



THE INDIAN ASSOCIATION
FOR THE
CULTIVATION OF SCIENCE

Annual Report for the Year 1936

THE
INDIAN ASSOCIATION
FOR THE
CULTIVATION OF SCIENCE

—*—
Annual Report for the Year 1936.
—*—

Report of the Committee of Management for the year 1936.

MEMBERS

The year under review started with 132 members on the rolls of the Association, of which 122 were life-members, 5 non-resident and 5 resident ordinary members. During the year two new life-members were enrolled and one non-resident member resigned. The total number of members at the end of the year was 133, of whom 124 are life-members, 4 non-resident and 5 resident ordinary members.

FINANCIAL

In the Annual Report for the year 1935 reference was made to the steps taken to restore the amounts due to the several funds. In this connection the following resolution was adopted at the last Annual General Meeting :

“that the Committee of Management be authorised to open accounts with the Imperial Bank of India for the following funds.

- (a) Ripon Professorship Fund.
- (b) Coochbehar Professorship Fund.
- (c) Hare Professorship Fund.
- (d) Victoria Professorship Fund.
- (e) Nikunja Garabini Prize Fund.
- (f) Jatindra Chandra Prize Fund.

- (g) Dr. Sircar Research Medal Fund.
 (h) Joy Kissen Mookerjee Prize & Gold Medal Fund.
 (i) Sir John Woodburn Medal Fund.
 (j) Building Fund.
 (k) Science Association Employees' Provident Fund.
 (l) Veharilal Mitra Fund.
 (m) Mahendralal Sircar Professorship Fund."

The Imperial Bank of India was accordingly instructed to establish separate accounts of these funds and to allocate the securities held by the Association to the different funds with a view to restore as far as possible the amount to the credit of each fund. 3½% G. P. Notes of the face value of Rs. 2,983-15-5, representing the amounts due to the several funds, still remain unallocated and are held in the General Fund which the Imperial Bank calls the "Plain Account". The position of the various funds is shown below.

1. Ripon Professorship Fund

| | | | | | | | |
|-----------------|-----|-----|-----|-----|------------|-----|-----------------------|
| 3% G. P. Notes | ... | ... | ... | ... | Face value | Rs. | 4,000-0-0 |
| 3½% G. P. Notes | ... | ... | ... | ... | " | " | 18,000-0-0 |
| | | | | | | | <u>Rs. 22,000-0-0</u> |

1936

| <i>Income</i> | | | <i>Expenditure</i> | | |
|-------------------|-----|-----------------|---|-----|-----------------|
| | Rs. | As. P. | | Rs. | As. P. |
| Opening balance | ... | 82 14 3 | Bank charges for allocating securities* | ... | 27 8 0 |
| Interest for 1936 | ... | 750 0 0 | drawing interest | ... | 8 4 0 |
| | | <u>832 14 3</u> | Closing balance | ... | <u>797 2 3</u> |
| | | | | | <u>832 14 3</u> |

2. Coochbehar Professorship Fund

| | | | | | | | |
|-----------------|-----|-----|-----|-----|------------|-----|-------------------|
| 3½% G. P. Notes | ... | ... | ... | ... | Face value | Rs. | 27,500-0-0 |
| | | | | | | | <u>27,500-0-0</u> |

1936

| <i>Income</i> | | | <i>Expenditure</i> | | |
|-------------------|-----|----------------|---|-----|-----------------|
| | Rs. | As. P. | | Rs. | As. P. |
| Opening balance | ... | 20 0 0 | Bank charges for allocating securities* | ... | 34 6 0 |
| Interest for 1936 | ... | 962 8 0 | drawing interest | ... | 10 5 0 |
| | | <u>982 8 0</u> | Closing balance | ... | <u>937 13 0</u> |
| | | | | | <u>982 8 0</u> |

3. Hare Professorship Fund

3½% G. P. Notes Face value Rs. 1,000-0-0

1936

| <i>Income</i> | | <i>Expenditure</i> | |
|-----------------------|----------------|--|----------------|
| | Rs. As. P. | | Rs. As. P. |
| Opening balance ... | 280 0 0 | Bank charges for allo- cating securities* ... | 1 4 0 |
| Interest for 1936 ... | 35 0 0 | drawing interest ... | 0 6 0 |
| | <u>315 0 0</u> | Closing balance ... | <u>313 6 0</u> |
| | | | <u>315 0 0</u> |

4. Victoria Professorship Fund

3½% G. P. Notes Face value Rs. 1,000-0-0

| <i>Income</i> | | <i>Expenditure</i> | |
|-----------------------|----------------|--|----------------|
| | Rs. As. P. | | Rs. As. P. |
| Opening balance ... | 280 0 0 | Bank charges for allo- cating securities* ... | 1 4 0 |
| Interest for 1936 ... | 35 0 0 | drawing interest ... | 0 6 0 |
| | <u>315 0 0</u> | Closing balance ... | <u>313 6 0</u> |
| | | | <u>315 0 0</u> |

5. Building Fund

3½% G. P. Notes Face value Rs. 7,500-0-0

1936

| <i>Income</i> | | <i>Expenditure</i> | |
|-----------------------|----------------|--|----------------|
| | Rs. As. P. | | Rs. As. P. |
| Opening balance ... | 80 0 0 | Bank charges for allo- cating securities* ... | 9 6 0 |
| Interest for 1936 ... | 262 8 0 | drawing interest ... | 2 13 0 |
| | <u>342 8 0</u> | Closing balance ... | <u>330 5 0</u> |
| | | | <u>342 8 0</u> |

6. Nikunja Garabini Prize Fund

3½% G. P. Notes Face value Rs. 500-0-0

1936

| <i>Income</i> | | <i>Expenditure</i> | |
|-----------------------|----------------|---|----------------|
| | Rs. As. P. | | Rs. As. P. |
| Opening balance ... | 403 14 2 | Bank charges for allocating securities* ... | 0 10 0 |
| Interest for 1936 ... | 17 8 0 | drawing interest ... | 0 3 0 |
| | <u>421 6 2</u> | Closing balance ... | <u>420 9 6</u> |
| | | | 421 6 2 |

7. Joy Kissen Mookerjee Medal Fund

| | | | | |
|---------------------|-----|-----|-----|---------------------------|
| 3½% G. P. Notes ... | ... | ... | ... | Face value Rs. 11,400 0 0 |
|---------------------|-----|-----|-----|---------------------------|

1936

| <i>Income</i> | | <i>Expenditure</i> | |
|-----------------------|----------------|---|----------------|
| | Rs. As. P. | | Rs. As. P. |
| Opening balance ... | 459 0 0 | Bank charges for allocating securities* ... | 14 4 0 |
| Interest for 1936 ... | 399 0 0 | drawing interest ... | 4 5 0 |
| | <u>858 0 0</u> | Closing balance ... | <u>839 7 0</u> |
| | | | 858 0 0 |

8. Woodburn Medal Fund

| | | | | |
|---------------------|-----|-----|-----|--------------------------|
| 3½% G. P. Notes ... | ... | ... | ... | Face value Rs. 1,000 0 0 |
|---------------------|-----|-----|-----|--------------------------|

1936

| <i>Income</i> | | <i>Expenditure</i> | |
|-----------------------|----------------|---|-----------------|
| | Rs. As. P. | | Rs. As. P. |
| Opening balance ... | 316 8 0 | Bank charges for allocating securities* ... | 1 4 0 |
| Interest for 1936 ... | 35 0 0 | drawing interest ... | 0 6 0 |
| | <u>351 8 0</u> | Closing balance ... | <u>349 14 0</u> |
| | | | 351 8 0 |

*Calculated pro rata. The total cost of allocation is Rs. 380-4-0

9. Jatindra Chandra Prize Fund

3½% G. P. Notes Face value Rs. 500 0 0

1936

| <i>Income</i> | | <i>Expenditure</i> | |
|-----------------------|----------------|---|----------------|
| | Rs. As. P. | | Rs. As. P. |
| Opening balance ... | 391 11 0 | Bank charges for allocating securities* ... | 0 10 0 |
| Interest for 1936 ... | 17 8 0 | drawing interest ... | 0 3 0 |
| | <u>409 3 0</u> | Closing balance ... | <u>408 6 0</u> |
| | | | 409 3 0 |

10. Dr. Sircar Research Medal Fund

3½% G. P. Notes Face value Rs. 4,000 0 0

1936

| <i>Income</i> | | <i>Expenditure</i> | |
|-----------------------|----------------|---|----------------|
| | Rs. As. P. | | Rs. As. P. |
| Opening balance ... | 470 0 0 | Bank charges for allocating securities* ... | 5 0 0 |
| Interest for 1936 ... | 140 0 0 | drawing interest ... | 1 8 0 |
| | <u>610 0 0</u> | Closing balance ... | <u>603 8 0</u> |
| | | | 610 0 0 |

11. M. L. Sircar Professorship Fund (a)

3½% G. P. Notes Face value Rs. 1,47,000-0-0

1936

| <i>Income</i> | | <i>Expenditure</i> | |
|---------------------|------------|---|------------|
| | Rs. As. P. | | Rs. As. P. |
| Opening balance ... | 200 0 0 | Contribution to the salary and Provident Fund of M. L. S. Professor ... | 5,145 0 0 |
| Interest ... | 5,145 0 0 | Closing balance ... | 200 0 |

12. Veharilal Mitra Fund (b)

3½% G. P. Notes Face value Rs. 1,32,000-0-0

1936

| | Rs. | As. | P. | | Rs. | As. | P. |
|-----------------|-------|-----|----|---|-------|-----|----|
| Interest | 4,620 | 0 | 0 | Contribution to the salary and Provident Fund of M. L. S. Professor ... | 4,620 | 0 | 0 |

13. Plain Account (c)

| | | | | |
|------------------------|----------------|--------|---|---|
| 3½% G. P. Notes | Face value Rs. | 29,500 | 0 | 0 |
|------------------------|----------------|--------|---|---|

14. Science Association Employees' Provident Fund

| | | | | |
|--|-----|---------------|----------|-----------|
| Cash certificates (purchase value) | Rs. | 7,331 | 4 | 0 |
| Loan (to be recovered from the staff) | ,, | 1,110 | 0 | 0 |
| Cash balance in P. O. Savings bank | ,, | 5,502 | 0 | 11 |
| | | <u>13,944</u> | <u>4</u> | <u>11</u> |

OPENING BALANCES OF THE SEVERAL FUNDS

| | Rs. | As. | P. |
|---|------------------|-----------|----------|
| 1. Mahendralal Sircar Professorship Fund | 200 | 0 | 0 |
| 2. Coochbehar Professorship Fund | 20 | 0 | 0 |
| 3. Ripon Professorship Fund | 82 | 14 | 3 |
| 4. Dr. Sircar Research Medal Fund | 470 | 0 | 0 |
| 5. Joy Kissen Mookherjee Medal | 459 | 0 | 0 |
| 6. Building Fund | 80 | 0 | 0 |
| 7. Victoria Professorship Fund | 280 | 0 | 0 |
| 8. Hare Professorship Fund | 280 | 0 | 0 |
| 9. Woodburn Medal Fund | 316 | 8 | 0 |
| 10. Nikunja Garabini Prize Fund | 403 | 14 | 2 |
| 11. Jatindra Chandra Prize Fund | 391 | 11 | 0 |
| | <u>Rs. 2,983</u> | <u>15</u> | <u>5</u> |

NOTE :—(a) Income ear-marked for M. L. S. Professor's salary & Provident Fund, includes securities of face value of Rs. 1,13,699-4-9 transferred from General Fund. This is to be recovered as further contribution to the M. L. S. Professorship Fund are received in way of life membership fees, vide resolution of the Managing Committee dated Dec. 22, 1936.

(b) Income ear-marked for M. L. S. Professor's salary and Provident Fund.

(c) The sum of Rs. 2983-15-5 as shown in detail, being the unallocated amounts due to the several funds, are included in the Plain account. This will be adjusted during 1937.

The amounts still remaining unallocated on account of the above funds will be adjusted during the current year.

2. The cash balance was not sufficient to meet the payments until the grant from the Government of India was received and it was necessary to borrow a sum of Rupees five thousand to make payments pending the receipt of the grant. Such a necessity may recur during the current year.

3. According to the present rules of the Association the Committee of Management is not empowered to take over-drafts from the Bank and on the authority of the Committee one of trustees, Mr. J. N. Basu and the Honorary Secretary arranged for the loan of Rs. 5,000 on behalf of the Association. The Committee of Management adopted the following resolution in this connection, which is being placed before the Annual General Meeting for confirmation :

“Resolved that the Committee of Management recommends to the General Meeting that the following Rule be added to the existing Rules of the Association and that the new rule be inserted between existing Rules 22 and 23.”

‘The Committee of Management will be entitled to borrow money from time to time on behalf of the Association not exceeding a total of Rupees ten thousand during any year on such terms and conditions as the Committee of Management shall think proper with or without security, the security being the whole or a part of the cash, securities or investments constituting the general fund of the Association and not the special trust funds belonging to the Association. All necessary documents to be executed on behalf of the Association for obtaining loans shall be executed by the Secretary and one of the Trustees of the Association other than the Secretary.’

4. The Government of India has not yet restored the 10% cut on the Government of India Grant.

5. The Honorary Secretary brought to the notice of the Committee of Management that the rent of shops was fixed some twelve years back and was exceptionally low and as a result of negotiation, which at one time looked as if legal action would be necessary, a happy solution has been arrived at. Excepting A. Burman all the tenants have agreed to pay the rent at the enhanced rate of 25% from November, 1936.

Messrs. B. N. Basu & Co., solicitors, have helped in all legal affairs and issued the relevant notices and letters without any remuneration.

6. **Science Association Employees' Provident Fund.** Cash certificates were purchased at a cost of Rs. 7,331-4-0 on account of the Provident Fund and kept in the custody of the Imperial Bank of India through their courtesy pending the final decision of the Commissioner of

Income-tax regarding the recognition of the Provident Fund. It is hoped that the final order will be received during the current year (1937).

7. In the report for the year 1935 mention was made of the steps taken to take stock of the scientific apparatus of the Association against the item of Rs. 1,15,657 shown in the balance sheet. The auditor was asked to prepare a list of apparatus purchased against the available vouchers. This has been done. A register of the apparatus purchased up to 1935 and still in stock has yet to be prepared.

8. The accounts of the Association are being kept in accordance with the resolutions of the Committee of Management and the auditor has been requested to examine them and make further recommendations if considered necessary regarding the form in which the books are to be maintained.

9. **Building Repairs.** A sum of Rs. 2,229-2-9 has been spent for repairing the leaks on the roofs and for renovating the lumber room attached to the workshop. Mr. M. N. Mukherji, B.E., has very kindly checked the estimates and bills and supervised the work without any remuneration.

10. The receipts and payments during the year 1936, the balance sheet on 31-12-36 and the budget estimates for 1937 are given in Appendix I.

RESEARCH SCHOLARSHIPS

Applications were invited in 8 leading newspapers at different parts of India for research scholarships and the following awards were made for the year 1937.

1. Mr. K. S. Sundararajan, M.Sc.
2. „ Akshyananda Bose, M.Sc.
3. „ Asutosh Mookherji, M.Sc.
4. „ Chandrasekhariah, M.Sc.
5. „ Santilal Banerji, M. Sc.
6. „ P. K. Seshan, M. Sc.
7. „ Jagattaran Dhar, M. Sc.

RULES FOR THE AWARD OF PROFESSORSHIPS, MEDALS, PRIZES, RESEARCH FELLOWSHIPS AND SCHOLARSHIPS

The following rules have been adopted by the Committee of Management for the award of Research Scholarships, Professorships, Medals and Prizes.

A. Professorships

1. Coochbehar Professorship (Annual interest Rs. 945-11-0).
 - (a) The income from the fund should be utilised in payment of honorarium to eminent scientists who delivered a course of lectures in the Association and whose association with the Institution is considered by the Committee of Management to be in the interest of the Scientific Progress of India.
 - (b) It shall ordinarily be awarded annually on some chemical subject. The subject need not be restricted to specialised topics.
 - (c) The remuneration shall be Rs. 900 for the course.
2. Ripon Professorship (Annual interest Rs. 771).
 - (a) The income from the fund should be utilised in payment of honorarium to eminent scientists who delivered a course of lectures in the Association and whose association with the Institution is considered by the Committee of Management to be in the interests of the Scientific Progress of India.
 - (b) It shall ordinarily be awarded annually for a course of lectures on some scientific subject other than chemistry. The subject need not be restricted to specialised topics.
 - (c) The remuneration shall be Rs. 750 for the course.
3. Victoria Professorship (Annual interest Rs. 44-12-0).
4. Hare Professorship (Annual interest Rs. 44-12-0).

Each of these professorships should be awarded for a course of lectures in every alternate year. The first award shall be made in 1937 and thereafter no award shall be made till the investment of the accumulated interest raises the annual income for each of these Professorships to Rs. 50.

General. A typescript copy of the lectures delivered by the above Professors should be made over to the Honorary Secretary in a form suitable for publication by the Association.

B. Medals

1. Joykissen Mookerjee Medal (Annual interest Rs. 415-1-0).—The income from the fund should be utilised in payment for a gold medal to be awarded to eminent scientists who delivered a course of lectures in the Association and whose association with the Institution is considered by the Committee of Management to be in the interest of the Scientific Progress of India.

2. Dr. Sircar Research Medal.—A gold medal should be awarded triennially for scientific research of a markedly original character carried out in India during the previous three years. The work shall be presented to the Association for publication and shall remain absolutely the property of the Association.

Applications shall be invited by advertisement and accompanied with a record of research work and references. The person selected for the award of the medal shall be requested to write a connected account of his subject suitable for publication. He may also be requested to deliver a course of lectures on the same subject.

3. Sir John Woodburn Medal (Annual interest Rs. 46-3-0).—Out of the interest of this fund a gold medal, to be called the Woodburn medal, be awarded every second or third year for original research in any branch of physical science by a native of India, (vide page 14, 23rd Annual Report held on 3rd August 1900).

C. Prizes

1. Jatindra Chandra Prize (Annual interest Rs. 31).
2. Nikunja Garabini Prize (Annual interest Rs. 31-8-0).

Considering the fact that the Association has discontinued the B.Sc. teaching classes the existing rule (vide Annual Report for 1935, page 8) cannot be given effect to. Each of these prizes shall be awarded in every alternate year for the best research carried out in the Association.

General. The award of medals and prizes shall ordinarily be made every year at the Annual General Meeting.

D. Research Fellowships and Scholarships

1. The Managing Committee shall be competent to appoint Research Fellows. The remuneration of such Fellows shall not be less than Rs. 125 per month. Research Fellows shall have independent facilities for work subject to the provision of Rule 13 of the conditions of service of the M. L. S. Professor.

2. Not less than two Research Scholars shall be attached to the M. L. S. Professor.

3. Applications shall be invited by advertisement.

4. All Research Fellows and Scholars and workers shall abide by the rules framed from time to time by the Committee of Management for their guidance and conduct.

5. All appointments of Research Fellows and Scholars shall be made by the Committee of Management, provided that for persons working in the Physics Laboratory the M. L. S. Professor shall be previously consulted.

6. A research scholar who has been elected for one year may be eligible for re-election, if his work has been satisfactory. He shall devote himself exclusively to research work in his special subject and shall not, so long as he is holding the scholarships, engage himself in any other remunerative work. He shall submit a six-monthly report of his work to the Committee of Management.

7. Ordinarily, a scholarship shall not be renewable after a period of three years, provided that the Managing Committee in exceptional circumstances may by a unanimous resolution agree to extend the scholarship for another year.

JOY KISSEN MOOKERJEE MEDAL

Sir E. John Russell, K.B.E., F.R.S., Director, Rothamsted Experimental Station, Harpenden has been invited to address the Association and it has been decided to award the Joy Kissen Mookerjee medal to him.

The Association had no seal or monogram and the Committee of Management has approved a seal of the Association. The design of the seal is also to be used for the award of medals and other relevant purposes.

POPULAR LECTURE

Two popular lectures were delivered during the year. The first one was delivered by Mr. P. Evans, M.A., F.R.S., F.N.I., Senior Geologist, Burmah Oil Co., on 'Science in the Oil Technology' in August, 1936 and the second lecture was delivered by Prof. P. N. Ghosh, M.A., Ph.D., Sc.D., on 'Illumination Past and Present' in September, 1936. It is intended to arrange for a larger number of lectures during 1937.

For the benefit of students in addition to the above, regular courses of lectures in Physics and Chemistry were delivered at the lecture hall with the aid of the apparatus and demonstrators of the Association.

STAFF

1. Dr. D. P. Rai Chowdhuri, D.Sc., has been granted leave without pay for four and half months.

2. Prof. K. S. Krishnan has been granted study leave for the period of 18th February to 5th July, 1937, on the following conditions :—

- (a) that study leave for the period, 18th February to 5th July, 1937 (both days inclusive) be granted to him on full pay,
- (b) that a sum of Rs. 4,000 be advanced to Prof. Krishnan on loan without interest on condition that he assigns an insurance policy on his life for Rs. 5,000 in favour of the Association and gives a personal security for the sum advanced to him and that the sum be recovered from him in 24 equal monthly instalments,
- (c) that he be permitted to accept remunerations for lectures delivered by him abroad and
- (d) that a sum of £25 be sanctioned to him towards the cost of his passage fare.

INDIAN JOURNAL OF PHYSICS ON PROCEEDINGS OF THE INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

Altogether 54 papers have been published in the Indian Journal of Physics, Vol. X during the year 1936. Of these five were contributed by authors from Lahore, one from Madras, one from Jaipur (Rajputana), one from Bombay, one from Benares, two from Allahabad, four from Patna, two from Waltair, one from Rajshahi, one from Delhi, two from Bangalore, one from Dacca, two from America, one from Aligarh and the remaining 29 papers were contributed by authors working in different institutions in Calcutta. The total number of pages published is 482.

Of these 54 papers, four are on Magnetism, two on X-rays, four on Wireless, thirteen on Raman Effect, eleven on Spectra and the rest on miscellaneous subjects, both theoretical and experimental.

A list of the papers published in the journal is given in Appendix II.

LIBRARY

A sum of Rs. 403-13-0 is still outstanding on account of the Journals which will be met from the grant under that head for 1937 (vide budget estimates for 1937).

A list of books and periodicals has been prepared but the stock has not been verified. This is difficult because quite a number of old vouchers are not available. A consolidated list of missing journals has not yet been prepared. The subscriptions for the following publications were continued.

1. Scientific American.
2. Nature.
3. Science Abstracts.
4. American Journal of Science.
5. Philosophical Magazine.
6. Phil. Trans. Royal Society, A.
7. Proc. Roy. Inst. Great Britain.
8. Physical Review.
9. Zeitschrift für Physik.
10. Proc. Royal Society, A.
11. Annalen der Physik.
12. Physikalisches Zeitschrift.
13. Journal of the American Chemical Society.
14. Proc. National Acad. Science, Washington.
15. Zeitschrift für physikalisches Chemie, A & B.
16. Zeitschrift für Kristallographie.
17. Annalen der Physique.
18. Comptes Rendus.
19. Chemical Abstracts.
20. Science Progress.
21. Transactions of the Faraday Society.
22. Naturwissenschaften.
23. Zeitschrift für Astrophysik.
24. Journal of the Chemical Physics.
25. Review of Modern Physics.
26. Journal of Physical Chemistry.

The Managing Committee acknowledge with thanks the presentation of Journals and Periodicals in exchange of our Proceedings and Journals from the following Societies and Institutions.

1. Abhandlungen der Bayerischen Akademie der Wissenschaften.
2. Acta Physica Polonica.
3. Annales de la Faculte de Sciences de Marseille.
4. Annales de L' Institut Pasteur.
5. Annales de L' Institut de Henri Poincare.
6. Arhiv za Hemiju I Farmaciju.
7. Atti della Reale Accademia Nazionale dei Lincei.
8. The Biological Bulletin.

9. Bulletin of Calcutta Mathematical Society.
10. International de L' academie Polonaise des Sciences et des Letters.
11. Bulletin de la Societe Royale des Sciences de Liege.
12. Bulletin de la Societe Vaudoise des Sciences Naturelles.
13. Bulletin de la Societe Roumaine de Physique.
14. Chinese Journal of Physics.
15. Comptes Rendus des Sciences de L' Academie des Sciences de Roumanie.
16. Comptes Rendus des Sciences de la Societe de Physique et D' Histoire Naturelle de Geneve.
17. Current Science.
18. Det. Kgl. Danske Videnskabernes Selskab (Mathematisk-Fysiske).
19. do do do do (Biologiske)
20. Economic Proceedings of the Royal Dublin Society.
21. Helvetica Physica Acta.
22. Il Novo Cimento.
23. Indian Journal of Agricultural Science.
24. Industrial and Engineering Chemistry.
25. Japanese Journal of Engineering.
26. do do Mathematics.
27. do do Physics.
28. Journal of the Royal Asiatic Society of Bengal.
29. do of Chemical Engineering (China).
30. do de chimie Physique.
31. do of the Chinese Chemical Society.
32. do of the Faculty of Sciences (Imperial University, Tokyo).
33. do of the Franklin Institute.
34. do of the Indian Chemical Society.
35. do of the Mathematics and Physics (America).
36. do de Physique.
37. do of the Research National Bureau of Standards.
38. do of the Institute of Science Bangalore.
39. do of Science of the Hiroshima University.
40. do of Scientific Instruments.
41. Lotos.
42. Manchester Literary and Philosophical Society's Publications.
43. Matematikai Fizikai Lapok.

44. Memoirs of the College of Science (Kyoto).
45. do do Faculty of Science of the Taihoku Imperial University.
46. Memoirs of the Academie Royale des Sciences et de letters de Danemark.
47. Memoirs of the Societe Vaudoise des sciences Naturelles.
48. Monthly Weather Review. (America).
49. Nachrichten von der Gesellschaft der Wissenschaften zu Göttingen. (Mathematik).
50. Nachrichten von der Gesellschaft Physik, Astronomie, Geophysik.
51. Nachrichten von der Gesellschaft Chemie, einschlo, physikalische Chemie).
52. Nachrichten von der Gesellschaft Geographie und Mineralogie.
53. do do Technik.
54. National Physical Laboratory Report, London.
55. National Research Council of Japan.
56. Nederlandsch Tijdschrift voor Naturkunde.
57. Natur und volk.
58. Physica.
59. Die Physik, Leipzig.
60. Physikalische Zeitschrift der Sowjetunion.
61. Proceedings Koninklijke Akademie van Wetenschappen te Amsterdam.
62. Proceedings of the American Philosophical Society.
63. do do Cambridge Philosophical Society.
64. do do Indian Academy of Sciences, A and B.
65. do do Imperial Academy, Tokyo.
66. do do National Academy of Sciences of India, Allahabad.
67. do do National Institute of Sciences of India.
68. do do Physical Society, London.
69. do do Physico-Mathematical Society of Japan.
70. do do Royal Society of Edinburgh.
71. do do University of Durham Philosophical Society.
72. Quarterly Journal of the Royal Meteorological Society.
73. Records of the Geological Survey of India.
74. Revue Generale des Sciences, Paris.
75. Report of Raio Research in Japan.
76. Review Trimestrelle Cannadienne.

77. The Scientific Proceedings of the Royal Dublin Society.
78. Science and Culture.
79. Scientific Papers of the Institute of Physical and Chemical Research, Tokyo.
80. Scientific Papers of the National Research Institute of Physics Academia, Sinica.
81. Science Reports of National Tsing Hua University, A and B.
82. Science Reports of the Tohoku Imperial University.
83. Scientific Notes.
84. Science Reports of the Tokyo Bunrika, Daigaku, A and B.
85. Sencken Bergiana.
86. Sitzungsberichte der prussischen Akademie der Wissenschaften.
87. do Philosophy, History.
88. do Akademie der Mathematisch-naturwissenschaft München.
89. Technical Physics of the U. S. S. R.
90. Terrestrial Magnetism and Atmospheric Electricity.
91. Tohoku Mathematical Journal.
92. Transactions of the Society of Mechanical Engineering, Japan.
93. do National Institute of Sciences of India.
94. do Royal Canadian Institute.
95. do Royal Society of Canada.
96. University of California Press Publications.
97. do Illinois Bulletin.
98. do Washington Publications.
99. Vierteljahrsschrift der Naturforschenden Gesellschaft in Basel.
100. Vierteljahrsschrift der Naturforschenden Gesellschaft in Zürich.
101. Wissenschaftliche Veröffentlichungen aus den, Berlin.
102. Nova Acta Regia Societatis Scientiarum Upsaliensis.

RESEARCH WORK DURING THE YEAR 1936

The report of the Mahendralal Sircar Professor is annexed herewith (vide Appendix III)

ACKNOWLEDGMENTS

The Committee of Management have great pleasure in recording their grateful thanks

- (a) to the Government of India for their generous contributions of Rs. 18,000 for the year 1935-36 and of Rs. 18,000 for the year 1936-37 which were both received during the year under report,

(b) to the University of Calcutta for printing the Journal free of cost,

(c) to the Corporation of Calcutta for exemption of Municipal tax.

They also express their grateful appreciation of the honorary services rendered by

(a) Messrs. J. N. Basu, N. C. Chunder, and J. C. Pal as advisors on legal matters,

(b) Mr. M. N. Mukherji, B. E., on engineering matters,

(c) Messrs. B. N. Basu & Co., solicitors,

(d) Prof. J. N. Mukherjee, D. Sc., F. R. A. S. B., F. N. I.,
The Honorary Secretary,

(e) Professor P. N. Ghosh, D. Sc., F. N. I., the Honorary Secretary,
Editorial Board, Indian Journal of Physics.

In presenting this report on behalf of the Committee of Management the Secretary expresses his thankfulness for the support and encouragement he has received from the President, Sir Nilratan Sircar M.A., M.D., D.C.L., Mr. J. N. Basu M.A., M.L.A., and Members of the Committee of Management including Dr. W. A. Jenkins, the representative of the Government of India on the Committee.

J. N. MUKHERJEE,

Honorary Secretary.

**Indian Association for the
Cultivation of Science.**

INDIAN ASSOCIATION FOR THE

Balance Sheet as at

| LIABILITIES | Rs. As. P. | | | Rs. As. P. | | |
|--|------------|----|---|------------|----|----|
| | | | | | | |
| General Fund | . | . | . | 2,03,060 | 4 | 5 |
| Depreciation (Reserve Fund) | . | . | . | 1,62,769 | 10 | 3 |
| Investment Reserve Fund | . | . | . | 400 | 0 | 0 |
| Government of India Grant (Unappropriated) | . | . | . | 18,603 | 6 | 0 |
| Mahendralal Sircar Research Fund | . | . | . | 1,47,200 | 0 | 0 |
| Veharilal Mitra Fund | . | . | . | 1,00,000 | 0 | 0 |
| Coochbehar Professorship Fund | 27,520 | 0 | 0 | | | |
| Accrued Interest thereon | 917 | 13 | 0 | 28,437 | 13 | 0 |
| Ripon Professorship Fund | 22,082 | 14 | 3 | | | |
| Accrued Interest thereon | 714 | 4 | 0 | 22,797 | 2 | 3 |
| Joykissen Medal Fund | 11,859 | 0 | 0 | | | |
| Accrued Interest thereon | 380 | 7 | 0 | 12,239 | 7 | 0 |
| Dr. Sircar Research Medal Fund | 4,470 | 0 | 0 | | | |
| Accrued Interest thereon | 133 | 8 | 0 | 4,603 | 8 | 0 |
| Woodburn Medal Fund | 1,316 | 8 | 0 | | | |
| Accrued Interest thereon | 33 | 6 | 0 | 1,349 | 14 | 0 |
| Hare Professorship Fund | 1,280 | 0 | 0 | | | |
| Accrued Interest thereon | 33 | 6 | 0 | 1,313 | 6 | 0 |
| Victoria Professorship Fund | 1,280 | 0 | 0 | | | |
| Accrued Interest thereon | 33 | 6 | 0 | 1,313 | 6 | 0 |
| Nikunja Garabini Prize Fund | 903 | 14 | 2 | | | |
| Accrued Interest thereon | 16 | 11 | 0 | 920 | 9 | 2 |
| Jatindra Chandra Prize Fund | 891 | 11 | 0 | | | |
| Accrued Interest thereon | 16 | 11 | 0 | 908 | 6 | 0 |
| Building Fund | 7,580 | 0 | 0 | | | |
| Accrued Interest thereon | 250 | 5 | 0 | 7,830 | 5 | 0 |
| Employees' Provident Fund | . | . | . | 12,834 | 4 | 11 |
| GRAND TOTAL | . | . | . | 7,26,581 | 6 | 0 |

1B, Old Post Office Street,
CALCUTTA

12th February, 1937.

DIX I CULTIVATION OF SCIENCE

31st December, 1936

| ASSETS | Rs. | As. | P. | Rs. | As. | P. |
|---|----------|-----|----|-----------------|----------|----------|
| Land & Building | | | | 31,680 | 11 | 9 |
| Lecture Hall and Gallery | | | | 23,465 | 5 | 3 |
| Vizianagram Laboratory | | | | 40,900 | 14 | 0 |
| Observatory Room | | | | 3,320 | 9 | 9 |
| Range of Shops (East) | | | | 2,516 | 10 | 9 |
| Range of Shops (West) | | | | 2,308 | 5 | 0 |
| Servants' Quarters | | | | 1,024 | 0 | 0 |
| Durwan's Quarters | | | | 303 | 13 | 9 |
| Scientific Instruments (Including on a/c. K. K. Tagore Fund Rs. 25,000/-) | | | | 1,18,532 | 5 | 2 |
| Botanical Instruments | | | | 2,329 | 6 | 0 |
| Workshop Instruments | | | | 9,861 | 5 | 9 |
| Tools and Implements | | | | 225 | 7 | 3 |
| Furniture | | | | 19,218 | 2 | 6 |
| Library | | | | 60,717 | 13 | 10 |
| Investments in G. P. Notes (At Face Value) | | | | | | |
| General Fund | 29,500 | 0 | 0 | | | |
| Mahendralal Sircar Research Professorship Fund | 1,47,000 | 0 | 0 | | | |
| Veharilal Mitra Fund | 1,32,000 | 0 | 0 | | | |
| Cooch Behar Professorship Fund | 27,500 | 0 | 0 | | | |
| Ripon Prize Fund | 4,000 | 0 | 0 | | | |
| Ripon Professorship Fund | 18,000 | 0 | 0 | | | |
| Joykissen Medal Fund | 11,400 | 0 | 0 | | | |
| Dr. Sircar Reseach Medal Fund | 4,000 | 0 | 0 | | | |
| Woodburn Medal Fund | 1,000 | 0 | 0 | | | |
| Hare Professorship Fund | 1,000 | 0 | 0 | | | |
| Victoria Professorship Fund | 1,000 | 0 | 0 | | | |
| Nikunja Garabini Prize Fund | 500 | 0 | 0 | | | |
| Jatindra Chandra Prize Fund | 500 | 0 | 0 | | | |
| Building Fund | 7,500 | 0 | 0 | | | |
| | | | | 3,84,900 | 0 | 0 |
| Suspense a/c. (Net) | | | | 91 | 0 | 0 |
| Imperial Bank of India (Current Account) | | | | 12,351 | 2 | 4 |
| Employees Provident Fund Investments | | | | | | |
| Postal Cash Certificates (Cost) | 7,331 | 4 | 0 | | | |
| Postal Savings Bank Account | 5,503 | 0 | 11 | | | |
| | | | | 12,834 | 4 | 11 |
| GRAND TOTAL | | | | 7,26,581 | 6 | 0 |

Subject to my separate report of even date, examined and found correct.

S. N. Mukherji, R.A.

Incorporated Accountant,

INDIAN ASSOCIATION FOR THE

Receipts and Payments Account for the

| RECEIPTS | Rs. As. P. | Rs. As. P. |
|--|------------|-------------------|
| Opening Balances on 1. 1. 36. | | |
| In Hand | 39 6 0 | |
| In Imperial Bank of India | 588 1 5 | |
| In Post Office Savings Bank | 3,416 14 3 | |
| Government of India Grant (1935-36 & 1936-37) | | 4,039 5 8 |
| Indian Journal of Physics—Sales and Subscriptions | | 36,000 0 0 |
| Indian Journal of Physics—Sales and Subscriptions | | 2,124 2 8 |
| Subscriptions from Members | | 146 0 0 |
| Miscellaneous Receipts | | 1,122 8 0 |
| Rent from Tenants | 3,927 0 0 | |
| Municipal-Tax from Tenants | 256 14 0 | |
| Dr. Sircar Memorial Fund—Donations | | 4,183 14 0 |
| Miscellaneous A/c (Staff Income-Tax) | | 325 0 0 |
| Miscellaneous A/c (Staff Income-Tax) | | 447 9 0 |
| Interest | | |
| Ripon P. F. | 714 4 0 | |
| Joykissen M. F. | 380 7 0 | |
| Victoria P. F. | 33 6 0 | |
| Dr. Sircar R. M. F. | 133 8 0 | |
| Coochbehar P. F. | 917 13 0 | |
| Woodburn M. F. | 33 6 0 | |
| Hare P. F. | 33 6 0 | |
| Jatindra Chandra P. F. | 16 11 0 | |
| Building Fund | 250 5 0 | |
| Nikunja Garabini P. F. | 16 11 0 | |
| Veharilal Mitra Fund | 4,620 0 0 | |
| Mahendralal Sircar Research P. F. | 5,145 0 0 | |
| General Fund | 1,092 12 0 | |
| | | 13,387 9 0 |
| Employees Provident Fund | | |
| Staff Contribution | 1,110 4 0 | |
| Association Contribution | 1,110 4 0 | |
| Interest from Association and Post Office Savings Bank Deposit | 1,356 10 8 | |
| Repayment of Loan by Member | 215 0 0 | |
| | | 3,792 2 8 |
| GRAND TOTAL | | 65,568 3 0 |

1B, Old Post Office Street,

Calcutta the 12th February, 1937.

CULTIVATION OF SCIENCE

year ended 31st December, 1936

| PAYMENTS | Rs. | As. | P. | Rs. | As. | P. |
|--|--------|-----|----|--------|-----|----|
| Scientific Instruments | . | . | . | 2,875 | 0 | 0 |
| Library Books | . | . | . | 4,119 | 14 | 0 |
| Indian Journal of Physics—Publication Expenses | . | . | . | 2,590 | 12 | 3 |
| Miscellaneous Charges | . | . | . | 1,267 | 5 | 0 |
| Miscellaneous A/c. (Staff Income-Tax, including Rs. 87-6-0 on last year's Account) | . | . | . | 534 | 15 | 0 |
| Bank Commission and Charges | . | . | . | 416 | 15 | 0 |
| Establishment | . | . | . | 14,805 | 13 | 9 |
| Municipal-Tax | . | . | . | 685 | 12 | 0 |
| Electric Charges | . | . | . | 665 | 12 | 9 |
| Gas Charges | . | . | . | 359 | 6 | 6 |
| Telephone Charges | . | . | . | 250 | 6 | 0 |
| Building Repairs | . | . | . | 2,229 | 2 | 9 |
| Printing Charges | . | . | . | 210 | 15 | 0 |
| Postage and Telegrams | . | . | . | 80 | 8 | 0 |
| Research Scholarships | . | . | . | 4,800 | 0 | 0 |
| Laboratory Charges | . | . | . | 1,599 | 3 | 9 |
| Contributions to Employees Provident Fund | | | | | | |
| Association Contribution (Annual) | 1,110 | 4 | 0 | | | |
| Arrear Interest | 1,280 | 10 | 0 | | | |
| | | | | 2,390 | 14 | 0 |
| Employees Provident Fund | | | | | | |
| Loan to Members | . | . | . | 500 | 0 | 0 |
| Closing Balances on 31-12-36. | | | | | | |
| In Imperial Bank of India | 12,351 | 2 | 4 | | | |
| (*) In Post Office Savings Bank | 5,503 | 0 | 11 | | | |
| (*) Postal Cash Certificates (Cost) | 7,331 | 4 | 0 | | | |
| (*) On Employees Provident Fund Account | . | . | . | 25,185 | 7 | 3 |
| GRAND TOTAL | . | . | . | 65,568 | 3 | 0 |

Subject to my separate report of even date, examined and found correct.

S. N. Mukherji, R. A.
Incorporated Accountant,

APPENDIX II

List of Papers Published in the Indian Journal of Physics during 1936.

1. On the Statistical Theory of Neutral $\bar{\alpha}$ Atoms—By Pannalal and Kosturilal.
2. On the Dissociation of SnCl and SnCl₂—By H. Lessheim and R. Samuel.
3. The D Layer—By P. Syam.
4. Raman Spectra of Quinoline, Quinaldine, *iso*Quinoline, and α - and β -Picolines—By S. K. Kulkarni Jatkar.
5. Studies on Water Jets—By K. Prosad and B. N. Ghosh.
6. Chemical Reactivity and Light Absorption—By N. R. Dhar and P. N. Bhargava.
7. On the Refractive Indices of Metallic Films showing Newton's Rings—By K. Prosad and B. N. Ghosh.
8. Raman Spectra of Terpenes and Camphors—By S. K. K. Jatkar and R. Padmanabhan.
9. On some Characteristics of Long and Short Spectral Lines—By S. Datta and Kedar Nath Chatterjee.
10. On the Wing accompanying the Rayleigh Line in Liquid Mixtures—By S. C. Sirkar.
11. The Spectrum of Doubly-ionised Antimony—By S. G. Krishnamurty.
12. The Effects of Heat and Ultra-violet Light on Rectifying Action of some Crystals—By B. K. Sen.
13. Production of Positrons from Bismuth—By H. P. De.
14. On the Nature of Intermolecular Oscillations in some Organic Crystals—By S. C. Sirkar.
15. On the Interpretation of the Raman Spectra of Formic Acid and Metallic Formates—By Jagannath Gupta.
16. On the Measurement of e. m. f. with a Triode Valve—By Sant Ram.
17. Analysis of Signal-fading Observations—By Bimalendu Sen Gupta and S. R. Khastgir.
18. The Origin of Mass in Neutrons—By M. N. Saha.
19. On a New Type of Absorption Bands of Potassium Vapour—By Birendra Kumar Chakravarti.
20. On the Absorption Spectrum and the Ground State of Ce^{iv} Ion—By S. Datta and Manindra Mohan Deb.

21. Spectrum of Doubly-ionised Zinc—By K. C. Mazumder.
22. On the Raman Spectra of Carbon tetrachloride in different States and at different Temperatures—By S. C. Sirkar.
23. On the Raman Spectra of Oxalates in Solution and the Structure of the Oxalate Ion—By Jagannath Gupta.
24. A Note on the Making of Prisms for Optical Work—By S. Hariharan.
25. Studies on some Indian Vegetable Oils—By G. N. Bhattacharyya.
26. On the Raman Spectrum of H_2S in the Solid State at Low Temperature—By S. C. Sirkar and Jagannath Gupta.
27. Influence of Magnetic Field on the Dielectric Constant of Liquids—By S. D. Chatterjee.
28. On the Linearity of Lorentz Transformation—By B. C. Mukherjee.
30. Studies on Constant Paramagnetism. Part I—By D. P. Roychowdhuri and P. N. Sen Gupta.
30. Studies on Constant Paramagnetism. Part II—By D. P. Roychowdhuri and P. N. Sen Gupta.
31. X-ray Studies on Electrodeposited Silver—By Sudhendu Busu and M. Hussain.
32. The Raoult Depression in Ordinary and Heavy Water—By V. T. Chiplunker.
33. Ultra-violet Content of Sunlight at Bombay—By N. R. Tawde, S. A. Trivedi and J. M. Patel.
34. Studies on some Indian Vegetable Oils. Part II—Dielectric Constant and Electric Moment—By G. N. Bhattacharyya.
35. On an Estimation of the Service Area of Calcutta Station—By K. K. Roy.
33. The Study of Duration of Contact of a Pianoforte String with a Hard Hammer striking near the End—By S. C. Dhar.
37. On the Polarisation of Raman Lines of Formic Acid and Formate and Trichloracetate Ions—By Jagannath Gupta.
38. The Ultra-violet Absorption Spectra of Pr^{+++} and Nd^{+++} Ions in Solution—By P. C. Mukherji.
39. The Phenomenon of Anode Sputtering and the Deposition of Metallic Films on the Cathode of a Haddings Tube,—By S. Sharan.
40. On a Proposed Form of the Principle of Equivalence and Deduction of Lorentz Transformation—By N. R. Sen.
41. On the Density of Saturated Vapour—By M. F. Somawala.
42. New Terms in the Arc Spectrum of Tellurium—By S. G. Krishnamurty.

43. On the Wing accompanying the Rayleigh Line in Liquid Mixtures. Part II—By S. C. Sirkar and Birendra Krishna Mookerjee.
44. Dissociation Equilibrium and Pair Generation—By Jai Kishen.
45. Influence of Magnetic Field on the Coefficient of Viscosity of Liquids—By S. D. Chatterjee.
46. Studies on some Indian Vegetable Oils. Part III—By G. N. Bhattacharyya.
47. On the Laws of Distribution of Velocities of Particles undergoing Emission and Absorption in a Radiation Field—By Jai Kishen and N. K. Saha.
48. The L Spectra of Iron above the Curie Point—By Surain Singh Sidhu.
49. The Band Spectrum of Gallium Oxide and Isotope Effect of Gallium—By M. K. Sen.
50. The Raman Spectra and Latent Heat of Fusion of Non-Associated Substances—By C. J. Philips.
51. Technique for making Schumann Plates—By P. N. Kalia.
52. A Note on the Spectrum of Singly-Ionised Zinc—By P. N. Kalia.
53. Raman Spectra of Oxalates and Oxalato-complexes. Vibrations of Dicarboxyl—By Jagannath Gupta.
54. On the Raman Spectra of different Modifications of a few Crystales —By S. C. Sirkar and Jagannath Gupta.

APPENDIX III

Report of the Mahendralal Sircar Professor on the Scientific Work of the Association during the year 1936.

The scientific investigations carried out during the year may be classified under the following heads :—

1. Studies on the absorption and fluorescence spectra of organic substances in various physical states and their relation to molecular structure.
2. Optical and magnetic studies on organic crystals with a view to elucidate their crystalline structure.
3. Investigations on the magnetic behaviour of paramagnetic ions in the S-state in crystals and calculation of their entropy and specific heat for temperatures in the neighbourhood of absolute zero.
4. Studies on the magnetic anisotropy of paramagnetic hydrated crystals in relation to the crystalline electric fields.
5. Magnetic properties of graphite and its oxides.
6. Diamagnetic susceptibility of organic substances in different states.
7. Studies on the magnetic double refraction of some sols and some organic compounds.
8. X-ray analysis of the structure of crystals.
9. Refractive and dielectric behaviour of carbon dioxide.
10. Maxwell effect in liquids.
11. Studies on constant paramagnetism.

1. Absorption and fluorescence spectra of organic substances.

In the last report we made a reference to the investigations carried on in the laboratory on the absorption and fluorescence of aromatic molecules of special structural interest in different physical states. The absorption spectra of several hydrocarbons have been studied by P. K. Seshan, in the vapour state over the spectral range 7000 Å—to 2200 Å. Most of these substances are polybenzene-nuclear compounds containing condensed, chain, and incomplete ring systems in the molecule. The condensed ring compounds generally exhibit a rich vibration band spectra, whereas most of the substances containing chain rings show no such structure in the region investigated. The band spectra of the condensed ring molecules become more and more diffuse as we go to the higher members of the series, and shift continually towards the red end of the spectrum. The absorption spectra of the vapours of some quinones and hydroquinones show a vibrational structure and some of them also a rotational fine structure.

From a general analysis of the band systems the values of the characteristic vibrational frequencies of the molecules in the normal and excited states, and of the electronic frequencies of the molecules have been determined in most cases, and they are discussed in relation to the structure of the molecules. It has been found that the vibrational frequency, both of the excited and of the normal molecules are practically of the same magnitude for all the hydrocarbons.

The absorption spectra of all these substances have been studied in alcoholic solution and some of them in the solid state. The rotational and vibrational structures observed in the vapour spectra are all quenched and the maxima of absorption are considerably shifted towards the red end of the spectrum as we pass from the vapour to the solution and still further to the solid.

The influence of the physical state on the absorption and fluorescence spectra of these organic substances has been further investigated. It has been found that the greater the refractive index of the medium in which the absorbing molecules are dispersed, the greater the shift, towards the red, of the absorption bands of the molecules from their positions in the vapour state. This result is very general and holds not only for the solutions in different solvents, but also for other physical states in which the absorbing molecules may be present, that is, the result holds whether the molecules in the medium surrounding the absorbing molecules are of the same kind as the absorbing molecules as in vapour, liquid or solid states of different kinds as in solutions in various solvents. In the case of dilute solutions, the positions of absorption bands are found to be practically independent of the concentrations. These observations can be explained as being due mainly to the refractivity of the medium and the corresponding Lorentz polarisation field acting on the absorbing molecule.

The influence of the physical state on fluorescence has been found to be very similar to that on absorption.

In continuation of the investigations on the polarized absorption by single crystals of aromatic substances (*vide* Annual Report, 1934) the fluorescence spectra of many of these single crystals have been studied. Many interesting observations on the fluorescence spectra of impurity molecules included in crystals have been made by P. K. Seshan and the present writer. These results were presented to the International Conference on Photo-luminescence held recently at Warsaw. The paper is under publication and it will be reviewed in the next report.

2. Optical studies on organic crystals.

The magnetic studies on organic crystals have given us valuable information regarding the molecular orientations in the crystal lattice. Optical measurements on these crystals give us similar information, though less precise. K. S. Sundararajan has studied the optical properties of a large number of organic substances, the principal refractive indices were measured with a crystal refractometer and the orientations of the principal optic axes were measured with a

Federov stage petrographic microscope. Among the substances studied are many of the poly-nuclear hydrocarbons which crystallise in the monoclinic prismatic class. It is observed that for these compounds the axes of largest and smallest refractive indices lie in the (010) plane, the former making a small angle with the 'c' axis. Since for all these molecules the optical polarisability is a minimum along the normal to the plane and a maximum along the length of the molecules, we can conclude that the molecules lie with their lengths in the (010) plane making a small angle with the 'c' axis. The molecular orientations thus arrived at from the optical measurements are found to be in close agreement with the results of X-ray and magnetic measurements.

An attempt has also been made to calculate the principal optical polarisabilities of the molecules from the observed crystal refractivities. There is some difficulty as the mutual influence between the optical dipole moments of the neighbouring molecules is quite large and the distribution of the refracting centres is far from isotropic. But an approximate calculation has been made which enables us to estimate the magnitude of the Lorentz field along different directions in the crystal.

3. Magnetic studies on organic crystals.

The use of magnetic data in the elucidation of crystalline and molecular structure has been dealt with in the previous reports. It was shown how a knowledge of diamagnetic susceptibilities of the crystal and the molecule gives valuable information about the orientations of the molecules in the crystal lattice. This method of analysing the crystal structure is of great value as it is much easier than the "trial and error" method of X-rays. The diamagnetic susceptibilities of the large number of organic crystals have been studied with specially devised experimental methods. The magnetic data have been discussed in relation to the magnetic susceptibilities of the molecules and their orientations in the crystal. Since for many of these molecules, the principal susceptibilities are known or can be estimated, their orientations in the crystal lattice could be predicted.

Complete X-ray analyses have been made for only some of these crystals and it is found that the molecular orientations arrived at from magnetic data agree closely with the X-ray determinations for most of these crystals. But in a few cases the agreement was not close enough. It was suspected that this might be due to some simplifying assumptions in the earlier treatment. So an exact mathematical relationship between the crystal and molecular diamagnetic susceptibilities and the molecular orientations in the crystal lattice has been formulated for the different crystal system by Mrs. Lonsdale and the present writer in a recent paper in the Proceedings of the Royal Society. The rigorous discussion shows that in the triclinic system, a study of the magnetic susceptibilities of the crystal alone gives directly the molecular orientations and the principal susceptibilities of the molecules. For crystals of higher symmetry, however, the information given by the magnetic studies is less definite. In the

monoclinic system, a knowledge of the magnetic susceptibilities of the crystal and the molecular orientations gives us the principal susceptibilities of the molecule. The converse problem is not so simple except in certain cases *viz.*, when the molecule is plane and normal to (010) plane or when one of the axes of the principal susceptibility (K_1 , along the length) lies in the (010) plane. Calculation on the basis of the rigorous theory shows that the magnetic data are entirely in accord with the best X-ray values.

Among other investigations, should be mentioned the magnetic measurements of Ganguli on hexaethylbenzene and of Banerjee on triphenylene. The former crystal is triclinic and it is found that two of the principal susceptibilities are nearly equal and numerically much smaller than the third. A discussion of the results shows that the benzene rings lie nearly parallel to the plane of approximate magnetic symmetry.

4. Approach to absolute zero of temperature

It was discussed in last year's report how measurements on the magnetic anisotropies at room temperature enable us to predict "The characteristic temperature" of the substance *i.e.*, the temperature at which the freedom of of the rotation of the spin axes gets severely restricted. Further studies on the magnetic anisotropies of single crystals of manganous and ferric salts have been made by S. Banerjee and the present writer. Since both the manganous and ferric ions are in the S-state, the anisotropies are very feeble, of the order of 1 part in 1500, and so a special experimental technique was developed for the measurement of such feeble anisotropies. The magnetic anisotropy is mainly due to the so-called Stark splitting of the S-levels under the influence of the crystalline field and in a small measure due to the diamagnetism of the crystal. The anisotropy due to the latter is evaluated from a study of the anisotropy in isomorphous diamagnetic salts. Hence the anisotropy due to the Stark splitting can be calculated, if certain simplifying assumptions are made.

This Stark splitting of paramagnetic S-levels plays an important part in very low temperature phenomena. For example at temperatures in the neighbourhood of absolute zero (0.K) the entropy is almost wholly determined by it, and consequently, the specific heat at these temperatures. It is, therefore, possible to predict the entropy temperature and the specific heat temperature curves close to absolute zero, purely from magnetic measurements at the room temperature.

A full report of these investigations is published as a memoir in the Philosophical Transactions of the Royal Society. The interactions between the spin moments and the part played by the Stark splitting in other phenomena *viz.*, Faraday rotation and absorption are discussed in that paper.

5. The magnetic anisotropy of paramagnetic hydrated crystals.

Calculations on the magnetic susceptibilities of salts of the iron group have shown that the paramagnetic ions are under the influence of considerable internal electric forces. The triclinic crystal copper sulphate pentahydrate belongs to this group and its susceptibility in the powder state has been studied in great detail by other investigators. But this alone does not give sufficient information about the crystalline fields. The magnetic anisotropy of these crystals naturally gives us more information and so a detailed study of the anisotropy of these crystals has been made by Ashutosh Mookherji and the present writer. The crystal has an axis of approximate magnetic symmetry. A discussion of the results shows that the crystalline field is slightly asymmetric and that the magnetic axes coincide with the crystalline field axes. This result is of much significance in as much as it shows that the asymmetry of the crystalline field is itself responsible for the magnetic anisotropy.

The magnetic properties of a number of other paramagnetic substances, notably selenates, double sulphates and other salts of the iron group of metals, and several salts of rare earth metals have also been studied. These magnetic investigations will be reviewed in the next report.

6. Magnetic studies on graphite.

The study of the abnormal unidirectional diamagnetism of graphite and its oxides was continued by Nripendralal Ganguli. It has been observed that this abnormal diamagnetism is very sensitive to any chemical treatment of the crystal. For example, on treating the crystal with a mixture of strong nitric and sulphuric acids, the abnormal susceptibility along the normal comes down rapidly from -22×10^{-6} to less than -2×10^{-6} per gram of carbon, whereas the value for directions in the plane remains unchanged. An indefinite diminution in the size of the crystal has also the same effect.

We have recently studied the temperature variations of the principal susceptibilities of graphite in the range 140°K to 1270°K . The magnetic anisotropy of the crystal diminishes rapidly with the temperature while the corresponding variation in the X_1 (susceptibility for directions in the basal plane) is very small.

7. Diamagnetic susceptibilities of organic substances in different physical states.

The experimental evidence regarding the dependence of diamagnetic susceptibility of organic substances on the physical state is highly conflicting. So a detailed study of the diamagnetic susceptibilities of a large number of substances in the molten state as also in the state of solutions in suitable solvents has been made by Akshayananda Bose. A modified Guoy method is used

for the molten liquids and the well known Quincke method for the solutions. It is found that within the limits of experimental errors, the diamagnetic susceptibility of these organic substances is independent of its physical state, that is, whether it is a single crystal or a molten liquid or in a state of solution.

8. Studies on magnetic double refraction.

In a paper "on the nonspherical nature of colloidal particles in relation to the formation of jelly structure" Dr. Satya Prakash has studied the magnetic birefringence of mercurisulphosalicylic acid sol in detail. Such sols exhibit marked magnetic birefringence which is almost proportional to concentration. In the presence of halide ions, the birefringence diminishes markedly, whereas it increases in the presence of nitrate ions or barium ions. The birefringence is also reduced by the addition of peptising agents and these results are explained as being due to the disintegration of the bigger aggregates to isotropic smaller ones. It is also observed that many jelly forming sols do not exhibit magnetic birefringence. So it is concluded that the presence of nonspherical particles is not an essential prerequisite for jelly formation.

A number of simple benzene, naphthalene, and anthracene derivatives has been studied by L. D. Mahajan for their magnetic double refraction in a state of solution in suitable solvents. For many of the benzene derivatives, the gram molecular birefringence is nearly of the same magnitude as for benzene, which suggests that both the magnetic and optical anisotropies of the molecule are mainly due to the benzene rings in it. The data for the derivatives of diphenyl, naphthalene, and anthracene show that in all the molecules studied, the different benzene rings are in the same plane.

9. X-ray studies on the structure of crystals.

The crystal structure of potassium bicarbonate has been studied by J. Dhar. From an analysis of the rotation and Weissenberg photographs, the dimensions of the unit cell have been determined. A study of the reflections from the various planes shows that the potassium atom lies practically in the (010) plane and the CO_3 group lies near the (400) plane. The magnetic susceptibilities of single crystals also point to the same conclusion.

The crystal structure of triphenylene has been studied by Guha, the results of which will be shortly published.

10. Refractivity and dielectric constant.

The theory of the anisotropic polarisation field put forward by Raman and Krishnan explains satisfactorily the deviations from the Lorentz formula. On the basis of the above theory, P. O. John has discussed the refractive and dielectric behaviour of carbon dioxide over a wide range of densities. He finds, in conformity with the predictions of the theory, that the anisotropy of the

polarisation field increases progressively with density and that for any given density, the degree of anisotropy required to explain the deviation from the Lorentz formula is the same for different wave-lengths of the incident light.

11. Maxwell effect in liquids.

Liquids in a state of viscous flow exhibit birefringence and the phenomenon is known as the Maxwell effect. A molecular theory of this effect was put forward by Raman and Krishnan in 1928, based on the idea that the birefringence arises from the optical anisotropy of the molecules and their tendency to orient under the shearing stresses in the liquid. In a recent paper G. G. Paldikar has applied the theory for a number of organic liquids, both aromatic and aliphatic hydrocarbons and he finds satisfactory agreement between theory and experiment.

12. Studies on constant paramagnetism.

As referred to in the last report an account of the behaviour of the atomic susceptibility of several rare earth salts towards the temperature is given in detail by Dr. D. P. Ray chowdhuri and P. N. Sen Gupta.

From the measurements it was found that some substances, showing the phenomenon of constant paramagnetism, as V_2O_5 , $KMnO_4$ have a negative and substances as $K_2Cr_2O_7$ have a positive coefficient of susceptibility compared with the regular paramagnetics. Also the constant atomic susceptibilities, as determined from the oxides of the consecutive elements from Ti - Mn, show a gradual increase with atomic number similar to the increase in magneton numbers of the regular paramagnetics with the increase in the number of 3d electrons in the ions. From the above similarity of behaviour it is suggested that Fe, Co, Ni have got a constant atomic susceptibility in compounds where the valency is fully saturated. Moreover, such a compound will be para or dia according as the paramagnetic atomic susceptibility of the transition element is greater or less than total diamagnetic susceptibility of the rest of the molecule. Also the X_A value is not an absolute constant for the atom but susceptible to the crystalline field as is manifested by the different values for the amorphous and crystalline varieties of V_2O_5 .

From a further study of the co-ordination compounds of the different transition series of elements it is found that the atomic magnetic susceptibility of the magnetic atom is not a constant. It has a higher value when the groups associated have a high dipole moment. For simple compounds the value depends on the type of binding as also on the element in combination.

For several other informations reference may be made to the original papers by the author.

List of Papers Published In 1936.

1. Diamagnetic Studies on Graphite and Graphitic Oxides.—By N. Ganguly, *Philosophical Magazine*, Vol. 21, pp. 355-369, (1936).
2. Absorption Spectra of Some Aromatic Compounds. Part I. Hydrocarbons.—By P. K. Seshan, *Proceedings of the Indian Academy of Sciences*, Vol. 3, pp. 145-171 (1936).
3. Absorption Spectra of Some Aromatic Compounds. Part II. Quinones and Hydroquinones.—By P. K. Seshan, *Proceedings of the Indian Academy of Sciences*, Vol. 3, pp. 172-187 (1936).
4. Magnetic Anisotropy and Crystal Structure of Hexaethylbenzene.—By Nripendralal Ganguli, *Zeitschrift für Kristallographie*, (A), Vol. 93, pp. 42-46 (1936).
5. Optical Studies on Organic Crystals. Part I.—By K. S. Sundararajan, *Zeitschrift für Kristallographie A*, Vol. 93, pp. 238-248 (1936).
6. Influence of Physical State on the Absorption and Fluorescence Spectra of Organic Compounds.—By P. K. Seshan, *Transactions of the Faraday Society*, Vol. 32, pp. 689-694 (1936).
7. Crystal Structure of Postassium Bicarbonate, KHCO_3 .—By Jagattaran Dhar, *Current Science*, Vol. 4, p. 867 (1936).
8. Investigations on the Magne-crystallic Action. IV.—Magnetic Behaviour of Paramagnetic Ions in the S-State in Crystals.—By K. S. Krishnan and S. Banerjee, *Philosophical Transactions of the Royal Society*, Vol. A, 235, pp. 348-366 (1936).
9. Magnetic Susceptibilities of Organic Substances in Different Physical States.—By Akshayananda Bose, *Philosophical Magazine*, Vol. 21, pp. 1119-1125 (1936).
10. Maxwell Effect in Liquids.—By G. G. Paldhikar, *Philosophical Magazine*, Vol. 21, pp. 1125-1130 (1936).
11. On the Refractivity and Dielectric Constant of Carbon Dioxide at High Pressures.—By P. O. John, *Philosophical Magazine*, Vol. 22, pp. 274-281 (1936).
12. Magnetic Birefringence in Solutions of Organic Substances.—By L. D. Mahajan, *Philosophical Magazine*, Vol. 22, pp. 717-725 (1936).
13. On the Nonspherical Nature of Colloidal Particles in Relation to the Formation of Jelly Structure.—By Dr. Satya Prakash, *Proceedings of the Indian Academy of Sciences*, Vol. 3, pp. 332-344 (1936).
14. Diamagnetic Anisotropy of Crystals in Relation to Their Molecular Structure.—By K. Lonsdale and K. S. Krishnan, *Proceedings of the Royal Society of London*, Vol. A 156, pp. 597-613 (1936).
15. The Magnetic Anisotropy of Copper Sulphate Pentahydrate $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, in Relation to its Crystal Structure. Part I.—By K. S. Krishnan and Asutosh Mookerjee, *Physical Review*, Vol. 50, pp. 860-860 (1936).
16. Studies of Constant Paramagnetism. Part I and Part II.—By D. P. Raychowdhury and P. N. Sen-Gupta, *Indian Journal of Physics*, Vol. X pp. 245-266 (1936).

BANI PRESS, CALCUTTA