**Georg(e) Placzek: a bibliometric study of his scientific production and its impact**

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**Abstract:** The availability of a number of databases, in particular the *Science Citation Index* (SCI), have encouraged the development and use of bibliometric techniques to analyze and evaluate the production and impact of scientists. To avoid pitfalls and their sometimes serious consequences, however, considerable experience with the method is needed. The case of George Placzek appears as an excellent one to illustrate the procedure and its problems. Placzek’s work covered a broad range of topics, including optical and neutron spectroscopy, neutron diffusion, nuclear reactions, and nuclear energy. He worked in a large number of places with some of the most outstanding collaborators and also as sole author during his short professional life. His publications appeared in regular, so-called source journals, in books, lecture notes and also internal reports which were classified till several years after the end of the war. In this article we analyze Placzek’s work and its impact with the aim of illustrating the power and virtues of bibliometric techniques and their pitfalls.

**1. Introduction**

The term *bibliometry* is usually applied to the quantitative investigation of the number of publications of individuals, institutions and/or disciplines and their impact as measured by the number of citations they received. The origin of modern bibliometry is related to the foundation in 1954, by E. Garfield, of the company *Eugene Garfield Associates*, one year before Placzek’s untimely death in 1955. In 1960 the company’s name was changed to *Institute of Scientific Information* (ISI). Its main product at the time was *Current Contents*, a booklet containing the table of contents of journals selected to be relevant to the progress of science.¹ In 1964 the ISI launched the *Science Citations Index* (SCI), covering at that time 600 scientific journals. In 1988 the printed SCI was complemented by an electronic version and in 1992 the ISI, based in Philadelphia, was bought by the *Thomson Corporation*. The next important step was the launching of the *Web of Science* (WoS) in 1997, available through the internet and covering about 7000 so-called source journals in all fields of scholarship. For a detailed discussion of bibliometric techniques and citation analysis see Moed ².
The *Web of Science* is based on the ISI citation indexes, in particular on the SCI. The WoS has probably become the most versatile and user friendly citation analysis tool and it is often institutionally available to researchers of many organizations. Its competent use, however, requires some experience and awareness of possibilities and pitfalls, such as interference with namesakes and access to citations of books (usually not source items) provided the citations appear in source items. The latter can be performed using the *Cited Reference Search* mode (see below).

In spite of his short scientific life (about 25 years) Placzek is an excellent subject for learning the pitfalls and tricks of citation analysis. He only published a few articles in source journals (about 30) and many of his citations belong to books, book articles and classified reports made available after the war or even after his death. His name is not very common (we have only found two namesakes cited both after his death).\(^{3,4,5}\) He worked and studied in a wide range of European cities - Vienna, Prague, Utrecht (1929), Leipzig (1930), Rome (1931-1932), Copenhagen (1932-1938), Paris, Kharkov (1936) - and, after his forced emigration in 1938, in Canada (Chalk River) and the United States (Los Alamos, Schenectady, Ithaca, Princeton, and most likely others) and even Jerusalem (1935). He entertained close connections with some of the leading physicists of the times, as will be seen below. Although he was single author of most of his publications in source journals, he coauthored a number of them with many of those leading physicists (Amaldi, Bethe, Bohr, Frisch, Korff, Landau, Nijboer, Peierls, Teller, Van Hove, Volkoff, and possibly others in wartime classified reports).

### 2. Publications in Source Journals: the General Search mode of the WoS

The present version of the *Web of Science* has two search modes: *General Search* mode and *Cited Reference Search* mode. The *General Search* mode archives and reveals publications in source journals starting in the year 1900 (access can be confined to more recent dates depending on financial arrangements). Any of the authors can be used for the search and also combinations thereof. The results are limited to citations (including self-citations) to the papers being queried, appeared in source journals only (not books or popular publications).

A printout of the results of the *General Search* for “Placzek G” (without any other restrictions) is shown in Table 1. The total number of records is rather small. It is even reduced from 22 to 20 when one deletes the two homonyms Gary Placzek (record 14) and Gregory Placzek (record 18). However, the total number of records belonging to George Placzek is increased from 20 to 29 if one adds 9 articles in source journals which seem to have been omitted from the Science Citation Index.
Six of these missing articles appeared in the Zeitschrift für Physik, considered a source journal since its inception in 1920 till 1998 when it adopted the name of European Physics Journal. However, for reasons unknown to us the issues covering the years 1927 to 1947, i.e. those in which Placzek published in this journal, are not accessible to the WoS. Among the six excluded papers by Placzek is a highly cited one (256 citations) on the rotational structure of Raman bands, coauthored with Edward Teller. Another highly cited article, by L. Landau and G. Placzek (217 citations), dealing with the Landau-Placzek Ratio between Brillouin and Raman scattering, is also missing in Table 1. The reason is that it appeared in German in the Physikalische Zeitschrift der Sowjetunion, at a time (1934) when Soviet journals are not considered source journals by the ISI.

Record 1 of 22
Author(s): PLACZEK, G
Title: THE SCATTERING OF NEUTRONS BY SYSTEMS OF HEAVY NUCLEI
Source: PHYSICAL REVIEW, 86 (3): 377-388 1952
Times Cited: 453

Record 2 of 22
Author(s): Bethe, HA; Placzek, G
Title: Resonance effects in nuclear processes
Source: PHYSICAL REVIEW, 51 (6): 450-484 MAR 1937
Times Cited: 175

Record 3 of 22
Author(s): PLACZEK, G; VANHOVE, L
Title: CRYSTAL DYNAMICS AND INELASTIC SCATTERING OF NEUTRONS
Source: PHYSICAL REVIEW, 93 (6): 1207-1214 1954
Times Cited: 137

Record 4 of 22
Author(s): PLACZEK, G
Title: ON THE THEORY OF THE SLOWING DOWN OF NEUTRONS IN HEAVY SUBSTANCES
Source: PHYSICAL REVIEW, 69 (9-10): 423-438 1946
Times Cited: 113

Record 5 of 22
Author(s): Bethe, HA; Korff, SA; Placzek, G
Title: On the interpretation of neutron measurements in cosmic radiation
Source: PHYSICAL REVIEW, 57 (7): 573-587 APR 1940
Times Cited: 83

Record 6 of 22
Author(s): PLACZEK, G; SEIDEL, W
Title: MILNE PROBLEM IN TRANSPORT THEORY
Source: PHYSICAL REVIEW, 72 (7): 550-555 1947
Times Cited: 71

Record 7 of 22
Author(s): PLACZEK, G; NIJBOER, BRA; VANHOVE, L
Title: EFFECT OF SHORT WAVELENGTH INTERFERENCE ON NEUTRON SCATTERING BY DENSE SYSTEMS OF HEAVY NUCLEI
Source: PHYSICAL REVIEW, 82 (3): 392-403 1951
Times Cited: 47

Record 8 of 22
Author(s): PLACZEK, G
Title: THE ANGULAR DISTRIBUTION OF NEUTRONS EMERGING FROM A PLANE SURFACE
Source: PHYSICAL REVIEW, 72 (7): 556-558 1947
Times Cited: 46

Record 9 of 22
Author(s): PLACZEK, G
Title: INCOHERENT NEUTRON SCATTERING BY POLYCRYSTALS
Source: PHYSICAL REVIEW, 93 (4): 895-896 1954
Times Cited: 37

Record 10 of 22
Author(s): Bohr, N; Peierls, R; Placzek, G
Title: Nuclear reactions in the continuous energy region
Source: NATURE, 144: 200-201 JUL-DEC 1939
Times Cited: 25

Record 11 of 22
Author(s): PLACZEK, G
Title: INCOHERENT NEUTRON SCATTERING BY POLYCRYSTALS
Source: PHYSICAL REVIEW, 105 (4): 1240-1241 1957
Times Cited: 19

Record 12 of 22
Author(s): PLACZEK, G; VANHOVE, L
Title: INTERFERENCE EFFECTS IN THE TOTAL NEUTRON SCATTERING CROSS-SECTION OF CRYSTALS
Source: NUOVO CIMENTO, 1 (1): 233-256 1955
Times Cited: 18

Record 13 of 22
Author(s): Placzek, G
Title: Concerning light dissapation near the critical point.
Source: PHYSIKALISCHE ZEITSCHRIFT, 31: 1052-1056 1930
Times Cited: 12
Record 14 of 22
Author(s): Spicer, KR; Costa, JE; Placzek, G
Title: Measuring flood discharge in unstable stream channels using ground-penetrating radar
Source: GEOLOGY, 25 (5): 423-426 MAY 1997
Times Cited: 7

Record 15 of 22
Author(s): PLACZEK, G; VOLKOFF, G
Title: A THEOREM ON NEUTRON MULTIPLICATION
Source: CANADIAN JOURNAL OF RESEARCH SECTION A-PHYSICAL SCIENCES, 25 (4): 276-292 1947
Times Cited: 4

Record 16 of 22
Author(s): PLACZEK, G
Title: THEORY OF SLOW NEUTRON SCATTERING
Source: PHYSICAL REVIEW, 75 (8): 1295-1295 1949
Times Cited: 3

Record 17 of 22
Author(s): PLACZEK, G
Title: CORRECTION
Source: NUOVO CIMENTO, 1 (5): 967-967 1955
Times Cited: 1

Record 18 of 22
Author(s): Placzek, G; Wiser, R; Roberts, KP
Title: Microscopic characterization of CDSE/ZNS nanocrystals.
Source: ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY, 229: U391-U392 340-CHED Part 1 MAR 13 2005
Times Cited: 0

Record 19 of 22
Author(s): PLACZEK, G
Title: CORRECTION
Source: PHYSICAL REVIEW, 94 (6): 1801-1801 1954
Times Cited: 0

Record 20 of 22
Author(s): PLACZEK, G
Title: SCATTERING OF X-RAYS BY ATOMS
Source: PHYSICAL REVIEW, 86 (4): 588-588 1952
Times Cited: 0

Record 21 of 22
Author(s): Bethe, HA; Korff, SA; Placzek, G
Title: On the interpretation of neutron measurements in cosmic radiation.
Source: JOURNAL OF THE FRANKLIN INSTITUTE, 230: 776-777 JUL-DEC 1940
Two additional articles by Placzek are missing pathologically from Table 1. One of them, on the Raman Effect of gaseous ammonia, appeared in the Zeitschrift für Physik 8 (10 citations) coauthored with E. Amaldi. The other, on the capture of slow neutrons, appeared in Nature 9, coauthored with O.R. Frisch (7 citations). It does not appear in the WoS under General Search. The whole volume 137 of Nature is actually missing. Such errors unfortunately are not uncommon for publications which predate 1945 and thus have been added to the WoS only recently (in 2005). Such publications can be retrieved in the Cited Reference Search mode (see next section). The total number of citations received by these 29 papers is 1734. This includes self citations but it does not include incorrect citations which, as we well see next, can be often revealed by using the Cited Reference Search mode of the WoS.

3. References to publications which did not appear in source journals or were incorrectly cited: The Cited Reference Search mode of the WoS

The Cited Reference Search mode enables access to all references appeared in source journals (whether the references are to articles in source journals cited either correctly or incorrectly), or references to articles published in non-source journals or in books or any other published material (sometimes even unpublished, e.g., theses, internal reports, or even private communications). Probably the most useful feature of this mode, especially concerning Placzek’s work, is the possibility of finding a measure of the impact of a book or a book article, as reflected in the citations in source journals. Conference proceedings, even if not published in source journals, can also be accessed using the Cited Reference Search mode.

As an example we deal with the problem of the missing Ref. 9. Because the articles in this missing volume of Nature are not source items, only the first author (Frisch O R ) must be queried under the Cited Reference Search. We then find 7 citations for Ref. 9. Care must be taken searching either O R or O* and not OR (without
blank). If the latter is done the system takes OR as a Boolean operator and gives an error message. The same procedure can be used to find the citations of Ref. 7. One must take into consideration here that the name of the first author deviates from the standard form “Landau L D” and the citations (217 citations) must be retrieved either under “Landau L” or “Landau L*”.

Placzek published in 1934 in the *Handbuch der Radiologie* a 270 pages article under the title (in German): “Rayleigh scattering and the Raman Effect”. It is probably the first comprehensive article on the theory of light scattering published after the discovery of the Raman Effect in 1928. In spite of having been written in German at a time when Germany’s star was beginning to wane, a *Cited Reference Search* reveals a total of about 986 citations for this article (see Table 2).

| Column 1: Consecutive numbering | Column 2: Number of citations at the date of search | Column 3: Short form of the cited publications |
|---------------------------------|--------------------------------------------------|---------------------------------------------|
| 1                               | 453 PLACZEK G                                    | 1952 V86 P377 PHYS REV                     |
| 2                               | 360 PLACZEK G                                    | 1934 V6 P205 HDB RADIOLOGIE                |
| 3                               | 280 PLACZEK G                                    | 1934 V6 P209 HANDB RADIOL                  |
| 4                               | 254 PLACZEK G                                    | 1933 V81 P209 Z PHYS                      |
| 5                               | 174 PLACZEK G                                    | 1937 V51 P450 PHYS REV                    |
| 6                               | 137 PLACZEK G                                    | 1954 V93 P1207 PHYS REV                   |
| 7                               | 113 PLACZEK G                                    | 1946 V69 P423 PHYS REV                    |
| 8                               | 83 PLACZEK G                                     | 1940 V57 P573 PHYS REV                    |
| 9                               | 83 PLACZEK G                                     | 1934 V2 P209 HDB RADIOLOGIE               |
| 10                              | 71 PLACZEK G                                     | 1947 V72 P550 PHYS REV                    |
| 11                              | 47 PLACZEK G                                     | 1931 V70 P84 PHYS                         |
| 12                              | 47 PLACZEK G                                     | 1951 V82 P392 PHYS REV                    |
| 13                              | 46 PLACZEK G                                     | 1947 V72 P556 PHYS REV                    |
| 14                              | 37 PLACZEK G                                     | 1954 V93 P895 PHYS REV                    |
| 15                              | 36 PLACZEK G                                     | 1940 V57 PA1075 PHYS REV                  |
| 16                              | 27 PLACZEK G                                     | 1934 V6 HANDBUCH RADIOLOGI                |
| 17                              | 25 PLACZEK G                                     | 1939 V144 P200 NATURE                     |
| 18                              | 24 PLACZEK G                                     | 1934 V6 P71 HDB RADIOLOGIE                |
| 19                              | 20 PLACZEK G                                     | 1934 V6 P2 HDB RADIOLOGIE                 |
| 20                              | 19 PLACZEK G                                     | 1957 V105 P1240 PHYS REV                  |
| 21                              | 18 PLACZEK G                                     | 1955 V1 P233 NUOVO CITMENTO               |
| 22                              | 15 PLACZEK G                                     | 1946 V37 P57 NRC1547 NAT RES COU          |
| 23                              | 14 PLACZEK G                                     | 1930 V31 P1052 PHYS Z                     |
| 24                              | 14 PLACZEK G                                     | 1931 V1 P71 LEIPZIGER VORTRAGE            |
| 25                              | 12 PLACZEK G                                     | 1929 V58 P585 Z PHYS                      |
| 26                              | 12 PLACZEK G                                     | 1935 V4 P209 RAYLEIGH SCATTERING          |
| 27                              | 11 PLACZEK G                                     | 1934 V2 P205 HDB RADIOLOGIE 6            |
| 28                              | 11 PLACZEK G                                     | 1995 P133 A25 MANH PROJ REP               |
| 29                              | 10 PLACZEK G                                     | 1950 P581 2 B E R K S MATH STAT           |
| 30                              | 9 PLACZEK G                                      | 1946 V25 P209 FUNCTIONS ENX               |
| 31                              | 9 PLACZEK G                                      | 1959 V6 P526 RAYLEIGH RAMAN SCAT          |
| 32                              | 9 PLACZEK G                                      | 1962 V6 P109 RAYLEIGH RAMAN SCAT          |
| 33                              | 8 PLACZEK G                                      | 1947 V25 P276 CANADIAN J RES A            |
| 34                              | 8 PLACZEK G                                      | 1951 P581 2 P B E R K S MATH STA          |
| 35                              | 8 PLACZEK G                                      | 1959 V4 P209 RAYLEIGH SCATTERING          |
PLACZEK G 1962 P139 UCRLTRANS526L US AT
...Placzek G 1997 V25 P423 GEOLOGY
PLACZEK G 1928 V49 P601 Z PHYS
PLACZEK G 1932 V2 P91 STRUCTURE MOLECULES
PLACZEK G 1934 V4 P205 HANDBUCH RADIOLOGIE
PLACZEK G 1934 V6 P203 MARX HDB RADIOLOGIE
PLACZEK G 1946 P49 MT1 NAT RES COUNC C
PLACZEK G 1962 V526 P175 UCRL TRANS
PLACZEK G 1929 V55 P81 Z PHYS
PLACZEK G 1931 V1 P293 LEIPZIGER VORTRAGE
PLACZEK G 1947 P6 MT16
PLACZEK G 1934 V6 P365 HDB RADIOLOGIE
PLACZEK G 1934 V6 P366 HANDBUCH RADIOLOGY
PLACZEK G 1934 V6 P371 HANDBUCH RADIOLOGIE
PLACZEK G 1934 V6 P423 HANDBUCH RADIOLOGIE
PLACZEK G 1934 V6 P64 RAYLEIGH RAMAN SCAT
PLACZEK G 1934 V7 P203 MARX HDB RADIOLOGIE
PLACZEK G 1947 P6 MT16
PLACZEK G 1949 V75 P1295 PHYS REV
PLACZEK G 1951 V37 P57 NRC1547
PLACZEK G 1954 V37 P57 NBS APPL MATH SER
PLACZEK G 1954 V93 P897 PHYS REV
PLACZEK G 1959 P133 526 UCRL
PLACZEK G 1962 V526 P138 UCRLTRANS526L DEP C
PLACZEK G 1934 V12 P209 HDB RADIOLOGIE
PLACZEK G 1934 V2 P316 HDB RADIOLOGIE
PLACZEK G 1934 V2 P328 HDB RADIOLOGIE
PLACZEK G 1934 V2 P343 HDB RADIOLOGIE 4
PLACZEK G 1934 V6 P208 HDB RADIOLOGIE
PLACZEK G 1934 V6 P224 HDB RADIOLOGIE
PLACZEK G 1934 V6 P276 HDB RADIOLOGIE
PLACZEK G 1934 V6 P283 HDB RADIOLOGIE
PLACZEK G 1934 V6 P293 HDB RADIOLOGIE
PLACZEK G 1934 V6 P321 HDB RADIOLOGIE 2
PLACZEK G 1934 V6 P323 HDB RADIOLOGIE 2
PLACZEK G 1934 V6 P355 MARX HDB RADIOLOGI
PLACZEK G 1934 V6 P371 HANDBUCH RADIOLOGI
PLACZEK G 1935 V2 P209 HDB RADIOLOGIE
| Ref. | Page | Year | Volume/Issue | Page | Journal/Citation |
|------|------|------|--------------|------|-----------------|
| 94   | 2    | 1935 | V6           | P209 | HDB RADIOLOGIE  |
| 95   | 2    | 1938 | V83          | P209 | Z PHYS          |
| 96   | 2    | 1939 | V6           | P209 | HDB RADIOLOGIE  |
| 97   | 2    | 1940 | V57          | P1072| PHYS REV        |
| 98   | 2    | 1942 |              | P133 | A25 MANH PROJ REP |
| 99   | 2    | 1947 |              | P49  | MT1 AE PROJ NAT RES |
| 100  | 2    | 1947 | V72          | P50  | PHYS REV        |
| 101  | 2    | 1949 | V2           | PCH7 | SCI ENG NUCLEAR POW |
| 102  | 2    | 1950 |              | P281 | UNPUB P BERKELEY S |
| 103  | 2    | 1953 | V71          | PS100| LOS ALAMOS SCI LAB |
| 104  | 2    | 1956 | V37          | P57  | NOMIT NAT RES COUNC |
| 105  | 2    | 1959 | V526         | P138 | UCRLTRANS526 U CAL |
| 106  | 2    | 1959 | V6           | P139 | RAYLEIGH RAMAN SCAT |
| 107  | 2    | 1962 |              |      | UCRLTRANS526L    |
| 108  | 2    | 1962 |              | P175 | UCRLTRANS526L US AT |
| 109  | 2    | 1962 | V526         | P562 | UCRL T          |
| 110  | 2    | 1980 |              |      | MOL VIBRATIONS  |
| 111  | 2    | 1995 |              |      | MOL VIBRATIONS  |
| 112  | 1    |      |              |      |                 |
| 113  | 1    |      |              |      |                 |
| 114  | 1    |      |              |      |                 |
| 115  | 1    | 1925 | V6           | P205 | HDB RADIOLOGIE 2 |
| 116  | 1    | 1929 | V81          | P81  | Z PHYS          |
| 117  | 1    | 1930 | V31          | P1051| PHYS Z          |
| 118  | 1    | 1930 | V33          | P832 | P AMSTERDAM     |
| 119  | 1    | 1930 | V38          | P832 | P AMST          |
| 120  | 1    | 1930 | V67          | P582 | Z PHYS          |
| 121  | 1    | 1931 | V1           | P105 | LEIPZIGER VORTRAGE |
| 122  | 1    | 1931 | V1           | P75  | LEIPZIGER VORTRAGE |
| 123  | 1    | 1931 | V1           | P81  | LEIPZIGER VORTRAGE |
| 124  | 1    | 1931 | V1           | P94  | LEIPZIGER VORTRAGE |
| 125  | 1    | 1931 | V1           | P96  | LEIPZIGER VORTRAGE |
| 126  | 1    | 1931 | V1           | PS100| LEIPZIGER VORTRAGE |
| 127  | 1    | 1931 | V70          | P287 | Z PHYS          |
| 128  | 1    | 1931 | V70          | P83  | Z PHYS          |
| 129  | 1    | 1931 | V70          | PS4  | Z PHYS          |
| 130  | 1    | 1931 | V71          | PS100| LEIPZIGER VORTRAGE |
| 131  | 1    | 1931 | V72          | P257 | Z PHYS          |
| 132  | 1    | 1932 | V4           | P211 | HDB RADIOLOGIE  |
| 133  | 1    | 1932 | V6           | P2   | HDB RADIOLOGIE  |
| 134  | 1    | 1932 | V6           | P211 | HDB RADIOLOGIE  |
| 135  | 1    | 1932 | V6           | P339 | HDB RADIOLOGIE  |
| 136  | 1    | 1933 | V6           | P2   | HDB RADIOLOGIE  |
| 137  | 1    | 1933 | V6           | P205 | MARX HANDBUCH RADI |
| 138  | 1    | 1933 | V6           | P339 | HDB RADIOLOGIE  |
| 139  | 1    | 1933 | V81          | P201 | Z PHYS          |
| 140  | 1    | 1933 | V81          | P208 | Z PHYS          |
| 141  | 1    | 1934 | V1           | P160 | HDB RADIOLOGIE  |
| 142  | 1    | 1934 | V1           | P244 | HDB RADIOLOGIE 2 |
| 143  | 1    | 1934 | V1           | P244 | HDB RADIOLOGIE 2 |
| 144  | 1    | 1934 | V2           | P308 | HDB RADIOLOGIE  |
| 145  | 1    | 1934 | V2           | P365 | HDB RADIOLOGIE  |
| 146  | 1    | 1934 | V2           | PCH12| HANDBUCH RADIOLOGIE |
| 147  | 1    | 1934 | V2           | PCH21| HANDBUCH RADIOLOGIE |
| 148  | 1    | 1934 | V2           | PCH21| HDB RADIOLOGIE  |
| 149  | 1    | 1934 | V25          | P209 | DANS HDB RADIOLOGIE |
| 150  | 1    | 1934 | V25          | P423 | HANABUCH RADIOLOGIE |
| 151  | 1    | 1934 | V4           | P238 | HANDBUCH RADIOLOGIE |
| Volume | Year | Citation |
|--------|------|----------|
| 152    | 1934 | V4 P253  |
| 153    | 1934 | V4 P323  |
| 154    | 1934 | V4 P38   |
| 155    | 1934 | V4 PR4   |
| 156    | 1934 | V526 P205|
| 157    | 1934 | V526 PCH8|
| 158    | 1934 | V6 P1    |
| 159    | 1934 | V6 P187  |
| 160    | 1934 | V6 P20   |
| 161    | 1934 | V6 P204  |
| 162    | 1934 | V6 P210  |
| 163    | 1934 | V6 P235  |
| 164    | 1934 | V6 P238  |
| 165    | 1934 | V6 P247  |
| 166    | 1934 | V6 P265  |
| 167    | 1934 | V6 P274  |
| 168    | 1934 | V6 P278  |
| 169    | 1934 | V6 P30   |
| 170    | 1934 | V6 P303  |
| 171    | 1934 | V6 P305  |
| 172    | 1934 | V6 P307  |
| 173    | 1934 | V6 P308  |
| 174    | 1934 | V6 P314  |
| 175    | 1934 | V6 P325  |
| 176    | 1934 | V6 P326  |
| 177    | 1934 | V6 P328  |
| 178    | 1934 | V6 P343  |
| 179    | 1934 | V6 P523  |
| 180    | 1934 | V6 PCH15 |
| 181    | 1934 | V6 PS100 |
| 182    | 1934 | V7 P71   |
| 183    | 1935 | P235     |
| 184    | 1935 | P49      |
| 185    | 1935 | V1 P233  |
| 186    | 1935 | V25 P423 |
| 187    | 1935 | V6       |
| 188    | 1935 | V6 P205  |
| 189    | 1935 | V6 P64   |
| 190    | 1938 | V2 P209  |
| 191    | 1938 | V4 P205  |
| 192    | 1939 | V86 P190 |
| 193    | 1940 | V25 P276 |
| 194    | 1943 | V4       |
| 195    | 1943 | V4       |
| 196    | 1943 | V4 P205  |
| 197    | 1944 | V25 P276 |
| 198    | 1946 | V2 P209  |
| 199    | 1946 | V2 P209  |
| 200    | 1946 | V69 P463 |
| 201    | 1947 | V25 P209 |
| 202    | 1947 | V72 P557 |
| 203    | 1947 | V72 P558 |
| 204    | 1947 | V72 P7   |
| 205    | 1947 | V79 P550 |
| 206    | 1949 | V2 P209  |
| 207    | 1949 | V2 P77   |
| 208    | 1950 | P7       |
| 209    | 1950 | P551     |
Entries 112-114: No details about the corresponding references are given. This must be either an oversight or corresponds to private communications.

**Table 2.** Placzek’s publications as appear in the WoS within the *Cited Reference Search* mode. Some of the most obvious cases of reference journal variations have been bundled together. The observant reader will still discover many reference errors.

We now illustrate on the basis of Table 2 the evaluation of citations to books and book chapters by articles in source journals. The second most cited entry in this table is listed to have been cited 360 times, having appeared in *Handbuch der Radiologie* in 1934 (Vol. 6, page 205). The third entry (280 citations) corresponds to the same publication but citing page 209 (and thus appears as if it were a wholly
different publication). The 9th entry (83 citations) corresponds obviously to the same publication but the volume is erroneously given as the 2nd, instead of the 6th. Hence, although it is the same, it is listed as a fully different publication. A total citation count for this book chapter must be performed by hand and include also the entries 16 (no page given, 27 citations), 18 (page 71, 24 citations), etc. By now it should have become clear that some authors list in the reference the first page of the chapter while others give simply the page that they are using. For a 270 page article the possibility of errors is rather large. The cumulative citations to the Handbuch der Radiologie article are obtained by hand from Table 2 to be 986. This is to be regarded as a lower limit corresponding to a single citation per citing article. Since a large article, like the one at hand, may be cited several times in a citing article, the total number of citations may be somewhat higher.

The outlined procedure can also be applied to the book on neutron diffusion, coauthored by Placzek. Although the book is known to be highly cited, it appears only once on Table 2 (see entry 215 in the Table), where the first author was incorrectly given as Placzek. The reason for the missing citations seems to be that Placzek is not the correct first author of the book and is thus often not cited in connection with it. Searching for the citations to the first author K.M. Case, in the Cited Reference Search mode one finds many to this book in several variations. The sum of all of them leads to a total of 630. The remaining items in Table 2 correspond to erroneous citations, internal reports, especially declassified ones related to the Manhattan project, lecture notes and, last but not least, citations of work appeared in non-source journals. The Cited Reference Search mode allows a counting of all references in source items, yielding for Table 2 a total of 2876. The 630 citations to Ref. 10 should also be added. This gives us a lower limit for the total number of citations of $2876 + 630 = 3506$.

In order to clarify the rather complicated pattern of the results in Table 2 we show in Figure 1 a bar diagram representing the number of citations received by Placzek’s articles, books, reports, etc. versus the year of publication. His first article, published in the Zeitschrift für Physik in 1928 and cited 6 times, is based on his doctoral thesis performed at the University of Vienna (title: Determination of density and shape of submicroscopic test bodies). His second article, published in 1929, shortly after the discovery of the Raman Effect, dealt with the theory of the Raman Effect. The years 1933-1934 represent his “annus mirabilis”, with nearly 1500 citations. During these years he published the article in the Handbuch der Radiologie, the work on the rotational spectra of molecules (with E. Teller) and the theory of the Landau-Placzek Ratio. In 1952 his most cited article (454 citations) appeared in the Physical Review, a journal that after emigration took the place of the Zeitschrift für Physik for communicating his work. The title of the paper, of
which he was single author, was “The scattering of neutrons by systems of heavy nuclei”. During 1952 he must also have been writing the book in Ref. 10.

Figure 1. Citation bar diagram with the number of citations vs. publication year of the Placzek papers as listed in Table 2. Note that his contribution to the book in Ref. 10 (630 citations) is not included for the reasons given in the text. For the meaning of “posthumous” papers see text.

According to Figure 1 there seem to be a few posthumous publications after his untimely death in 1955. The most recent one (Geology, 1997) is not his work but that of a namesake. However, that listed as published in 1995 corresponds to a report of the Manhattan project, cited 5 times (see Table 2) but hard to obtain for ordinary mortals. The 1997 paper (7 citations) is actually a publication by Gary Placzek, who worked at the US geologic survey. We have succeeded in contacting the other namesake who appears as the 18th record in Table 1 (Gregory Placzek). He is an undergraduate at the University of Tulsa, majoring in chemistry and is not related to George (only a few members of the Brno Placzek clan managed to survive the holocaust). The reason why he does not appear in Table 2 or in Figure 1 is that his paper, an abstract of a talk delivered this year, has no citations (yet). The user of the WoS should keep in mind that uncited papers appear in the General
Search mode but not under the Cited Reference Search mode (after all, they have not been cited yet).

The really posthumous publication by George Placzek was submitted in 1956 (Incoherent neutron scattering by polycrystals), indeed after Placzek’s death. It is based on sketchy, unpublished notes which, because of their interest, were edited and refereed by L. Van Hove, a rather unusual procedure justified only by the importance of the work (number 20 in Table 2, 19 citations). Papers No. 31 (1959) and 32 (1962) in Table 2 and Figure 1 seem to refer to some English translation of paper No. 2, like many of his “pseudo-posthumous” papers unavailable to us.

We include next a figure with the time evolution of the yearly citations of Placzek’s most cited papers (1, 2-3, and 4 of Table 2). The citations to the Handbuch article (1993) increased drastically from 1960 till 1977, reaching the rather high value of 40 citations per year in 1977. They have been falling smoothly since then, to reach the still important value of 13 in 2005 (many authors would be happy to be cited as frequently 70 years after publication). The decrease may be due to the appearance of a large number of books on light scattering. Let us not forget, however, that the book was written in German and no English translation, if extant, is easily available. The citations to the Placzek and Teller article (No. 4 of Table 2) follow a similar time evolution, with the vertical axis properly scaled. It was also written in German which, by 1975, had lost its appeal as a scientific language. The yearly citations of Placzek’s most cited paper, however, after rising to a maximum around 1975, have remained nearly constant at around 10 per year.
Figure 2. Citation history of Placzek’s three most cited papers. HBR represents the *Handbuch der Radiologie*.

What else does Figure 2 tell us? The number of citations received by the three publications remains nearly constant at a low level till about 1955-1960. They take off sometime within this period to reach their maxima around 1975. Because of the long period of low citation activity, followed by a big upsurge, they deserve the name of *sleeping beauties*. One may speculate about the causes for this relatively sharp growth in the late fifties. We mention two possibilities: the *Sputnik Effect* and the advent of Laser-Raman spectroscopy and also inelastic neutron scattering. The launching of *Sputnik* in 1957 produced a shock in the United States which was to be counteracted by massive support and development in the physical science and engineering. Raman spectroscopy had remained a rather academic specialty since its discovery in 1928, because of the weak light sources available. The invention and industrial production of gas lasers resulted in easy accessibility of Raman spectroscopy during the mid sixties. The colossal development that followed brought to the fore Placzek’s *Handbuch* article at a time when hardly any in-depth publications of the underlying theory were available.
The time dependence pattern shown in Figure 2 for the three most cited of Placzek’s works is also found for the sum of all citations (cumulative impact). This is illustrated in Figure 3 which indicates that his work is still cited at the rate of about 35 citing papers per year, a rather remarkable number of citations for publications that, on the average, are 75 years old.\textsuperscript{14}

\textbf{Figure 3.} Time dependence of the citations of the ensemble of all Placzek publications. The number of \textbf{citing} papers versus their year of publication is given. The 630 citations of the book by Case and Placzek are not included here.

\textbf{4. Informal citations by name only}

Some contributions to science become household words (e.g. Maxwell’s Equations, Bose-Einstein Statistics, the Ginzburg-Landau Equations, the Landau-Placzek Ratio) and full reference to the original work, in terms of a formal citation, is then often not given. Instead, the name of the author or the concept bearing his name is given, often in the title, the abstract or the keywords. It then becomes difficult for those of us who want to go to the original sources to figure out where to find them. This widespread practice may also pose problems for settling priority
issues. Fortunately, the WoS, in its *General Search* mode, querying for the name of
the author as a topic offers the possibility of finding out how many times the author
is mentioned as an “informal reference” provided his name appears in the title of a
paper, the abstract, or the keywords.\(^\text{15}\) We have found that the name “Placzek” has
been thus mentioned informally in 118 publications.

It is also possible with the Boolean operators available in the WoS to find out in
what connection a given author is cited informally. It suffices to look at the title,
the abstract and/or the keywords of one of the informally citing papers to find out
one associated concept and then query under “topic” the author’s name followed
by the Boolean operator AND and the desired concept. The results found for
Placzek are:

| Author’s Term                  | Frequency |
|-------------------------------|-----------|
| Landau-Placzek Ratio          | 61 times  |
| Placzek’s approximation       | 28 times  |
| Placzek’s polarizability      | 17 times  |
| Placzek’s lemma               | 9 times   |
| Placzek’s theory              | 2 times   |

Although neither Placzek’s approximation nor Placzek’s theory are very tale
telling terms, the Landau-Placzek Ratio, Placzek’s polarizability and Placzek’s
lemma have become household words.

We display in Table 3 the number of informal citations for Placzek and his
prominent coworkers. In all cases except for Frisch and Case it can be easily found
from the WoS, *General Search* mode (under *Topic*). No such results are given for
either Frisch, Korff or Case. For Frisch and Korff, the large number of namesakes
in the biomedical field would impose a rather tedious separation by hand. For
Case, the various ordinary meanings of the word do not allow the computer to
recognize it as a family name. For comparison we have added to Table 3 C.V.
Raman, Raman spectroscopy being one of the fields in which Placzek excelled,
and two living Nobel laureates, Ginzburg and Hänsch.
| Author                  | Informal citations | Reference citations | Hirsch number h | Andersen index IA |
|-------------------------|--------------------|---------------------|-----------------|------------------|
| E. Amaldi (1931-1989)   | 46                 | 1331                | 19              | 0.40             |
| H. Bethe * (1927-2004)  | 5616               | 20504               | 58              | 3.46             |
| N. Bohr * (1909-1962)   | 2938               | 2716                | 20              | 0.97             |
| K.M. Case (1948-1989)   |                    | 3034                | 27              | 1.80             |
| S.A. Korff (1927-1982)  |                    | 911                 | 13              | 0.30             |
| L.D. Landau * (1926-1968) | 19155             | 10919               | 31              | 6.19             |
| B.R.A. Nijboer (1937-1988) | 19                 | 1488                | 16              | 0.57             |
| R. Peierls (1929-1995)  | 4442               | 5556                | 28              | 1.04             |
| G. Placzek (1930-1955)  | 118                | 1252                | 12              | 2.00             |
| E. Teller (1931-2003)   | 9661               | 27742               | 40              | 5.35             |
| L. Van Hove (1949-1990) | 297                | 9913                | 43              | 5.90             |
| G.M. Volkoff (1939-1963) | 67                 | 1128                | 11              | 1.96             |
| C.V. Raman * (1907-1970)| 95669              | 1152                | 17              | 0.29             |
| V.L. Ginzburg * (1939-) | 5960               | 21243               | 40              | 4.88             |
| T.W. Hänsch * (1969-)  | 300                | 12405               | 62              | 9.57             |

* Nobel Laureates

**Table 3.** Several impact indexes of Placzek, some of his coworkers and, for comparison, C.V. Raman and two living Nobel laureates (Ginzburg and Hänsch). The informal references are discussed in Sect. 4, the $h^{16}$ and IA $^{17}$ indexes in Sects. 5 and 6, respectively. In parentheses: time periods of scientific activity.

Table 3 exposes Landau and Raman as the two giants of the informal citations, followed by Teller and Bethe. Landau is mostly informally cited in connection with the Ginzburg-Landau Equations (Ginzburg: Nobel Laureate 2003, Landau: NL 1962). Bethe (NL 1967) is mostly cited informally in connection with the Bethe Ansatz. Raman (NL 1930), of course becomes a household word in
connection with Raman spectroscopy, Placzek in connection with the Landau-Placzek Ratio.

It is interesting to note that there is no direct correlation between the informal citations and the two impact indexes $h$ and $IA$ to be discussed in the next two sections. There may actually be some kind of anti-correlation: informal citations are often used at the expense of the corresponding formal ones.

5. The Hirsch index $h$

This index was introduced recently by J. Hirsch as a measure of the cumulative impact of a person’s scientific work within a given discipline. It can be easily obtained, within a minute or so, provided one has access to the WoS (General Search mode) and the number of highly cited namesakes is low. The index $h$ is simply defined as the number of articles in source journals that have had $h$ citations or more. It is not easy to include books and other items listed in the Cited Reference Search mode (we do not do it here). The index $h$ increases with the age of the scientist and comparison between different disciplines should be avoided unless a reliable relative calibration is available.

Particularly striking is the comparison of the informal references of Raman (a whopping 95669) with his low $h$ (18, only slightly higher than that of Placzek). The total number of Raman’s citations (1570 as obtained in the Cited Reference Search mode) is also considerably lower than that found for Placzek (2627). It is easy to conjecture the reason for this apparent discrepancy. The Raman Effect was discovered in 1928 and awarded the Nobel Prize in 1930, which made it almost immediately a household word. The original source item publication appeared in Nature but was cited only 170 times: authors preferred to mention simply Raman Effect than give a formal citation. Many of his publications appeared in Indian journals which are even now not in the list of source items. As an example we mention an article in the Proc. of the Indian Acad. of Sciences 2, 406 (1935), cited 383 times (Raman’s most cited paper). Later issues of this journal are now listed as source items.

We conclude the discussion of Table 3 by mentioning E. Amaldi, a close friend and coauthor of Placzek. The small number of informal citations corresponds mainly to the “Fermi-Amaldi Correlation Terms”. Amaldi’s Hirsch number is only slightly higher than that of Placzek inspite of his having been blessed with a much longer life (1908-1989). In principle, the impact of early papers and thereby the overall impact of pioneers like Niels Bohr are highly underestimated: The proliferation of science implies a proliferation of citable papers, resulting in increasing ratios of
references per paper (reference count) and citations per paper, respectively. These ratios have approximately doubled within the last half century. Hence, the Hirsch numbers of scientists from different time periods are hardly comparable.

6. The Andersen Index IA

The index IA, proposed by O.K. Andersen\textsuperscript{17}, is obtained with the following expression:

\[
\text{IA} = \frac{\text{number of citations}}{(\text{years of scientific life})^2}
\]

In the above expression the number of citations is usually obtained from the General Search mode of the WoS, although a correction for wrong citations based on the Cited Reference Search mode can also be included. The years of scientific life are taken to include the period from the first publication (this has been done here but sometimes the year in which the PhD was granted is taken) till present if the author is alive or till the year of his death (the latter applies to all authors in Table 3 except Ginzburg and Hänsch). The square in the denominator of the expression has been included to keep IA constant whenever the number of citations per publication and the number of publications per year remains constant throughout the scientific life.

The highest IA index in the upper part of Table 3 is that of Landau (6.19). This number is, however, rather low compared with present day authors of similar caliber (The IA index of this year’s Nobel laureate T.W. Hänsch is 9.57). This effect is even more striking in the case of H. Bethe (3.46) who enjoyed a rather long (scientific) life, thus enhancing the denominator of the above expression while his productivity decreased in the later years of his life. Amaldi stayed in Italy during and after the war. His productivity decreased significantly during this period.\textsuperscript{20} Even during the recovery after 1950, his productivity remained low. He was heavily involved in rebuilding Italian science at the political and administrative level, including the promotion of large national and international projects (CERN, Frascati, the European Space Agency). He was also involved in projects and workshops dealing with disarmament and the peaceful use of atomic energy, obviously at the expense of conventional scientific research. Hence his low IA number (0.40). The other IA giants in Table 3 are E. Teller (5.35) and L. Van Hove (5.90). The IA of G. Placzek (2.0) falls somewhere in the middle. It would be increased by about a factor of two if his highly cited book and book article were included.
7. Conclusions

We have performed a bibliometric (citations) analysis of Placzek’s scientific publications. His variegated and tragic life offers an excellent case study for such analysis. We conclude that Placzek ranks according to standard bibliometric impact indexes, and in spite of his untimely death, among the giants of his life period, many of whom are found as coauthors in his publications.

References

1 This selection, performed by the ISI, is based on the so-called Bradford’s law (1953) which loosely interpreted states that of all journals dealing with scientific issues, only a small proportion (~10 %) are relevant to the progress of science. The relevant journals, as selected by the ISI according to well defined criteria and revised at regular intervals, are called source journals. For a detailed discussion of modern bibliometric methods see Ref. 2.

2 H.F. Moed, Citation Analysis in Research Evaluation, Springer, Heidelberg (2005).

3 The WoS, unfortunately, only records the initials of the first names. One of the mentioned namesakes is called Gregory 4, the other Gary 5.

4 G. Placzek, R. Wiser, and K.P. Roberts, Abstracts Am. Chem. Soc. 229, U-391 (2005).

5 K.R. Spicer, J.E. Costa and G. Placzek, Geology 25, 423 (1997).

6 G. Placzek and E. Teller, Z. Phys. 81, 209 (1933).

7 L. Landau and G. Placzek, Phys. Z. der Sowjetunion 5, 172 (1934).

8 E. Amaldi and G. Placzek, Z. Phys. 81, 259 (1933).

9 O.R. Frisch and G. Placzek, Nature 137, 357 (1936).

10 K.M. Case, F. de Hoffmann, and G. Placzek, Introduction to the theory of neutron diffusion, Vol. 1, Los Alamos, NM (1953).

11 The posthumous publication has the following footnote: “The present note contains results obtained by George Placzek a few years ago and never published,
except in very fragmentary form as a Letter to the Editor [G. Placzek, Phys. Rev. 93, 895 (1954)]. In view of the importance of these results for actual computation of slow-neutron scattering cross sections, it was considered useful to publish them after Dr. Placzek’s death, as a complement to the above-mentioned letter. The author’s original notes have been reviewed and edited for publication by L. Van Hove, Utrecht, Netherlands.”

12 See, for instance, the Springer Series Light Scattering in Solids, Vols. 1-9, which was launched in 1975.

13 A.F.J. van Raan, Scientometrics 59, 461 (2004).

14 Note that the ordinate of this figure corresponds to the number of citing papers which, as already mentioned, may be somewhat lower than the number of citations.

15 Caveat: The abstracts are only stored in the WoS after 1990. A given name can appear as an informal and a formal citation simultaneously, although this case is not very common.

16 J. Hirsch, Proc. Nat. Acad. Sciences 102, 16569 (2005).

17 O.K. Andersen, private communication.

18 Generally, papers in the biomedical field are cited twice as much as those in either physics or chemistry.

19 C.V. Raman, Nature 121, 501 (1928).

20 M. Cardona and W. Marx, Scientometrics 64, 313 (2005).

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