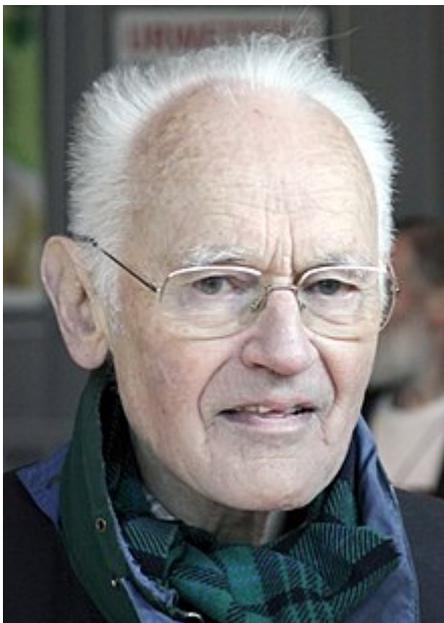


# Wolfgang Behmenburg

Wolfgang Behmenburg (\* 29. August 1933 in Oberhausen, † 31. Mai 2017 in Berlin) was a German physicist who performed pioneering research in atomic and molecular physics. He taught physics at Universität des Saarlandes, Saarbrücken and Heinrich-Heine-Universität, Düsseldorf. He trained and was thesis advisor to over 25 students, most of whom became physicists in industry or physics teachers.

## Life and Professional Activity

W. Behmenburg grew up as the oldest of four sons of Hertha and Carl Behmenburg in Oberhausen. His brothers, Manfred, Horst and Ernst Behmenburg, were two, four and nine years younger, respectively. Wolfgang attended schools in Sulzbach-Rosenberg und Amberg.



Wolfgang Behmenburg in 2010 (Photo: U. Rosowski)

After studying two semesters at the Universität Darmstadt W. Behmenburg moved to Göttingen to continue his studies there. Not untypical for the time, they included pedagogical subjects so that in 1957 he passed the first state exam for certification as a high-school (Gymnasium) teacher. The conditions in nearly all of the German universities in the 1950s for physics were still heavily impacted by World War II. Though Göttingen suffered little destruction, shortages of books and equipment, and the ravaged ranks of physics professors after the Nazi period limited what could be learned and what research could be attempted. But he went on to pursue doctoral studies at the Justus-Liebig Universität, Gießen, and was awarded the Ph.D. degree in 1961 as a student of Professor Albert Schmillen<sup>[1]</sup>.

He subsequently eagerly accepted the offer of a post-doctoral researcher with physicist [Hedwig Kohn](#)<sup>[2]</sup> at Duke University (U.S.A) from 1961 to 1963. This was a very fruitful period and he referred with enthusiasm and respect to Kohn as having taught him how to perform experimental research in a dedicated manner<sup>[3]</sup>.

From 1963 to 1970 he was employed at the Universität des Saarlandes, in the Institute of Physics, whose director, Prof. Conrad v. Fragstein, was a former doctoral student of Kohn.

Apart from his research, W. Behmenburg taught in the physics undergraduate laboratory, lectured, and supervised four students. He received the Habilitation degree from this university in 1971.

In 1970 he moved to the [Heinrich-Heine-Universität, Düsseldorf](#), where he worked in the Institut für Physik I (later renamed to Institut für Experimentalphysik). He became an adjunct ("außerplanmäßiger") professor in 1976, and a professor ("Professor auf Lebenszeit") in 1982. He retired in August 1997, but remained scientifically active until 2002.

In his academic career, he was known as a dynamic researcher, a motivating supervisor and a skilled organizer.

His field of research, laser spectroscopy, was later continued and extended by the research groups of Prof. S. Schiller and Prof. A. Görlitz in the Institut für Experimentalphysik to the regime of ultracold neutral and charged atoms and molecules.

## Scientific Works

The research program of Wolfgang Behmenburg was focused on studying intra-atomic interactions which occur when two atoms briefly come close to each other in a collision. Specifically, he considered the case of an electronically excited metal atom and a rare gas in the electronic ground state. The experimental technique consisted in performing optical spectroscopy in the far wing of transition lines of metal atoms contained in a cell together with rare gas atoms. The goal was to determine or test interaction potentials and transition dipole moment functions through the influence of collision-induced transitions on the metal atom spectra. This was possible through a comparison of the experimentally recorded spectra and theoretically computed spectra in the range of room temperature thermal energies. Examples of studied systems were (RG: rare gas atom): Hg - RG, Na - RG, Li - RG, Ba - RG, Cd - RG.

As experimental techniques, he used simple absorption (or laser excitation) and dispersed emission spectroscopy, in the near UV, visible and near infrared regions. Here, continuous-wave dye lasers and diode lasers were employed. He also used nonlinear laser spectroscopy (third-harmonic and sum frequency generation) by means of a pulsed dye laser. He introduced a novel, very sensitive, technique based on light scattering from collision molecules following excitation in the far line wing.

For analysis of the phenomena occurring during collisions in terms of interatomic potentials, Behmenburg employed the adiabatic theory of collisional line broadening or, if necessary, a nonadiabatic approach using the coupled-channel calculations of thermally averaged line profile.

Behmenburg had particularly important achievements in the former case. Here, basing himself on a classical, quasistatic version of the line shape theory, in 1972 he proposed and developed the method of inversion of the far line wing absorption profile which enabled determination of the potential curves in both electronic states involved in the given transition<sup>[4]</sup>. This method, known as Behmenburg-Gallagher inversion technique (because at the same time a similar method was published by Gallagher at Joint Institute of Laboratory Astrophysics, Boulder, Colorado), was a basis for determination of the potential curves for many diatomics. It was applicable only for single adiabatic excited states and monotonic line wing profiles. Therefore, when this was not the case, the suitable interaction potentials and dipole transition

moment functions were determined or tested from comparison of spectra derived experimentally with simulated ones, using more advanced quasiclassical or (more frequently) a fully quantum mechanical theory of these phenomena.

An important example of a successful match between experiment and theory was his important study of the system Li\* (electronically excited Li) + He<sup>[5]</sup>, performed with a number of international collaborators.

An early and widely cited contribution of W. Behmenburg to the physics of light emission in gases was his study of frequency shifts and spectral widths of the sodium emission line at high temperature<sup>[6]</sup>, performed while post-doctoral researcher at Duke University. He was able to show, using high-resolution classical spectroscopy with a Fabry-Pérot interferometer, that for some gaseous collision partners, the shifts and widths cannot be explained by a van-der-Waals interaction potential between the atoms but by the Lennard-Jones potential.

Behmenburg's scientific work is documented in 45 scientific publications<sup>[7]</sup>. The first refereed publication appeared in 1961. The last was published in 2002<sup>[8]</sup>, after his retirement, the result of a formal collaboration with the Institute of Experimental Physics of Warsaw University. As of June 2017, his publications were cited 536 times (without self-citations).

He organized the workshop “Atomic Interactions in Laserfields” on 26.-27. February 1987.

Conferences attended by Behmenburg included:

- 1982 6th ICOLS (Int. Conf. on Laser Spectroscopy), Boulder CO
- 1984 7th ICSLS (Int. Conf. on Spectral Line Shapes), Aussois
- 1986 DPG Frühjahrstagung, Heidelberg
- 1987, 3.-9. 9. Summer School Quantum Optics, Fromborg
- 1992 11th ICSLS Carry Le Rouet, June 8-12, 1992
- 1993 5th Intl. Workshop on Atomic Interactions in Laser fields, Meudon-Bellevue, 17-18 May 1993
- 1994 Thorun/Warszaw
- 1994 DPG Frühjahrstagung, Hamburg
- 1995 ECAMP 5, Edinburgh, April 1995
- 1997 29th EGAS Berlin, July 1997
- 1998 DPG Frühjahrstagung, Konstanz
- 1999 [Intl. Workshop on Atomic Interactions in Laser Fields](#), September 1-3, 1999, Nicholas Copernicus University, Torun, Poland

## Scientific Cooperations

W. Behmenburg collaborated intensely with F. Schuller (University of Paris Nord - Paris XIII, from 1975 onwards), Frank Rebenrost (Max-Planck-Institut für Quantenoptik Garching), G. Nienhuis (Univ. Utrecht), Teresa Grycuk (Warsaw University, from 1989 onwards). Other coworkers were Martin Jungen (Univ. Basel), H. Bettermann (Univ. Düsseldorf), V. Staemmler (Ruhr-Universität Bochum), G. Peach (Univ. College London), Alex Devdariani (St. Petersburg State Univ.), as well as M. Findeisen (Warsaw Univ.), J. Grosser (Univ. Hannover), and others.

His research work was funded in part by the [Deutsche Forschungsgemeinschaft](#) and by the [Gesellschaft der Freunde und Förderer der Universität Düsseldorf](#).

## Training and advising of young scientists

The scientific work was done in close collaboration with students pursuing a "Diplom" (similar to a M.Sc. degree but requiring more research) or doctoral degree. At least 35 such degrees were awarded to students he supervised in Saarbrücken and Düsseldorf.

### Diploma thesis students

("+" indicates year of thesis submission)

- Helmut Müller (1964)
- Dietmar Gebhard (1968)
- Joachim Losen (+1972)
- Friedhelm Vomberg (+1975)
- Michael Bäcker (+1975)
- Volker Kroop (+1976)
- Peter Heidenreich (+1975)
- Hans-Joachim Boschek (1977)
- Jens Heinrich (+1977)
- Hans-Christian Petzold (+1977)
- Christian Kammler (+1977) (State examination thesis)
- Horst Müller (+1980)
- Bernd Koch (1979-80)
- Heinz Hartmut Ibowski (+1980)
- Achim Dallmann (+1982)
- Thomas Woschnik (+1985)
- Falk Hummernbrum (+1986)
- Thomas Beyer (+1988)
- Jörg Dressler (+1989)
- Addissou Makonnen (+1990)
- Martin Klauke (+1990)
- Mario Andreas (+1993)
- Andreas Kaiser (+1993)
- Dirk Dimmerling (+1995)
- Jörg Gastel (+1995) (State examination thesis)
- Joachim Bernhard Bonsmann (+1996)
- Mark Gunnar Lindenblatt (+1998)
- Michael Bracht (+1998)

### Doctoral students and their theses

(with year of thesis submission)

- Dietmar Gebhard (1975) *Untersuchungen zur Neutralteilchenwechselwirkung in den Flügeln der stoßverbreiterten Hg-Absorptionslinie  $\lambda 1850 \text{ \AA}$*
- Volker Kroop (1983) *Lichtstreuung in der Nähe atomarer Resonanzen mit Multiplett-Struktur*
- Jens Heinrich (1983) *Resonante Frequenzumsetzung von Laserstrahlung in Metaldämpfern*

- Heinz Ibowski (1985) *Spektroskopie und Kinetik zwei-Photonen-gepumpter Metall-Edelgas-Excimere*
- Alfred Schnitzer (1985) *Untersuchungen atomarer Rydbergzustände durch Linienprofil-Analyse von Summenfrequenz-Erzeugungsspektren*
- Alfred Ermers (1989) *Untersuchung optischer Halbstöße bei Natrium-Edelgas-Systemen*
- Thomas Woschnik (1991) *Untersuchung asymptotischer Potentialverläufe für die Wechselwirkung von Na(3D) mit Helium und Argon mittels Absorptions-Linienprofilmessungen*
- Addissou Lothar Makonnen (1995) *Untersuchung der Sigma-Wechselwirkung in Li\*(3P,3D)-Edelgas-Stoßmolekülen mittels optischer 2-Stufen-Anregungsspektroskopie in den Flügeln des Li-Übergangs 2P → 3D*
- Andreas Kaiser (1997) *Anregungs- und Emissionsspektroskopie von Lithium-Edelgas-Stoßmolekülen in Rydbergzuständen*

## Academic Teaching

W. Behmenburg taught up to his retirement advanced courses in laser physics and laser techniques in spectroscopy, and undergraduate courses on atomic physics, including problem sessions. In the period 1970-71 he set up the physics undergraduate laboratory at the Universität Düsseldorf, then a new university.

## Personal Life

Wolfgang Behmenburg was unmarried and had no children.

W. Behmenburg was fond of mountains and bicycle tours. He had a love of classical music and played the violin, which accompanied him throughout his life, since before his stay in the US.

During retirement, W. Behmenburg laid aside his violin and started improving his piano skills. He played it well into his later years, often together with friends. The genealogy of his family became a topic to which he devoted a good part of his time.

He maintained close contacts with his former thesis students and regularly met former colleagues in the Freundeskreis Saarbrücker Physiker. He also remained a frequent visitor to the Institut für Experimentalphysik, taking a keen interest in the progress of its doctoral students and post-doctoral researchers and interacting socially with them.

From 2015 until 2017 Behmenburg lived in a retirement home in Berlin. After a short illness he died peacefully on 31. May 2017. He was buried on 1. July 2017 in his parents' grave in Bochum-Wattenscheid.

## Humanitarianism

After his retirement, W. Behmenburg engaged in social work, frequently visiting retirement homes and lecturing about physics. In 2004 he spent 4 weeks in Lodwar in Kenia, giving a physics course to school children, including demonstration experiments. He was engaged in politics on topics of sustainability, especially renewable energies.

W. Behmenburg bequeathed the largest part of his estate (252 000 €) to [Gesellschaft der Freunde und Förderer der Universität Düsseldorf](#) for the support of young researchers at the [Institut für Experimentalphysik](#) of the Heinrich-Heine-Universität, Düsseldorf. In this respect, he followed the example of his former supervisor H. Kohn, who also donated her estate to her institute of last activity <sup>[9]</sup> M.Sc., doctoral, and post-doctoral students working in experimental quantum optics, fundamental physics, and non-application-oriented spectroscopy are supported with fellowships. The foundation started its activities in November 2017.

## References

[1] W. Hanle, A. Scharmann, *Zur Geschichte der Fächer und zentralen Einrichtungen der Justus-Liebig-Universität Gießen nach 1957 (II): Physik*, Gießener Universitätsblätter XV (2), Oktober 1982 [\[Link1\]](#)

[2] Brenda P. Winnewisser, *Hedwig Kohn – eine Physikerin des zwanzigsten Jahrhunderts*, Physik Journal 2 (2003) Nr. 11 [\[Link2\]](#)

[3] Duke University Archive, Hedwig Kohn Collection, contributions from B.P. Winnewisser

[4] W. Behmenburg, *A New Optical Method for the Determination of Interatomic Potentials*, Z. Naturforschung A 27, 31-36 (1972); doi.org/10.1515/zna-1972-0106

[5] W. Behmenburg et al, *Optical transitions in excited alkali plus rare-gas collision molecules and related interatomic potentials: Li\* + He*, J. Phys. B 29, 3891-3910 (1996); doi.org//10.1088/0953-4075/29/17/013

[6] W. Behmenburg, *Broadening and shift of the sodium D2 line by various perturbing gases under flame conditions*, J. Quant. Spect. Rad. Transfer 4, 177-193 (1964); doi.org//10.1016/0022-4073(64)90061-5

[7] 37 of these are indexed in the Web of Science

[8] W. Behmenburg et al., *The near UV emission spectra of the Li\*He excimers: experimental and theoretical studies*, J. Phys. B. 35, 747-760 (2002); doi.org//10.1088/0953-4075/35/4/301

[9] Duke University Archive, Hedwig Kohn Collection, contributions from B.P. Winnewisser