Helmholtz-Rayleigh Interdisciplinary Silver Medal
in
Biomedical Acoustics and Physical Acoustics

Vera A. Khokhlova

2023

The Silver Medal is presented to individuals, without age limitation, for contributions to the advancement of science, engineering, or human welfare through the application of acoustic principles, or through research accomplishment in acoustics.

PREVIOUS RECIPIENTS

Helmholtz-Rayleigh Interdisciplinary Silver Medal

Gerhard M. Sessler	1997	Ronald A. Roy	2010
David E. Weston	1998	James E. Barger	2011
Jens P. Blauert	1999	Timothy J. Leighton	2013
Lawrence A. Crum	2000	Mark F. Hamilton	2014
William M. Hartmann	2001	Henry Cox	2015
Arthur B. Baggeroer	2002	Armen Sarvazyan	2016
David Lubman	2004	Blake S. Wilson	2017
Gilles A. Daigle	2005	Kenneth S. Suslick	2018
Mathias Fink	2006	Barbara G. Shinn-Cunningham	2019
Edwin L. Carstensen	2007	Michael R. Moldover	2021
James V. Candy	2008	George L. Augspurger	2022

Interdisciplinary Silver Medal

Eugen J. Skudrzyk	1983
Wesley L. Nyborg	1990
W. Dixon Ward	1991
Victor C. Anderson	1992
Steven L. Garrett	1993

ENCOMIUM FOR VERA A KHOKHLOVA

…for contributions to the application of nonlinear acoustics to medical ultrasound

10 MAY 2023 • CHICAGO, ILLINOIS

Vera Aleksandrovna Khokhlova *née* Kovrigina, was born and raised in Moscow, USSR (now Russia). Her parents, Aleksandr Kovrigin and Elina Andrikanis, were physicists, both graduated from the Physics Faculty of the Lomonosov Moscow State University (MSU), which later became the Alma mater for Vera as well. Vera's father strongly influenced Vera's choice of a scientific career. Aleksandr Kovrigin was a member of the scientific group of Rem Khokhlov, a prominent Soviet scientist (Vice President of the Russian Academy of Sciences, Rector of Moscow State University, one of the pioneers of nonlinear optics), who was in the 1960s transforming MSU into a leading international research center for both nonlinear optics and nonlinear acoustics. Vera's father became one of the key experimentalists of the Khokhlov's group and pioneered many discoveries in the field of nonlinear optics.

Besides science, Vera's father was very active in many outdoor sports, and one of his passions was downhill skiing – again, a passion that he transferred to his daughters – Ekaterina and Vera. Vera was especially successful. During her high school years, she even was qualified as a Candidate Master of Sports – the third official level rank in sports in the USSR. As a student at MSU, she became a member of the university downhill skiing club team and participated in numerous competitions. In one of the years at the university, she won the MSU championship. This passion continues to this day as Vera keeps her childhood tradition of ski outings with her family and for members of her lab every winter.

Vera's aptitude and fondness for physics and math became apparent quite early; in the 6th grade of her middle school she transferred from her neighborhood school to the famous "*Moscow Physico-Mathematical School No. 2*." Many of the school graduates afterwards became well-known scientists and tech entrepreneurs. After graduation with the Gold Medal in 1979, Vera entered the Physics Faculty of MSU. There she met her future husband – Dmitry (Mitya) Khokhlov (son of Academician Rem Khokhlov); they were married in 1982. As a student, Vera joined the group headed by another member of Rem Khokhlov's team – Oleg Rudenko. The group was specializing in nonlinear acoustics, which became the field of Vera's scientific activities throughout her life. Oleg Sapozhnikov was in the same student group as Vera since the first year in MSU, and they joined Oleg Rudenko's group simultaneously. This was a start of their lifelong collaboration that included the formation of the Laboratory for Industrial and Medical Ultrasound (LIMU) at MSU.

Vera received the MSc degree from MSU in 1986 and defended her PhD thesis in 1991, which was devoted to statistical properties of diffracting and discontinuous acoustic waves of high intensity. Since then, she has been a faculty member in the Department of Acoustics, Physics Faculty of MSU. In 2012, Vera defended the Doctor of Science thesis, summarizing her studies on shock wave propagation and effects in inhomogeneous media in application to the problems of medical and atmospheric acoustics.

Vera started collaborations with her colleagues from the USA in 1990s. Her first visit was to Austin with Mark Hamilton and David Blackstock in the Mechanical Engineering Department at the University of Texas at Austin in 1993. On a later trip to the US, she stopped off in Seattle to visit Larry Crum's group: Center for Industrial and Medical Ultrasound (CIMU) in the Applied Physics Laboratory (APL) of the University of Washington (UW). This was the start of a collaboration with CIMU colleagues, which has continued for nearly 25 years. Shortly after Vera joined the APL/UW team, Oleg Sapozhnikov followed her to Seattle and they have become an essential part of the CIMU group. Together they write joint proposals with CIMU staff, perform experiments, supervise graduate students, and often bring their students from Moscow to participate in research projects. Vera is delighted to share the podium with Gold Medal recipient Mark Hamilton, and with Julianna Simon,

recipient of the Lindsay Award, and one of her graduate students at CIMU, for whom she served as co-advisor.

Vera has become recognized as the leading international expert on nonlinear sound beams used in biomedical applications and in atmospheric acoustics. Her strength is her ability to combine understanding of basics physics with expertise on numerical modeling to tackle important applications of acoustic beams containing shocks. Vera is especially recognized by her studies on High Intensity Focused Ultrasound (HIFU) therapy – one of the most important practical applications of nonlinear acoustics. In particular, she is renowned as an inventor of boiling histotripsy, for which she has numerous publications and several patents (most already licensed by commercial firms).

Vera has been an active member of the ASA for many years. She is an ASA Fellow, was elected to the ASA Executive Council, and is currently the head of the ASA Commission on International Research and Education (CIRE). Vera's ASA service is in addition to her international service that includes two terms on the Board of the International Society for Therapeutic Ultrasound and Board member of the Russian Acoustical Society.

Vera and Dmitry have two daughters, Tatiana (born in 1982) and Maria (born in 1988); both of whom also became physicists. Following the paths of their grandparents and parents, they graduated from the Physics Faculty of MSU and defended their PhD theses there. Now Tatiana is a Research Associate Professor at the University of Washington; Maria is a co-founder of the international tech startup company "*Traceair*." Vera relishes her research visits to Seattle as she can also visit her grandchildren, Peter (11), (little) Tanya (8), and Max (3).

The field of therapeutic ultrasound has become a promising major advance in medicine, with over 150 medical indications being studied, over 100 device manufacturers, and hundreds of treatment centers for patients. Vera Khokhlova has played an important role in the evolution of this field and is a much deserving recipient of the Helmholtz-Rayleigh Interdisciplinary Silver Medal of the Acoustical Society of America.

LAWRENCE A. CRUM
OLEG A. SAPOZHNIKOV
MARK F. HAMILTON