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Recently Professor Werner Baur of the University of Illinois at Chicago pointed out that 19 of the 100 most cited chemical papers<sup>1</sup> were in his specialty of crystallography. Fifteen of them had been published in *Acta Crystallographica*.

Baur's letter has prompted this report on *Acta Cryst.* In a subsequent study we hope to examine the entire field of crystallography along the lines pursued in fields like geology and pediatrics.<sup>2,3</sup>

In Figure 1a, we show the journals most cited by *Acta Cryst.* It is significant that only six journals account for 50% of the references in *Acta Cryst.* This includes a high degree of self-citation. The self-citing rate is 36%. Twenty-five journals account for about 64% of the total of 7752 citations in this journal. The last ten of these may not be too significant considering the size of the sample involved.<sup>4</sup> Excluding self-citation, *Nature* is the fourth journal most heavily cited by *Acta Cryst.* *Nature* was also fourth in the case of *Journal of Geophysical Research*<sup>5</sup> and third in the case of *Astrophysical Journal*.<sup>6</sup>

The 25 journals which cited *Acta Cryst.* most frequently are shown in Figure 1b. These journals account for about 70% of all citations to *Acta Cryst.* Only seven journals account for half the total. *Nature* ranks only 22nd,

just below *Sov. Phys. Crystallogr. USSR*. Although *Science* appears 14th in Figure 1a, it does not show up in Figure 1b. Thus its importance to crystallography seems minimal. Fourteen journals are common to the two lists, but the *J. Chem. Soc., Inorg. Chem., Acta Chem. Scand., J. Amer. Chem. Soc., J. Chem. Phys.* and *Zschr. Kristallogr.* are especially noteworthy, as well as *J. Molec. Biol.*

*Acta Cryst.* is cited half again as often as it cites other publications. In 1969, its 7752 citations involved about 440 different items, mainly journals, and then miscellaneous books, theses, reports, etc. But 4932 citations were to the journals listed in Figure 1a. On the other hand, it was cited 11,588 times by about 280 journals. In the more recent data our research department is now compiling, we expect to have far more detailed information on the "all other" categories which account for so many references in fields like this one.

Articles from *Acta Cryst.* cited more than 100 times during the period 1961-1972 are shown in Figure 2. The papers are ranked by frequency of citation. The first, Cromer and Waber's paper on scattering factors, was 88th on a list of the 100 most cited papers of science for 1961-1972,<sup>7,8</sup> and third on the list of 100 'chemical' papers most frequently cited in 1972, mentioned above. Other papers from the latter list

Figure 1a.

| Journals Cited by <i>Acta Crystallographica</i> |             |                                 |                              |
|---|-------------|---------------------------------|------------------------------|
| RANK  | Times Cited | Cumulative Percent of Citations | Journal                      |
| 1969**  |             |                                 |                              |
| 1.  | 2788        | 36.0                            | *Acta Crystallogr.           |
| 2.  | 320         | 40.1                            | *J. Chem. Soc.               |
| 3.  | 316         | 44.2                            | *J. Amer. Chem. Soc.         |
| 4.  | 236         | 47.2                            | *J. Chem. Phys.              |
| 5.  | 140         | 49.0                            | *Nature                      |
| 6.  | 112         | 50.5                            | *Z. Kristallogr.             |
| 7.  | 108         | 51.9                            | Proc. Roy. Soc. London       |
| 8.  | 96          | 53.1                            | *Acta Chem. Scand.           |
| 9.  | 96          | 54.3                            | *Inorg. Chem.                |
| 10.   | 96          | 55.6                            | Ricerca Scientifica          |
| 11.   | 92          | 56.8                            | *J. Molec. Biol.             |
| 12.   | 56          | 57.5                            | *Phys. Rev.                  |
| 13.   | 56          | 58.2                            | Comp. Meth. Phys. Science    |
| 14.   | 52          | 58.9                            | Science                      |
| 15.   | 44          | 59.4                            | *B. Chem. Soc. Japan         |
| 16.   | 40          | 60.0                            | Ark. Kemi                    |
| 17.   | 36          | 60.4                            | J. Phys. Chem. Solids        |
| 18.   | 36          | 60.9                            | J. Phys. Chem.               |
| 19.   | 32          | 61.3                            | J. Inorg. Nucl. Chem.        |
| 20.   | 32          | 61.7                            | *Phys. Stat. Solidi          |
| 21.   | 32          | 62.1                            | *J. Phys. Soc. Japan         |
| 22.   | 32          | 62.5                            | Tetrahedron                  |
| 23.   | 28          | 62.9                            | *J. Appl. Phys.              |
| 24.   | 28          | 63.3                            | Angew. Chem.                 |
| 25.   | 28          | 63.5                            | Physica                      |
|   | 4932        | 63.6                            | Total of above 25 journals   |
|   | 2820        | 36.4                            | Citations to 416 other items |
|   | 7752        | 100.0                           | Total citations              |

\*Journals common to both lists

\*\*Figures are an annual extrapolation from a quarterly sample. See reference 4.

are asterisked.

*Acta Cryst.* can justifiably take pride in its impact on science. The 45 papers listed here stand high in a list of the 6000 papers in science cited 100 times or more in 1961-72. Their standing indicates the significant role of crystallography in chemistry and physics and molecular biology. Of the 6000, about 2200 were cited more than 200 times; 20 of them are on this list. Only 960 were cited more than 300 times; here are 12 of them. Of 515 cited more than 400 times, six are on this list. Of

Figure 1b.

| Journals that Cited <i>Acta Crystallographica</i> |              |                                 |                                |
|---|--------------|---------------------------------|--------------------------------|
| RANK  | Times Citing | Cumulative Percent of Citations | Journal                        |
| 1969**  |              |                                 |                                |
| 1.  | 2788         | 24.1                            | *Acta Crystallogr.             |
| 2.  | 756          | 30.6                            | *J. Chem. Soc.                 |
| 3.  | 596          | 35.7                            | *Inorg. Chem.                  |
| 4.  | 532          | 40.3                            | *Acta Chem. Scand.             |
| 5.  | 388          | 43.7                            | *J. Amer. Chem. Soc.           |
| 6.  | 372          | 46.9                            | Annu. Rep. Progr. Chem. B      |
| 7.  | 364          | 50.0                            | *J. Chem. Phys.                |
| 8.  | 260          | 52.3                            | *Z. Kristallogr.               |
| 9.  | 192          | 53.9                            | Z. Naturforsch. B.             |
| 10.   | 180          | 55.5                            | *J. Molec. Biol.               |
| 11.   | 172          | 57.0                            | *J. Appl. Phys.                |
| 12.   | 164          | 58.4                            | *Phys. Stat. Solidi            |
| 13.   | 144          | 59.6                            | B. Soc. Chim. France           |
| 14.   | 140          | 60.8                            | Z. Anorg. Allg. Chem.          |
| 15.   | 120          | 61.9                            | Helv. Chim. Acta               |
| 16.   | 120          | 62.9                            | *Phys. Rev.                    |
| 17.   | 116          | 63.9                            | Canad. J. Chem.                |
| 18.   | 112          | 64.9                            | J. Less-Common Met.            |
| 19.   | 96           | 65.7                            | *J. Phys. Soc. Japan           |
| 20.   | 96           | 66.5                            | Proc. Nat. Acad. Sci. USA      |
| 21.   | 96           | 67.3                            | Sov. Phys. Crystallogr. USSR   |
| 22.   | 92           | 68.1                            | *Nature                        |
| 23.   | 84           | 68.9                            | *B. Chem. Soc. Japan           |
| 24.   | 76           | 69.5                            | J. Appl. Crystallogr.          |
| 25.   | 76           | 70.2                            | Rec. Trav. Chim.               |
|   | 8132         | 70.2                            | Total of above 25 journals     |
|   | 3456         | 29.8                            | Citations from 264 other items |
|   | 11588        | 100.0                           | Total citations                |

the 330 papers cited more than 500 times, *Acta Cryst.* published six. All in all, a noteworthy record.

It is interesting to note that 23 papers were published in the 1960s, but 21 also appeared in the 1950s. Cruickshank's paper on electron density is the only hangover from the 1940s. I don't know who Cruickshank is by the way, but I am willing to assert that his contribution to crystallography must be significant. Of the 45 articles listed, Cruickshank's name appears on six. Similarly, Hamilton published four;

hensive analysis may turn up other equally significant papers in this field published in other journals. For example, Professor Baur has pointed out to me that both *Nature* and *Inorganic Chemistry* made our 1972 list of 100 most cited 'chemical' papers with articles concerning methods of crystal structure determination.<sup>9</sup>

1. Garfield, E. A list of 100 most cited 'chemical' articles. *Current Contents* (CC<sup>®</sup>) No. 10, 6 March 1974, p. 5-12.

Journal Evaluation. Science 178:111-115, 1972.  
 5. -----, Journal citation studies. XI. *Journal of Geophysical Research*. CC No. 13, 14 August 1974, p. 5-8.  
 6. -----, Journal citation studies. XII. *Astrophysical Journal and its Supplements*. CC No. 35, 28 August 1974, p. 5-9.  
 7. -----, Selecting the all-time citation classics; here are the fifty most cited papers for 1961-1972. CC No. 2, 9 January 1974, p. 5-8.  
 8. -----, The second fifty papers most cited from 1961-1972. CC No. 6, 6 February 1974, p. 5-9.  
 9. Baur, W. Personal communication, 28 June 1974.

R Figure 2. Highly Cited Articles from *Acta Crystallographica*

- K 1961-1972
- \*1. 908 Cromer D T & Waber J T. Scattering factors computed from relativistic Dirac-Slater wave functions. *Acta cryst.* 18:104-09, 1965.
  - \*2. 831 Cromer D T. Anomalous dispersion corrections computed from self-consistent field relativistic Dirac-Slater wave functions. *Acta cryst.* 18:17-23, 1965.
  - 3. 719 Berghuis J, Bertha J J, Haanappel M & Potters M. New calculations of atomic scattering factors. *Acta cryst.* 8:478-83, 1955.
  - \*4. 609 Hanson H P, Herman F, Lea J D & Skillman S. HFS atomic scattering factors. *Acta cryst.* 17:1040-44, 1964.
  - \*5. 562 Karle J & Karle I L. The symbolic addition procedure for phase determination for centrosymmetric and noncentrosymmetric crystals. *Acta cryst.* 21:849-59, 1966.
  - \*6. 519 Hamilton W C. Significance tests on the crystallographic R factor. *Acta cryst.* 18:502-10, 1965.
  - 7. 394 Dauben C H & Templeton D H. A table of dispersion corrections for x-ray scattering of atoms. *Acta cryst.* 8:841-42, 1955.
  - 8. 352 Cruickshank D W J. The accuracy of electron-density maps in x-ray analysis with special reference to dibenzyl. *Acta cryst.* 2:65-82, 1949.

\*On the list of 100 chemical papers most frequently cited in 1972<sup>1</sup>.

9. 336 Howells E R, Phillips D C & Rogers D. The probability distribution of x-ray intensities. II. Experimental investigation of the x-ray detection of centres of symmetry. *Acta cryst.* 3:210-14, 1950.
- \*10. 327 Busing W R & Levy H A. The effect of thermal motion on the estimation of bond lengths from diffraction measurements. *Acta cryst.* 17:142-46, 1964.
11. 323 McWeeny R. X-ray scattering by aggregates of bonded atoms. I. Analytical approximations in single-atom scattering. *Acta cryst.* 4:513-19, 1951.
12. 322 Schomaker V, Waser J, Marsh R E & Bergman G. To fit a plane or a line to a set of points by least squares. *Acta cryst.* 12:600-04, 1959.
- \*13. 284 Zachariasen W H. The secondary extinction correction. *Acta cryst.* 16:1139-44, 1963.
14. 266 Cruickshank D W J. The analysis of the anisotropic thermal motion of molecules in crystals. *Acta cryst.* 9:754-56, 1956.
- \*15. 241 Busing W R & Levy H A. High speed computation of the absorption correction for single crystal diffraction measurements. *Acta cryst.* 10:180-92, 1957.
16. 232 Cruickshank D W J. Errors in bond lengths due to rotational oscillations of molecules. *Acta cryst.* 9:757-58, 1956.
- \*17. 226 Schomaker V & Trueblood K N. On the rigid-body motion of molecules in crystals. *Acta cryst. B.* 24:63-76, 1968.
- \*18. 206 Sayre D. The squaring method: a new method of phase determination. *Acta cryst.* 5:60-65, 1952.
19. 204 VanNiekerc J N & Schoening F R L. A new type of copper complex as found in the crystal structure of cupric acetate,  $\text{Cu}_2(\text{CH}_3\text{COO})_4 \cdot 2\text{H}_2\text{O}$ . *Acta cryst.* 6:227-32, 1953.
- \*20. 203 Shannon R D & Prewitt C T. Effective ionic radii in oxides and fluorides. *Acta cryst. B.* 25:925-46, 1969.
21. 195 Phillips D C. On the visual estimation of x-ray reflexion intensities from Weissenberg photographs. *Acta cryst.* 7:746-51, 1954.
- \*22. 190 Cromer D T & Mann J B. X-ray scattering factors computed from numerical Hartree-Fock wave functions. *Acta cryst. A.* 24:321, 1968.
23. 190 Karle I L & Karle J. An application of a new phase determination procedure to the structure of cyclo(hexaglycyl)hemihydrate. *Acta cryst.* 16:969-75, 1963.
24. 185 Forsyth J B & Wells M. On an analytic approximation to the atomic scattering factor. *Acta cryst.* 12:412-15, 1959.
- \*25. 183 Karle J & Hauptman H. A theory of phase determination for the four types of non-centrosymmetric space groups  $1P222$ ,  $2P22$ ,  $3P12$ ,  $3P2$ . *Acta cryst.* 9:635-51, 1956.

26. 182. Freeman A J. Atomic scattering factors for spherical and aspherical charge distributions. *Acta cryst.* 12:261-71, 1959.
27. 180 Cruickshank D W J & Robertson A P. The comparison of theoretical and experimental determination of molecular structures with applications to naphthalene and anthracene. *Acta cryst.* 6:698-705, 1953.
28. 178 Ibers J A & Hamilton W C. Dispersion corrections and crystal structure refinements. *Acta cryst.* 17:781-82, 1964.
29. 167 Lang A R. The projection topograph: a new method in x-ray diffraction microradiography. *Acta cryst.* 12:249-50, 1959.
30. 167 Watson R E & Freeman A J. Hartree-Fock atomic scattering factors for the iron transition series. *Acta cryst.* 14:27-37, 1961.
31. 164 Hamilton W C, Rollett J S & Sparks R A. On the relative scaling of x-ray photographs. *Acta cryst.* 18:129-30, 1965.
32. 154 Moore F H. Analytic constants for atomic scattering factors. *Acta cryst.* 16:1169-75, 1963.
- \*33. 146 Zachariassen W H. A general theory of x-ray diffraction in crystals. *Acta cryst.* 23:558-64, 1967.
34. 142 Cruickshank D W J. Coordinate errors due to rotational oscillations of molecules. *Acta cryst.* 14:896-97, 1961.
35. 127 Doyle, P A & Turner P S. Relativistic Hartree-Fock x-ray and electron scattering factors. *Acta cryst. A.* 24:390, 1968.
36. 123 Coppens P, Leiserowitz L & Rabinovich D. Calculation of absorption corrections for camera and diffractometer data. *Acta cryst.* 18:1035-38, 1965.
37. 121 Peterson S W & Levy H A. A single-crystal neutron diffraction study of heavy ice. *Acta cryst.* 10:70-76, 1957.
38. 117 Dunitz J D. The crystal structures of copper dipyrindine dichloride and the violet form of cobalt dipyrindine dichloride. *Acta cryst.* 10:307-13, 1957.
39. 113 Dawson B. Atomic scattering factors from wave functions calculated by the Poly-Detor method: Cl, S and S<sup>-</sup>. *Acta cryst.* 13:403-08, 1960.
40. 111 Tomiie Y & Stam C H. Calculation of atomic scattering factors using Slater wave functions: sodium to calcium. *Acta cryst.* 11:126-27, 1958.
41. 110 Dahl L F & Rundle R E. The crystal structure of dimanganese deca-carbonyl, Mn<sub>2</sub>(CO)<sub>10</sub>. *Acta cryst.* 16:419-26, 1963.
42. 106 LaPlaca S J & Ibers J A. Crystal and molecular structure of tris(triphenylphosphine) rhodium carbonyl hydride. *Acta cryst.* 18:511-19, 1965.
43. 103 Rollett J S. The correlation of intersecting layers of x-ray intensity data. *Acta cryst.* 13:273-74, 1960.

44. 102 Hamilton W C. On the treatment of unobserved reflexions in the least-squares adjustment of crystal structures.  
*Acta cryst.* 8:185-86, 1955.
45. 101 Ahmed F R & Cruickshank D W J. A refinement of the crystal structure analyses of oxalic acid dihydrate.  
*Acta cryst.* 6(5):385-92, 1953.