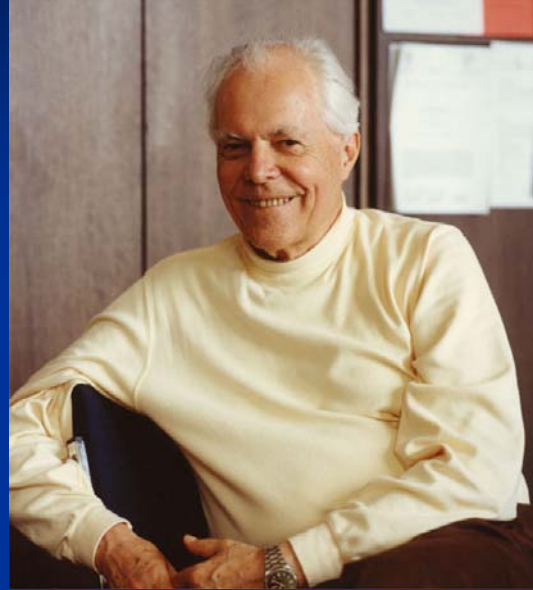
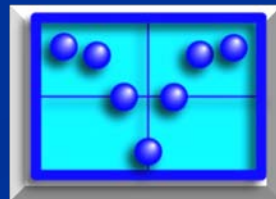


50 Years of the Mössbauer Effect



J. G. Stevens, A. M. Khasanov,
N. F. Hall, I. A. Khasanova
Mössbauer Effect Data Center



Five Decades of the Mössbauer Effect*

The Rudolf Years
1958-1967

The Great Mössbauer Expansion
1968-1977

The Applications Years
1978-1987

The Golden Years
1988-1997

The Search for the Future
1998-2007

The Rudolf Years 1958-1967

The Unexpected

Zeitschrift für Physik, Bd. 151, S. 124—143 (1958)

Aus dem Institut für Physik im Max-Planck-Institut für medizinische Forschung,
Heidelberg

Kernresonanzfluoreszenz von Gammastrahlung in Ir¹⁹¹

Von
RUDOLF L. MÖSSBAUER*

Mit 8 Figuren im Text

(Eingegangen am 9. Januar 1958)

Die Kernresonanzabsorption der dem Zerfall von Os¹⁹¹ folgenden 129 keV-Gammastrahlung in Ir¹⁹¹ wird untersucht. Der Wirkungsquerschnitt für die Resonanzabsorption wird als Funktion der Temperaturen von Quelle und Absorber im Temperaturbereich 90° K < T < 370° K gemessen. Die Lebenszeit τ_r des 129 keV-Niveaus in Ir¹⁹¹ ergibt sich zu $(3,6_{-0,5}^{+0,5}) \cdot 10^{-16}$ sec. Der Absorptionsquerschnitt zeigt bei tiefen Temperaturen einen starken Anstieg als Folge der Kristallbindung der Absorber- und Präparatsubstanzen. Die Theorie von LAMB über die Resonanzabsorption langsamer Neutronen in Kristallen wird auf die Kernresonanzabsorption von Gammastrahlung übertragen. Bei tiefen Temperaturen ergibt sich eine starke Abhängigkeit des Wirkungsquerschnittes für die Kernabsorption von der Frequenzverteilung im Schwingungsspektrum des Festkörpers.

1. Einleitung

Die Kernresonanzfluoreszenz von Gammastrahlung ist das kernphysikalische Analogon zu der bekannten Fluoreszenzerscheinung der Atomhülle: Anregung eines Kernniveaus durch Einstrahlung der eigenen Linie, wobei die Emission und Absorption in Kernen gleicher Art stattfindet. Die Quanten erfahren bei ihrer Emission bzw. Absorption Energieverluste infolge Abgabe von Rückstoßenergie an die emittierenden bzw. absorbierenden Kerne, was zu einer Verschiebung der Emissionslinie gegenüber der Absorptionslinie führt. Bei Kernübergängen ist, umgekehrt wie bei optischen Übergängen, die durch den Rückstoßenergieverlust der Quanten bedingte Linienverschiebung immer groß gegen die natürliche Linienbreite, d.h. die Resonanzbedingung ist verletzt. Da jedoch die tatsächliche Breite der Linien durch die Temperaturbewegung der Kerne in Quelle und Absorber bestimmt wird**, die zu Doppler-Verschiebungen der Quantenenergien führt, wird für einen Teil der Quanten der Rückstoßenergieverlust kompensiert und die durch den Rückstoßeffect verletzte Resonanzbedingung wiederhergestellt.

* Neue Anschrift: Labor für technische Physik, Technische Hochschule München.

** Die natürliche Linienbreite kann in allen hier interessierenden Fällen gegenüber der Doppler-Breite vernachlässigt werden.

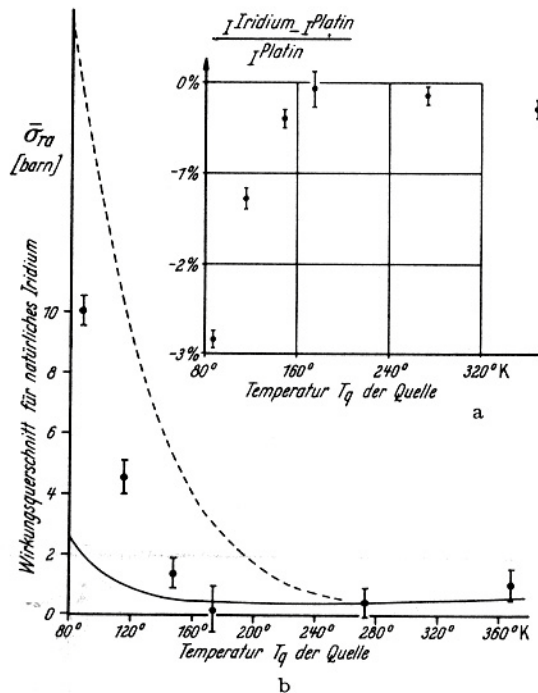


Fig. 8a. Relatives Intensitätsverhältnis $(I^{Ir} - I^{Pt})/I^{Pt}$ der hinter Iridium- bzw. Platinabsorbern gemessenen 129 keV-Gammastrahlung als Funktion der Temperatur der Quelle. Die Temperatur der Absorber betrug konstant 88° K

Fig. 8b. Der Wirkungsquerschnitt $\bar{\sigma}_{r,a}$ für die Kernresonanzabsorption in Ir¹⁹¹ als Funktion der Temperatur der Quelle, für eine Absorbentemperatur von 88° K. \square Meßpunkte; ——— theoretischer Verlauf für ein quadratisch mit der Frequenz ν ansteigendes Schwingungsspektrum (Debye-Spektrum); - - - - - theoretischer Verlauf für eine mit ν^2 proportionale Frequenzverteilung, die bei der gleichen Grenzfrequenz abgebrochen wurde, d.h. die gleiche Debye-Temperatur besitzt. Die Debye-Temperaturen der transversalen und der longitudinalen Komponenten wurden gleichgesetzt

The Rudolf Years

1958-1967

The First Mössbauer Spectrum

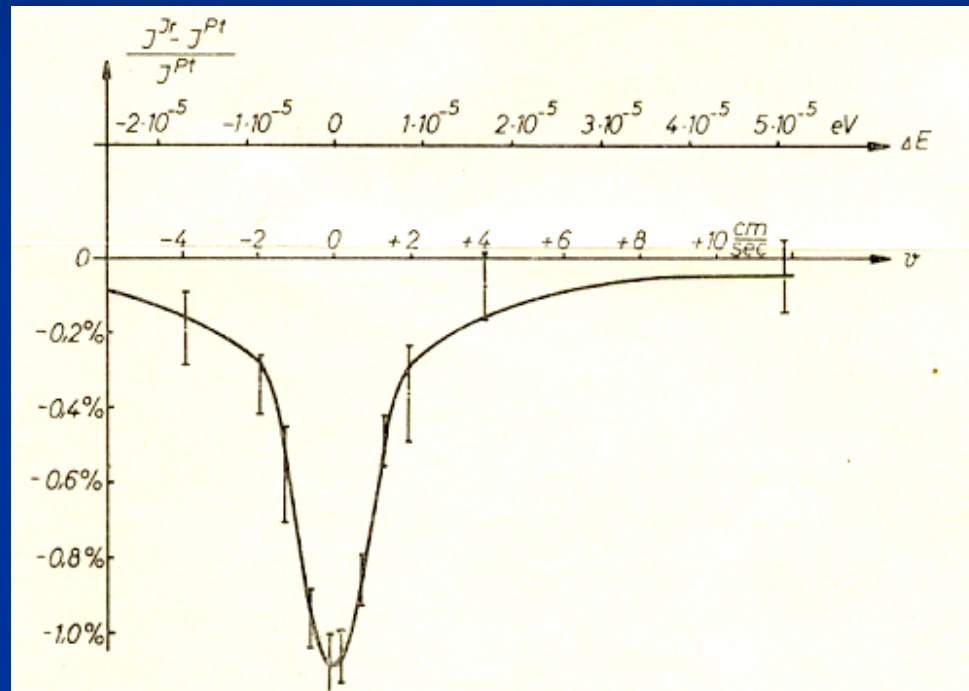
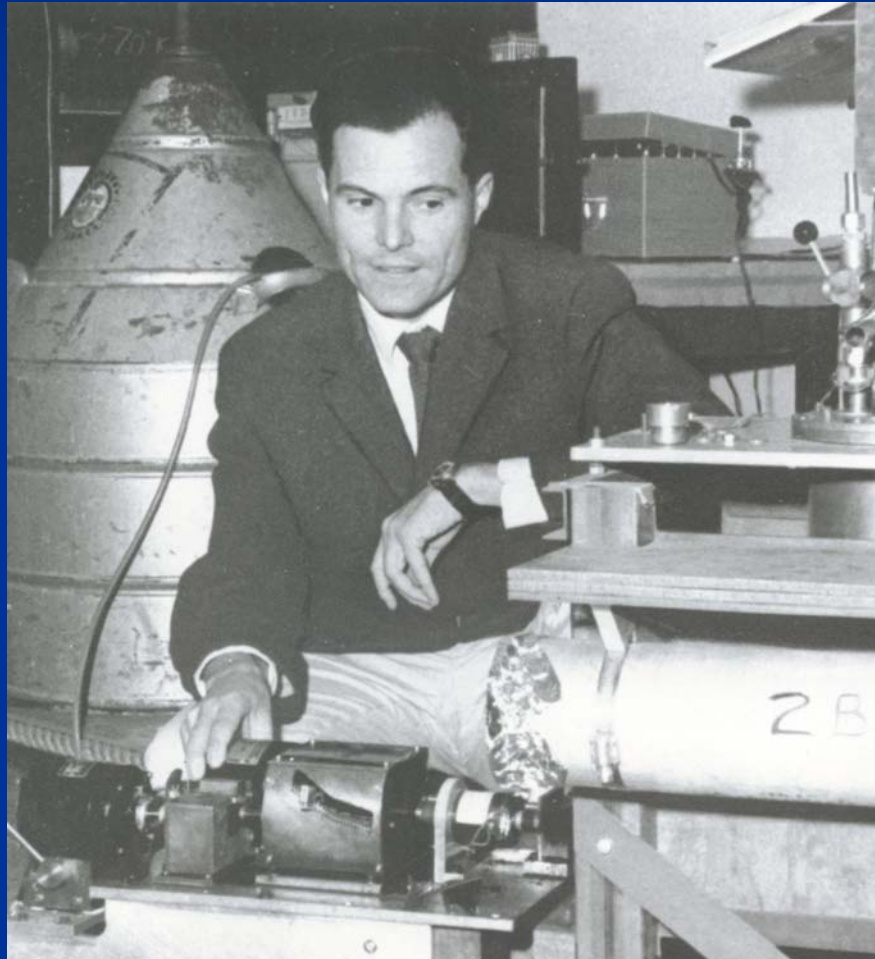


Abb. 3. Relatives Intensitätsverhältnis $(I_{Ir} - I_{Pt})/I_{Pt}$ der hinter Iridium- bzw. Platinabsorbern gemessenen γ -Strahlung als Funktion der Geschwindigkeit der Quelle relativ zu den Absorbern. $E = (v/c) \cdot E_0$ ist die Energieverschiebung der 129 keV-Quanten relativ zu den ruhenden Absorbern. Als Strahlungsquelle diente eine 65 mCurie starke Osmiumquelle, deren Zerfallsspektrum die 129 keV-Linie in Ir^{191} enthält.

The Rudolf Years 1958-1967

The CalTech Days



The Rudolf Years 1958-1967

The Nobel Prize



The Rudolf Years

1958-1967

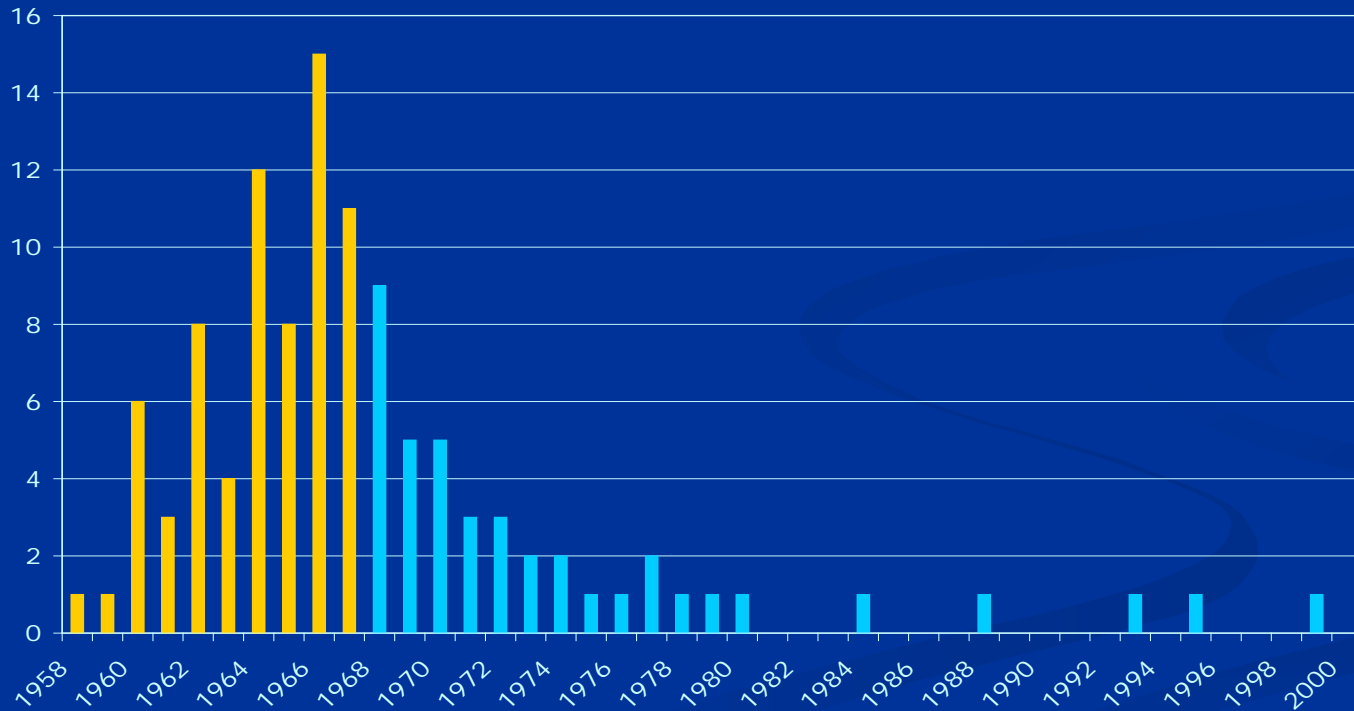
Conferences

- ICAME
 - 1960: Urbana, Illinois, USA
 - 1961: Saclay, France
 - 1962: Dubna, USSR
 - 1963: Ithaca, New York, USA
- 1965 – IAEA Panel on Applications of the Mössbauer Effect in Chemistry and Solid-State Physics
- 1966 – The Mössbauer Effect and Its Application in Chemistry (American Chemical Society Symposium)
- 1967 – The Mössbauer Effect (Faraday Society Symposium)

The Rudolf Years 1958-1967

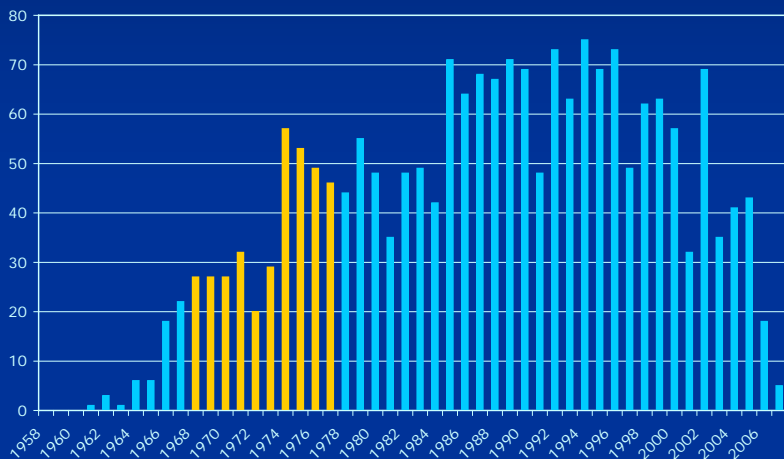
New Mössbauer Transitions

New Mössbauer Transitions Observed

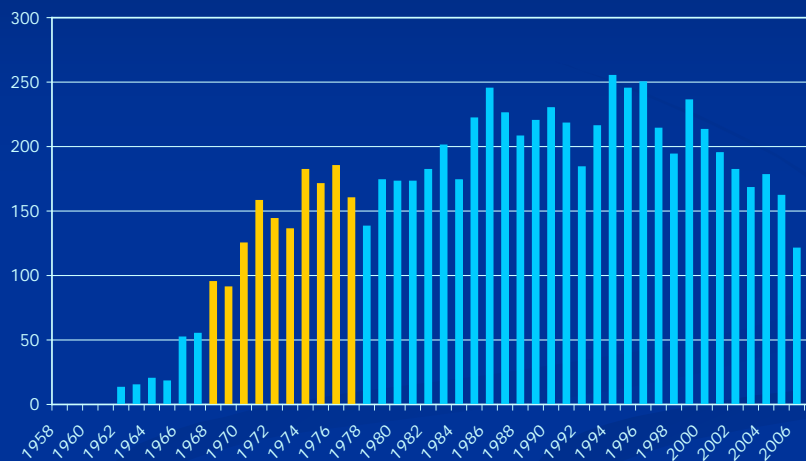


The Great Mössbauer Expansion 1968-1977

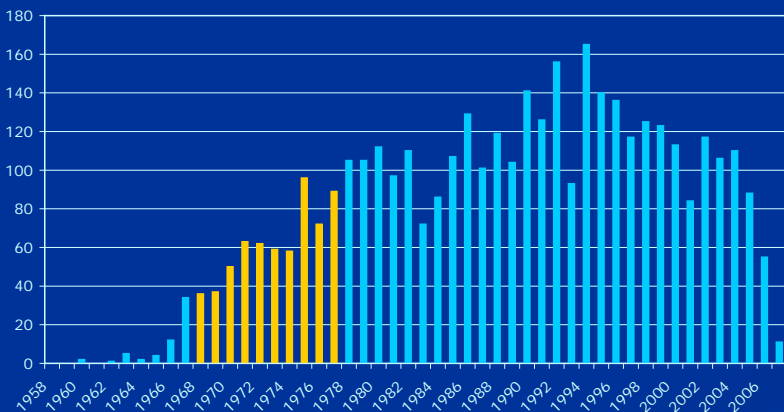
Biological Studies



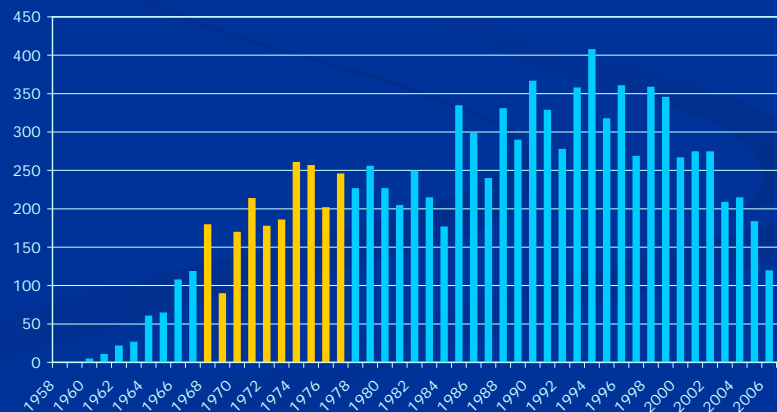
Organic Compounds Studies



Terrestrial and Extraterrestrial Mineral Studies



Metals and Alloys Studies



The Great Mössbauer Expansion 1968-1977

The Flood of Mössbauer Books

Year	Author/Editor	Title	Publisher
1968	V. I. Gol'danskii, R. H. Herber, eds.	Chemical Applications of Mössbauer Spectroscopy	Academic Press
1968	J. Danon	Lectures on the Mössbauer Effect (Documents on Modern Physics Series)	Gordon and Breach
1971	L. May, ed.	An Introduction to Mössbauer Spectroscopy	Plenum
1971	G. K. Wertheim, A. Hausmann, W. Sander	Electronic Structure of Point Defects as Determined by Mössbauer Spectroscopy and by Spin Resonance (Defects in Crystalline Solids Series; 4)	North-Holland/American Elsevier
1971	N. N. Greenwood, T. C. Gibb	Mössbauer Spectroscopy	Chapman and Hall
1971	C. P. Poole, H. A. Farach	Relaxation in Magnetic Resonance: Dielectric and Mössbauer Applications	Academic Press
1973	G. M. Bancroft	Mössbauer Spectroscopy: An Introduction for Inorganic Chemists and Geochemists	Wiley
1975	U. Gonser, ed.	Mössbauer Spectroscopy (Topics in Applied Physics; 5)	Springer-Verlag
1976	R. L. Cohen, ed.	Applications of Mössbauer Spectroscopy, Vol. 1	Academic Press
1976	T. C. Gibb	Principles of Mössbauer Spectroscopy (Studies in Chemical Physics Series)	Wiley

The Great Mössbauer Expansion 1968-1977

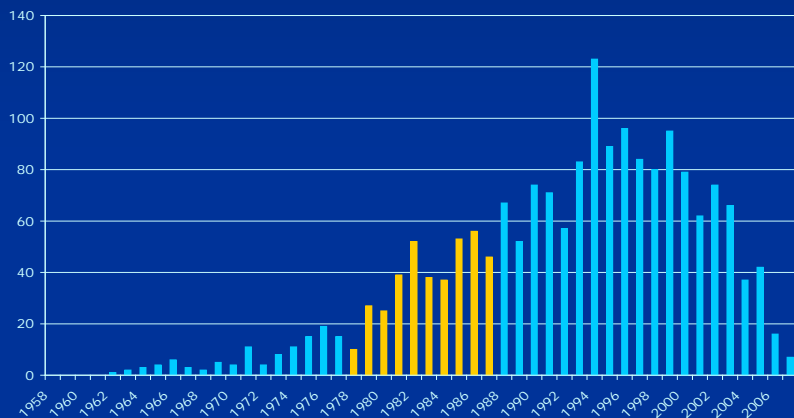
Many Conferences

■ ICAME

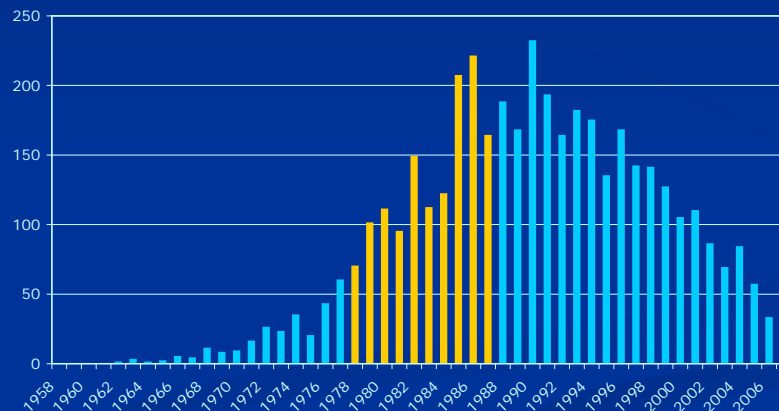
- 1968: Varna, Bulgaria
 - 1969: Tihany, Hungary
 - 1971: Dresden, Germany
 - 1972: Ayeleth Hashahar, Israel
 - 1973: Bratislava, Czechoslovakia
 - 1974: Bendor, France
 - 1975: Cracow, Poland
 - 1976: Corfu, Greece
 - 1977: Bucharest, Romania
- 1969 – Meeting on Mössbauer Spectroscopy in Biological Systems
 - 1971 – IAEA Panel on Mössbauer Spectroscopy and Its Applications
 - 1976 – First Nassau Mössbauer Conference
 - 1977 – Argonne Workshop on New Directions in Mössbauer Spectroscopy

The Applications Years 1978-1987

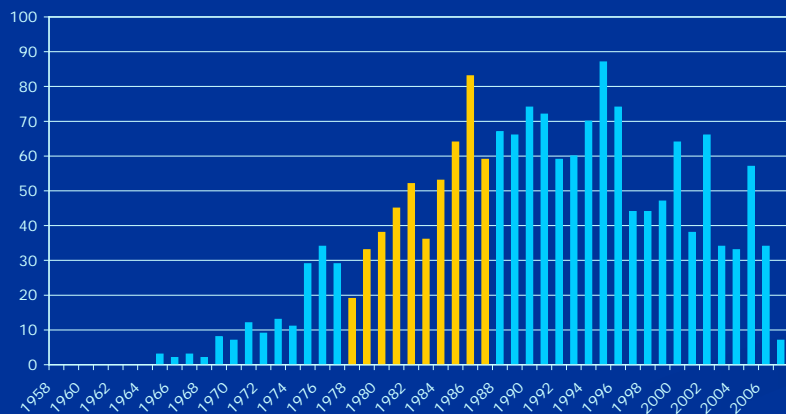
Surface Studies



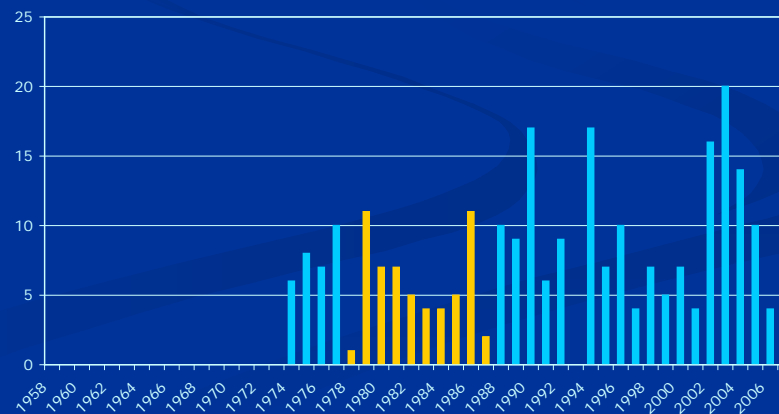
Studies of Amorphous Materials



Catalyst Studies



Art Studies



The Applications Years 1978-1987

Mössbauer Books on Applications

Year	Author/Editor	Title	Publisher
1978	G. K. Shenoy, F. E. Wagner, eds.	Mössbauer Isomer Shifts	North-Holland
1978	P. Gütllich, A. Trautwein, R. F. Link	Mössbauer Spectroscopy and Transition Metal Chemistry (Inorganic Chemistry Concepts Series; 3)	Springer-Verlag
1979	A. Vertes, L. Korecz, K. Burger	Mössbauer Spectroscopy (Studies in Physical and Theoretical Chemistry Series; 5)	Elsevier Scientific
1980	R. L. Cohen, ed.	Applications of Mössbauer Spectroscopy, Vol. 2	Academic Press
1981	U. Gonser, ed.	Mössbauer Spectroscopy II: The Exotic Side of the Effect (Topics in Current Physics Series; 25)	Springer-Verlag
1983	V. B. Thosar, P. K. Iyengar, J. K. Srivastava, S. C. Bhargava, eds.	Advances in Mössbauer Spectroscopy: Applications to Physics, Chemistry and Biology (Studies in Physical and Theoretical Chemistry Series; 25)	Elsevier Scientific
1984	R. H. Herber, ed.	Chemical Mössbauer Spectroscopy	Plenum
1984	G. J. Long, ed.	Mössbauer Spectroscopy Applied to Inorganic Chemistry, Vol. 1 (Modern Inorganic Chemistry Series)	Plenum
1985	T. E. Cranshaw, B. W. Dale, G. O. Longworth, C. E. Johnson, eds.	Mössbauer Spectroscopy and its Applications	Cambridge University Press
1986	D. P. E. Dickson, F. J. Berry, eds.	Mössbauer Spectroscopy	Cambridge University Press

The Applications Years 1978-1987

Conferences

■ ICAME

- 1978: Kyoto, Japan
 - 1979: Portoroz, Yugoslavia
 - 1981: Jaipur, India
 - 1983: Alma-Ata, USSR
 - 1985: Leuven, Belgium
 - 1987: Melbourne, Australia
- 1984: First ISIAME in Honolulu, Hawaii
 - 1978: Seeheim Workshop Series Begins
 - 1980: ACS Symposium on Recent Chemical Applications of Mössbauer Spectroscopy
 - 1984: ACS Symposium on Twenty-Five Years of Chemical Mössbauer Spectroscopy
 - Regional Conferences for Brazil, China, the Czech and Slovak Republics, Italy, the French-Speaking Countries, The Netherlands and Belgium, Poland, Russia, and the UK

The Applications Years 1978-1987

The first issue of the *Mössbauer Effect Reference and Data Journal* published by the Mössbauer Effect Data Center

1978 The First Seeheim Mössbauer Workshop held under the leadership of P. Gütlich on April 11-14

The first Italian Mössbauer Conference held in Ferrara, Italy on May 5

1979 The first French Speaking Mössbauer Conference held in Poitiers, France on May 30 and 31

1980 The first Chinese Mössbauer Conference held in Beijing from June 16-21

1982 The first Brazilian Mössbauer Conference held in Porto Alegre on October 23 and 24

1984 The first International Symposium on the Industrial Applications of the Mössbauer Effect (ISIAME) held in Hawaii December 16-21, organized by Gary Long and John Stevens

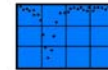
The Golden Years 1988-1997



The Golden Years 1988-1997

The Rise of Synchrotron Radiation

Mössbauer Effect Reference and Data Journal



May 1999 • Volume 22 Number 5

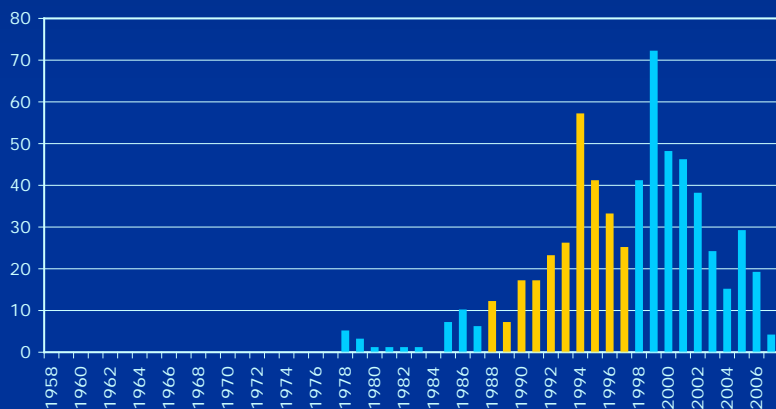


Exciting Developments in Synchrotron Mössbauer Spectroscopy

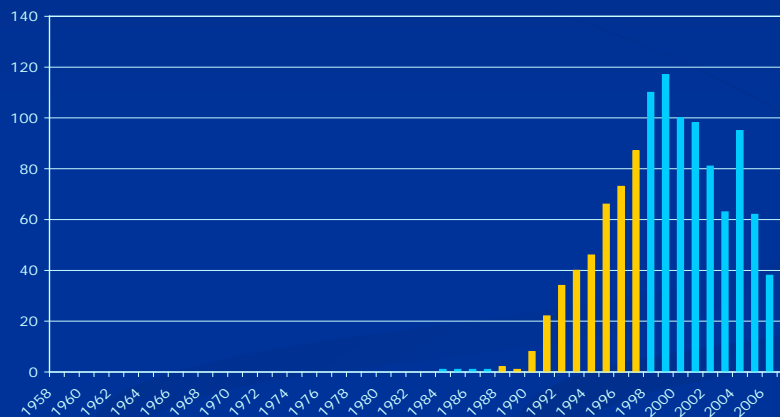
The Golden Years 1988-1997

More Developments and Applications

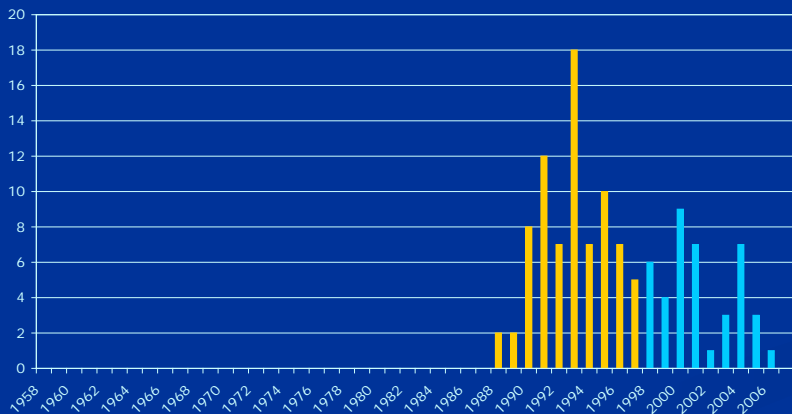
Synchrotron Studies



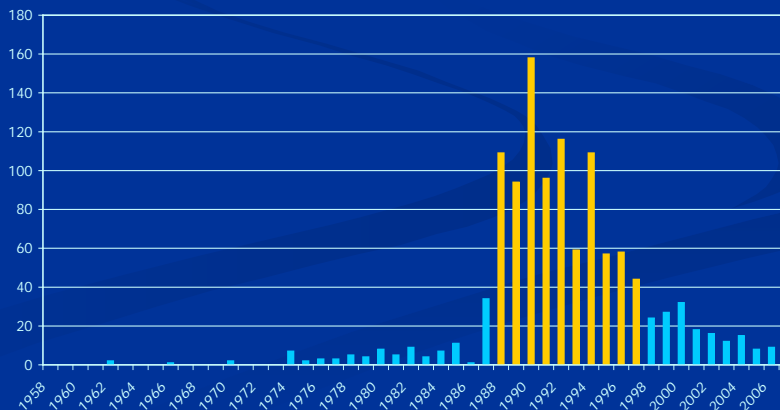
Mechanical Milling Effects



Quasicrystal Studies



Superconductor Studies



The Golden Years

1988-1997

Mössbauer Books

Year	Author/Editor	Title	Publisher
1989	G. J. Long, ed.	Mössbauer Spectroscopy Applied to Inorganic Chemistry, Vol. 2 (Modern Inorganic Chemistry Series)	Plenum
1989	G. J. Long, F. Grandjean, eds.	Mössbauer Spectroscopy Applied to Inorganic Chemistry, Vol. 3 (Modern Inorganic Chemistry Series)	Plenum
1990	A. Vertes, D. L. Nagy, eds.	Mössbauer Spectroscopy of Frozen Solutions	Akademiai Kiado
1993	S. Mitra	Applied Mössbauer Spectroscopy: Theory and Practice for Geochemists and Archeologists	Elsevier Science & Technology Books
1993	G. J. Long, F. Grandjean, eds.	Mössbauer Spectroscopy Applied to Magnetism and Materials Science, Vol. 1	Plenum
1993	G. N. Belozerskii	Mössbauer Studies of Surface Layers (Studies in Physical and Theoretical Chemistry Series; 81)	Elsevier Science
1996	G. J. Long, F. Grandjean, eds.	Mössbauer Spectroscopy Applied to Magnetism and Materials Science, Vol. 2	Plenum
1997	A. Vertes, Z. Hommonay, eds.	Mössbauer Spectroscopy of Sophisticated Oxides	Akademiai Kiado
1997	A. G. Maddock	Mössbauer Spectroscopy: Principles and Applications of the Techniques (Horwood Chemical Science Series)	Horwood

The Golden Years 1988-1997

Conferences

■ ICAME

- 1989: Budapest, Hungary
- 1991: Nanjing, China
- 1993: Vancouver, Canada
- 1995: Rimini, Italy
- 1997: Rio de Janeiro, Brazil

- 1988: First LA CAME held in Rio
- 1988: ISIAME Conference series continues in Parma, Italy
- 1988: The Seeheim Workshop series continues
- 1993: The Nassau Conference series continues
- Regional Conferences continue in Brazil, China, the Czech and Slovak Republics, Italy, The Netherlands and Belgium, the Nordic countries, and Russia

The Golden Years 1988-1997 Databases

Welcome to Mössbauer Effect Data Center

http://orgs.unca.edu/medc/

Mössbauer Effect Data Center DataBase - References

[References](#) [Data](#) [Help](#)

Search for References

1 Keyword code: equals []

2 Keyword code: equals []

3 Keyword code: equals []

Authors : equals [R.L.Mössbauer]

Journal : equals []

Vol : equals []

Issue : equals []

Pages : equals []

Year : equals []

Title : equals []

Language code : equals []

Reference key : equals []

Sort by : Year [] ascending []

When Searching : Match All Words between fields (AND) Match any words between fields (OR)

Welcome to Mössbauer Effect Data Center

http://orgs.unca.edu/medc/

Mössbauer Effect Data Center DataBase - References

[References](#) [Data](#) [Help](#)

Reference search results

Displaying records 1 thru 20 of 99 records found. (20 records displayed).

Kernresonanzfluoreszenz von Gammastrahlung in Ir191. R.L.Mössbauer - <i>Zeitschrift für Physik</i> , 151 , , 124-43, (1958)	58M001
Kernresonanzabsorption von Gammastrahlung in Ir191 R.L.Mössbauer, - <i>Naturwissenschaften</i> , 45 , , 538-9, (1958)	58M002
Nuclear Resonance Absorption of Gamma Rays in Ir191 P.P.Craig, J.G.Dash, P.J.McGuinness, D.Nagle, R.R.Reiswig, - <i>Phys. Rev. Lett.</i> , 3 , , 221-3, (1959)	59C001
Nuclear Resonance Absorption of Gamma Rays at Low Temperatures Z.C.Lee, L.Meyer-Schutzmeister, J.P.Schiffer, D.Vincent, - <i>Phys. Rev. Lett.</i> , 3 , , 223-5, (1959)	59L001
Kernresonanzabsorption von Gamma-Strahlung in Ir191 R.L.Mössbauer, - <i>Z. Naturforsch., A: Astrophys., Phys. Phys. Chem.</i> , 14A , , 211-6, (1959)	59M001
Resonant Absorption of the 14.4-keV Gamma Ray from 0.10-microsec Fe57 R.V.Pound, G.A.Rebka, Jr., - <i>Phys. Rev. Lett.</i> , 3 , , 554-6, (1959)	59P001
Gravitational Red-shift in Nuclear Resonance R.V.Pound, G.A.Rebka, Jr., - <i>Phys. Rev. Lett.</i> , 3 , , 439-41, (1959)	59P002
Recoilless Resonance Absorption of Gamma Rays in Fe57 J.P.Schiffer, W.G.Marshall, - <i>Phys. Rev. Lett.</i> , 3 , , 556-7, (1959)	59S001

The Golden Years

1988-1997

1988

The first Latin American Conference on the Applications of the Mössbauer Effect (LACAME) held in Rio de Janeiro from October 31 through November 4, chaired by Jacques Danon

1992

The Mössbauer Information Exchange (MIX) launched by Denes Nagy and colleagues in Hungary

1993

The International Board on the Applications of the Mössbauer Effect (IBAME) formed

1997

The Mössbauer Effect Data Center introduces the Mössbauer Web page for the community

The Search for the Future 1998-2007

Professor Mössbauer in Oman



The Search for the Future 1998-2007

Mössbauer on Mars

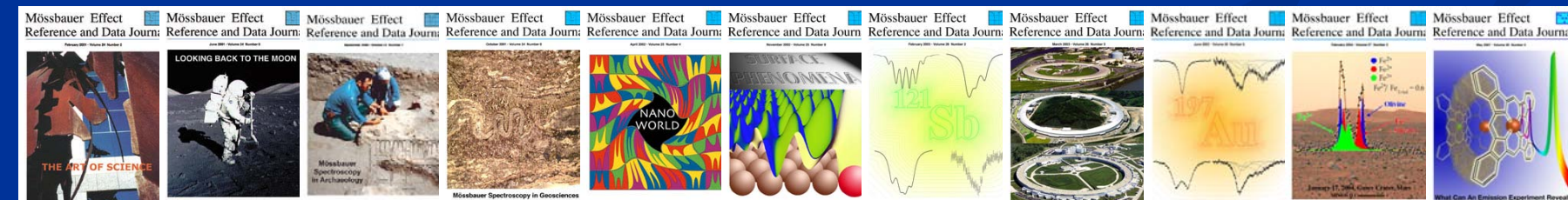
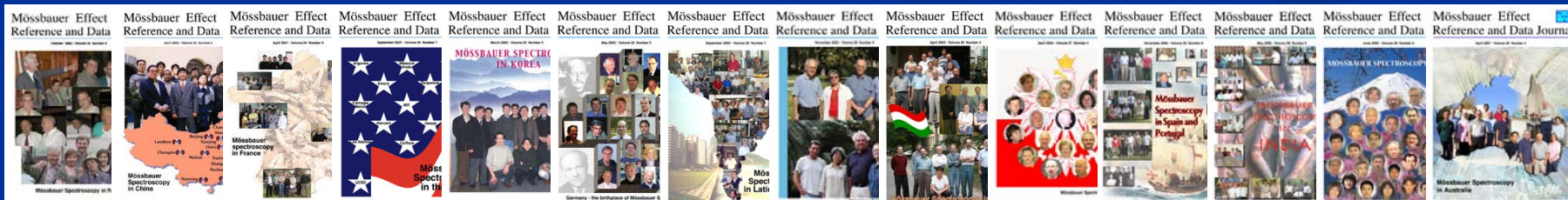
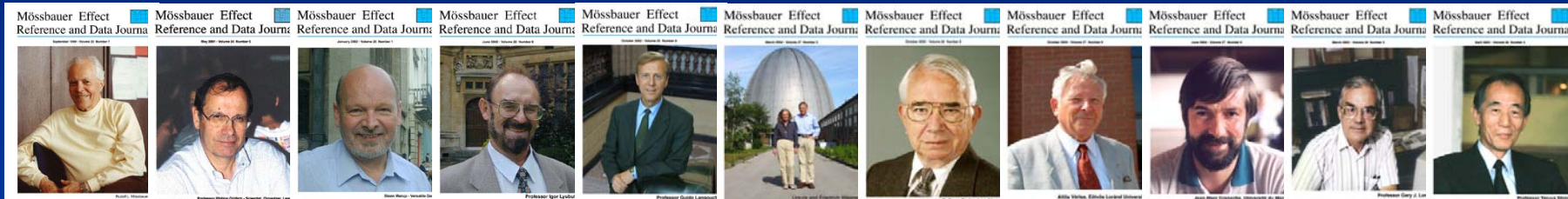


The Search for the Future 1998-2007

Conferences

- ICAME
 - 1999: Garmisch-Partenkirchen, Germany
 - 2001: Oxford, England
 - 2003: Muscat, Oman
 - 2005: Montpellier, France
 - 2007: Kampur, India
- The LACAME, ISIAME, Seeheim, and Nassau Conference series continue
- Regional Conferences continue in China, the Czech and Slovak Republics, Poland, Russia, and the UK

The Search for the Future 1998-2007 MERDJ



The Search for the Future

1998-2007


Web Sites

MÖSSBAUER EFFECT
DEDICATED TO BRINGING TOGETHER SCIENTISTS, STUDENTS AND RESEARCH GROUPS


Welcome
Mössbauer
Information
Conferences
News
Instruments
Sources
Books
Labs
Regional

IBAME
MEDC

Welcome to Mössbauer Spectroscopy

 In a resonance absorption experiment the energy of incident radiation should match exactly the energy separation between the two levels of the absorption system. For example, radiation of Na atom match exactly the excitation energy of the other Na atom and is therefore, effectively absorbed by it. Applying the same logic to irradiation and absorption of gamma-rays, same electromagnetic radiation as in the case of Na atoms...

 *The Mössbauer Community:* Forty-five years ago Professor Rudolf L. Mössbauer published a paper in *Z. Phys.* that initialized a new research area, impacting many segments of the sciences. Research in this area became known as Mössbauer spectroscopy, and has encompassed an international scientific community unto itself. This community is led by the elected members of the [International Board on the Applications of the Mössbauer Effect \(IBAME\)](#) with support from the [Mössbauer Effect Data Center \(MEDC\)](#)

 *Applications:* The Mössbauer effect is being used to answer many of the most interesting questions we have in science. Examples include investigations on the surface of [Mars](#), developing an understanding of the [nano world](#), and [the study of corrosion](#).
Credit: NASA/JPL

This site is supervised by Mössbauer Effect Data Center, University of North Carolina at Asheville, Asheville, NC, 28804, USA. Contact email: mailto:medc@unca.edu

Mössbauer Effect Data Center | Directory | Database | Journal | Resources | Services | Contacts

The Mössbauer Effect Data Center (MEDC) is a part of the University of North Carolina at Asheville, providing information services to the international scientific community in the field of Mössbauer spectroscopy. Current number of data records in the MEDC database - over 100,000.

Cover story:
Gopal Shenoy

Gopal Shenoy: A Leader Pushing the Frontiers of Science

 **MERDJ September 2007**
Volume 30 Number 7
(Subscriber download)

Ir. Gopal Shenoy, of Argonne National Laboratory, has spent nearly five decades of his illustrious research career promoting and pushing the frontiers of science. Dr. Shenoy (lovingly known as Gopal to the international community and GK to his fellow students from Bombay University) is a very active researcher in the field of synchrotron radiation and has authored/coauthored more than 200 publications in the area of Mössbauer spectroscopy and hyperfine interactions in solids. At present, Gopal is the Senior Scientific Advisor at the Advanced Photon Source and an Argonne Distinguished Fellow, the highest rank awarded to a scientist or engineer at Argonne National Laboratory.

October 14-19, 2007
International Conference on the Applications of the Mössbauer Effect (ICAME 2007); Kanpur, India. Call for abstracts...


E. Murad, J. Cashion, Mössbauer

www.mossbauer.org

www.unca.edu/medc

The Search for the Future

1998-2007

1998 The entire Mössbauer database is made available to the community from the Mössbauer Effect Data Center

2004 NASA Mars Exploration Rovers *Spirit* and *Opportunity*, each containing the MIMOS II miniaturized Mössbauer spectrometer, land on the surface of Mars

2005 The Mössbauer community Web site <www.mossbauer.org> launched by the Mössbauer Effect Data Center

2006 Göstar Klingelhöfer receives the first IBAME Award in recognition of his exceptional contribution to Mössbauer spectroscopy

2007 50,000 Mössbauer Publications

Summary of Mössbauer Contributions

50 Years

51,265 Publications

45,859 Authors

3,354 Journals

1,506 Books*

*Including 132 Books Dedicated Completely to Mössbauer Spectroscopy

Online Database



- Upgraded MEDC Web-Access Database
- Expanded Search Capabilities
- Regularly Updated Content



“Learn from yesterday, live for today, hope for tomorrow. The important thing is not to stop questioning.”

– *Albert Einstein*

