brief description of preliminary experiments with an electromagnetic shock-tube using pre-ionization in the Z direction followed by a theta pinch. Main purpose of the experiment is to form a high-temperature plasma in deuterium gas by shock heating without the trapped magnetic field usually associated with theta pinches."

87. Burton, W.M. and Wilson, R.
Life history of impurity ions in Zeta. (Abstract only).
Bull. Amer. Phys. Soc., series II, vol.5, no.5, June 15, 1960. pp.341-342.

"The temporal frequency distribution of the various states of ionization of impurity ions in a hydrogen plasma is considered theoretically. A general approach is attempted in that conservation of the particles in the plasma is not assumed and in addition to atomic processes, "discharge" processes of loss and gain of ions are considered empirically. Observations of the time variation of the intensities of resonance lines of impurity ions in Zeta are made by means of a vacuum ultra-violet monochromator covering the wavelength range 500-2000A. The solution of the relevant problem of radiative transfer shows that the assumption of proportionality between the observed spectral line intensity and the number of emitting ions is valid over the range of conditions investigated. The observations confirm the existance of the discharge processes of loss and gain and show that these are the dominant processes governing the ion populations."

88. Lees, D.J. and others.
Regular oscillations in a toroidal discharge. (Abstract only).
Bull. Amer. Phys. Soc., series II, vol.5, no.5, June 15, 1960. pp.381-382.

"Regular oscillations of electric and magnetic fields have been observed in hydrogen discharges in a 12-in. bore torus of 4 : 1 aspect ratio for currents below about 8 ka and applied fields below 80 gauss, and gas pressures in the range 0.4-2.0 μ. These oscillations are propagated as traveling waves with frequencies in the range 2-15 kc/sec. and wavelength about 45 cm. Similar oscillations are observed in discharges in argon with frequencies lower by a factor of about 4. The electric field oscillations, observed with an electrostatic probe, consist of regularly spaced short pulses of up to 10-v/cm amplitude, correlated with the magnetic field oscillations, with random fluctuations of frequencies up to at least 1 Mc/sec superimposed. During the pulse the radial component of plasma velocity, given by $E \Lambda B / |B|^2$, is directed outwards. It is suggested that the structure of the wave is similar to that studied by Sawyer, Scott, and Stratton, the electric field is developed across the notch in the current channel observed by them, which would then be a region of turbulent outward motion of the plasma. The relevance of these observations to the high-current containment problem will be discussed."

89. Sweetman, D.R.
The dissociation of fast H_2^+ ions by hydrogen.
Proc. Roy. Soc., A, vol.256, no.1286, July 5, 1960. pp.416-426.

"H_2^+ ions of energy 100 to 800 keV have been passed through hydrogen gas and the cross-sections for the following four processes determined:-
(1) $H_2^+ \rightarrow H^+ + H^o$; (2) $H_2^+ \rightarrow H^+ + H^+$; (3) $H_2^+ \rightarrow H^o + H^o$; (4) $H_2^+ \rightarrow H_2^o$
results are compared with earlier cross-section measurements."

90. Bodin, H.A.B. and others.
Neutron emission from linear pinches in deuterium at high rates of current rise.
J. Nucl. Energy, pt.C, vol.1, no.4, July, 1960. pp.206-214.

"Describes the neutron emission observed during an investigation of the characteristics of fast linear Z-pinches using a low inductance condenser bank. Neutron production is compared with results obtained elsewhere and is shown to be different in several respects from that obtained with low power banks, but is similar to that reported in more recent, high-power experiments. It is shown that much of the yield is non-thermonuclear and a number of existing theories for the production of neutrons by acceleration processes in plasma are discussed. A process of neutron production in fast linear pinches is suggested, which qualitatively accounts for many recently reported results; the proposed mechanism becomes the well-known Colgate process in discharges where m = o instabilities lead to narrow necks in the plasma. Reasons are given to account for the absence of appreciable thermonuclear yields which might be expected from theoretical considerations."

91. Harrison, E.R.
Theory of auroral structures.
Nature, vol.187, no.4735, July 30, 1960. pp.383-386.

"The present treatment collects together some of the properties, such as stability, peculiar to beams guided by the geomagnetic field prior to their entry into the denser regions of the atmosphere. It turns out that stable beams are possible provided they are thin in cross section. It seems reasonable that quiescent arcs and rays are equilibrium structures, free at least from any gross forms of instability, whereas many of the transient effects of auroral phenomena are the result of unstable streams."

92. Thornton, E.
Design and performance of a compact surge generator.
Brit. J. Appl. Phys., vol.11, no.7, July, 1960. pp.265-268.

"A compact surge generator for investigation of a fast, linear, pinched discharge using only moderate energy storage is described. The behaviour of the surge generator when short circuited is determined from the current waveform, and inductance and resistance values are deduced. The inductance and resistance of the switch are much less than those for the whole circuit with a linear discharge in deuterium."

93. Roberts, K.V.
End loss in the linear θ-pinch. (Letter)
J. Nucl. Energy. pt.C, vol.1, no.4, July, 1960. pp.243-244.

"Studies the loss of plasma from a configuration in which some of the magnetic field lines that pass through the mirrors are mixed throughout the plasma. The analysis brings out a severe requirement on 'cusped configurations' if they are to be used for serious plasma containment. This is that only a negligible quantity of flux from the main body of the plasma can be allowed to pass through the cusps."

94. Wright, J.K. and Phillips, N.J. (Letter)
The confinement of shock-heated plasmas in mirror magnetic fields.(Letter)
J. Nucl. Energy, pt.C, vol.1, no.4, July, 1960. pp.240-243.

"A theoretical analysis of the shock-heated theta pinch."

95. Butt, E.P. and Gillespie, A.B.
The measurement of voltage, current and magnetic field in pulsed toroidal gas discharge apparatus at Harwell.
Fifth International Instruments and Measurements Conference, Stockholm, September, 1960. Proceedings, vol.2, pp.938-973.

"A review of the methods used for making electrical measurements on Zeta and other smaller machines at Harwell. Some comments on future systems of measurement are included."

96. Bodin, H.A.B. and others.
Rapid compression heating of a plasma in the linear Z-pinch.
Nuclear Fusion, vol.1, no.1, September, 1960. pp.54-61.

"Electrical characteristics of discharges with high and low initial rates of current rise are briefly described and the electrical measurements are used to determine the work done on the plasma by rapid compression. The first part discusses the energy put into the gas and the magnetic field up to the time of the first maximum contraction. It is then shown that in high power discharges the energy input to the gas by compression never significantly exceeds its value at that time. The second part of the paper presents and analyses results which show how the heating is limited by wall effects. The consequences of these effects are discussed."

97. Green, T.S. and Niblett, G.B.F.
Rayleigh-Taylor instabilities of a magnetically accelerated plasma.
Nuclear Fusion, vol.1, no.1, September, 1960. pp.42-46.

"High speed photography has been used to study the compression of a deuterium plasma by an axial magnetic field generated by a single turn coil. In this experiment the plasma implodes at a constant acceleration of 5×10^{12} cm/sec^2. Flutes which develop on the outer surface of the plasma are interpreted as magnetohydrodynamic Rayleigh-Taylor instabilities produced by the inward acceleration of the interface separating magnetic field and plasma. The observed growth rates are in agreement with simple theory."

98. Adlam, J.H. and Holmes, L.S.
Production of millimicrosecond current pulses using a pressurized spark gap.
Jnl. Sci. Instr., vol.37, no.10, October, 1960. pp.385-388.

"A pressurized spark gap has been designed to discharge a number of co-axial cables in parallel, thus producing a current pulse of 10^4A with a rise time of 4.5 m sec. It is intended to use a number of these spark gaps in parallel, and to test the feasibility of doing this, measurements have been made of the statistical variation of the time lag for breakdown after triggering."

99. Dolder, K. and Hide, R.
Experiments on the passage of a shock wave through a magnetic field.
Rev. Mod. Phys., vol.32, no.4, October, 1960. pp.770-779.
(Published version of AERE - Z/R 2722)

"Main objective of the experiments described is to investigate the over-all conditions required for hydromagnetic interaction to occur between the rapidly moving slug of gas behind a strong shock in argon produced in a combustion driven shock tube and the magnetic field of a short coil wound symmetrically around the tube."

100. Green, T.S.
Evidence for the containment of a hot, dense plasma in a theta pinch.
Phys. Rev. Letters, vol.5, no.7, October 1, 1960. pp.297-300.

"Describes the results of measurements which have been made of axial containment of a plasma in a high-power linear theta pinch device and shows that in a narrow range of pressures (c.75 microns) a high degree of containment is achieved, and that the plasma has a high β and a high temperature."

101. Hancox, R.
Importance of insulating inclusions in arc initiation.
Brit. Jnl. Appl. Phys., vol.11, no.10, October, 1960. pp.468-471.

"The initiation of arcs on a metal surface in contact with a plasma has been studied with metal specimens known to contain microscopic alumina inclusions. The specimens were biased negatively with respect to the plasma, and for voltages above 300 V the time lag before arcing occurred was inversely proportional to the positive ion current drawn by the specimen from the plasma, but independent of voltage. At lower voltages the time lag increased rapidly with decreasing voltage. Arcing was also independent of the nature of the ions and the pressure of neutral gas in the plasma. These results are consistent with the initiation of the arcs by dielectric charging and breakdown of the inclusions."

102. Tayler, R.J.
Stability of twisted magnetic fields in a fluid of finite electrical conductivity.
Revs. Mod. Phys., vol.32, October, 1960. pp.907-913.
(Based on AERE - T/R 2787, AERE - T/R 3100 and AERE - T/R 3229.)

103. Thompson, W.B. and Hubbard, J.
Long-range forces and the diffusion coefficients of a plasma.
Rev. Mod. Phys., vol.32, no.4, October, 1960. pp.714-718.

"A discussion of the nature of the effective interaction between particles in an ionised gas when correlation effects are taken into account."

104. Allen, T.K. and others.
Instability of a positive column in a magnetic field.
Phys. Rev. Letters, vol.5, no.9, November 1, 1960. pp.409-411.

"The particle and energy losses from a long positive column of a helium glow discharge have been shown to decrease with increasing longitudinal magnetic field but only for fields less than a critical field B_c. It has also been shown that at B_c the discharges lose their azimuthal symmetry and appear as constricted, rotating, luminous helices. The wavelengths and oscillation frequencies of such helices have now been measured for a number of discharge conditions and the experimental results are compared with the two existing theories and are shown to be in reasonable agreement with one of them."

105. Jones, H.W. and Saunders, P.A.H.
Swept Langmuir probe system for intense gas discharges.
Jnl. Sci. Instr., vol.37, December, 1960. pp.457-459.

"Apparatus described provides a pulse of biasing voltage to a probe system so that electron temperatures up to 2×10^5 °K and ion densities up to 5×10^{14}/cc can be measured. The system consists of a low impedance voltage sweep generator, a transformer-coupled measuring circuit and a logarithmic amplifier. The apparatus can be used to sample a portion or the whole of the electron energy distribution by using double probes of equal or greatly unequal areas. The probe plots are displayed directly on an oscilloscope."

106. Sweetman, D.R.
The lifetime of the He^- ion.
Proc. Phys. Soc., vol.76, pt. 6, no.492, December, 1960. pp.998-1000.

"Reports measurements which set a lower limit of 1.0×10^{-5} sec on the lifetime of the He^- ion and indicate a loss cross section, for interaction with gas molecules of $2.13 \pm 0.2 \times 10^{-16}$ om^2 per molecule at 1.09 MeV energy."

107. Davenport, P.A.
Rectification in a 50 cycle discharge.
J. Nucl. Energy, pt.C, vol.3, no.1, January, 1961. pp.32-33.

"Fifty cycle mains excitation has been used on the Russian thermonuclear apparatus Alpha for pre-ionization and on Zeta for out-gassing the stainless steel liner and in both cases low pressure discharges were obtained. Similar discharges, scaled down by a factor of three in linear dimensions for experimental convenience have been investigated and rectification observed, the gas current showing a marked tendency to flow in only one direction with respect to the axial magnetic field.

It is shown that under conditions of low pressure and small electric fields, toroidal discharges in axial magnetic fields are profoundly affected by small transverse magnetic fields of the order of 1 per cent of the axial field. Great care is therefore necessary in the design of lumped axial field coils and in the layout of their electrical connexions if such effects are to be avoided. This is especially true of coil systems fed from high-voltage capacitor banks, as they tend to employ high ratios of current to axial field."

108. Jukes, J.D.
Plasma cyclotron radiation and fusion reactors.
J. Nucl. Energy, pt.C, vol.3, no.1, January, 1961. pp.1-7.

"The theory of cyclotron radiation from high-temperature plasma confined within a magnetic field is applied to the estimation of the radiation loss from plasma confined in fusion reactors. It is shown how a metallic reflector placed around the plasma should limit the seriousness of this loss. In the case of a mirror machine, comparison is made with the mirror loss and the electrical power dissipated in the coils producing the magnetic field. Ratios of power lost are found as functions of β / η (Plasma to magnetic pressure ratio/absorption coefficient of the reflector) and βBR(B is the field strength, R the mean radius) which are also compared with the nuclear yield. For the stabilized pinch and stellarator, cyclotron loss is compared with nuclear yield.

With β not less than 0.1 it is shown that cyclotron loss can be unimportant in all three types of D-T reactor. For the D-D mirror machine the minimum necessary value of BR would be about 2×10^8 gauss cm, whilst for the pinch or stellarator the minimum necessary current or BR, based only on radiation loss, is 18×10^6 amperes or 3.5×10^6 gauss cm respectively."

109. Hubbard, J.
The friction and diffusion coefficients of the Fokker-Planck equation in a plasma. Pt.1.
Proc. Roy. Soc., series A, vol.260, no.1300, February 7, 1961. pp.114-126.
(Published version of AERE - T/P 78).

"In a recent paper it was shown how the diffusion coefficients of the Fokker-Planck equation could be calculated in the case of a plasma in thermal equilibrium by a method which included automatically correlation effects and avoided the use of a cut-off procedure. In this paper the method is extended to plasmas not in thermal equilibrium and a calculation of the friction coefficient is given."

110. Vaughan-Williams, R.W. and Haas, F.A.
An error in the thermal conductivity for a fully ionized gas.
Phys. Rev. Letters, vol.6, no.4, February 15, 1961. pp.165-166.

"The existance of a discrepancy between the thermal conductivities for a fully ionized gas perpendicular to a magnetic field as calculated by (1) Marshall, and (2) Rosenbluth and Kaufmann is discussed. The source of this discrepancy is shown to be an error in the last collision integral of Marshall (AERE - T/R 2419)."

111. Aitken, K. and others.
Pinch stability experiments (Abstract only).
Bull. Amer. Phys. Soc., series II, vol.6, no.2, March 20, 1961. pp.204.

"Further results are reported on the surface instabilities or "fluttering" observed in discharges in both the pinch and hard-core geometries. In the pinch case these instabilities are predicted by hydromagnetic theory, and detailed comparison between the observations and theoretical predictions shows fair agreement. The hardcore although theoretically stable, shows instabilities similar to those observed in the pinch. It has been established by correlation measurements that the wavelength of the dominant mode is equal to the pitch of the magnetic field spiral. By varying the shape of the initially applied axial field, it has been shown that end effects due to the "freezing" of this field in the copper electrodes are unimportant. An explanation of the results is proposed in terms of the finite conductivity of the plasma."

112. Bodin, H.A.B. and others.
The damping of Rayleigh-Taylor instabilities in a thetatron discharge.
Nuclear Fusion, vol.1, no.2, March, 1961. pp.139-143.

"A high-speed framing camera has been used to photograph deuterium and helium discharges in which flute instabilities are driven by the inertial force of a radial acceleration. The wavelength of the instability increases with decreasing initial pressure, suggesting the damping effect of viscocity; in some cases this damping apparently prevents the growth of flutes entirely. A simple theory of viscous damping is in qualitative agreement with the observations. An instability due to the radial acceleration accompanying a rotation of the plasma appears at about peak field."

113. Ramsden, S.A. and others.
Time-resolved Doppler width studies in a high-current pulsed discharge. (Abstract only).
Bull. Amer. Phys. Soc., series II, vol.6, no.2, March 20, 1961. pp.205-206.

"A well-known and valid objection to the interpretation of Doppler width measurements in high-current pulsed discharges in terms of ion temperature is the possibility of mass motion of the plasma column. This can lead to a displacement of the line as a whole with consequent broadening. A method is described for detecting such a displacement. Results are presented for the spark line HeII 4686 produced in a high-current toroidal discharge in helium."

114. Taylor, J.B.
Diffusion of a plasma across a magnetic field.
Phys. Rev. Letters, vol.6, no.6, March 15, 1961. pp.262-263.

"Classical calculations lead to a diffusion proportional to $1/B^2$ whereas Bohm has suggested that there might be a form of diffusion in which fluctuating electric fields are present leading to a diffusion proportional to $1/B$. A derivation of diffusion has been found which encompasses both classical and Bohm diffusion and indicates that, when suitably expressed, the Bohm formula gives the maximum value which the transverse diffusion can ever attain."

115. Anderson, N.
Equilibrium electron distributions in electric and magnetic fields.
J. Electronics and Control, vol.10, no.4, April, 1961. pp.285-291.

"Equilibrium distributions of electrons are considered in electric and magnetic fields such that the distribution function only depends on the invariants of the motion of the individual particles. The author assumes the motion to be collision-free and determines the electric and magnetic fields as functions of the parameters of the distribution function for which he assumes a particularly simple form. The purpose of the study is to try to obtain information about the reverse procedure, that is, constructing equilibrium distributions for a given field configuration. It seems, from the results obtained in the most simple case discussed, that the method does not offer much promise of being able to decide the equilibrium distribution for a given field configuration, since the number of parameters in the solutions for the field is too large to enable one to see its behaviour when the distribution function is varied."

116. Ashby, D.E.T.F., and others.
Experimental and theoretical observations on a fast linear pinch.
J. Nucl. Energy, pt.C, vol.3, no.2, April, 1961. pp.162-166.

"Summary of preliminary experimental data obtained at low bank voltage on the shock-heated linear Z-pinch, designed to show that in such a discharge it ought to be possible to get detailed quantitative agreement between experiment and a one-dimensional magnetohydrodynamic calculation, provided the right theoretical model is used. The data is compared with calculations on the IBM 7090 using the computer programme developed by Hain and Hain (1959) which solves the magnetohydrodynamic equations for the collapse of a fully ionised cylindrical plasma. The results are encouraging and it would appear to be practicable to use the programme as a powerful tool to interpret experimental information, to interpolate details of plasma behaviour that are not yet brought out explicitly by the diagnostics and to suggest new experiments. The main experimental parameters are given."

117. Gabriel, A.H. and others.
Low-inductance capacitor banks and linear pinched discharges.
J. Sci. Instruments, vol.38, no.4, April, 1961. pp.136-142.

"Details are given of low inductance capacitors, and capacitor banks with energy storages in the range 1 to 10 kJ capable of giving maximum currents of 1.2 MA and rates of rise of 6×10^{12} A/S. The working voltage in the work described is 10 kV, but the techniques have been used at higher voltages, up to 40 kV. An outline of the measurement techniques, used in the study of linear pinched discharges in low-pressure deuterium with these banks, is given."

118. Jukes, J.D.
Electrostatic instabilities in ohmically heated plasmas.
J. Nucl. Energy, pt.C, vol.3, no.2, April, 1961. pp.140-145.

"The dispersion equation for electrostatic oscillations in a current-bearing plasma is solved for marginal stability when the electron and ion temperatures are unequal. The result is applied to a plasma ohmically heated by a current which is constant with time. A criterion for instability is compared with a rather similar one for the formation of a runaway beam of electrons. Comparison is made with some experiments in which plasma has been ohmically heated (ZETA and Stellarator B1) and which has developed some instability."

119. Laing, E.W. and Robson, A.E.
Non-adiabatic magnetic traps.
J. Nucl. Energy, pt.C, vol.3, no.2, April, 1961. pp.146-155.

"A novel method of injection into a mirror machine, reported recently by Sinelnikov et al, is analysed in detail by numerical and perturbation solutions of the equations of motion of a single particle. The principle of the method is to inject particles through one of the mirrors, along the lines of force. The magnetic field in the centre of the machine has a small spatially periodic radial component which, for certain initial conditions, causes a resonant interchange of energy from the longitudinal to the transverse component of the particle's velocity. This results in reflection of the particles by the end mirror, and by suitable adjustment of the mirrors the particles may be contained inside the machine for an appreciable number of transits. The possibility of increasing the accumulation of particles by combining this method of injection with molecular-ion dissociation is also discussed."

120. Rusbridge, M.G. and others.
Regular oscillations in a toroidal discharge.
J. Nucl. Energy, pt.C, vol.3, no.2, April, 1961. pp.98-105.

"Regular oscillations have been detected under a limited range of conditions in a 12-in.bore torus. The electric and magnetic fields associated with these have been investigated and indicate a helical notch of reduced density travelling on the pinched current channel with a uniform velocity. A possible explanation of the phenomenon is given. The oscillation is considered to be growing as a sound wave in a partially-ionized medium. The mode is cited as an example of a pinched discharge with poor confinement."

121. Reynolds, J.A. and Quinn, J.M.P.
The shock model of the dynamic pinch.
J. Nucl. Energy, pt.C, vol.3, no.2, April, 1961. pp.135-139.

"Various models of the dynamic Z-pinch are discussed and photographic evidence from experiments using hydrogen and deuterium discharges in a straight tube is given in support of a shock model which allows for energy spent in ionization and dissociation. Effectively the ionization and dissociation reduce the γ from 5/3 to the region of 1.2. The temperature of the shocked gas is calculated from the measured shock velocity and the curve of temperature against initial gas pressure is given. This temperature varies between 0.5 and 25 eV for pressures of 10,000 μ to 100 μ which corresponds to 10 to 30% of the directed radial energy of the ions. Thus the pinch, during the implosion phase, consists of a rapidly imploding skin of low energy plasma."

122. Anderson, N.
Oscillations of a plasma in a static magnetic field.
Proc. Phys. Soc., vol.77, pt.5, no.497, May 1, 1961. pp.971-979.

"Considers the propagation of waves through an infinite homogeneous plasma permeated by a static magnetic field. The Boltzmann equation is linearized by the usual perturbation method and the distribution function obtained in the form of an integral. From the expression for the distribution function the current density is calculated, which on insertion into Maxwell's equations gives the dielectric tensor relating the components of the displacement to those of the electric field. Explicit expressions are given for the components of the dielectric tensor in the particular case when the mean Larmor radius of the particles is considerably less than the wavelength of the oscillation and the wave velocity considerably greater than the mean thermal velocity of the particles. Under these conditions, the change in the wave velocity due to thermal effects is calculated by means of an eigenvalue method which uses the wave velocity in the absence of thermal effects and the dielectric tensor calculated."

123. Carruthers, R. and Smart, D.L.
Engineering aspects of plasma physics.
(I.E.E. lecture delivered March 22, 1961.)
Atom, no.55, May, 1961. pp.20-28.

"A review of developments in thermonuclear research with emphasis on the engineering problems involved, particularly energy storage, switching and containment vessels."

124. Dungey, J.W.
The action of Vlasov waves on the velocity distribution in a plasma.
J. Fluid Mech., vol.10, pt.3, May, 1961. pp.473-479.

"A one-dimensional model with no magnetic field is considered. It is supposed that the plasma starts in thermal equilibrium and then a current is forced to grow. Instability leads to the growth of waves, which are shown to stir the distribution in phase space, but only over a limited range of velocity. It is concluded that in order to restore stability the energy in the wave must become comparable to the energy of drift.

125. Harding, G.N. and others.
Emission of sub-millimetre electromagnetic radiation from hot plasma in Zeta.
Proc. Phys. Soc., vol.77, pt.5, no.497, May 1, 1961. pp.1069-1075.

"The first results are reported of experiments using a technique new to plasma research, namely spectroscopy in the far infra-red region (wavelength 0.1 - 1.6 mm). The shapes of the spectra obtained from Zeta are consistent with the observed radiation being entirely due to free-free transitions (bremsstrahlung) and become characteristic of black-body emission at the longer wavelengths. The measured absolute values of the surface brightness of the discharge are in agreement (subject to reasonable assumptions) with the predictions of quantum theory."

126. Hubbard, J.
The friction and diffusion coefficients of the Fokker-Planck equation in a plasma. Pt.2.
Proc. Roy. Soc., series A, vol.261, no.1306, May 16, 1961. pp.371-387.
(Published version of AERE - T/P 79.)

"In two recent papers a method of calculation of the coefficients of the Fokker-Planck equation which includes in a proper way correlation effects between distant particles has been expounded. In this paper the theory is extended to include a proper treatment of close binary encounters."

127. Lees, D.J. and Rusbridge, M.G.
Magnetic field diffusion in Zeta. (Letter).
Phys. Fluids, vol.4, no.5, May, 1961. pp.653-654.

"Calculations of the characteristic diffusion time in the stabilized pinch are at variance with experimental results. More detailed measurements not only confirm this discrepancy in the magnitude of the diffusion time but show that its variation with temperature is in complete disagreement with earlier calculations. The reasons for this are discussed."

128. Phillips, N.J.
Plasma diffusion in systems with partial losses.
Proc. Phys. Soc., vol.77, pt.5, no.497, May, 1961. pp.965-970.

"In certain experimental fusion devices, plasma is confined by a magnetic field and steadily lost out of the ends of a magnetic bottle. When the scattering rate of particles is high, field diffusion and particle loss can be considered from a microscopic point of view. The formation of a steady-state sheath into which particles diffuse only to be lost along the lines of force was suggested by Wright and Phillips (1960). The elementary theory is considerably developed here into a state in which the original approximations are evident, though the theory remains essentially phenomenological. It is shown that a steady-state plasma sheath is formed whose thickness depends on the plasma resistivity, sound speed and length. The sheath moves into the plasma with a speed which depends on the same parameters.

129. Dugdale, R.A. and others.
Some effects of thermal shock produced by intense gas discharges.
Trans. Brit. Ceramic Soc., vol.60, no.6, June, 1961. pp.427-448.
(Published version of AERE - R 3371)

"The effects of thermal shock under relevant conditions on a number of brittle materials have been investigated. The plasma of an intense low-pressure carbon arc of ~ 20 μs duration supplied heat to specimen surfaces at rates of up to several hundred kW/cm^2. Under sufficiently severe conditions all the materials tested suffered surface damage except fused silica. Most of the cracking appears to be due to the relief of tensile and shear stresses set up as the surface cooled from a hot plastically deformed condition. Repeated application of thermal shocks produced additonal damage which, on alumina and porcelain surfaces, took the form of pillar-like growths, the mechanism for which may be associated with the plastic deformation while hot. The bend strength of glass specimens after a single shock is interpreted on the Griffith theory relating strength to crack size. It is concluded that surface damage due to thermal shock will lead to enhanced evaporation, wall erosion, and structural weakening in apparatus for research into controlled thermonuclear reactions."

130. McWhirter, R.W.P.
Rates of recombination in hydrogenic plasmas. (Letter)
Nature, vol.190, no.4779, June 3, 1961. pp.902-903.

"Experimental determinations of rates of recombination of ions with electrons indicate that these rates are greater than simple theory predicts. In this communication there is proposed a more complex recombination mechanism which is based on well-known atomic collision processes and which may help to explain the observed values."

131. Maskrey, J.T. and others.
Arc initiation on heated metals by a hydrogen discharge. (Letter)
Nature, vol.190, no.4780, June 10, 1961. pp.997-998.

"Reports on investigation of the arcing characteristics of refractory metals exposed to a toroidal discharge. Experiments show that a marked transition from an arcing state to a non-arcing state occurs during both heating and cooling and this is attributed to (a) on heating, the solution of second phases; (b) on cooling, their precipitation. The results support the hypothesis that arcs are initiated through the agency of second phases and that the conditioning of various metals against arcing at room temperatures is due to the depletion at the surface of insulating inclusions."

132. Allen, T.K. and Bickerton, R.J.
Experiments on the compression of plasma in cusp geometry (Letter).
Nature, vol.191, no.4790, August 19, 1961. pp.794-795.

"Short note on the main parameters and preliminary results of the cusped field experiments."

133. Aitken, K. and others.
Pinch stability : theory and experiment.
I.A.E.A. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, September, 1961. Proceedings. Nuclear Fusion, 1962.supplement, pt.3. (not yet published.)

"Presents new experimental observations on the nature of the instabilities found in the linear hard-core pinch, discusses the theoretical effect on stability of allowing for finite electrical conductivity in the two limits of very large and very small conductivity, compares the results of the small conductivity approximation with the behaviour of a model hard-core experiment using liquid mercury and finally discusses the plasma results in the light of these extensions to stability theory."

134. Allen, T.K., McWhirter, R.W.P. and Spalding, I.J.
Experiments on cusp compression.
I.A.E.A. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, September, 1961. Proceedings. Nuclear Fusion, 1962 supplement, pt.1, pp.67-73.

"A fast compression experiment in spindle cusp geometry is performed on plasma pre-ionized and pre-heated to above 10^5 ^oK by colliding shock waves. Two forms of instability associated with acceleration during the compression phase are observed at high initial densities in hydrogen or with heavy gases. At lower pressures in hydrogen the expected stable compression occurs. A comparison is made between the experimental results and existing theories of cusp systems."

135. Blevin, H.A. and Thonemann, P.C.
Plasma confinement using an alternating magnetic field.
I.A.E.A. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, September, 1961. Proceedings. Nuclear Fusion, 1962. supplement, pt.1, pp.55-60.

"It is shown theoretically and experimentally that magnetic fields of megacycle frequencies can penetrate a dense plasma if the conductivity is sufficiently high. In the presence of an external axial magnetic field certain configurations of alternating magnetic fields lead to the diffusion of plasma either towards the walls or towards the axis. In the latter case confined plasmas have been produced in which an external field of about 1000 gauss is reduced to zero at the axis. Examples of radial electron density profiles are presented."

136. Bodin, H.A.B. and others.
Rapid axial contraction of a high density deuterium plasma in a thetatron discharge.
I.A.E.A. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, September, 1961. Proceedings. Nuclear Fusion, 1962 supplement, pt.2, pp.511-520.

"This paper presents experimental observations of the axial contraction of a dense deuterium plasma during the second half-cycle of a high-current magnetic compression experiment in which reversed trapped field is left over from the first half-cycle. The reversed field configuration produces a rapid axial contraction and subsequent expansion of the plasma column during which energy in the trapped magnetic field is dissipated. High speed streak and framing cameras and external flux coils are used to monitor the profile of the plasma and to measure the axial velocity of the change in cross-sectional plasma area. Peak axial velocities of 1.2×10^7 cm/sec are recorded. Measurement of the velocity and area ratio of the propagating discontinuity provides a method of determining the ion temperature ahead of and behind the area change.

A theoretical appendix analyses the propagation characteristics of area waves and area shocks and presents solutions of the appropriate conservation equations."

137. Bodin, H.A.B. and others.
The influence of trapped field on the characteristics of a magnetically compressed plasma (Thetatron).
I.A.E.A. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, September, 1961. Proceedings. Nuclear Fusion, 1962 supplement, pt. 2, pp.521-532.

"Recent results of an experimental investigation of deuterium plasma compressed by a rapidly rising magnetic field are presented and discussed. The discharge which occurred on the second half-cycle of a sinusoidal driving field without preionization was studied and it was found that in the pressure region 50 - 95 μ Hg the trapped flux varied in the range $\pm$ 25 kilomaxwells. Thus careful control of the initial pressure provided a simple way of varying the trapped flux. In this pressure range the characteristics of the discharge were observed to change markedly, and it is shown that the properties of the plasma are primarily determined by the trapped flux. Three types of discharge are analysed in detail. The first type, trapping maximum parallel flux, has a low β and a low temperature; it is well contained and emits neither neutrons nor soft x-rays although hard x-rays are observed. The second type traps much less parallel flux, has β between 0.2 and 0.8, emits no neutrons and only very small yields of x-rays, and escapes rapidly. The third type traps maximum reversed flux, which is subsequently destroyed. The implosion velocity increases with pressure and the neutron and soft x-ray intensities peak sharply at the pressure at which the trapped reversed field energy and the total energy (field and particle) are a maximum. Soft x-ray measurements lead to an electron temperature between 180 and 400 eV, and total energy measurements show that sufficient energy is available to raise the ions to a temperature of 1 keV. The plasma forms an unstable closed field loop configuration, contracts axially and remains contained away from the walls for about 2.5 μs, after which it normally breaks up following a rapid rotation."

138. Cole, H.C. and others.
Plasma loss in Zeta.
I.A.E.A. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, September, 1961. Proceedings. Nuclear Fusion, 1962 supplement, pt.3, (not yet published).

"Observations are presented on the Zeta discharge in deuterium at initial pressures of 0.25 - 20 mtorr, and in other gases, at currents of between 100 - 900 kA. The observations are interpreted in terms of energy loss, and of plasma loss and injection."

139. Jones, B.B. and Wilson, R.
Spectroscopic studies of ion energies in Zeta.
I.A.E.A. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, September, 1961. Proceedings. Nuclear Fusion, 1962 supplement, pt.3, (not yet published)

"A simple analysis of the motion of ions in time varying electric fields in a magnetically constrained plasma shows that their energies depend on their charge and mass and the characteristic frequency of the perturbing field. This is used as a guide in interpreting the observations. It is shown that the ion energies vary with time of appearance and conclusions concerning the heating mechanism are based on observations of different ionic species made at the same time. The ion energies E_i, can be represented by a constant energy plus an energy corresponding to a common velocity system, the directed motion being perpendicular to the magnetic field. The heating mechanism is interpreted as a low frequency perturbation, perpendicular to the magnetic field lines, and showing a marked degree of relaxation towards thermalization. For one specific condition, $E_i = 102 + 2.3 \frac{M_i}{M_D}$ (eV). This is used to deduce the deuteron energies and a relaxation time of 13 μsec is calculated for the directed mode. This agrees well with the ion-ion relaxation time. Calculation of the equivalent electric field driving the directed mode gives a value of the same order as that observed with electrostatic probes. The ion energies and electrostatic fluctuations are consistent with each other."

140. Lees, D.J. and others.
Skin formation and diffusion in a toroidal discharge.
I.A.E.A. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, September, 1961. Proceedings.

"Application of hydromagnetic theory to the pinched discharge has suggested that stability may be expected only if currents flow within a thin skin region at the surface of the plasma. This paper reports studies on skin formation in Zeta which show that for low energy input and high pressure, the diffusion of magnetic fields is compatible with a resistive process. For high energy input or pressures below 5 microns it is incompatible with such a mechanism. Evidence from Langmuir probes and streak photographs show that there is toroidal asymmetry. Electric field measurements also show asymmetry and suggest that the plasma may be generated in the form of rotating filaments. It is concluded that asymmetry of this type is an important part of the phenomenon and may account for the anomalously rapid field mixing and skin diffusion."

141. Rusbridge, M.G. and others.
Electric and magnetic field fluctuations in high-current toroidal discharges.
I.A.E.A. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, September, 1961. Proceedings. Nuclear Fusion, 1962 supplement, pt.3, (not yet published).

"The general behaviour of the fluctuations of electric and magnetic fields observed in discharges in ZETA and the Mk.IV torus under conditions in which the mean magnetic fields are fully diffused is summarized. A simple hydromagnetic model of the perturbations is introduced and it is shown that the magnetic field fluctuations agree with the model closely, while the electric fields do not. The magnetic field fluctuations are found to correspond to modes which are probably stable, while the predicted instabilities make only a small contribution to the fluctuation level."

142. Stringer, T.E. and Stocker, P.M.
Electrostatic instabilities in current carrying and counter-streaming plasmas and studies of the non-linear Boltzmann - Vlasov equation.
I.A.E.A. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, September, 1961. Proceedings.

"The maximum growth rate of longitudinal plasma waves of small amplitude in a current carrying plasma and in two counterstreaming plasmas is evaluated as a function of the drift velocity and the electron to ion temperature ratio. A non-linear dispersion equation is derived from the collisionless Boltzmann equation, using an iteration procedure, and is used to predict the upper limit to the instability in a current carrying plasma."

143. Sweetman, D.R.
Mirror machine experiments and related cross-section measurements at A.W.R.E. Aldermaston.
I.A.E.A. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, September, 1961. Proceedings. Nuclear Fusion, 1962 supplement, pt.1, pp.279-287.

"An experiment (Phoenix) is described in which a beam of 30 keV neutral atoms is injected into a magnetic mirror field with 50 kilogauss central value and 100 kilogauss in the mirrors. The conditions for achieving exponential build-up of the plasma density are discussed and the significance of the initial trapping efficiency is brought out. A brief summary is given of recent unpublished atomic cross-section measurements relevant to the thermonuclear field, involving the dissociation of H_{2+} and H_{3+} by gases.

144. Tayler, R.J.
The influence of the Hall effect on a simple hydromagnetic stability problem.
I.A.E.A. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, September, 1961. Proceedings. Nuclear Fusion, 1962 supplement, pt.3. (not yet published).

145. Taylor, J.B.

Stochastic methods in the theory of plasma diffusion.
I.A.E.A. Conf. on Plasma Physics and Controlled Nuclear Fusion Research, Salzburg, September, 1961. Proceedings. Nuclear Fusion, 1962 supplement, pt.2, pp.477-480.

"Although the theory of diffusion is fairly complete for thermal plasma (i.e. plasma in local thermodynamic equilibrium), there is almost no information on non-thermal plasma and it may well be that the conventional transport equation approach is not suited to a discussion of this problem. Al alternative approach utilising the correlation function of the fluctuating electric field in the plasma as its starting point has therefore been examined. In the first application of this approach, to thermal plasma, Nyquist's theorem played a central role.

In discussing non-thermal plasma Nyquist's theorem cannot be used but instead one can employ equations of motion of the Langevin type. In the present paper the application, and the limitations, of this approach are discussed; it is shown that the diffusion of ions across a magnetic field can be derived simply in terms of the effective dynamic friction coefficient and the significance of this result is discussed. In particular it appears that for given plasma pressure there is a maximum value for the diffusion, related to the controversial "Bohm" diffusion. Comparison of this result with recent measurements on the Stellarator indicates that the maximum is attained in the turbulent plasma resulting from ion-wave instability."

146. Hamberger, S.M.

Measurement of neutral atom density in a highly ionized plasma by absorption of line radiation.
Fifth Int. Conf. on Ionization Phenomena in Gases, Munich, September, 1961. Proceedings, vol.2, pp.1919-1930.

"The paper describes a method of estimating the density of neutral atoms in particular states of excitation in an intense pulsed discharge. A beam of nearly monochromatic radiation, whose wavelength corresponds to an appropriate atomic transition, is passed through the plasma and its transmission measured as a function of time. The measuring beam is distinguished from the plasma emission by a high frequency modulation method.

Some preliminary experiments are described in which H light is used to estimate the population of atoms in the excited state corresponding to principal quantum number n = 2 in a pulsed toroidal discharge in hydrogen."

147. Harding, G.N.

Spectroscopic investigation of plasma in the wavelength range 0.1-2.0 mm.
Fifth Int. Conf. on Ionization Phenomena in Gases, Munich, September, 1961. Proceedings, vol.2, pp.1977-1986.

"The radiation emitted by ZETA in the wavelength range 0.1-2.0 mm. has been measured using a vacuum grating spectrograph. The detector was either a carbon bolometer or an indium antimonide photo-conductor, giving time-integrated or time resolved measurements respectively.

Continuous spectra were obtained which can be explained on the basis of free-free emission and absorption. At short wavelengths the plasma is optically thin while at long wavelengths a black-body spectrum is obtained. Thus both electron temperature and density can be found.

Measured values of these parameters obtained under varying conditions of pressure and magnetic field are presented and their significance discussed."

148. Harrison, M.F., Dolder, K.T. and Thonemann, P.C.
The measurement of the ionization cross sections of ions by electron impact.
Fifth Int. Conf. on Ionization Phenomena in Gases, Munich, September, 1961. Proceedings, vol.2, pp.1251-1257.

"A method, using crossed ion and electron beams, has been developed to measure ionization cross sections of ions by electron impact.

The cross section of He^+ ions has been measured for electron energies up to 1 Kev with an estimated accuracy of ± 10% for electron energies greater than 150 ev. The cross section agrees closely with quantum theory at higher electron energies. When suitably scaled it is similar to that measured by Fite and Brackmann for atomic hydrogen except that the ionic cross section is larger for electron energies less than about five times the threshold.

149. Hobbs, G.D. and others.
The temporal variation of line radiation from impurities in Zeta.
Fifth Int. Conf. on Ionization Phenomena in Gases, Munich, September, 1961. Proceedings, vol.2, pp.1965-1976.

"The temporal variation of the intensity of line radiation in the vacuum ultraviolet from impurities in the Zeta discharge has been studied both experimentally and theoretically. The comparison between computed and observed intensities is discussed in terms of simple ionization, recombination, and excitation processes and used to establish the adequacy of the ionization coefficients employed.

With the exception of those closely associated with recombination all the main features observed are accounted for theoretically. It is observed that in a plasma with a time varying electron temperature, proportionality between ion density and line intensity should in no approximation be assumed."

150. Little, P.F.
Acoustic waves in a plasma.
Fifth Int. Conf. on Ionization Phenomena in Gases, Munich, September, 1961. Proceedings, vol.2, pp.1440-1455.

"Compressional waves have been transmitted along a cylindrical column of plasma. A short external coil modulated the plasma density over a small region through the influence of its magnetic field, and the waves were demonstrated by a photomultiplier connected to a phase sensitive detector.

Propagation was found above a cut off frequency close to that predicted by theory for the simplest bounded mode for electro-acoustic waves, and in both directions along the column.

The theoretical dispersion curve could be fitted to the observations within 15% (except for some points near the cut off) by choosing appropriate values of the electron temperature and plasma radius. The temperature so chosen was 30% less than that obtained from probe measurements, and the plasma radius used was within 10% of the value found directly. Since other modes than the lowest also propagate, some of the discrepancies may be attributed to their presence.

Transmission has been observed from 25 kc/s to 50 kc/s, corresponding to wavelengths from 30 cm to 3 cm in the plasma. The upper limit to the frequency was apparently set by the physical size of the exciter."

151. Medford, R. and others.
Interferometric measurements of electron density in deuterium plasma. Fifth Int. Conf. on Ionization Phenomena in Gases, Munich, September, 1961. Proceedings, vol.2, pp.2000-2012.

"A technique is described for measuring the spatial distribution of electrons in high density plasmas."

152. Reynolds, J.A. and Phillips, N.J.
Magnetic field diffusion during the initial stages of the Theta pinch. Fifth Int. Conf. on Ionization Phenomena in Gases, Munich, September, 1961. Proceedings, vol.2, pp.2288-2298.

"This paper presents results of an experimental investigation of the influence of field diffusion on the formation of trapped magnetic field in the theta pinch. Measurements were made with a magnetic probe and a streak camera during the breakdown and implosion stage of a hydrogen discharge in the pressure range 8 μHg to 6×10^3 μHg. The peak rate of change of magnetic field was 25 kG/μs and the peak field was 13 kG.

The initial breakdown always occurs near a zero in the magnetic field and, for an initial breakdown near the second and subsequent zeros, the trapped field at the start of the radial implosion is always reversed with respect to the external field. However, during the implosion the trapped field can either remain reversed and be magnified or change sign and be magnified depending on whether the initial trapped field is above or below a critical value; near the second zero the critical value is 0.9 kG. This behaviour is due to a combination of two processes : the radial implosion which magnifies the field, and diffusion which changes the total trapped flux. An implosion model in which field diffusion is taken into account is in agreement with experiment."

153. Riviere, A.C. and Sweetman, D.R.
The dissociation of molecular ions by strong magnetic fields. Fifth Int. Conf. on Ionization Phenomena in Gases, Munich, September, 1961. Proceedings, vol.2, pp.1236-1250.

"Experiments are described in which the dissociation of the molecular hydrogen ions H_2^+, H_3^+, D_2^+ and HD+ with energies up to 2 MeV was observed in electric fields up to 5×10^5 V/cm. The dissociation occurred from the uppermost vibrational levels and the population of these levels was increased by forming diatomic ions from the break-up of accelerated triatomic ions. The maximum fraction of the beam dissociated was 0.3 per cent. Dissociation by a v x B field was observed and found to be approximately equal to the effect of the equivalent electric field. Collision of H_2^+ ions with hydrogen gas molecules resulted in a decrease of the fraction dissociated. Ions were passed through two successive high field regions interposed by a 4^o deflection. Results are interpreted in terms of the dependence of the dissociation effect on the quantum number mj. He^- ions were completely dissociated into helium atoms and electrons by an electric field of 4.5×10^5 V/cm."

154. Thompson, M.W.
A theory of high energy sputtering based on focused collision sequences.
Fifth Int. Conf. on Ionization Phenomena in Gases, Munich, September, 1961.
Proceedings, vol.1, pp.85-95.

"Sputtering from monocrystals along simple crystal axes is invoked as evidence for focused sequences of atomic collisions travelling back to the surface from the initial ion-atom collision. A theory of sputtering is developed on this basis which predicts that the sputtering ratio as a function of energy E_1, should rise to a broad maximum, followed by a decrease approximately as $1/E_1$. The calculations are in quantitative accord with light ion sputtering experiments, but are only capable of qualitative predictions for heavy ions. The observed cosine law of sputtering from polycrystalline targets is accounted for."

155. Wright, J.K., Medford, R.D. and Chambers, B.
Longitudinal shock waves in plasma columns confined by external magnetic fields.
Fifth Int. Conf. on Ionization Phenomena in Gases, Munich, September, 1961.
Proceedings, vol.2, pp.2147-2164.

"In this paper we discuss the propagation of shock waves along plasma columns confined by external magnetic fields and derive the Rankine Hugoniot relations. The theory is illustrated by a specific example where we observed this type of shock wave in a theta discharge."

156. Gillespie, A.B.
Electronic instruments and techniques for plasma physics research in the U.K.
Proc. Joint Nuclear Instrumentation Symposium, Raleigh, N.C. September, 1961.
Trans. I.R.E. Prof. Group on Nuclear Science, vol.NS-8, no.4, October, 1961.
pp.40-50.

"The paper describes electronic instruments and techniques which have been developed and used in support of the U.K. plasma physics research programme. These generally fall under the headings of machine design, machine control and instrumentation, and plasma diagnostics. To date, most work has been in the latter category which involves a wide variety of measurements ranging from the low frequency end of the spectrum to high energy nuclear radiations. Many of the diagnostic instruments described have been developed for use with Zeta, the large toroidal discharge experiment at the Atomic Energy Research Establishment, Harwell."

157. Jukes, J.D.
High frequency tail of cyclotron radiation from a hot plasma.
Phys. of Fluids, vol.4, no.9, September, 1961. pp.1184-1185.

"Comments on a paper by Hirshfield and others which suggests that however efficient reflectors may be at containing the blackbody part of the radiation, the entire tail of radiation will always escape, representing an irreducible loss. It is shown, in fact, that reflectors are very effective in reducing the loss in both regions."

158. Taylor, J.B.
Diffusion of plasma ions across a magnetic field.
Phys. of Fluids, vol.4, no.9, September, 1961. pp.1142-1145.

"Earlier work on the application of the correlation function of the electric field in a plasma is extended to the problem of diffusion of ions across a magnetic field. It is shown that the flux can be considered in three parts; one depends on the electric field correlation function and the others on the dynamic friction, which is related to the correlation function by Nyquist's theorem. When the ion and electron temperatures are unequal the present result differs from that obtained by a Chapman-Enskog type analysis of the transport equation and the interpretation of this difference is discussed. Some consequences of the diffusion formula, as it concerns impurities, are noted."

159. Wright, J.K. and others.
A new 'wedge' type instability observed in a 'theta' pinch.
Nature, vol.191, no.4793, September 9, 1961. pp.1054-1056.

"Observations made during the first half-cycle of the theta-pinch discharge show a number of bright radial 'wedges' which develop into flutes with trapped magnetic field inside them. The evidence suggests that the radial wedges are formed only when there is a trapped magnetic field in the same direction as the driving field, that is, when the azimuthal currents on the shock front and the current sheet have opposite directions of rotation."

160. Dolder, K.T., Harrison, M.F.A. and Thonemann, P.C.
A measurement of the ionization cross-section of helium ions by electron impact.
Proc. Roy. Soc., A, vol.264, October, 1961. pp.367-378.

"An apparatus, based on the crossed-beam principle, is described for measuring the ionization cross-section of ions by electron impact. The cross-section for the reaction $He^+ + e \rightarrow He^{2+} + 2e$ is determined from the threshold at 54.4 to 1000 eV. The results are compared with the ionization cross-section of atomic hydrogen and with theory. The He^+ cross-section, when scaled by the appropriate factor, is very similar to that of atomic hydrogen but increases more rapidly in the neighbourhood of the threshold. At the highest electron energies the cross-section agrees well with that predicted by the Coulomb-Born approximation but is considerably lower at the cross-section maximum. For electron energies above 150 eV the error in the measurement is estimated to be less than $\pm$ 10%."

161. Gross, M.J. and Millar, W.
Observations with a small theta-pinch. (Letter)
J. Nucl. Energy, Pt.C, vol.3, no.4, October, 1961. pp.295-296.

"Describes the characteristics and operation of a small theta pinch apparatus having the following parameters:- peak magnetic field on axis - 80 kG; period of oscillation of the field - 2.5μ sec; capacitor energy - 1.3 kJ at 20 kV. Some typical results are illustrated."

162. Miyajima, S., Ito, S. and Thonemann, P.C.
Plasma drift velocity across a confining magnetic field.
Proc. Phys. Soc., vol.78, pt.4, no.502, October 1, 1961. pp.618-620.

"The steady drift velocity of fully ionized plasma across a confining magnetic field is usually given as

$$v = \frac{\eta}{\beta^2} \nabla p$$

where η is the electrical resistivity and β a steady magnetic field normal to the plasma pressure gradient ∇p. The above equation is derived from the equation of plasma motion by neglecting the inertia term $(v.\nabla)v$. It is shown in this note that the $(v.\nabla)v$ term cannot be neglected if the plasma is bounded by a material wall. This does not imply that the plasma cannot be confined by a magnetic field. It is shown that the velocity of plasma drift transverse to a magnetic field is correctly given by the above equation for an unbounded plasma provided $v^2 \ll c^2$ whereas for a bounded plasma the upper limit to the drift velocity is close to $[k(T_e + T_i)m_i]^{\frac{1}{2}}$ independent of the magnetic field strength."

163. Tayler, R.J.
Necessary and sufficient conditions for the hydromagnetic Rayleigh-Taylor stability of a cylindrical plasma.
J. Nucl. Energy, pt.C, vol.3, no.4, October, 1961. pp.266-272.
(Published version of AERE - M 736.)

"It is shown that necessary and sufficient conditions for the stability of a cylindrical discharge can be extended to the case in which there is an external gravitational potential present. In particular explicit forms are obtained for the analogues of three well-known stability criteria: the sufficient condition for stability of the hard-core pinch, Suydam's necessary condition for stability and the necessary and sufficient condition for stability against interchange perturbations of a system with a magnetic field of constant pinch."

164. Wright, J.K. and others.
Equilibrium configuration of the plasma in theta discharges with reversed trapped magnetic fields.
J. Nucl. Energy, pt.C, vol.3, no.4, October, 1961. pp.242-245.

"The equilibrium state of a long tubular plasma with reversed trapped magnetic fields is discussed. It is shown that an equilibrium position stable to longitudinal perturbations exists for each value of the ratio of external to trapped flux providing the cross-sectional area of the plasma is less than half the total area of the system.

Variations in the containing magnetic field give rise to variations in the length and the cross-sectional area of the plasma tube. With observations confined to the end-view of the plasma and assuming that the tube did not vary in length, the observed variation in cross-sectional area would lead one to an assumption of an apparent value of $\gamma = 4$ for the plasma."

165. Carruthers, R.
A review of fusion research in the United Kingdom.
Int. Conf. on High Magnetic Fields, Massachusetts Institute of Technology, November 1-4, 1961. Proceedings, pp.701-705.

"A very brief account of U.K.A.E.A. work in the C.T.R. field with a brief mention of work in other U.K. laboratories."

166. Carruthers, R.
The storage and transfer of energy.
Int. Conf. on High Magnetic Fields, Massachusetts Institute of Technology, November 1-4, 1961. Proceedings, pp.307-318.
(Published version of CLM - P7).

"Pulsed magnetic fields require an energy store which can be switched to the load coil for the desired experimental period. At the end of this period the energy is removed from the load and either dissipated or returned to the store.

Energy may be stored in a number of ways, as electric charge in a capacitor, as magnetic energy in an inductor, as kinetic energy in a mechanical system, (e.g. fly wheel), or as chemical energy (e.g. batteries or explosives). The appropriate method of energy storage is determined by the rate of rise of magnetic field required and by the number of pulses needed before the apparatus is of no further use. The paper discusses the various forms of energy storage in the light of these experimental requirements.

The switching problems vary considerably between the different forms of energy storage. Very high rates of rise call for spark gap type switches handling high instantaneous powers, whilst the longer pulses impose unusually arduous duties on mechanical switches. Recent development work on both high and low pressure spark gaps and mechanical switches for use at voltages up to 100 kV and currents up to 200 kA is described."

The practicability of inductor storage for energies in the region of 100 megajoules and current rise times of about 10 milliseconds has been studied. Work on the study of suitable circuits and the development of a circuit breaker to meet the onerous duty of transferring current from store to load is reported."

167. Skellett, S.
Design of 100 kG pulsed coils for Phoenix mirror machine.
Int. Conf. on High Magnetic Fields, Massachusetts Institute of Technology, November 1-4, 1961. Proceedings, pp.296-306.

"Describes the design, manufacture and testing of coils operating in liquid nitrogen at -196°C."

168. Davenport, P.A.
The magnetic containment of plasma.
Elect. Rev., vol.169, no.20, November 17, 1961. pp.796-798.

"Explains the current lines of development in this field and gives an indication of future possibilities."

169. Medford, R.D. and others.
A new application of the Faraday magneto-optical effect for diagnostic measurement of transient magnetic fields.
Nature, vol.192, no.4803, November 18, 1961. pp.622-624.

"Describes a new technique for recording time variations in a longitudinal magnetic field which uses simple, inexpensive apparatus and is easily incorporated into experiments already using streak camera observations."

170. Burton, W.M. and Wilson, R.
Spectroscopic investigations of plasma containment in Zeta.
Proc. Phys. Soc., vol.78, pt.6(ii), no.506, December 15, 1961. pp.1416-1438.

"Observations are made of the time variation of the intensities of spectral lines emitted by small quantities of impurity ions in a deuterium discharge in Zeta. A vacuum ultra-violet monochromator which covers the wavelength range 500-2000 Å is used. The observations are interpreted in terms of temporal ionization distributions determined for a partially contained plasma model. The observations are consistent with the model and it is shown that plasma containment in Zeta is violated by two processes : an escape of plasma to the wall represented by a loss rate coefficient $\lambda(sec^{-1})$, and an injection of atoms in a neutral or low state of ionization represented by an injection coefficient A (sec^{-1}). The value of λ is effectively independent of the stabilizing magnetic field strength B_2, whereas the injection coefficient varies considerably with this parameter. Both λ and A are closely correlated with ε , the energy input per unit mass of gas, and over the range of conditions investigated they show a linear increase with ε. The ion containment time $1/\lambda$ is about 100 microseconds at $\varepsilon = 3keV/m_p$ and at this condition most of the energy input is carried to the walls by the escaping plasma. The net effect of the processes of loss and injection controls the variation of plasma line density, and in general this shows a decrease with time or 'pump-out'. This is measured and related to other discharge phenomena."

171. Dungey, J.W.
Torque on a plasma in terms of magnetic stress.
Nuclear Fusion, vol.1, no.4, December, 1961. pp.312.

"There is some evidence for plasma rotation in induction pinches. This note explores the electromagnetic mechanisms which might be responsible for transfer of angular momentum to the plasma."

172. Fawcett, B.C., Jones, B.B. and Wilson, R.
Vacuum ultra-violet spectra of multiply ionized inert gases.
Proc. Phys. Soc., vol.78, pt.6(i), no.505, December 1, 1961. pp.1223-1226.

"The high temperature plasma (kTe $\simeq$ 20 eV) produced in Zeta is a copious source of spectral lines emitted by highly ionized atoms in the vacuum ultra-violet. Spectroscopic investigations in the wavelength range 400-1000 Å have revealed several new lines due to the multiply ionized inert gases, Ne, A, Kr, and Xe. The method of identification is based on the successive appearance of the ionization states of each element, supplemented by isoelectronic calculations which also allowed transitions to be assigned to most lines."

173. Harrison, E.R.
The effect of particle streams on transverse hydromagnetic waves.
Proc. Phys. Soc., vol.78, pt.6(i), no.505, December 1, 1961. pp.1236-1243.

"A magnetic field is 'frozen' into a moving conducting fluid when certain conditions are fulfilled as for example, when the frequency of the fluid disturbance is small compared with the cyclotron frequencies of the fluid particles. If the fluid contains streams of moving particles, parallel to the magnetic field, the magnetic field is also 'frozen' into the streams when there are transverse perturbations. The condition now is that the Doppler shifted frequency of the disturbance must be small compared with the cyclotron frequency of the stream particles. It follows that the phase velocity of transverse hydromagnetic waves is modified if such streams are present. In effect, the momentum flux of the streams reduces the 'tension' of the magnetic flux lines. When the kinetic energy density relative to the centre-of-mass system exceeds the magnetic energy density, the phase velocity in an infinite medium has complex conjugate values and the hydromagnetic wave grows in amplitude. In the case of a stream of finite radius the phase velocity shows dispersion for wavelengths greater than the stream radius and there is an increase in the domain of stability."

174. Jukes, J.D.
Stability of the sharp pinch and unpinch with finite conductivity.
Phys. of Fluids, vol.4, no.12, December, 1961. pp.1527-1533.

"The stability of the sharp linear pinch and unpinch is analyzed using a model in which the magnetic fields are separated by a thin current layer of large, but finite electrical conductivity. Elsewhere the contained fluid is assumed to have zero conductivity, a model which may, for example, approximate a plasma pinch heated by the intermixing of skew magnetic fields. The perturbed radial displacement of the layer is assumed to be constant across the layer and small wavelength perturbations comparable to the layer thickness are not considered. Viscoscity is also neglected. The infinitely conducting 'stabilized' pinch and the unpinch are now shown to be overstable to perturbations whose helices are approximately orthogonal to the helix of the mean magnetic field across the layer. The overstable growth rate is typically one tenth of the geometric mean of a fundamental, oscillatory frequency and the Ohmic diffusion rate of the layer."

175. Jukes, J.D.
Towards controlled fusion.
Discovery, vol.22, no.12, December, 1961. pp.540-546.

"A survey of thermonuclear research and experiment with brief description of the various kinds of devices in use."

176. Riviere, A.C. and Sweetman, D.R.
Search for vibrational energy effects in dissociation of H_2^+ ions by hydrogen gas.
Proc. Phys, Soc., vol.78, pt.6(i), no.505, December 1, 1961. pp.1215-1217.

"The dissociation cross section on interaction with hydrogen gas was measured for H_2^+ ions with energies between 280 and 670 keV and with both high and low vibrational excitation. An increase of $7 \pm 4\%$ was found for the cross section for simple dissociation in the case of the more highly vibrationally excited ions. For dissociation into two protons the difference between the cross sections was certainly less."

177. Thompson, W.B.
Dynamics of high temperature plasmas.
Reports on Progress in Physics, vol.24, 1961. pp.363-424.

"A survey is given of present models of the dynamic behaviour of a fully ionized plasma, with particular emphasis on those useful in stability studies. The models discussed include magnetohydrodynamics which, while not fully justified, is widely used, the classical kinetic theory which probably is not applicable to hot laboratory plasmas, and the collisionless kinetic theory, which while incomplete seems suited to the discussion of the stability of plasmas. The properties of small oscillations are discussed, both sound waves and electrical oscillations, and stress is laid on the dielectric behaviour of the plasma. A consistent derivation of the Fokker-Planck equation is sketched, using the dielectric properties of the plasma. Many important dynamical problems are omitted - there is no discussion of the collisionless shock, or of the breakdown of hydrodynamic behaviour through electron runaway in electric fields, and there is little discussion of particular configurations."

178. Wright, J.K. and others.
Interferometric measurements of the electron density in a shock-heated deuterium plasma.
Proc. Phys. Soc., vol.78, pt.6(ii), no.506, December 15, 1961. pp.1439-1448.

"Results are reported of experiments new to plasma research, namely time-resolved interferometry in the optical region. It is shown how the electron density distribution of a fast cylindrical pinched discharge may be measured and how the physical conditions in the discharge may be deduced from such measurements."

179. Blackman, V.H. and Niblett, G.B.F.
Ionization processes in shock waves.
In: Ferri, A., ed. Fundamental data obtained from shock-tube experiments.
Pergamon Press, 1961. pp.221-241.

"A review of results of measurements of the electrical conductivity of shock-heated gases over a limited range of conditions and a comparison of results with theory. Experimental and theoretical studies of the approach to equilibrium ionization behind strong shock waves are reviewed."

180. Harrison, E.R.
Acceleration of electrons in plasmas.
J. Nucl. Energy, pt.C, vol.4, no.1, January, 1962. pp.7-13.

"When an applied electric field greatly exceeds the value $E_c = e/\lambda_D^2 \simeq 10^{-8} n/T$ V cm^{-1} (where λ_D is the Debye length) the rate of momentum transfer in electron-ion encounters is negligible. One would therefore suppose that the electrons and ions of a plasma should be freely accelerated. The experimental results from plasma betatrons have shown, however, that with electric fields of $E_o \gg E_c$ the accelerated electron currents are still extremely small. Evidently the theory of runaway electrons is valid for $E_o \ll E_c$, but is inadequate when $E_o \geq E_c$, and a more sophisticated theory is required which takes into account the momentum transfer processes in collective interactions. In a finite plasma there are no exponentially growing longitudinal plasma oscillations when $\lambda_D k' > 0.755$, where k' depends upon the boundary conditions. In a cylindrical plasma of radius a, k' is approximately equal to a^{-1}. In such a plasma $E_o \gg E_c$ is a sufficient condition for the free acceleration of the electrons and ions. However, the current that is achieved when the electrons approach the velocity of light is small, and is typically less than 0.1 amp. If it is possible to accommodate a very wide energy spread in a circular machine it is shown that the electrons can then be accelerated free from longitudinal instabilities when $E_o \ll E_c$. But in machines such as plasma betatrons only a relatively narrow energy spread can be tolerated, and the question is then how large must the applied field be to accelerate the electrons in spite of the electrostatic instability ? Approaching the problem from a phenomenological point of view, one finds that the sufficient condition is that $E_o > \tilde{E}_c$, where $\tilde{E}_c = 4\pi n e k'^{-1} \simeq 10^{-6} n k'^{-1}$ V cm^{-1} is now the maximum possible fluctuating electric field. The value of $\tilde{E}_c$ is many orders of magnitude larger than E_c. Thus, in order to force the electrons out of their thermal state in a machine designed to yield several kilo-amperes of relativistic electrons requires accelerating electric fields not of a few volts per cm but of the order of 10^6 V cm^{-1}."

181. Hearn, A.G., Jones, B.B. and Ramsden, S.A.
The variation with time of the profiles of spectral lines emitted from a high-current toroidal discharge.
J. Nucl. Energy, pt.C, vol.4, no.1, January, 1962. pp.23-30.

"The intensity of the profile of the He II line at 4686Å emitted by a helium plasma in the Mark IV torus was measured at three wavelengths using photomultipliers. A gaussian profile was fitted and expressed as an apparent temperature and mass motion velocity. A comparison of the area of the gaussian profile with the total intensity of the line showed that for much of the pulse, the profile departs substantially from gaussian. It is unlikely that the motion of the plasma as a whole can contribute significantly to the line width measured photographically."

182. Little, P.F.
Observations on an expanding plasma.
J. Nucl. Energy, pt.C, vol.4, no.1, January, 1962. pp.15-22.

"The expansion of a plasma into a lightly ionized low-pressure gas has been investigated experimentally. It has been shown that the velocity of expansion can be derived from the electro-acoustic velocity in the plasma in the same way that the velocity of expansion of a neutral gas moving into a vacuum is derived from the sound speed within it. Collisions with the background gas and plasma influence the electro-acoustic velocity through the electron temperature during the expansion."

183. Phillips, N.J.
Formation and implosion of a current sheet in a gas discharge containing reversed magnetic fields.
Proc. Phys. Soc., vol.79, no.507, January 1, 1962. pp.171-179.

"A theory is developed of the formation and implosion of a gas discharge in reversed axial magnetic fields. When a discharge is formed in neutral gas containing a trapped field of opposite sense to the applied field, the formation and implosion of the discharge are profoundly influenced. A simple theory of the formation of a reversed field sheath in neutral gas is given and it is shown that the sheath thickness is proportional to the plasma wavelength $(m_e c^2/4\pi n_e e^2)^{1/2}$ and weakly dependent on the ratio of scattering to ionization rates. On the basis of Buneman's theory of electrostatic instability of electron streams it is suggested that ionization growth rates are limited by the onset of electrostatic instability when the electron temperature in the sheath exceeds a certain value ($\simeq$ 50 eV) determined by the high energy behaviour of the scattering and ionization rates. The implosion of the discharge can be appreciably affected by the finite resistivity of the plasma and a simple model of the implosion of a resistive reversed field pinch is discussed. Owing to field annihilation during the implosion and the effect of wall hang-up, implosions may be considerably faster than those achieved under like field conditions. It is shown that a critical magnitude of the initial reversed field exists above which it is amplified reversed and below which it passes through zero and is amplified with the same sense as the external field."

184. Taylor, J.B. and Roberts, K.V.
Rotational transforms in a toroidal fast compression experiment.
Phys. Rev. Letters, vol.8, no.2, January 15, 1962. pp.52-53.

"Introduces the idea of "Magnetic moulding" to produce a Stellarator-type vacuum magnetic field in a fast compression device. Although primarily envisaged as a means for overcoming difficulties associated with the use of helical windings in a fast system, it has an added advantage in that none of the magnetic surfaces cut the tube walls so that all the region inside the tube is a possible containment region, i.e. the magnetic aperture can be the same as the geometrical aperture, making more efficient use of magnetic energy."

185. Bickerton, R.J.
Status of world fusion.
Nucleonics, vol.20, no.2, February, 1962. pp.55-59.

"A review of progress based on results communicated at the I.A.E.A. Conference on Plasma Physics and Controlled Nuclear Fusion, Salzburg, September, 1961."

186. Butt, E.P.
Minimum impedance conditions in the Zeta discharge. (Abstract only.)
Bull. Amer. Phys. Soc., series II, vol.7, no.2, February 23, 1962.
pp.148.

"Changes in the impedance of the discharge in Zeta occur at particular values of current, the impedance being a minimum when the magnetic helices describe an integral number of turns in the mean discharge length. Studies of these impedance minima have been made in discharges prolonged by feeding energy into the clamp circuit. The main capacitor bank stored 1.5 Mjoule at 24 kV and the clamp bank 3.0 Mjoule at 8 kV. The rise time was about 700μsec.

It was found that at low pressures (0.5 mtorr) the current persisted only when peak current coincided with a minimum impedance; at high pressures the length of the discharge was limited by the total charge available. The duration of the discharge was increased under suitable conditions from 1.0 to 6.0 msec. Measurements indicate that both the ultraviolet light and total energy radiated are less during the constant current portion of the pulse than at other times. Energy balance calculations show that a substantial part of the energy input during low impedance, constant current conditions is contained and that losses are reduced during this period."

187. Gibson, A, and Mason, D.W.
Energy loss processes in Zeta.
Proc. Phys. Soc., vol.79, pt.2, no.508, February 1, 1962. pp.326-350.
(CLM - P2)

"The energy lost from Zeta discharges, in deuterium and argon by radiation, plasma particles and non-thermal electrons, has been investigated experimentally over a wide range of conditions. Two definite regimes of energy loss have been established. These regimes are determined principally by the pressure at which the machine is operated. At high pressures (5 microns) line radiation from impurities is the dominant loss process and under certain discharge conditions accounts for all the energy fed into the discharge. Theoretical considerations are presented to show that the observed impurity content of 10^{11} atoms per cubic centimetre can account for the radiation loss. At lower pressures (0.5 micron) the energy is lost by particles, firstly by plasma which is not efficiently confined and secondly by fast electrons which are accelerated at the termination of the current pulse and strike the tube walls with about 8 keV of energy.

The results reported are related to energy loss observations made by workers with other stabilized pinch devices."

188. Harrison, E.R.
Stability of longitudinal electrostatic oscillations in plasmas of finite dimensions.
Proc. Phys. Soc., vol.79, pt.2, no.508, February 1, 1962. pp.317-325.

"This paper discusses the stability of longitudinal electrostatic oscillations in plasmas of finite dimensions. It is shown that in general the effect of simple boundary conditions is to increase the domain of stability. Thus, a cylindrical plasma of radius a, consisting of electron and ion streams of equal temperatures and surrounded by a coaxial conducting boundary of radius b, where $b \gg a$, is stable for all stream velocities when $\lambda_D > 0.53a(\text{In } b/a)^{1/2}$, where λ_D is the Debye length. In the case of a plane-shaped plasma of semi-width a, between parallel plane-conducting boundaries at distance b, the equivalent condition is $\lambda_D > [\, 2(ab-a^2) \,]^{1/2}$. More generally, for multi-stream plasmas, in which the component streams have arbitrary temperatures and densities, it is possible to give a sufficient condition of stability for all stream velocities. The stability of three-stream plasmas is briefly discussed, and it is shown that the experimental results of Looney and Brown, and their failure to observe any excitation of plasma oscillations, are in accord with the stability criterion for plasmas of finite dimensions. Attention is drawn to the similarity between plane shaped plasmas and auroral arcs, and also the similarity between cylindrical shaped plasmas and auroral rays. It is suggested that the difference of the stability conditions for plane and cylindrical shaped plasmas may account for the tendency of auroral arcs to disrupt into rayed structures."

189. Tosswill, C.H., Schofield, J.M.S. and Atkinson, D.W.
Beam-plasma interaction in a torus. (Abstract only.)
Bull. Amer. Phys. Soc., series II, vol.7, no.2, February 23, 1962. pp.151.

"A microsecond pulsed beam of 5-kV electrons is directed along the axis of a torus containing hydrogen plasma; with a guiding magnetic field the beam may make many circuits of the torus, and the study of beam-plasma interactions over long distances becomes possible. The beam source is reduced to a size which does not obstruct either normal plasma processes or repeated transits of the beam yet it emits a strong beam capable of detection in the presence of large plasma currents. X-rays from a perforated target intercepting $1/10$ of the beam at each transit show a beam range >10 m in 1 μ of neutral or weakly ionized hydrogen. These results are consistent with binary collision data. In dense plasma ($> 10^{12}$ ions/cc) a drastic curtailment in the x-ray response reveals some severe loss process, not explicable by the action of fields present in the undisturbed plasma, but suggesting a collective interaction between beam and plasma. Experiments to identify the interaction mechanism are proceeding. When the beam travels in a tenuous plasma, oscillations are seen with $\omega_{ci} < \omega < \omega_{ce}$. These oscillations are electromagnetic, and there is evidence for polarization normal to the beam."

190. Wilson, R.
Far ultra-violet studies of the solar corona and chromosphere.
The Observatory, vol.82, no.926, February, 1962. pp4.

191. Dellis, A.N. and Weaver, J.M.
Measurement of a high refractive index for transmission of 3 cm microwaves through a plasma.
Nature, vol.193, no.4822, March 31, 1962. pp.1274-1275.

"The properties of wave propagation through a plasma parallel to a superimposed magnetic field have been investigated experimentally. It is shown that, for plasma densities well above the critical density, only a right-handed circularly polarized signal is propagated. No signal at all is propagated for such densities if the electron cyclotron frequency is below the applied frequency. The plasma refractive index for this right-hand mode exceeds unity. The polarization sense of both modes is defined relative to the direction of the magnetic field and not to the direction of propagation.

Measurements of the amplitude of the propagated right-hand signal for moderate plasma densities are consistent with the absorption predicted by the Appleton-Hartree relation, taking the electron density and temperature values measured by the Langmuir probe."

192. Roberts, K.V., and Taylor, J.B.
Magnetohydrodynamic equations for finite Larmor radius.
Phys. Rev. Letters, vol.8, no.5, March 1, 1962. pp.197-198.

"It is shown that the finite Larmor radius stabilization demonstrated by Rosenbluth, etc. can be obtained from the magnetohydrodynamic equations by making prescribed modifications to the ion pressure tensor and to Ohm's law. It is not essential to use Vlasov's equation for this type of problem and the more elementary derivation given here may help to make the physics clearer."

193. Sweetman, D.R.
Conference on plasma physics and thermonuclear fusion, Salzburg, September, 1961.
Brit. J. Appl. Phys., vol.13, no.3, March, 1962. pp.102.

"A brief review of the most important results disclosed at Salzburg."

194. Adams, J.B.
Controlled fusion research.
J. Inst. Elect. Engrs, vol.8, no.88, April 1962. pp.193-196.

"A review of present experimental work in controlled nuclear fusion, based on the information made available at the Salzburg conference."

195. Allen, J.E., James, T.E. and Worsnop, P.A.
The design of a cusp compression experiment (Spice). (Abstract only).
Colloque sur les Problèmes Techniques Particuliers aux Recherches sur la Fusion Controlée, Fontenay-aux-Roses, April, 1962. Summary of papers, pp.62.

196. Alston, L.L.
Insulation studies for high-voltage pulsed equipment. (Abstract only).
Colloque sur les Problèmes Techniques Particuliers aux Recherches sur la Fusion Controlée, Fontenay-aux-Roses, April, 1962. Summary of papers. pp.15-16.

197. Hancox, R.
The triggering of low pressure spark gaps. (Abstract only).
Colloque sur les Problèmes Techniques Particuliers aux Recherches sur la Fusion Controlée, Fontenay-aux-Roses, April, 1962. Summary of papers. pp.37.

198. Millar, W.
Long pulses of high frequency oscillations at high power levels. (Abstract only).
Colloque sur les Problèmes Techniques Particuliers aux Recherches sur la Fusion Controlée, Fontenay-aux-Roses, April, 1962. Summary of papers. pp.58-59.

199. Gabriel, A.H., Niblett, G.B.F. and Peacock, N.J.
Vacuum ultraviolet radiation from a magnetically compressed plasma.
First International Conference on Vacuum Ultraviolet Radiation Physics, Los Angeles, April, 1962. Proceedings. J. Quant. Spectrosc. Radiat. Transfer, vol.2, October/December, 1962. pp.491-502.

200. Wilson, R.
The spectroscopy of non-thermal plasmas.
First International Conference on Vacuum Ultraviolet Radiation Physics, Los Angeles, April, 1962. Proceedings. J. Quant. Spectrosc. Radiat. Transfer, vol.2, October/December, 1962. pp.477-490.

201. Copley, D.M. and Whiteman, K.J.
Some hydromagnetic equilibria that satisfy the necessary and sufficient stability conditions.
J. Nucl. Energy, Pt.C, vol.4, no.2, April, 1962. pp.103-110.

"A criterion that is both necessary and sufficient for the stability of a cylindrically symmetric hydromagnetic equilibrium has been obtained by Newcomb and Suydam. A numerical method of using the criterion to test for stability is described and some stable equilibrium configurations presented."

202. Alston, L.L.
Effects due to voltage waveshape and void parameters.
Int. Conf. on Gas Discharges and the Electricity Supply Industry, Leatherhead, May, 1962. pp.461-467.

"A review of the effects of applied voltage waveshape on the electrical breakdown of solid insulation by discharges in voids is presented, together with data on effects due to void size and position. It is shown that the life of insulation subjected to voltage pulses may decrease if (1) the peak value, (2) the peak-to-peak value, (3) the rate of change of voltage, (4) the pulse duration, or (5) the interval between pulses is increased. Experiments are described where polythene samples containing artificial voids were subjected to unidirectional pulses of rectified 50c/sec alternating voltage and 1/50 μ sec impulses. Results show that at high stresses with the void adjacent to the anode, breakdown may occur in a shorter time than when the void is adjacent to the cathode. It is suggested that the present results indicate that intrinsic breakdown of the polythene occurred after relatively little erosion by discharges and, at high stresses where intrinsic breakdown may occur, voids adjacent to the anode are more deleterious, but at lower stresses where the mechanism of erosion predominates, voids at the anode are less harmful than at the cathode."

203. Bates, D.R., Kingston, A.E. and McWhirter, R.W.P.
Recombination between electrons and atomic ions. I. Optically thin plasmas.
Proc. Roy. Soc., A, vol.267, no.1330, May 22, 1962. pp.297-312.

"Consideration is given to the interacting collisional and radiative processes occurring in a plasma. A statistical theory describing the general loss mechanism, for which the name collisional-radiative recombination is proposed, is described. This theory enables the collisional-radiative recombination coefficient α to be determined knowing the relevant spontaneous transition probabilities and the rate coefficients for radiative recombination and collisional excitation and ionization.

Detailed calculations are carried out on hydrogen-ion plasmas which are optically thin. It is found that α is an increasing function of the number density of free electron n(c) the increase being especially marked if the electron temperature T is low; for example, if T is 250°K α becomes almost 20 times as great as the radiative recombination coefficient (which describes the loss in a very tenuous plasma) when n(c) is only about 10^8 cm^3 , whereas if T is 64000°K α does not become as great as this until n(c) is about $10^{18}/cm^3$. From a similar investigation in which the ground level of the hydrogen atom is made inaccessible (in crude representation of an alkali atom) it is inferred that the value of α is probably not very sensitive to the species of singly charged ion involved.

Recombination of electrons with bare nuclei of charge Ze to form hydrogenic ions is similarly treated for an optically thin plasma. It is shown that to a close approximation the reduced coefficient α/Z is a function of a reduced temperature T/Z^2 and a reduced number density $n(c)/Z^7$ only. The values of the reduced coefficients are of comparable magnitude and have a similar dependence of the reduced temperature and density as the coefficients for hydrogen ion plasmas.

The variation of the recombination coefficient α with Z in the same plasma (i.e. same n(c) and T) is investigated. It may be expressed in the form $\alpha \propto Z^z$ where the index z depends on n(c) and T. Though z is generally positive as would be expected, it is negative if n(c) and T are very high. A physical explanation of this is presented."

204. Bovey, L. and Gabriel, A.H.
Spectroscopic studies using time-resolution techniques.
Spectrochimica Acta, vol.18, May, 1962. pp.631-654.

"A series of grating and prism spectrographs and direct-recording spectrometers used to record spectra over the range 100-8000 Å at microsecond intervals or less are described. Studies were made of atomic spectra emitted by large-scale discharges such as occur in Zeta, Sceptre, Thetatron, Torus T.A. 2000, the ion injection machine (M.M.I.I.) and other smaller laboratory experiments with electron densities ranging from 10^{14} to $10^{18} cm^{-3}$ and temperatures 1 to 100 eV. Results are discussed in theories involving ionization, excitation and recombination conditions within the plasma. The use of (and necessary apparatus for) time-resolved spectra in the spectrochemical analysis of copper alloys was also described."

205. Jones, B.B.
A method for obtaining accurate half-density widths of spectral lines photographed in the vacuum ultraviolet.
Applied Optics, vol.1, no.3, May, 1962. pp.239-242.

"A method has been developed for finding the half-intensity width, to an accuracy of ±5%, of the profiles of spectral lines photographed in the vacuum ultraviolet. Plate calibration is achieved by an aperture restriction device placed at the Sirks focus of a 3-meter normal incidence vacuum spectrograph. This gives a stepped intensity in the focal plane with a standard ratio of 2:1. The measurement is not affected by reciprocity law failure or intermittency effect in the photographic emulsion, and can be used with pulsed pight sources."

206. Ramsden, S.A. and McLean, E.A.
Optical refractivity of free electrons. (Letter).
Nature, vol.194, no.4830, May 26, 1962. pp.761-762.

"Reports measurements of the optical refractivity of free electrons in a hydrogen plasma in which simultaneous determinations of electron density are obtained from the Stark effect broadening of Hβ and Hγ , and from a measurement of the absolute continuum intensity. Comparison of these with values of electron density obtained from the refractive index of the free electrons shows agreement within the accuracy of the measurements."

207. Robson, A.E.
A short review of fusion studies.
Int. Conf. on Gas Discharges and the Electricity Supply Industry, Leatherhead, May, 1962. pp.509-516.

208. Bickerton, R.J. and Spalding, I.J.
The hydromagnetic stability of the hardcore pinch with small electrical conductivity.
J. Nucl. Energy, pt.C, vol.4, no.3, June, 1962. pp.151-158.

"The hydromagnetic stability of a simplified hardcore system is examined in the limit of very small electrical conductivity. It is shown that instabilities develop due to the rapid penetration of magnetic field into the plasma and the growth rates are calculated. A model experiment using liquid mercury has been carried out and the results are compared with theory. Good agreement is obtained when the latter is modified to include the effect of surface tension."

209. Blackwell, D.E. and Wilson, R.
Interference to optical astronomy from belts of orbiting dipoles (needles).
Quart. J. Roy. Astron. Soc., vol.3, no.2, June, 1962. pp.109-114.

210. Dugdale, R.A., Maskrey, J.T. and McVickers, R.C.
Arc initiation on heated molybdenum exposed to a toroidal hydrogen discharge.
J. Nucl. Materials, vol.6, no.1, May-June, 1962. pp.35-45.

"Arc initiation on metals subjected to a gas discharge is a problem important to controlled thermonuclear research. Previous work has suggested the importance of surface contamination to arc initiation under these conditions. In particular, second phase particles of high electrical resistivity, present as impurities in metals, were believed to be important arc initiators. By varying the temperature of a refractory metal the second phase content may be influenced in various ways. We have made an experimental investigation of arc initiation on molybdenum and other refractory metals as a function of temperature and heat treatment the results of which are consistent with these ideas. The interpretation suggests that arcing stops when certain second phases dissolve at high temperatures, that there is a critical size of particle for arc initiation which decreases with increasing specimen voltage and increasing ion current density and that it is possible to deplete the specimen of the arc initiating impurities by combined electrical treatment and heat treatment. The latter process can be carried to the stage where a temperature-independent non-arcing state is achieved at a specimen voltage of 2 kV and ion current density of 23 A/cm^2 in a pulse of 200 μsec duration.

211. Fisher, D.L. Green, T.S. and Niblett, G.B.F.
An experimental and numerical study of radial hydromagnetic oscillations.
J. Nucl Energy, pt.C, vol.4, no.3, June, 1962. pp.181-184.

"Reports additional measurements of the radial hydromagnetic oscillations of a plasma compressed by a fast-rising axial magnetic field and compares them with numerical computations using the programme developed by Hain et al for solving the hydromagnetic equations."

212. Little, P.F.
Ion waves in a bounded plasma.
Nature, vol.194, no.4834, June 23, 1962. pp.1137-1139.

"Experiments have been carried out on the transmission of low-frequency ion waves in the direction of the electron drift along a mercury arc column. Measurements were made with and without an axial magnetic field. It is established that, when a small axial field is applied, ion waves are observed, of higher phase velocities than in an infinite medium. In zero axial field the experimental errors are larger but there is some indication that such waves exist. It is shown that the maximum electron drift velocity permissible in a plasma where $T_i \sim T_e$ is about ten times the ion thermal velocity if growing waves are not to arise."

213. Wort, D.J.H.
Directional coupler in oversize waveguide.
J. Sci. Instrum. vol.39, no.6, June, 1962. pp.317.

"The use of oversized waveguide (WG16, 1" x $\frac{1}{2}$") gives considerably less attenuation than standard waveguide in long waveguide runs, but the standard WG16 components are unsuitable as directional couplers. The coupler described can be made in the laboratory to ordinary workshop tolerances and has been found effective at 4.2 mm wavelengths, though it is evident that the technique is applicable at shorter wavelengths."

214. Phillips, N.J.
On the initial stages of a pinch discharge. (Letter).
Proc. Phys. Soc., vol.80, pt.1, no.513, July 1, 1962. pp.307-309.

"During the formative stages of a gas discharge, the resistivity of the partially ionized gas will be almost entirely due to electron-neutral particle collisions, with Coulomb collisions between the electrons and positive ions beginning to dominate at a fractional ionization of about 10^{-2}. It is shown that there is a tendency for the total number of electrons in the current sheet to set a limit to itself before implosion, particularly if the ratio of initial applied electric field to the initial gas pressure is large. In the latter case it is suggested that the role of the current sheet in the z pinch as a collector of the neutral gas initially in the discharge tube may have to be reconsidered."

215. Skinner, A.
Versatile high-speed rotating-mirror cameras.
J. Sci. Instrum., vol.39, no.7, July, 1962. pp.336-343.

"A description is given of some high speed rotating mirror streak and framing cameras, together with a discussion of the fundamental limits of performance of such instruments. These cameras have been developed at the Atomic Weapons Research Establishment, Aldermaston, and are now in regular use in the study of high temperature plasmas and explosive phenomena. Versatility combined with maximum efficiency of performance have been the over-riding considerations in their design. Interchangeable optical systems have enabled framing rates of 8 million per second to be achieved with frame sizes of 8 mm at the top end of the scale, to framing rates of one million per second with $25\frac{1}{2}$mm frame size at the bottom end. The corresponding maximum numbers of exposures obtainable are 117 and 23. Streak writing speeds of up to 30 mmμ sec^{-1} are available. Synchronization of the events to be photographed is necessary and is achieved with an integral photoelectric system."

216. Harrison, E.R.
Ion oscillations in multistream plasmas.
Proc. Phys. Soc., vol.80, pt.2, no.514, August 1, 1962. pp.432-440.

"Longitudinal ion oscillations (including ion-ion oscillations) in twostream and multistream plasmas are discussed using first the fluid equations and then the Vlasov equations. Ion oscillations occur when the electron inertia is small compared with the electron pressure, or, stated in an alternative way, when the magnitude of the phase velocity of the wave relative to the electrons is less than the electron thermal speed. The fluid approach to the subject fails to treat in an adequate way the damping effect of the ion thermal motions and therefore cannot provide precise criteria for stability. Furthermore, in a collision-free plasma it is not clear from the fluid treatment whether the electrons fluctuate isothermally or adiabatically, and to this extent there is some doubt whether ion oscillations are possible in the absence of electron-electron collisions. On the assumption that collisions are of negligible effect, the Vlasov equations are then used to derive an ion oscillation dispersion relation in which, for wavelengths greater than the electron Debye length, the ion plasma frequencies are reduced by the screening effect of the electrons. This equation shows that the electron gas fluctuates isothermally and the electron density therefore varies according to the Boltzmann law. The stability of ion-ion oscillations in multistream plasmas is then considered. It is shown, for example, that the sufficient condition for stability for all possible velocities of the ion streams is

that $(T_j^{-1})^{-1}/T_e \geqslant 0.2847$, where T_e is the electron temperature and (T_j^{-1}) is the mean reciprocal of the ion temperatures. This result is for singly-charged ions and is readily generalized for multiply-charged ions. When the multistream medium consists of two identical counterstreaming plasmas the condition that there are no exponentially time growing ion oscillations is determined in terms of the plasma velocities."

217. Jephcott, D.F. and Stocker, P.M.
Hydromagnetic waves in a cylindrical plasma : an experiment.
J. Fluid Mechanics, vol.13, no.4, August, 1962. pp-587-596.

"In a previous paper (Woods 1962) a theory is presented which leads to a general dispersion relation for hydromagnetic waves in a dissipative plasma contained in a cylindrical tube. In the present paper experimental observations are compared with the predictions of this theory.

An experiment is described in which torsional hydromagnetic waves are excited in a gas discharge. Measurements of the wave velocity and damping are compared with solutions of the dispersion equation which are computed from measured values of the plasma parameters. The results are consistent with the theory, and good numerical agreement is obtained by assuming a loss of particles to the tube walls. There is evidence of a cut-off in wave propagation in the region of ion cyclotron resonance."

218. Green, T.S.
An investigation of the Theta pinch using magnetic pick-up loops.
Nuclear Fusion, vol.2, nos.1-2, September, 1962. pp.92-101.

"This paper presents an account of the investigation of the behaviour of the plasma in a theta-pinch device using a magnetic pick-up loop system. The technique has been developed to determine the current in the plasma from measurements made outside the plasma. Experimental results are presented to show the extent to which this determination contributes to an understanding of the phenomena of magnetic field trapping, radial and axial motion and containment which occur in the Thetatron. Specific measurements can be made of the strength of trapped field when it is reversed. Observations can also be made of the variation of the plasma line density with time, and this has enabled a study of axial contraction and expansion to be made. It is found that the rate of axial contraction decreases as the strength of the reversed trapped field decreases. Near the transition region between the trapping of reversed and like magnetic field the line density is observed to be constant in time suggesting good containment."

219. Haas, F.A.
A physical derivation of Landau damping. (Letter).
Nuclear Fusion, vol.2, nos. 1-2, September, 1962. pp.105-106.

220. Johns, T.F.
Prospects for thermonuclear power.
London, Harrap, September, 1962. 78pp., Illus., 10s. 6d.

"An elementary introduction to thermonuclear devices for the general reader."

221. Wort, D.J.H.
Solar temperature at 2-mm wavelength. (Letter).
Nature, vol.195, no.4848, September 29, 1962. pp.1288-1289.

"Measurements of the apparent temperature of the sun at a wavelength of 2.04 mm gave a result of 5,670 ± 230°K, indicating that the Athay radio model of the chromosphere requires some adjustment; in particular that the temperature of the 'cold' component of the chromosphere in the model is some 800°K too high."

222. Allan, D.W.
On the behaviour of systems of coupled dynamos.
Proc. Camb. Phil. Soc., vol.58, pt.4, October, 1962. pp.671-693.

"The bevaiour of a system of two coupled disk dynamos is studied in considerable detail. It is shown that in several cases the stability criteria and general behaviour are closely related to those for the single dynamo studied by Bullard, which are resumed briefly. Extended numerical investigations of the non-linear behaviour of the system are presented: these show that a true 'reversal of field' may occur."

223. Dugdale, R.A., McVickers, R.C. and Ford, S.D.
The bursting of tubes containing gas discharges.
Brit. J. Appl. Phys., vol.13, no.10, October, 1962. pp.508-513.

"During a study of thermal shock effects produced on brittle materials by an intense gas discharge of 20 μsec duration, breakage of specimens and bursting of tubes sometimes occurred. Observations have been made of the conditions under which these effects occur. Changes in strength and erosion of materials by the discharge were also studied. These observations suggest that breakage is not primarily a thermal shock effect but arises from an impulse generated within the tube. Further experiments on the effect of tube material on specimen breakage and measurements of the impulse produced in a silica tube as aginst an alumina tube, suggest that, for glasses at least, the impulse is caused by a transient high pressure due to evaporation. A semi-quantitative discussion supports this conclusion."

224. Jephcott, D.F.
The Salzburg Conference on Plasma Physics and Controlled Nuclear Fusion Research. (4th to 9th September 1961).
Contemporary Phys., vol.4, no.1, October, 1962. pp.49-54.

"A review of developments in cusp and mirror geometries based on information disclosed at the conference."

225. Medford, R.D., Powell, A.L.T. and Fletcher, W.H.W.
Existance of weak R-type ionization fronts.
Nature, vol.196, no.4849, October 6, 1962. pp.32-33.

"Some evidence is given for the existence of weak R type ionization fronts obtained during investigations of electromagnetically driven planar shock waves in the laboratory. Although not conclusive the observed phenomena may help to resolve the anomaly introduced by the Chapman-Jouget hypothesis which shows that, on the strophysical scale, such fronts cannot exist."

226. Medford, R.D., and others.
Longitudinal shocks in unpinch geometries.
J. Nucl. Energy, pt.C, vol.4, no.5, October, 1962. pp.341-346.

"The propagation of longitudinal shock waves along plasma columns confined by external and internal magnetic fields are analysed. The specific cases of the 'unpinch' and 'hardcore' geometries are considered and their existence shown in the former case.

The use of longitudinal shocks in a linear pinch for diagnostic purposes is demonstrated."

227. Temperley, H.N.V.
Statistics of a two-dimensional lattice gas. Part.I.
Proc. Phys. Soc., vol.80, pt.4, no.516, October 1, 1962. pp.813-820.

"In continuation of former work on a simple model in which two molecules may not occupy neighbouring sites on a plane square lattice, various portions of the virial series are derived. The series is split up, not into individual cluster-sums, but into contributions from various types of groups of sites, in the manner introduced by Rushbrooke and Scoins in 1953. It is concluded that the main contributions to the virial series come from single sites, neighbouring pairs and 'open' rings of sites, and that contributions from other types of domains of sites are small in comparison, some vanishing identically."

228. Temperley, H.N.V.
Statistics of a two-dimensional lattice gas. Part.II.
Proc. Phys. Soc., vol.80, pt.4, no.516, October 1, 1962. pp.823-829.

"The work of part I suggests that the contributions to the virial series from domains of sites that are not rings or pairs can be neglected. The consequences of this approximation, named the 'necklace' approximation, are studied. Enough information is available for these consequences to be worked out almost completely for the plane square lattice. The contribution from rings of four and eight sites are worked out explicitly, while the effect of longer rings of sites can be allowed for also. It is concluded that the correct consequence of this model is a first-order phase change, despite the fact that simpler approximations predict a second-order change. Comparison with a matrix calculation for an 8 x infinite lattice shows satisfactory agreement, and enables the influence of boundaries on the phase change to be estimated."

229. Wort, D.J.H.
The emission of microwave noise by plasma.
J. Nucl. Energy, pt.C, vol.4, no.5, October, 1962. pp.353-357.

"This work determines the thermal microwave emissivity of a plasma of infinite extent, in which there is a linear gradient of electron number density in the direction of observation. The region in the plasma which contributes most effectively to the radiation is found to lie close to the plane of critical density. The effect of reflecting walls surrounding the plasma is included, and some mention is made of the directional properties of the radiation. A discrepancy between theory and observation appears on consideration of the experimental results from the Zeta plasma."

230. Bates, D.R., Kingston, A.E. and McWhirter, R.W.P.
Recombination between electrons and atomic ions.
II. Optically thick plasmas.
Proc. Roy. Soc., A, vol. 270, no. 1341, November 13, 1962. pp.155-167.

"The effect of self-absorption on the rate of collisional-radiative recombination is investigated using the statistical theory developed in an earlier paper. Detailed calculations are carried out on hydrogen ion plasmas. The following cases are treated: case (i), plasma optically thick towards lines of the Lyman series; case (ii), plasma optically thick towards lines of all series; cases (ic) and (iic), plasma as in cases (i) and (ii) respectively but also optically thick towards the Lyman continuum. It is found that self-absorption may reduce the recombination coefficient considerably even in the low electron density limit."

231. Bishop, A.E., Edmonds, G.D. and Sheffield, J.
A 100 kV switch for rapid discharge of high energy capacitors.
J. Sci. Instrum., vol. 39, no. 11, November, 1962. pp.566-568.

"A pressurized, low inductance switch (250 nH) operating between 40 and 100 kV and up to 30 kA for discharging low inductance capacitors is described. The breakdown time of the switch is about 60 nsec, with a jitter of less than 20 nsec."

232. Hancox, R.
Triggering mechanism of low-pressure spark gaps.
Rev. Sci. Instr., vol. 33, no. 11, November, 1962. pp.1239-1244.

"The triggering delay in two low-pressure spark-gap switches, operating in the pressure range 10^{-3} to $3X10^{-2}$mm Hg, has been measured under a wide range of conditions. When the trigger pin is in the negative electrode, the delay is found to consist of two components. The first part depends on the construction of the trigger pin, the trigger voltage, and the impedance of the trigger circuit, while the second depends on the nature and pressure of the gas in the gap, and the voltage and impedance of the circuit being switched. If the trigger pin is in the positive electrode a further delay is added which is approximately equal to the transit time of an ion across the gap. A mechanism for the breakdown is proposed which is consistant with the measurements and with previously reported results."

233. Pease, R.S.
Experiments on the problem of controlled thermonuclear reactions.
Nature, vol. 196, no. 4861, December 19, 1962. pp.1247-1253.

"Substance of a lecture delivered to Section A (Physics) of the British Association for the Advancement of Science, September 4, 1962."

234. Thompson, W.B.
An introduction to plasma physics.
Oxford, Pergamon Press, December, 1962. 256pp., 70s.

"An introduction to the study of the dynamics of an idealized plasma in which inelastic processes including ionization and recombination are unimportant."

AUTHOR INDEX

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